Pecuniary Externalities in Labor Markets and Questions in Macroeconomics and International Trade

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Pecuniary Externalities in Labor Markets and Questions in Macroeconomics and International Trade

A dissertation presented by

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Pecuniary Externalities in Labor Markets and Questions in Macroeconomics and International Trade

Abstract

I analyze how various types of structural change including labor market reform, trade liberalization, product market reform and technological progress affect labor markets in closed and open economies. In order to do this, I propose a model of labor markets which captures frictions and pecuniary externalities as well as different types of labor market reform in a very general way. Embedding this framework into general equilibrium models with imperfect competition in product markets and endogenous entry I find that the strength of pecuniary externalities in labor markets is absolutely crucial: In closed economies sufficiently strong pecuniary externalities in labor markets require "supply-side approaches" to labor market reform to raise aggregate employment, while "demand-side approaches" are required otherwise. Product market deregulation and technological progress raise aggregate employment in closed economies only if pecuniary externalities in labor markets are sufficiently strong. Similar results hold in open economies although terms-of-trade-effects may slightly change the picture depending on their strength. Further, distributional conflicts both within and across countries may arise from those effects, but they can be avoided by means of multilateral coordination. Trade liberalization increases aggregate employment only if pecuniary externalities in labor markets are sufficiently strong. Firm heterogeneity amplifies both gains and losses from trade liberalization. Sufficiently strong pecuniary externalities in labor markets also make positive international spill-overs of unilateral structural change more likely. I present my results in terms of threshold-rules for the strength of pecuniary externalities in labor markets and I provide careful analyses of what determines the size of the threshold for each question I address: Generally, the strengths of product-variety-effects and of a mark-ups-channel working through product markets as well as the importance of the extensive margin of production play a central role, but both the importance of network production structures and of international trade matter, too.

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Preface

In this dissertation, I argue that the strength of pecuniary externalities in labor markets matters for many important and arguably highly policy-relevant questions from the fields of macroeconomics and international trade. In particular, I show that the strength of pecuniary externalities in labor markets plays a central role for answering the following questions: Which type of labor market reform is required to permanently raise aggregate employment – should the position of firms or labor be strengthened? What is the effect of labor market reform on real wages? How do technological improvements affect aggregate employment and real wages? What are the effects of product market deregulation on labor markets? How does trade liberalization affect welfare, aggregate employment and real wages? Does reallocation in product markets in response to trade liberalization amplify or alleviate the effects of trade liberalization on welfare and on labor markets? To which extent do labor markets shape reallocation in product markets which occurs if trade is liberalized? How is an economy affected if a trade partner implements a reform in labor markets or product markets? And do such unilateral reforms entail the potential for international conflicts? May international coordination of structural reforms be preferable? What are the effects of technological progress abroad on employment and real wages in an open economy? Which types of structural reforms are likely to induce distributional conflicts within countries and how can such conflicts potentially be avoided?

Throughout this dissertation I will speak of pecuniary externalities in labor markets as capturing channels through which the outcome of the wage-determination process at the firm-level is endogenous to the aggregate state of the labor market and hence dependent on the decisions other agents, who are not directly involved in the wage-determination process at a given firm, make in the labor market: In particular, the level of the real wage paid by a given firm might be higher, the lower unemployment is and hence the easier it is for workers to find a new job and the harder it is for firms to hire. This is the type of pecuniary externality I will focus on and as I will show, it can arise from various concrete institutional aspects of labor markets. Although I will provide explicit micro-foundations for such pecuniary externalities based on well-established theories of labor markets and equilibrium unemployment, a major goal of this dissertation is to work in a framework which goes beyond concrete institutional assumptions about labor markets and which thus allows for more general insights. Therefore, in order to give answers to the questions I ask in this dissertation, I first develop a highly tractable model of labor markets which

captures pecuniary externalities in labor markets as well as labor market frictions in a very general way and which comprises central aspects of several different leading concrete theories of the labor market.

I then embed this labor market framework into general equilibrium models which are suitable for analyzing the aforementioned questions from the fields of macroeconomics and international trade. Except for my approach to modelling labor markets, all general equilibrium models which will be used throughout this dissertation have four additional important common aspects, where these four additional aspects are related to the specification of preferences, technology and product markets: First, I will work under the assumption of imperfect competition in product markets. Second, the extensive margin of production and employment, i.e. the number of firms and products, will be endogenous. Third, there will be (internal) economies of scale at the firm-level. And fourth, the specification of technology and preferences is allowed to be such that there can be product-variety-effects (i.e. changes in welfare and price-indices which are directly due to changes in product variety) and such that mark-ups may change with the toughness of competition. These four elements are standard elements of models of (intra-industry) international trade and as I will argue, there are very good reasons to consider them in the analysis of purely macroeconomic questions in closed economies, too. As I will demonstrate, these elements of product market institutions, preferences and technology give rise to additional linkages between aggregate employment and real wages which are independent from the relationship between real wages and aggregate employment that arises from pecuniary externalities in the labor market. In particular, I will show that the class of general equilibrium models I will work with throughout this dissertation can be represented in terms of two equations or, graphically, in terms of two curves, which connect the level of real wages in an economy to the level of aggregate employment. One of those equations/curves captures the pecuniary externalities and frictions in labor markets, while the other contains those additional forces which work through product markets, preferences and technology. The elasticities of those curves will turn out to play a central role for answering virtually all of the aforementioned questions and as I will show, the strength of pecuniary externalities in labor markets is closely connected to the elasticity of the curve which captures the labor market aspects of the model. But as I will explain, the elasticity of the other curve can be given a very clear interpretation, too. Thus, this class of general equilibrium models, and especially this particular representation of those models in terms of two equations/curves, will turn out to be a very useful and very powerful laboratory for addressing the questions I seek to answer in this dissertation as it delivers not only sharp insights but also allows for a careful inspection of the underlying channels.

I organize my analysis by means of dividing the questions I seek to answer into three categories. Each of the three parts of this dissertation addresses the questions from one of those three categories. In part I, I begin with questions which do not necessarily require a framework with international trade and thus, I examine the effects of labor market reform, of technological progress and of product market deregulation on aggregate employment, real wages and welfare in the context of a closed economy putting the main emphasis on labor market reform. Part I also provides the foundations of my methodological approach which I use throughout all three parts of the dissertation: In part I, I develop my approach to modelling the labor market, I provide explicit micro-foundations for this approach, I discuss why the four aforementioned elements of technology, preferences and product market structure should be taken into account in analyses which put a major emphasis on issues related to unemployment, I show how general equilibrium models of this class can be given the aforementioned representation in terms of two equations in the levels of aggregate employment and the real wage where one equation captures the labor market and the other one additional forces working through product markets, technology and preferences, and I provide a detailed analysis of what shapes these curves and determines their elasticities. In addition, I suggest a classification of institutional changes in the labor market using two categories which I call "supply-side policies" and "demand-side policies" and I discuss which concrete types of institutional change in leading labor market theories fall into which of those two categories and I demonstrate how those two categories of labor market reform can be captured in a very general way in my labor market framework. Roughly speaking, "supply-side policies" aim at strengthening the position of firms in the labor market, while "demand-side policies" aim at strengthening workers' position in labor markets.

Apart from these methodological contributions, the major results I obtain in part I of this dissertation are as follows: Most importantly, I derive a "sufficient statistics"-formula which indicates whether it takes a labor market reform which qualifies as a "supply-side policy" or a labor market reform which qualifies as a "demand-side policy" to raise aggregate employment as well as real wages and welfare. This central formula contains a handful of well-defined elasticities one of which characterizes the strength of the pecuniary externality in the labor market. The formula has the form of a threshold-rule for the strength of the pecuniary externality in the labor market inasmuch as I find that only if that pecuniary externality is sufficiently strong, supply-side approaches to labor market reform are successful, while demand-side approaches are required otherwise. The size of this threshold depends on forces which work through the product market, technology and preferences: I show that the threshold is higher, the more

important the extensive margin of production and employment is, the stronger product-variety-effects are and the more sensitive mark-ups are to the toughness of competition. Hence, forces related to imperfect competition, product differentiation and the extensive margin are found to push towards demand-side policies, while strong pecuniary externalities in labor markets – which essentially imply high wage-flexibility – favor supply-side approaches to labor market reform. Further, a more prominent role for network production structures is found to push towards demand-side policies. Moreover, I demonstrate that the same formula also indicates whether technological progress leads to an expansion or contraction of aggregate employment and what the effects of product market deregulation on aggregate employment and real wages are.

In part II of this dissertation I focus on the effects of trade liberalization between identical countries on aggregate employment, real wages and welfare working within the standard setting of intra-industry trade with heterogeneous firms which I augment by my approach to modelling the labor market. This framework is shown to have a similar representation as the closed-economy framework from part I and can thus be analyzed using a closely related methodological approach. My major findings are as follows: First, I argue that trade liberalization leads to an increase in aggregate employment, real wages and welfare if and only if the pecuniary externality in labor markets is sufficiently strong, while aggregate employment, real wages and welfare decline in response to trade liberalization if that is not the case. I come up with a threshold-rule which has the same structure and contains the same elasticities as in the closed-economy case discussed in part I and which indicates how strong the pecuniary externality in labor markets needs to be and hence how much wage-flexibility is required for trade liberalization to have beneficial effects. Institutional details of labor markets are thus found to be absolutely crucial for the question whether trade liberalization has beneficial or detrimental effects. Turning to the role of firm-heterogeneity and the associated reallocation patterns trade liberalization induces through selection effects in product markets, I make two further major points: First, my approach to modelling the labor market which accounts for the role of pecuniary externalities in labor markets in a very clear and transparent way reveals that labor market forces are not determining reallocation patterns brought about by trade liberalization in product markets and that selection effects which lead to the exit of the least productive producers and thus to increases in average productivity are not working through labor markets. But second, I argue that selection effects in product markets and firm-heterogeneity still matter for the magnitude of the effect of trade liberalization on aggregate employment: In a nutshell, my findings imply that details of labor markets – and in particular the strength of pecuniary externalities in labor

markets – are crucial for shaping the *direction* of welfare- and employment-changes in response to trade liberalization, while firm-heterogeneity and the associated selection effects in product markets do not matter for that, but those selection effects still matter for the *size* of welfare- and employment-changes in response to trade liberalization and generally amplify them, i.e. I find that selection effects related to firm-heterogeneity make welfare-gains bigger and welfare-losses worse and lead to larger changes in aggregate employment in response to trade liberalization.

In part III of this dissertation I then discuss questions from the intersection of macroeconomics and international trade in a framework which – in contrast to the one from part II of this dissertation – allows for asymmetries across countries. On a methodological level, I first show how asymmetries and trade-related interdependences across countries play into my representation of models of the type I use throughout this dissertation in terms of two equations/curves per country and how these equations/curves are related across countries. With this apparatus I then analyze two major sets of questions: On the one hand, I revisit many questions regarding structural change in a single economy from part I of this dissertation and ask whether the results change if international trade is taken into account. On the other hand, I study in great detail international spill-over effects of unilateral structural changes such as labor market reform, product market reform or technological progress. Regarding the first aspect, I find that allowing for international trade and asymmetries across countries only affects my results from part I of this dissertation inasmuch as it entails terms-of-trade-effects which go along with a change in aggregate employment in an economy. However, in many respects the presence of such effects does not change the major insights from the closed-economy case from part I *qualitatively*, but it just has quantitative effects on the relevant threshold-rules. Most importantly, the insights that sufficiently strong pecuniary externalities in labor markets make sure that a country benefits from technological progress or product market deregulation happening in that country and that sufficiently strong pecuniary externalities in labor markets make supply-side policies capable of raising aggregate employment in the labor market in which they are implemented go through. However, in one important dimension terms-of-trade-effects may change the picture from the closed-economy case substantially if they are strong enough, which is the case if economies are sufficiently integrated so that international trade is sufficiently important: While I find in part I that labor market reform in closed economies always moves real wages and aggregate employment in the same direction, I argue that in sufficiently open economies unilateral employment-enhancing supply-side interventions in the labor market may cause a divergent movement in real wages and

aggregate employment *within* the reforming country, which obviously entails the potential for distributional conflicts and which might therefore represent a serious obstacle to unilateral labor market reform from a political economy perspective. Unilateral employment-enhancing demand-side interventions in labor markets and unilateral product market reform do not entail such problems, but, of course, demand-side policies are not always appropriate to raise aggregate employment. Turning to the question how such conflicts *within* countries over unilateral labor market reform can be avoided, I suggest that multilateral labor market reform represents a way out of this dilemma as it avoids terms-of-trade-effects if it is done in a particular way.

Regarding the issue of international spill-overs of unilateral structural change which I take up in part III of this dissertation, I find once again that the strength of pecuniary externalities in the labor markets of the global economy is absolutely central: My analysis implies that if and only if those pecuniary externalities are sufficiently strong, economies benefit from unilateral employment-enhancing labor market reforms which are implemented abroad. Further, I find that sufficiently strong pecuniary externalities in labor markets represent a sufficient condition for a given economy to benefit from technological progress or product market deregulation which happens entirely abroad and which does not directly affect any firms from that given economy. Hence, a major result of part III is that strong pecuniary externalities and hence high wage-flexibility in the labor markets of the global economy make it more likely that countries "import" benefits of structural changes in foreign economies they trade with. But what if those pecuniary externalities are not strong enough so that international spill-overs are negative in the sense that what is beneficial for one economy harms the other one? Especially when it comes to policy-induced structural change such as labor market reform or product market reform, such negative spill-overs entail the potential for another type of distributional conflicts – namely between rather than within countries. But as in the case of distributional conflicts within countries, I argue that international coordination of structural change represents a way to avoid negative spill-over effects and hence potential conflicts at an international level and the key is again that international coordination of structural change represents a way to avoid terms-of-trade-effects.

The three parts this dissertation consists of are written in the form of fully self-contained academic papers. Thus, it is possible to read any of the three parts without knowledge of the other two. However, part I provides theoretical foundations which greatly simplify the understanding of parts II and III. Further, inasmuch as all parts are closely related to each other regarding the underlying modelling framework and the methodology on the one hand and

regarding the questions they address on the other hand, some repetitions across different parts are unavoidable under that formal structure of this dissertation. Because each part has the standard form of an academic paper, I will speak of "this paper", "the present paper", "my related paper" or the like when referring to different parts of this dissertation throughout my exposition. The two respective other parts of the dissertation are also referred to as "part I/II/III of this dissertation" throughout the exposition. In spite of the structure of three self-contained papers, I use Roman numerals in the numbering of sections, equations, propositions, corollaries, definitions, figures and appendices throughout this dissertation to indicate the different parts of the dissertation, while I use Arabic numerals or Roman letters for that within each part. Pages and footnotes, however, are numbered continuously. Definitions of parameters or variables remain valid only within a given part of this dissertation and may change from one part to a different part.

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Part I:

How to Raise Aggregate Employment: Supply-Side or Demand-Side Policies?

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Abstract for Part I

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I propose a very general labor market model which embraces the crucial aspects of several leading concrete theories of labor markets and unemployment and which allows me to model demand-side and supply-side policies in a very general way. I embed this framework into a series of purely real general equilibrium models which all feature imperfect competition in product markets, an endogenous extensive margin of production and firm-internal economies of scale but which in concrete terms cover a wide array of assumptions on technology, preferences and product market structure. I show that a single and quite simple formula involving a handful of well-defined elasticities determines whether supply-side or demand-side policies are required to raise aggregate employment in all of these models. I thus provide a "sufficient statistics"-approach for settling the question which type of labor market reform is required to boost employment. This formula implies that more wage-flexibility in the form of a stronger pecuniary externality in labor markets favors supply-side approaches, while more flexible mark-ups, stronger product-variety-effects, a higher relative importance of the extensive margin of employment and a stronger role for production networks favor demand-side approaches. In addition, I show that the same simple formula can be used to assess the impacts of both product market (de-)regulation and technological improvements on aggregate employment.

I.1 Introduction

It seems that most economists – as well as the general public – agree that permanently increasing the level of aggregate employment is a desirable objective for economic policy. When it comes to the question how to achieve this, however, there seems to be far less consensus. In particular, there seem to be two major competing ways of thinking about and answering the "how"-question, which I will refer to as the "supply-side view" and the "demand-side view", respectively, throughout this paper. The typical argument one hears from a "demand-side economist" goes as follows: "One needs to strengthen workers' position in labor markets so that they will be paid higher real wages given the level of employment and this will boost consumption expenditure and hence aggregate demand. This increase in aggregate demand is strong enough such that firms – even though they need to pay higher wages – will find it profitable to raise employment by expanding their scale of operation or newly entering the market. As a result, employment, real wages and consumption will all be higher." The expression of such a view can be found, for instance, in various places in Henry Ford's autobiography (Ford (1922)): Ford (1922) asks "Then why do we hear so much talk about the "liquidation of labour" and the benefits that will flow to the country from cutting wages – which means only the cutting of buying power and the curtailing of the home market?" (p.116) and claims that "[…] there is no economy in low wages. It is bad financial policy to reduce wages because it also reduces buying power." (p. 163). A "supply-side economist" would typically object: "Such a policy has the exact opposite effect: The aggregate-demand-channel does not dominate, but higher costs would rather induce firms to shut down or cut back on production if they need to pay higher wages given employment, so employment and consumption would go down." Instead a "supply-side economist" would typically make the exact opposite argument: "One needs to strengthen the position of *firms* in labor markets so that real wages *decline* given the level of employment. As a result of lower costs, firms will find it optimal to increase employment by expanding their scale of operation or newly entering the market. This raises employment and real wages might also turn out to be higher in the end as purchasing power increases due to increased competition in product markets which brings down mark-ups and due to increased product variety." Either type of argument might be right: In the end, it all comes down to the question whether the increase (decline) in costs or the increase (decline) in aggregate demand which are both associated with an increase (decline) in real wages for a given level of aggregate employment resulting from strengthening the

position of labor (of firms) in the labor market is the dominant force for shaping the incentives for firms to adjust employment and to enter/exit. But even that question is a very hard one.

In this paper, I contribute to settling this debate and to advance our understanding under which conditions "supply-side approaches" are required and under which conditions it rather takes a "demand-side approach" for permanently increasing aggregate employment. I conduct my analysis under six major premises: First, I work under the assumption of *imperfect competition* in product markets. This is done for realism. Second, I work under the assumption of an *endogenous extensive margin of production and employment* – for two reasons: On the one hand, it makes much methodological sense for any analysis of aggregate employment to endogenize both the extensive and the intensive margin. On the other hand, there is much evidence for significant amounts of entry and exit taking place permanently at both the firm- and the product-level (even at business cycle frequencies), so the extensive margin does seem to matter.[1] In fact, I will argue that the extensive margin plays an important role when it comes to answering the question whether supply-side or demand-side policies are required to increase aggregate employment. Third, I work under the assumption of there being *quasi-fixed costs of production*. The presence of such costs is certainly a realistic assumption and having them also helps with my objective of endogenizing the extensive margin of production/employment. But on the other hand and conceptually even more importantly, such an element induces economies of scale (even under constant marginal costs) and thus generates a role for labor market frictions: As Weitzman (1982) observed, if there were not any firm-internal economies of scale,[2] there could not be unemployment as workers could simply self-employ themselves.[3] Taking his argument one step further, it follows that labor market frictions are meaningless in the absence of internal economies of scale as no worker would ever seek employment in a frictional labor market when self-employment is at least as profitable – which it necessarily is in the absence of internal economies of scale. Further, self-employed atomistic firms which can avoid turning to a frictional labor market would actually have an advantage over larger organizations which –

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[1] For instance, see the studies by Dunne, Roberts and Samuelson (1988) for the firm-level and by Broda and Weinstein (2010) for the product-level.

[2] He speaks of "increasing returns" in his analysis, but he essentially means the same as he works with quasi-fixed costs/entry-costs and constant marginal costs, too.

[3] Note that barriers to entry also generate a role for labor market frictions but all that barriers to entry do in economic terms is precisely inducing economies of scale – at least as soon as one thinks about economically relevant opportunity costs.

by hiring non-owner workers – are subject to search costs, matching frictions, imperfect monitoring of worker effort, firing restrictions, fairness/morale-issues in the workforce, etc. Hence, for models of labor markets (or labor market frictions) to be meaningful, internally consistent and logically coherent, economies of scale which firms can exploit and which give larger organizations an edge over self-employed businesses are a necessity. Fourth, in my specification of technology and preferences I allow for *"love for variety"/"returns to specialization"* and/or *variable mark-ups*. I will argue that these elements, too, may play a crucial role for determining whether supply-side or demand-side policies are required to increase aggregate employment.

The final two of the six premises of my analysis are directly related to the labor market: Fifth, I assume the presence of a *pecuniary externality in the labor market* through which the real wage any given firm ends up paying is endogenous to the aggregate state of the labor market and hence a function of the decisions other firms and workers in the labor market make. This element, too, will turn out to be crucial for determining whether or not supply-side or demand-side policies can do the job of permanently raising aggregate employment. In addition to that, it is obviously highly realistic to assume that the state of the labor market which captures the "outside options" for firms and workers (i.e. how easily and at which costs a firm can find an alternative worker and how easily and at which wage a worker can find alternative employment) affects the outcome of the wage-determination procedure at the firm-level. And the presence of such a pecuniary externality in the labor market can easily be motivated with the help of economic theory, too: As a benchmark, consider first a Walrasian labor market. In that type of labor market, wages are exclusively determined via aggregate market conditions as any firm which would offer less than the market-clearing real wage would immediately see its workers departing and work at other firms while a firm offering more than the market-clearing real wage would see workers queueing up for jobs and would thus be able to reduce its wage. But also when moving to frictional labor markets, such pecuniary externalities can easily be motivated using standard economic theory: For instance, in the "search and matching"-view of the labor market à la Mortensen and Pissarides (1994) a tighter labor market makes search more difficult and hence more costly for firms, which effectively raises workers' bargaining power ex-post (i.e. after a match has been formed) and thus induces higher real wages. Another example is that of "efficiency wages" in the spirit of Shapiro and Stiglitz (1984) where workers dislike putting in effort at work and firms cannot monitor effort perfectly: When unemployment is lower in such an environment, the expected costs of "shirking" decline as workers understand that even if they are fired when being detected, they will find a new job more quickly, so to prevent workers from

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reducing effort, firms find themselves forced to increase real wages to drive up the expected costs of shirking so that workers maintain full effort in spite of lower unemployment. Hence, the state of the labor market affects real wages at the firm-level via an incentive-compatibility constraint in that type of model. Third, "fairness theories" in the tradition of the contributions by Akerlof (1982) and Akerlof and Yellen (1990) typically imply that wages are pinned down by fairness considerations where the wage which is perceived to be fair is lower, the higher unemployment is.

My sixth and final premise is the existence of *labor market frictions* by which I mean any element that implies that – in contrast to the Walrasian benchmark case – wages do not drop to zero as soon as aggregate employment is below full-employment. It goes without saying that the presence of such frictions is of course a necessary ingredient for a meaningful theory of unemployment, too, as any such theory has to provide an explanation for how real wages are pinned down[4] and for how in equilibrium there can be both non-zero wages and unemployed workers. Hence, neither labor market frictions nor firm-internal economies of scale are sufficient for generating unemployment as a meaningful equilibrium outcome,[5] but both are a necessary ingredient for that purpose and thus need to be taken into account.

Based on these theoretical considerations, I propose a very general formulation of labor market frictions and pecuniary externalities in the labor market. In contrast to many other models of frictional labor markets, my formulation does not rely on particular institutional assumptions, but it still nests the most important theories of frictional labor markets as I demonstrate in appendix I.C. Further, my model of the labor market allows me to introduce "supply-side policies" and "demand-side policies" in a very general way: I will model a "supply-side policy" (a "demand-side policy") as any kind of policy-intervention that changes the institutional structure of the labor market such that it implies lower (higher) real wages *given* the level of aggregate employment. This definition is in line with my motivating discussion and it is also consistent with how Blanchard and Giavazzi (2003) think

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[4] This is actually an aspect Weitzman's (1982) model suffers from and which gives it a hard time of really explaining unemployment as I discuss in greater detail in appendix I.B.

[5] If one does not have firm-internal economies of scale, full-employment would obtain via the possibility of self-employment which allows workers to avoid potentially frictional labor markets as discussed above, while if one does not have labor market frictions and is thus in the world of a Walrasian labor market, Walrasian forces would bring about full-employment regardless of firm-internal economies of scale (or one would have zero wages, which is not a meaningful equilibrium outcome).

about regulation/deregulation of labor markets in their well-known study. However, in appendix I.C I connect my general approach back to more concrete theories of the labor market my model arguably nests and thus, I provide explicit examples of what the "supply-side policies" and "demand-side policies" I analyze in abstract terms could represent.

I embed the general model of the labor market I propose into a series of general equilibrium models which cover a broad range of assumptions on technology, preferences and the structure of product markets, but which all satisfy my four other premises as they all exhibit imperfect competition in product markets, endogenous entry, quasi-fixed costs of production and a formulation of preferences and technology that allows for "love for variety"/"returns to specialization" and variable mark-ups. I find that in all these models I study, the same principle governs whether supply-side or demand-side interventions in labor markets are suitable for raising the long-run level of aggregate employment. I summarize this single principle that I find to hold under quite general conditions in terms of a formula that contains several well-defined elasticities all of which could in principle be estimated without imposing the formal structure of any economic model. That elasticity-formula I provide and which holds in all versions of my model takes the form of a simple threshold-rule indicating whether supply-side or demand-side policies are needed to raise aggregate employment – it is always one or the other. Hence, the analysis in this paper essentially provides a "sufficient statistics"-approach to answering its motivating question.

My major findings regarding "comparative statics" are as follows: I argue that *ceteris paribus* a supply-side intervention in the labor market is more likely to increase aggregate employment the stronger the pecuniary externality in the labor market is, the less sensitive mark-ups are to the toughness of competition, the weaker the role for "love for variety" in preferences or for "returns to specialization" in technology is, the less important for movements in aggregate employment the extensive margin of employment is relative to the intensive margin of employment and the less important the role of intermediate goods (and hence of production networks) is in the production structure of the economy, while the exact opposite conclusions apply to the case of demand-side policies. Moreover, I argue that the presence of a pecuniary externality in the labor market is a necessary (but not sufficient) condition for supply-side policies to be capable of raising aggregate employment. As stronger pecuniary externalities in labor markets imply greater sensitivity of real wages to the aggregate state of the labor market, I thus argue that greater "wage-flexibility" in that particular sense makes a stronger case for supply-side approaches

and that such approaches always require some wage-flexibility in that sense to be effective. Conversely, I find an endogenous extensive margin of production along with mark-ups being variable or there being what I will call "product-variety-effects" to be a necessary (but not sufficient) condition for demand-side policies to be capable of raising aggregate employment.[6]

In addition to studying labor market reform, I demonstrate that my "sufficient statistics"-approach is also applicable to at least two other types of macroeconomic questions:[7] First, I show that my elasticity-formula can also offer guidance regarding the effects of product market (de-)regulation on aggregate employment. This question has previously been analyzed in less general models – both regarding product and labor markets – by Blanchard and Giavazzi (2003), Ebell and Haefke (2009) and Felbermayr and Prat (2011) among others, so that I generalize – and partly challenge – their insights. Second, I show that my formula can also be used to understand the effects of technological improvements on aggregate employment and to indicate under which circumstances and thus for which reasons technological improvements might – at least on impact – lead to a decline in aggregate employment as has been documented and discussed by a large literature inspired by the works by Shea (1999), Galí (1999) and Basu, Fernald and Kimball (2006).

My analysis is structured as follows: In section I.2 I develop my basic model. In section I.3 I solve that model. In section I.4 I derive and discuss the major results on labor market reform and explain the underlying mechanisms of the model and build intuition for them. In section I.5 I discuss my other applications to product market deregulation and technological progress. In section I.6 I go through different alternative versions of the model with different assumptions on market structure, technology and preferences and thus establish the robustness and general

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[6] Since I am able to show that my conclusions also hold in the concrete case of a "search and matching"-model à la Mortensen and Pissarides (1994) and a "fairness"-model à la Akerlof and Yellen (1990) if one adjusts those models such that they satisfy my four premises on technology, preferences and product markets, it follows that the comparative statics of those models can – but need not – be very different from what the literature has emphasized to this date: In particular, the literature so far has emphasized that what my model classifies as "supply-side policies" is always the appropriate way to boost employment in the standard "search and matching"-model while "demand-side policies" never work in that context and that in the "fairness"-model à la Akerlof and Yellen (1990) relaxing fairness norms/constraints would boost employment. I challenge these views and argue that they may but need not be true under my four premises on technology, preferences and product markets that most notably involve imperfect competition and firm-internal economies of scale – which according to Weitzman's (1982) famous argument are arguably required to make such models internally consistent.

[7] See part II of this dissertation for an argument that several questions in international trade can also be addressed with that formula.

applicability of my central formula. Section I.7 contains a brief discussion of how my theoretical results may be quantified and connected to some empirical work. Section I.8 contains some concluding remarks.

I.2 Description of the Basic Model

I.2.1 Preliminaries, Labor Supply, the Aggregate Good and Preferences

Time is discrete and periods are indexed by t. For simplicity, I assume the absence of any savings technology, i.e. all produced output of a period needs to be sold and consumed in the same period and perishes at the end of the period otherwise. I study the case of a closed economy[8] populated by a mass $L > 0$ of identical households so that I work with the convenient concept of a representative household. Each single household is endowed with one unit of labor time per period. Consumption is the only aspect that matters for utility by assumption. Hence, aggregate labor supply is exogenously fixed at L. For my purposes, i.e. for the study of aggregate outcomes and mostly positive questions, it would make no difference whether or not one assumes that households provide consumption insurance for each other,[9] but it will be most convenient for the exposition to assume perfect consumption insurance. Hence and given that leisure and effort at work do not show up in utility by assumption so that differences in employment-status do not affect utility, I will simply specify per-period utility at the level of the representative household and assume that it is equal to the quantity of the aggregate (consumption) good – which will be introduced shortly – consumed by the representative household in the respective period. As there is no interdependence across periods in this model, it is not necessary to write down any inter-temporal utility function and one can just work with all agents optimizing on a per-period basis. The representative household owns all firms operating in the economy and receives the profits all those firms make (if there are any) as a lump-sum reimbursement.

The economy is assumed to produce a single good, which is only used for consumption purposes, so that I will refer to it as the "aggregate (consumption) good". That aggregate good, however, comes in a continuum of horizontally

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[8] Cf. parts II and III of this dissertation for extensions of the present setting to open-economy issues.

[9] This is mainly due to two aspects: First, as I restrict attention to homothetic demand systems, the income distribution does not affect (aggregate) demand and since in addition labor supply is assumed to be exogenous, the distribution of income or consumption is irrelevant for aggregate outcomes. Second, it will turn out that under my six premises insider-outsider-conflicts never arise as increases in aggregate employment never happen at the expense of declines in real wages.

differentiated varieties. I use ω to index varieties and for expositional purposes it will be convenient to assume that any given variety uniquely corresponds to one firm and vice versa, so that the same index ω will also be used for firms. It is assumed that there exists an unbounded set of varieties which could potentially be produced in any given period and I will use Ω to denote that set. The purpose behind assuming that set to be unbounded is to avoid imposing exogenous constraints on firm entry. The aggregate consumption good is defined according to the following aggregator which merges elements from the standard CES-case à la Dixit and Stiglitz (1977) with two extensions of that case studied/introduced by Benassy (1996, 1998) and Blanchard and Giavazzi (2003), respectively:

$$(\text{I.1}) \qquad C_t = \left((N_t)^{v - \frac{1}{\sigma(N_t)-1}} \right) \left(\left[\int_{\omega \in \Omega} \left((c_t(\omega))^{\frac{\sigma(N_t)-1}{\sigma(N_t)}} \right) d\omega \right]^{\frac{\sigma(N_t)}{\sigma(N_t)-1}} \right) \quad \forall t$$

C_t denotes the quantity of the aggregate consumption good consumed by the representative household in period t and thus constitutes my measure of utility and welfare in period t. $c_t(\omega)$ denotes the quantity of variety ω consumed by the representative household in period t. $\sigma(N_t)$ denotes the elasticity of substitution across varieties and following the modelling approach by Blanchard and Giavazzi (2003) I make it endogenous to the mass of varieties which are available to consumers in the respective period, which I denote by N_t and which simply corresponds to the mass of varieties that are produced in equilibrium in period t. In particular, it is assumed that $\sigma(N_t)$, which is assumed to be defined over $N_t \in [0, \infty)$, is a differentiable and (weakly) monotonically increasing function, i.e. $\frac{\partial \sigma(N_t)}{\partial N_t} \geq 0 \ \forall N_t \geq 0$. Intuitively, this means that the elasticity of substitution is higher the more varieties consumers can chose from, i.e. a greater mass of varieties makes consumers more sensitive to differences in relative prices, which is intuitive and which captures (in a somewhat crude way) the basic ideas of the Hotelling-model of product differentiation as Blanchard and Giavazzi (2003) observe. Further, to ensure that the model is well-behaved, I need to make the standard assumption of imposing that the elasticity of substitution is greater than unity everywhere, i.e. $\sigma(N_t) > 1 \ \forall N_t \geq 0$. My motivation for following Blanchard and Giavazzi (2003) in making the elasticity of substitution an increasing function of the mass of available varieties is to allow for variable mark-ups in the sense that equilibrium mark-ups change as the mass of available varieties in equilibrium, N_t, and

hence the mass of competitors in product markets changes. Variable mark-ups will turn out to be an element that has important consequences for what the appropriate policy for raising aggregate employment is.

To understand the role the term $(N_t)^{v-\frac{1}{\sigma(N_t)-1}}$ plays in the aggregator specified in (I.1), it is useful to consider the price-index that is associated with that aggregator: Solving the standard per-period utility maximization problem of the representative household who in a given period seeks to distribute a given amount of expenditure over the set of varieties offered for purchase in that respective period (I will denote the set of varieties produced and hence offered for purchase in period t by Υ_t) and who takes nominal prices for varieties as given (I will use $P_t(\omega)$ to denote the nominal price of variety ω in period t), one arrives at the following expression for the "cost of living"-index in period t, i.e. for the nominal costs of obtaining one unit of the aggregate consumption good and hence one unit of utility in period t:[10]

$$(\text{I.2}) \qquad P_t = \left((N_t)^{\frac{1}{\sigma(N_t)-1}-v}\right)\left(\left[\int_{\omega \in \Upsilon_t} \left((P_t(\omega))^{1-\sigma(N_t)}\right) d\omega\right]^{\frac{1}{1-\sigma(N_t)}}\right) \quad \forall t$$

In an equilibrium where all producing firms charge the same price for their respective varieties, i.e. where $P_t(\omega)$ is the same for all varieties in the set Υ_t,[11] one can thus write this "cost of living"-index as $P_t = \left(V(N_t)\right)\left(P_t(\omega)\right)$ where $V(N_t) = (N_t)^{-v}$ is a term I will refer to as the "variety-effect-term" because that formulation of P_t indicates that for a given level of prices at the micro-level, i.e. for a given level of $P_t(\omega)$ for all varieties in the set Υ_t, the welfare-relevant price-index P_t is still responsive to changes in the mass of available varieties: Due to the presence of the variety-effect-term $(N_t)^{-v}$ in the formulation $P_t = \left(V(N_t)\right)\left(P_t(\omega)\right)$, P_t declines as the mass of available varieties increases even if the level of $P_t(\omega)$ for all varieties in the set Υ_t remains unchanged. Thus, this term is capturing an effect according to which more choice makes people better off even for a given distribution/level of prices at the micro-level. In particular, in an equilibrium of this model where all producing firms charge the same price, the elasticity of the price-index P_t with respect to N_t keeping the level of $P_t(\omega)$ fixed for all varieties in the set Υ_t equals the elasticity of the variety-effect-term $V(N_t)$ with respect to N_t which I will henceforth denote by

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[10] This means that a level of nominal expenditure of E_t allows the representative household to consume exactly $\frac{E_t}{P_t}$ units of the aggregate consumption good by making optimal buying choices in product markets in period t.

[11] For the purpose of this paper, I will assume that producing firms are homogeneous and thus make identical decisions. See part II of this dissertation for an extension to the case of heterogeneous firms.

$\eta_V(N_t)$ and which is defined formally as $\eta_V(N_t) = \frac{\partial(V(N_t))}{\partial N_t}\frac{N_t}{V(N_t)}$. In the case of the price-index from (I.2) where the

variety-effect-term is $V(N_t) = (N_t)^{-v}$ one thus obtains $\eta_V(N_t) = -v$, which is independent from N_t. Thus, the

parameter v captures the strength of a pure "product-variety-effect" on the "cost of living"-index, i.e. it captures the

strength of an effect that operates given the level of prices at the micro-level. Put differently, this parameter

summarizes the strength of the "love for variety"-feature in preferences and I will assume $v \geq 0$ throughout my

analysis, i.e. this effect is either positive or absent. Introducing the term $(N_t)^{v-\frac{1}{\sigma(N_t)-1}}$ into the aggregator specified

in (I.1) thus enables me to capture the "product-variety-channel", according to which an increase in product variety

N_t reduces the "cost of living"-index P_t, in an independent way from another channel through which N_t affects P_t

which works through reductions in mark-ups (and which comes from the elasticity of substitution being

endogenous to N_t) and hence reductions in prices at the variety-level, i.e. reductions in the level of $P_t(\omega)$ for the

varieties in the set Υ_t. This part of my modelling strategy follows the work by Benassy (1996, 1998).

The goal in using such a preference specification which makes it possible to disentangle a "product-variety-channel" and a "variable-mark-ups-channel" while remaining as close to standard CES as possible is to build intuition for my results in the most straightforward and transparent way. Further below I will study the case of QMOR-preferences à la Feenstra (2014) where mark-ups are also variable but where the strength of the "love for variety"-feature of preferences and the size of mark-ups are related in a well-defined way and where neither the mark-ups-channel nor the product-variety-channel is described by a constant elasticity. The results I obtain for that alternative – perhaps more rigorous – preference specification are qualitatively the same in all respects. Further, by means of setting $v = \frac{1}{\sigma(N_t)-1}$ and $\sigma(N_t) = \overline{\sigma}$ in (I.1) where $\overline{\sigma} > 1$ is a constant one gets back to the case of standard CES-preferences. Throughout my exposition of the basic version of the model with the aggregator as written in (I.1) I will also comment on the standard CES-case that it nests.[12]

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[12] Following Ethier (1982) one can also give a different interpretation to the mark-ups-channel and to the product-variety-channel which involves technology rather than preferences: Rather than interpreting the aggregator in (I.1) as capturing the tastes by consumers for variety, one could re-interpret this aggregator as being the production function of a perfectly competitive final good sector, which produces the final consumption good using a continuum of horizontally differentiated intermediate goods indexed by ω as inputs. In that case, one might rather want to speak of "returns to specialization" or "external economies of scale" in production/technology rather than of "love for variety" in preferences when interpreting the variety-effect-term. And obviously, also when thinking about the production-side it makes sense to assume that firms are more price-sensitive in their choices of inputs

I.2.2 Production Technology

For simplicity, it is assumed that production requires only a single input which is labor. I assume that in order to produce $y_t(\omega) > 0$ units of output of a given variety $\omega \in \Omega$ in period t, a total amount of $\frac{y_t(\omega)}{A} + f^P$ units of labor is required in period t where $A > 0$ is a technology shifter which will become useful when I turn to the application of my model to the question why technological improvements might lead to a contraction of aggregate employment. $f^P > 0$ is a parameter which captures quasi-fixed costs of production: In any period in which a given firm is producing a strictly positive quantity of its variety, it needs to incur quasi-fixed costs of $f^P > 0$ units of labor.[13] These costs need not be incurred when the firm chooses to remain passive in a given period. The decision whether to produce or to remain passive is made at the very beginning of each period for the respective period and does not affect the production possibilities of the firm in any future period. Note that these f^P units of labor thus introduce firm-internal economies of scale into the model: Even though the aforementioned specification of technology implies constant marginal costs at the firm-level, average costs at the firm-level are decreasing in firm-level output due to those quasi-fixed costs. As argued in the introduction, economies of scale make it meaningful to introduce labor market frictions. Additionally, they of course help with pinning down the extensive margin of production and employment endogenously. Finally, I will use changes in the level of f^P to think about changes in product market regulation in section I.5. In terms of notation, let $l_t(\omega)$ henceforth denote the total quantity of labor firm ω uses in period t, i.e. total employment at firm ω in period t.

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when they can choose from a greater variety of inputs, i.e. the feature $\frac{\partial \sigma(N_t)}{\partial N_t} > 0$ can also easily be motivated from the production-side. For most of my exposition I will, however, refer to the aggregator in (I.1) as describing preferences in order to avoid confusion between such aspects of "returns to specialization" and the elements of the production technology I will introduce next.

[13] In terms of labor, one can think about this fixed input requirement as managerial labor, headquarter services, entrepreneurial input, etc. More broadly and thinking about inputs other than labor, one might want to interpret this element of the model as capturing a patent or some other sort of private technological know-how in terms of intangible technological inputs or – in marketing-related contexts – as a brand or a distribution network or a loyal customer base or – in purely technological respects – as lumpy pieces of machinery and equipment which can handle multiple output-levels and are not available in smaller units. Of course, many other interpretations are possible, too. Even though some of the aforementioned inputs might not entail costs in an accounting sense, in economic terms one would still need to account for the opportunity costs of using them.

I.2.3 Product Markets and Payment System

For product markets I assume monopolistic competition, i.e. firms set prices for their respective varieties which the representative household as the single customer in product markets takes as given when going shopping. $P_t(\omega)$ is thus treated as a choice variable for any firm $\omega \in \Upsilon_t$. In each period, the representative household also takes his/her total labor income and any income from firm profits as given when maximizing utility by means of making buying-decisions in product markets. Firms in turn make their decisions independently from each other with the goal to maximize their own profits, which also applies to decisions about whether or not to be actively producing in any given period.

I will only solve for quantities and for relative prices so that I do not fully specify the monetary side of the model and I do not explicitly model any details of the payment system which operates in the background, either: That payment system is basically assumed to be frictionless including frictionless credit (at zero interest within periods for simplicity), so that on the one hand, firms can use their revenues of a given period to pay their wage-bills of that period and so that on the other hand, the representative household can use both labor income and reimbursed firm profits of a given period for making purchases in product markets in that same period. By assumption, there is no inter-temporal savings technology.

I.2.4 The Labor Market

Regarding the labor market, I seek to keep the analysis on a level that is as general as possible and thus, I will introduce my two major premises about the labor market – the presence of a pecuniary externality in wage-determination that makes real wages at the firm-level endogenous to aggregate labor market conditions and the presence of labor market frictions which imply non-zero real wages even under strictly positive unemployment – in a very general way. In appendix I.C, I go into greater detail and show how my assumptions can explicitly be micro-founded by resorting to well-established models of frictional labor markets.

As labor markets serve the function of pinning down the levels of wages and employment, I basically need to specify how these variables are determined in my approach: I assume that the real wage, i.e. the wage in units of the aggregate consumption good, paid by a given producing firm ω in period t, which I denote by $w_t(\omega)$, is given by:

(I.3)
$$w_t(\omega) = g_{\theta_t}\left(\frac{L_t^E}{L}\right) \quad \forall \omega \in \Upsilon_t \; \forall t$$

L_t^E denotes aggregate employment in period t so that $\frac{L_t^E}{L}$ is the economy-wide employment rate in period t. $g_\theta(\cdot)$ is assumed to be a differentiable function which is defined over the unit interval $[0,1]$ and which is characterized by a set of parameters which I summarize in the vector θ. Further, I restrict attention to such realizations of the parameter vector θ that satisfy $g_\theta\left(\frac{L_t^E}{L}\right) > 0$ for $\frac{L_t^E}{L} \in (0,1]$, $g_\theta(0) \geq 0$ and $\frac{\partial g_\theta\left(\frac{L_t^E}{L}\right)}{\partial \frac{L_t^E}{L}} \geq 0 \; \forall \; \frac{L_t^E}{L} \in [0,1]$ (i.e. it is assumed that the function $g_\theta(\cdot)$ is (weakly) monotonically increasing in its argument). I will use θ_t to denote the period t realization of the vector θ, i.e. I will use θ_t to denote the vector containing the concrete values of the parameters contained in the vector θ which are relevant for period t, so that θ will be used to refer generally to a vector of labor market parameters while θ_t will be used for the vector of the concrete values of these parameters in period t reflecting the fact that I assume that economic policy can change the values of the parameters contained in the vector θ (but not the set of parameters contained in that vector) over time within bounds such that the aforementioned properties of the function $g_\theta\left(\frac{L_t^E}{L}\right)$ remain satisfied. I will refer to the relationship in (I.3) as the "wage-determination-schedule" or "WD-curve".

The relationship in (I.3) has two major properties which correspond exactly to my two major premises about labor markets: First, it introduces a pecuniary externality into the labor market as it specifies that the real wage any given firm pays is a function of the employment rate in the labor market in which all firms hire – by assumption employment contracts or "matches" last for only one period in this simple model. Consequently, the decisions other agents in the labor market make in the respective period (in particular the labor-demand- or hiring-decisions by other firms) affect real wages at any given firm and thus impose an externality on any given firm. In particular, it is assumed that the higher aggregate employment is, the higher will be the real wage a given firm ends up paying. As I discuss in appendix I.C, such a result comes out of several well-established labor market models such as the "search and matching"-model à la Mortensen and Pissarides (1994), the "efficiency wage"-model à la Shapiro and Stiglitz (1984) and the "fairness model" à la Akerlof and Yellen (1990). To reiterate, the fact that the WD-curve is increasing is meant to capture the idea that the "outside options" available to firms and workers in the labor market affect the outcome of wage-determination at the firm-level and inasmuch as the "outside option" of workers is

likely better if aggregate employment is higher (so that labor markets are "tighter") while it is worse for firms in that case, a positive slope for the WD-curve is a natural assumption.

Second, the "WD-curve" in (I.3) clearly introduces an element of labor market frictions into the model as it clearly specifies that in contrast to what the frictionless Walrasian benchmark would imply, wages do not drop to zero even if there is strictly positive unemployment, i.e. even if $\frac{L_t^E}{L} < 1$. Once again, there are many types of frictions that would deliver this and the "search and matching"-model à la Mortensen and Pissarides (1994), the "efficiency wage"-model à la Shapiro and Stiglitz (1984) and the "fairness model" à la Akerlof and Yellen (1990) represent three examples of such frictions.

I will conduct most of my analysis under the assumption of the general $g_\theta(\cdot)$-function specified above, but for some applications, it will be particularly convenient to assume the following concrete functional form that I will refer to as the "isoelastic WD-curve":

$$(I.4) \qquad w_t(\omega) = g_{\theta_t}\left(\frac{L_t^E}{L}\right) = \psi_t\left(\left(\frac{L_t^E}{L}\right)^{\xi_t}\right) \quad \forall \omega \in Y_t \ \forall t$$

ψ and ξ are parameters and in this concrete example the vector θ would contain exactly those two parameters ψ and ξ, while θ_t would contain the period t realizations of those parameters, which I denote by ψ_t and ξ_t, respectively. Further, I impose the restrictions $\psi_t > 0 \ \forall t$ and $\xi_t \geq 0 \ \forall t$ on this concrete functional form for the general $g_\theta(\cdot)$-function. Under that functional form assumption the elasticity parameter ξ captures the strength of the pecuniary externality in the labor market as it captures the sensitivity of real wages with respect to changes in aggregate labor market conditions. The higher the value of that parameter is, the stronger is that sensitivity and hence the pecuniary externality in the labor market. In the limit of $\xi_t \to \infty$, this labor market model becomes essentially arbitrarily close to a Walrasian labor market in which the WD-curve on a graph with aggregate employment on the horizontal axis would be vertical at $L_t^E = L$, i.e. the higher ξ_t is, the more flexible is the labor market in the respective period and that means that a stronger pecuniary externality corresponds to a more flexible labor market. A nice aspect of the functional form assumption in (I.4) is that it can be shown to come out of a static version of a "search and matching"-model à la Mortensen and Pissarides (1994) with a standard choice for the

matching function as soon as one adapts that standard labor market model to make it consistent with my four premises about technology, preferences and product markets. The proof is contained in appendix I.C.

Regarding the determination of employment I make the natural assumption that whenever aggregate labor demand is less than or equal to the exogenous amount of labor supply L, all firms are able to hire as much as they want to at the respective wage they pay (which is implied by the WD-curve), so in a sense, employment is assumed to be "demand-determined" as long as aggregate labor demand in a given period and at the level of the wage all firms pay is not sufficient to fully exhaust labor supply. This assumption seems to be very natural.[14] Further, I assume that rationing rules applying in a case where aggregate labor demand in a given period exceeds L given the level of real wages coming out of the WD-curve for full-employment are such that there does not exist any equilibrium in which agents would be constrained in the sense that there would be at least one firm ω which would want to hire more than it actually could at the given wage coming out of the WD-curve. And under such assumptions on rationing rules there does not exist any equilibrium with excess demand in the labor market.[15] This greatly simplifies the analysis as it implies that everyone's labor demand at the going wage will be satisfied in equilibrium, which, however, still allows for the possibility of full-employment.

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[14] Note that the case in which there are "search and matching"-frictions such that not all vacancies a firm posts would be filled still falls into this category of employment being "demand-determined": In that case, an atomistic firm takes not only the wage but also expected search costs in the labor market as given and then simply posts as many vacancies as necessary in order to obtain (perhaps in expectation if labor is not infinitely divisible) its desired level of hiring given non-labor costs of employment and hiring, given what it knows about how many vacancies are required (in expectation) to hire one unit of labor and given the anticipated outcome of the bargaining-process for wage-determination. Hence, with "search and matching"-frictions, too, firms (at least in expectation) are typically able to hire as much as they desire given wages and aggregate labor market conditions so that one may still speak of employment as being "demand-determined".

[15] A simple example of such a rationing rule which would be sufficient for my purposes is the case in which firms need to post vacancies to hire workers but where vacancy-posting is costless and in which there is a frictionless matching mechanism which proceeds such that in the case of excess demand in labor markets (i.e. whenever the total mass of vacancies posted exceeds L) each vacancy is filled with equal probability: In that case, firms would have an incentive to deviate and to increase their number of vacancies if they found themselves (in expectation) not able to hire as much as they would want to at the going wage and given what all others do, so this particular rationing rule clearly implies that in equilibrium, all producing firms must necessarily be able to hire as much as they desire given aggregate outcomes and the WD-curve. And even without costs of posting vacancies and without matching frictions, non-zero wages even under less than full-employment are easy to motivate: Firms will enjoy bargaining power as long as there is unemployment and that bargaining power is typically increasing in the unemployment rate as captured in my formulation of the WD-curve, while workers might still enjoy bargaining power due to potential discretion over the completion of their job, parts of which might be unverifiable or unobservable so that no worker could commit not to engage in detrimental actions, which then also implies that firms cannot benefit from replacing one worker by another one as any other worker would have the same incentives to threaten bad actions in order to achieve better terms once being hired.

I.2.5 Demand-Side Policies and Supply-Side Policies

To enable the model to speak to the question whether "demand-side policies" or "supply-side policies" are required to increase aggregate employment, one obviously needs to define such policies in formal terms within the framework I have developed. The following formal definition is consistent with the general idea of "supply-side policies" and "demand-side policies" I have outlined in the introduction:

DEFINITION I.1 (*Demand-Side Policies and Supply-Side Policies*): Consider any two consecutive periods t and $t + 1$. A change in the values of the parameters contained in the vector θ from period t to $t + 1$ is called a *demand-side policy* if and only if $g_{\theta_{t+1}}\left(\frac{L_t^E}{L}\right) > g_{\theta_t}\left(\frac{L_t^E}{L}\right) \; \forall \, L_t^E \in (0, L]$, i.e. if and only if via the WD-curve θ_{t+1} implies a strictly higher real wage than θ_t for any given strictly positive rate of aggregate employment. A change in the values of the parameters contained in θ from period t to $t + 1$ is called a *supply-side policy* if and only if $g_{\theta_{t+1}}\left(\frac{L_t^E}{L}\right) < g_{\theta_t}\left(\frac{L_t^E}{L}\right) \; \forall \, L_t^E \in (0, L]$, i.e. if and only if via the WD-curve θ_{t+1} implies a strictly lower real wage than θ_t for any given strictly positive rate of aggregate employment.

I introduce demand-side and supply-side policies as changes in the concrete values of the parameters contained in the vector θ characterizing the functional form of $g_\theta(\cdot)$ and hence the WD-curve since that function is assumed to capture the institutional details of the labor market as explained above. In terms of the concrete functional form assumption for $g_\theta(\cdot)$ from (I.4) which I will use for some results further below and where the vector θ includes the parameters ψ and ξ, a demand-side (supply-side) policy consists in an *increase* (*decrease*) in ψ_t and/or in a *decrease* (*increase*) in ξ_t from one period to the next. In appendix I.C I provide micro-founded concrete examples for supply-side and demand-side policies in the sense of DEFINITION I.1 within concrete labor market models such as the "search and matching"-model à la Mortensen and Pissarides (1994). Figure I.1 illustrates the effects of demand-side and supply-side policies on the WD-curve[16] where the shift/rotation of the curve brought about by a demand-side policy is labeled with a "D" while the shift/rotation of the curve brought about by a supply-side policy is labeled with an "S".

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[16] Throughout this dissertation I will visualize the WD-curve in diagrams with the level of aggregate employment rather than the employment rate on the horizontal axis. The reasons for this will become clear below.
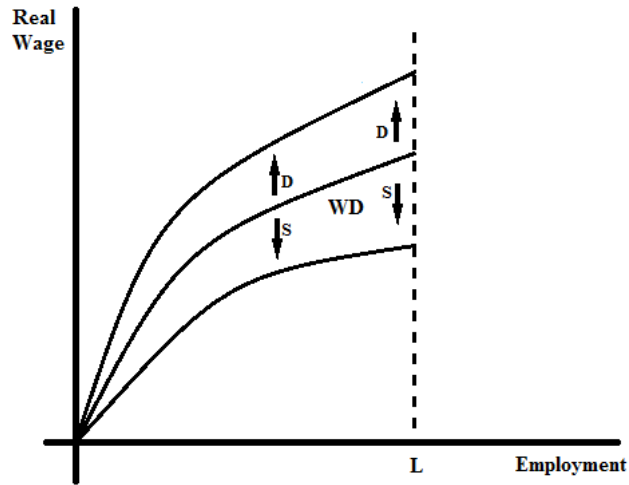
Figure I.1: The effects of demand-side and supply-side policies on the WD-curve.

I.2.6 Timing Assumptions

To complete the description of the model, let me outline the timing assumptions I make regarding the order of events and decisions both within periods and across periods: First, I assume that any changes in labor market institutions occur only *between* periods. This means that θ_t, which is relevant for the labor market outcome of period t, is determined between periods $t-1$ and t and hence known to all agents at the beginning of period t and then it remains unchanged for the remainder of the period. The timing of all actions within any given period is assumed to follow a natural order: First, any firm from the set Ω decides irrevocably whether or not it wants to be active in the respective period. Then the labor market takes place and leads to an outcome according to what has been described in section I.2.4 given θ_t. After that production follows. Product markets open once production is completed, so that consumers go shopping and consume during the last part of a period.

It is important to emphasize again that these timing assumptions imply that all firms – regardless whether or not they have been actively producing in the previous period – decide whether or not they want to be actively producing in period t at the beginning of period t after observing the new economic fundamentals for period t which are given by the period t labor market institutions as summarized in θ_t. Hence, all firms in the economy

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which could potentially produce in period t, which are all firms in the unbounded set Ω, are effectively engaged in a big economy-wide simultaneous one-shot game at the beginning of any given period t and in this game, it is determined which firms produce and which firms remain inactive in the respective period. As a result, the mass of producing firms will adjust instantaneously at the beginning of period t to new economic fundamentals realized between periods $t-1$ and t such that all firms earn exactly zero profits in any given period. These assumptions on dynamics rule out out-of-equilibrium dynamics with non-zero profits as the mass of firms essentially behaves like a "jump-variable" rather than like a (potentially slowly moving) state-variable.

These timing assumptions regarding entry and exit are motivated by and consistent with several empirical results in the literature on entry and exit at the firm-level or at the product-level: Using the U.S. Annual Survey of Manufactures from the U.S. Census Bureau for the years 1972 to 1997, Lee and Mukoyama (2015) find average annual rates of entry and exit at the plant-level in U.S. manufacturing of around 5 to 6% and document that entry rates are strongly procyclical while exit rates are somewhat acyclical. This indicates that entry and exit is an important and sizable phenomenon at the plant-level and that firms are re-optimizing regarding their entry- and exit-decisions at high frequencies, so that usually a high number of firms/plants enter and exit simultaneously within a given period. In particular, this suggests that allowing for big instantaneous movements ("jumps") in the mass of producing firms seems to be a more realistic assumption than making the mass of producers a (potentially slowly moving) state-variable. Moving to the product-level – which might even be the more appropriate level to look at both for the product-variety-channel and for the variable-mark-ups-channel I will emphasize in this paper – and to an even higher frequency, this picture becomes even stronger: Broda and Weinstein (2010) using ACNielsen Homescan data for the U.S. at a quarterly frequency from 1999 to 2003 document that – weighted by shares of total expenditure – entry at the product-level is procyclical while exit is countercyclical where these weighted rates of entry (exit) in terms of four-quarter growth rates fluctuate between 13 and 17 (between 6 and 8) percent over their sample period that includes the 2001 recession.[17] This lends further support to the view that firms revise their entry- and exit-decisions at high frequencies and simultaneously and that the mass of actively producing firms and hence the mass of products/varieties – which is more directly related to the product-variety- and mark-ups-channels I will emphasize – can move a lot within short time-horizons. In fact, Bergin and Corsetti (2008) using a standard

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[17] Cf. figure 1 in Broda and Weinstein (2010).

monetary VAR approach and U.S. data at the monthly frequency from 1959 to 1994 document that net business formation responds significantly to various measures of monetary policy innovations within a few months. Although they do not find the instantaneous response of entry to be significant, this finding seems to support the view that the mass of producing firms represents a variable that responds quickly and sizably to changes in economic fundamentals – even monetary ones.

These observations motivate my timing assumptions according to which at the beginning of each period all firms – previously producing and previously inactive ones – are engaged in a big simultaneous game when making entry-decisions and hence, firms respond at the beginning of period t to changes in economic fundamentals between periods $t-1$ and t such that the mass of producing firms and the mass of produced varieties (which are identical by construction in my model) adjust immediately – and, if necessary, with a sizable jump – to changes in labor market fundamentals such that all firms earn zero profits in each period. And since the change in economic fundamentals on which I put the major emphasis in the present work represents a change in labor market institutions which is very unlikely to be completely unexpected in practice as lengthy legislation-processes usually precede the implementation of such reforms, the assumption that firms adjust quickly to such changes in labor market institutions when deciding on entry and exit seems to make a lot of sense.[18] In section I.5 in the present paper as well as in related open-economy work (cf. part II of this dissertation), however, I relax these timing assumptions and discuss to which extent my conclusions are robust to alternative sets of assumptions where entry/exit might take time or the mass of (potential) producers is assumed to be a slowly moving state-variable so that non-zero profits and out-of-equilibrium dynamics are possible.[19]

The assumption that firm-level employment and real wages are determined period by period, too, reflects the fact that I assume that labor contracts last for only one period. This assumption is motivated by the observation made by Stole and Zwiebel (1996a) according to which "Labor contracts are frequently incomplete, with only a limited

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[18] Furthermore, several recent papers emphasizing the extensive margin of production in macroeconomic contexts have operated under similar timing assumptions whereby firms decide on entry/exit on a period-by-period basis and thus earn zero profits (at least in expectation) in each period. Examples include the study of the relationship between monetary policy and the extensive margin of production by Bergin and Corsetti (2008) or the study of the role of multi-product firms for amplifying business cycles by Minniti and Turino (2013).

[19] If one considers the limit of $f^X \to \infty$ in the model studied in part II of this dissertation, one is back in the case of a closed economy, which makes the results in section II.6 from that part comparable to the present study of a closed economy.

capability to bind either party to the relationship. Employees are generally free to quit at will, and firms typically can dismiss part of their labor force subject to only limited penalties or costs." (p. 195).

I.3 Solving the Model

Since there is no interdependence across periods in this model regarding decision-making by economic agents, it is sufficient to solve for equilibrium in a given period, which I will refer to as "per-period equilibrium": A dynamic equilibrium path simply consists of a sequence of these per-period equilibria. In this section I therefore solve for the per-period equilibria. The equilibrium concept I will use for per-period equilibrium is that of subgame-perfect Nash equilibrium. This means that I will take the timing within any given period as outlined above explicitly into account when solving the model: I will solve the model by means of first characterizing optimal decision-making by agents given the choices made by all others (and given the resulting aggregate outcomes in the period) where following the general idea of backwards-induction I start with the last decision to be made within the given period and then move successively through the various subgames a period consists of towards the front of that period. In a second major step, I then derive the aggregate outcomes implied by the results for optimal decision-making under given choices made by all other agents (i.e. under given aggregate outcomes) and this will result in a characterization of the per-period Nash equilibria as "fixed points" of the model. I will, however, only be interested in per-period Nash equilibria in which a strictly positive mass of varieties is produced in strictly positive quantities and sold at strictly positive prices. Whenever I will speak of "any Nash equilibrium of the model" or the like in the following, I only mean equilibria satisfying this requirement. And whenever there is only a single Nash equilibrium which falls into that category, I will refer to it as "unique". In addition, the reader should keep in mind that throughout my analysis it is assumed that the rationing rule applying in cases with excess demand in labor markets is such that no Nash equilibria exist in such cases.

Buying-decisions in product markets represent the last type of decision agents need to make in a given period: The representative household seeks to choose quantities of all the varieties offered for purchase in that period in a way to obtain the largest possible amount of the aggregate consumption good given the aggregator in (I.1), given his/her total income and given the prices for all the varieties which are offered in the period. Solving that optimization problem results in the following residual demand functions firms face in product markets in a given period t:

(I.5) $$d_t(\omega) = \left(\left(P_t(\omega) \right)^{-\sigma(N_t)} \right) \left((P_t)^{\sigma(N_t)} \right) C_t \left((N_t)^{(\sigma(N_t)-1)v-1} \right) \quad \forall \omega \in \Omega \; \forall t$$

P_t is the welfare-relevant price-index from (I.2) that is obtained in the process of solving that optimization problem.[20] $d_t(\omega)$ denotes total demand for variety ω by the representative household in period t.

Firms take their respective residual demand functions from (I.5) as given when making pricing- and selling-decisions in product markets and any firm finds it optimal to choose a combination of price and quantity sold located exactly on (rather than below) its residual demand curve for obvious reasons. Therefore, the representative household will be able to buy exactly as much of any variety as he/she would like to at the going prices and as it is evidently optimal for the representative household to consume everything he/she buys, the following must be true in equilibrium:

(I.6) $$d_t(\omega) = c_t(\omega) \quad \forall \omega \in \Upsilon_t \; \forall t$$

Further, by means of using (I.5) and (I.6) and that firms in equilibrium always choose a combination of price and quantity sold located on their respective residual demand curves one obtains the following expression for period t firm-level revenues in equilibrium as a function of quantity sold in period t (for which I will henceforth use $d_t(\omega)$ since it has been shown that the representative household in equilibrium will buy exactly as much as needed to exactly satisfy his/her demand for any given variety):

(I.7) $$R_t\big(d_t(\omega) \big) = P_t \left((C_t)^{\frac{1}{\sigma(N_t)}} \right) \left((N_t)^{\frac{(\sigma(N_t)-1)v-1}{\sigma(N_t)}} \right) \left(\big(d_t(\omega) \big)^{\frac{\sigma(N_t)-1}{\sigma(N_t)}} \right) \quad \forall \omega \in \Upsilon_t \; \forall t$$

It is straightforward to verify that as soon as a strictly positive mass of varieties is produced and sold at strictly positive prices, marginal revenue is necessarily strictly positive for any strictly positive level of $d_t(\omega)$, which implies that any firm which has completed the production stage and has produced $y_t(\omega)$ units of output of its

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[20] Since the aggregator in (I.1) is homothetic, it not only follows that P_t captures the monetary per-unit costs of obtaining one unit of the aggregate consumption good in period t in the cost-minimizing way but also that the total costs of obtaining $x > 0$ units of the aggregate consumption good in the cost-minimizing way are xP_t, so that in equilibrium $P_t C_t$ is total expenditure of the representative household in period t, where the actual quantity of the aggregate good consumed, C_t, can be used inasmuch as in equilibrium the representative household is always able to buy exactly as much as he/she desires of any given (offered) variety at the given prices and given his/her total income. The reasons for that will be explained in the main part of the text. Restricting attention to equilibria in which a strictly positive mass of varieties is sold at strictly positive prices thus translates into the requirement that $P_t > 0$ and $C_t > 0$ must be true in equilibrium.

variety in period t will find it optimal to sell all of its output at the end of the period and to choose the price on the

residual demand curve consistent with that quantity. Hence, the following must be true in equilibrium:

(I.8) $$d_t(\omega) = y_t(\omega) \quad \forall \omega \in Y_t \; \forall t$$

The WD-curve specified in (I.3) implies that in any equilibrium in which a strictly positive mass of varieties is

produced in strictly positive quantities, aggregate employment and hence real wages are strictly positive, so it must

be optimal for any firm to hire the lowest possible quantity of labor which allows the firm to produce its desired

quantity of output. Making use of that insight and of the specification of the production technology and of the

expression for firm-level revenues in equilibrium from (I.7) as well as of (I.8), one obtains the following expression

for the equilibrium profits of any producing firm as a function of its output-level $y_t(\omega)$:[21]

(I.9) $\Pi_t\big(y_t(\omega)\big) =$

$$P_t\left[\left((C_t)^{\frac{1}{\sigma(N_t)}}\right)\left((N_t)^{\frac{(\sigma(N_t)-1)v-1}{\sigma(N_t)}}\right)\left((y_t(\omega))^{\frac{\sigma(N_t)-1}{\sigma(N_t)}}\right) - \frac{1}{A}\big(w_t(\omega)\big)\big(y_t(\omega)\big) - \big(w_t(\omega)\big)f^P\right] \quad \forall \omega \in Y_t \; \forall t$$

The expression for profits from (I.9) represents the objective function of any given firm when deciding how much

output to produce and hence how many workers to hire conditional on having decided on a strictly positive level of

output. A firm takes all variables at the aggregate level appearing in its objective function as given as it is of

measure zero, but a firm also takes the real wage it pays as given. This follows directly from the specification of the

WD-curve in (I.3) according to which the real wage at the firm-level is fully determined by aggregate variables and

parameters of the model. Hence, the objective function in (I.9) contains a single choice variable for the firm which

is $y_t(\omega)$ and it is strictly concave in $y_t(\omega)$ under my assumption $\sigma(N_t) > 1 \; \forall \, N_t > 0$. Thus, the optimal output-

level for any producing firm ω can be found by solving the first-order condition associated with maximizing the

expression in (I.9) over $y_t(\omega)$. This yields:

(I.10) $$y_t(\omega) = \left(\left(\frac{\sigma(N_t)-1}{\sigma(N_t)}\right)^{\sigma(N_t)}\right)\left((A)^{\sigma(N_t)}\right)\left((w_t(\omega))^{-\sigma(N_t)}\right)\left((N_t)^{(\sigma(N_t)-1)v-1}\right)C_t \quad \forall \omega \in Y_t \; \forall t$$

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[21] Multiplying the real wage $w_t(\omega)$ by P_t transforms it from units of the aggregate consumption good into monetary units and hence, the product of the two yields the nominal wage firm ω pays in period t which is relevant for firm-level profits in nominal terms.

In equilibrium, each producing firm must be able to hire enough labor to attain this optimal output-level, which simply follows from the fact that it is assumed that rationing rules applying in labor markets with excess demand are such that there cannot be any equilibrium in such a situation. Hence, the expression from (I.10) represents period t firm-level output in any equilibrium of the model. Equilibrium firm-level employment in period t, $l_t(\omega)$, is then simply equal to $\frac{y_t(\omega)}{A} + f^P$ if one uses the expression from (I.10) for $y_t(\omega)$. Note that in a *ceteris paribus* sense, output and employment at the firm-level are thus decreasing in the real wage. Combining equilibrium firm-level output from (I.10) with (I.8) and with the residual demand curve from (I.5), one finds the following solution for equilibrium prices:

(I.11) $$P_t(\omega) = \frac{\sigma(N_t)}{\sigma(N_t)-1} \frac{1}{A} P_t\big(w_t(\omega)\big) \quad \forall \omega \in \Upsilon_t \ \forall t$$

Hence, the mark-up over marginal costs (in nominal terms) firms charge in equilibrium, which I will henceforth denote by $\mu(N_t)$, is given by $\mu(N_t) = \frac{\sigma(N_t)}{\sigma(N_t)-1}$. Note that if $\frac{\partial \sigma(N_t)}{\partial N_t} > 0 \ \forall \ N_t > 0$, $\mu(N_t)$ declines as N_t increases, i.e. the level of mark-ups is inversely related to the toughness of competition as captured by the mass of competitors in product markets. In this sense mark-ups can be said to be "variable". A decline in $\mu(N_t)$ in response to an increase in N_t is also referred to as a "pro-competitive effect" in the literature.

Taking the expression for equilibrium firm-level output from (I.10) back to the expression for equilibrium firm-level profits in (I.9) yields a new expression for profits any producing firm earns in equilibrium which only depends on variables firms take as given:

(I.12) $$\Pi_t(\omega) = P_t\big(w_t(\omega)\big) \left[\frac{1}{\sigma(N_t)} \left(\left(\frac{\sigma(N_t)-1}{\sigma(N_t)}\right)^{\sigma(N_t)-1} \right) \left(A\right)^{\sigma(N_t)-1} \left(N_t\right)^{(\sigma(N_t)-1)v-1} \left(\big(w_t(\omega)\big)^{-\sigma(N_t)}\right) C_t - f^P \right]$$

$$\forall \omega \in \Upsilon_t \ \forall t$$

It is easy to verify that firm-level profits are strictly declining in the real wage and strictly increasing in aggregate consumption in a *ceteris paribus* sense. At the stage where entry-decisions are made, firms anticipate that they will earn the level of profits stated in (I.12) if being active in period t and thus incurring for that period the quasi-fixed costs captured by the parameter f^P. The entry-decisions all firms make in this model economy on a per-period basis at the beginning of each single period are only optimal given what everyone else does if these profits are

exactly zero.[22] Zero profits thus represent the outcome of the simultaneous entry-game played by all economic agents at the beginning of each period. Imposing zero profits on the expression for firm-level profits from (I.12) and noting that the WD-curve from (I.3) implies that in equilibrium all firms pay the same real wage in period t – which I will henceforth denote by w_t where $w_t(\omega) = w_t \ \forall \omega \in Y_t \ \forall t$ – then implies that the following needs to be true in equilibrium:

(I.13) $$C_t = \left(\left(\frac{\sigma(N_t)}{\sigma(N_t)-1}\right)^{\sigma(N_t)-1}\right)\left(\sigma(N_t)\right)f^P\left((A)^{1-\sigma(N_t)}\right)\left((N_t)^{1-(\sigma(N_t)-1)v}\right)\left((w_t)^{\sigma(N_t)}\right) \ \forall t$$

This condition thus implicitly defines optimal entry-decisions. Optimizing behavior by all agents in the model given the decisions made by all other agents and given the resulting aggregate outcomes has now been fully characterized, so that it is time to aggregate and derive the "fixed points", i.e. the per-period Nash equilibria: Combining the expression for firm-level output in equilibrium from (I.10) with (I.6) and with (I.8) to get an expression for equilibrium consumption of each variety and then plugging that into the aggregator from (I.1) and using that producing firms make identical decisions in equilibrium yields:[23]

(I.14) $$w_t = \frac{1}{\mu(N_t)} A \frac{1}{V(N_t)} \ \forall t$$

This equation is very important for this model: It demonstrates that the equilibrium real wage in any given period is determined via three forces: First, it is inversely related to the level of the mark-up $\mu(N_t) = \frac{\sigma(N_t)}{\sigma(N_t)-1}$ all firms charge in equilibrium. This is very intuitive: In a model where labor is the only factor of production, prices at the variety-level are essentially mark-ups over the nominal wage and to the extent that the welfare-relevant price-index is positively related to the level of the price all firms charge at the variety-level, i.e. positively related to the level of $P_t(\omega)$ chosen by all producing firms, the real wage – consisting of the nominal wage divided by the price-index – must be inversely related to the level of the mark-up all firms pick in equilibrium. Declines in mark-ups thus translate into higher real wages. Second, the level of technology as captured by A plays positively into real wages,

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[22] To see this, note that since each firm is of negligible size, it could always replicate what another firm does without changing aggregate outcomes, so if profits were positive, additional firms would have an incentive to change their decisions given what all others do and produce rather than remain inactive, while the opposite would be true if profits were strictly negative.

[23] The same equilibrium condition obtains if one takes the prices firms charge in equilibrium as stated in (I.11) to the expression for the price-index P_t from (I.2).

which is intuitive, too, as it is crucial for the marginal product of labor. Third, the variety-effect-term $V(N_t) = (N_t)^{-v}$ defined above in the context of my discussion of the product-variety-effect on the "cost of living"-index shows up in (I.14): This means that given mark-ups and technology (i.e. for given levels of the nominal wage and for given nominal prices at the variety-level), real wages may still increase as more choice becomes available to consumers. Consequently, equation (I.14) indicates that given technology and preferences, there are only two channels through which real wages can change and both of them are connected to the extensive margin of production: Increases (declines) in N_t lead to higher (lower) real wages by reducing (raising) mark-ups and by decreasing (increasing) the "cost of living"-index through the product-variety-effect. As those channels are essentially the same as the ones through which P_t is connected to N_t, I will use the same terminology as introduced above in the context of my discussion of the expression for P_t in (I.2) and refer to these two channels that connect real wages to the extensive margin as the "variable-mark-ups-channel" and the "product-variety-channel", respectively.

To complete the aggregation steps required for deriving per-period Nash equilibria, one finally derives an expression for aggregate employment in equilibrium: For that purpose one uses the expression for equilibrium firm-level output in (I.10) to derive an expression for firm-level employment in equilibrium using $l_t(\omega) = \frac{y_t(\omega)}{A} + f^P \ \forall \omega \in \Upsilon_t \ \forall t$ and when aggregating, one then makes use of the fact that producing firms make identical decisions and one also brings in the expression for C_t from (I.13). This yields:

$$(I.15) \qquad\qquad L_t^E = \big(\sigma(N_t)\big)N_t f^P \quad \forall t$$

Since $\frac{\partial(\sigma(N_t))}{\partial N_t} \geq 0 \ \forall \ N_t > 0$, it follows that aggregate employment in period t and the mass of producing firms, N_t, are positively related, which is intuitive as this basically means that any change in aggregate employment in this model always involves a change along its extensive margin in the same direction. With the help of (I.14) and (I.15) one can now also re-write (I.13) as follows:

$$(I.16) \qquad\qquad C_t = w_t L_t^E \quad \forall t$$

This says that aggregate consumption (expenditure) equals aggregate labor income in real terms and this is just a natural implication of zero profits in equilibrium (which is what equation (I.13) asserts). One can now establish the following proposition:

PROPOSITION I.1 (*EE-Curve*): The equilibrium relationships in (I.14) and (I.15) implicitly define an equilibrium relationship between the period t real wage, w_t, and period t aggregate employment, L_t^E, over $L_t^E \in (0, L]$ which I will call the *EE-curve* and which I will denote by

(I.17) $$w_t = h(L_t^E) \quad \forall t$$

where $h(\cdot)$ is a differentiable and non-decreasing function defined over $(0, L]$ so that $\frac{\partial h(L_t^E)}{\partial L_t^E} \geq 0 \ \forall \ L_t^E \in (0, L]$ and where that function takes on only non-negative values, i.e. where $h(L_t^E) \geq 0 \ \forall \ L_t^E \in (0, L]$.

Proof: In appendix I.A. ∎

Note that the EE-curve combines all optimality conditions, equilibrium relationships and accounting identities of the model except for the WD-curve: The derivation of the EE-curve is based on profit-maximizing decisions by firms regarding prices, output and labor demand, on utility maximization by customers in product markets, on zero profits ("free entry") and on the implied aggregate relationships. Hence, the EE-curve is essentially a "melting pot" of all equilibrium/optimality/accounting-conditions of the model except for the one that describes the pecuniary externality and the frictions involved in labor markets and in wage-determination. Thus, the EE-curve contains "everything else" in the model other than those two elements of the labor market. It is important to note that just like the WD-curve, the EE-curve is only defined for employment-levels $L_t^E \leq L$. The reason for this is that in the derivation of this curve one makes use of the fact that all firms are able to hire as much labor as they would like to given the real wage they pay and this can obviously only be true as long as $L_t^E \leq L$ since there is not enough labor available to go to higher levels of aggregate employment. Any equilibrium of the model must be located on the EE-curve as it has to satisfy all the conditions behind that curve as well as the fact that employment is demand-

determined (i.e. there not being any rationing), which – in addition to the fact that firms take the level of real wages as given – is the only assumption about labor markets behind the EE-curve.[24]

At this stage, one is thus left with a representation of the model in terms of four equilibrium conditions in four (aggregate) variables of interest for any given period t: Those variables are the equilibrium real wage w_t, aggregate consumption C_t, the mass of producing firms N_t and aggregate employment L_t^E and the associated four equilibrium conditions consist of the WD-curve in (I.3) (which needs to hold for w_t, too, as $w_t(\omega) = w_t \; \forall \omega \in Y_t \; \forall t$), of the EE-curve $w_t = h(L_t^E)$ (which is implicitly defined by (I.14) and (I.15)), of the expression for C_t from (I.16) and finally of (I.15) which implicitly defines N_t given L_t^E. The following is a summary of this system:

(I.18)
$$w_t = g_{\theta_t}\left(\frac{L_t^E}{L}\right)$$

(I.19)
$$w_t = h(L_t^E)$$

(I.20)
$$C_t = w_t L_t^E$$

(I.21)
$$L_t^E = \left(\sigma(N_t)\right)N_t f^P$$

Noting that this system has a recursive structure whereby one can solve for w_t and L_t^E from the first two equations and then recover the values of C_t and N_t from the last two equations, one thus arrives immediately at the following proposition:

PROPOSITION I.2 (*Existence of Per-Period Nash Equilibria*): Any set of values for w_t and L_t^E with $0 < L_t^E \leq L$ which satisfies the WD-curve implied by (I.3) and by $w_t(\omega) = w_t \; \forall \omega \in Y_t \; \forall t$ and which also satisfies the EE-curve in (I.17) (which is implicitly defined by (I.14) and (I.15)) represents a per-period Nash equilibrium of period t of the model. The model does not exhibit any other per-period Nash equilibria.

Proof: This follows directly from the preceding arguments and my requirement that a strictly positive mass of varieties is produced in strictly positive quantities in equilibrium. ∎

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[24] As long as it is assumed that rationing rules applying in labor markets with excess demand are such that no equilibrium with excess demand in the labor market exists, any equilibrium must be located on the EE-curve. Otherwise, at least in principle, additional full-employment equilibria with rationing off the EE-curve (which still need to be on the WD-curve, though) could exist.

This means that the per-period Nash equilibria of the model of any given period t are given by any intersections of the WD-curve of period t with the EE-curve for which $0 < L_t^E \leq L$ is true – note that the EE-curve will be the same in every period as long as the only parameters whose values change over time are the ones contained in θ as those do not show up in (I.14) and (I.15) which jointly define the EE-curve. This completes the solution of the model as conditions for the existence of equilibria within periods have been established and as a system of equations which allows solving for these equilibria has been derived. Dynamic equilibria simply consist of sequences of per-period equilibria. Thus, the model can now be applied to studying the questions motivating this paper. Before turning to that, however, let me present an additional formal result for existence and uniqueness of per-period Nash equilibrium in a particular and very useful special case of my model. The following obtains as a corollary of PROPOSITION I.2:

COROLLARY I.1 (*Existence and Uniqueness of Per-Period Nash Equilibrium for Standard CES-Preferences and an Isoelastic WD-Curve*): If the WD-curve takes on the isoelastic functional form from (I.4) and if $v = \frac{1}{\sigma(N_t)-1}$ and $\sigma(N_t) = \overline{\sigma}$ where $\overline{\sigma} > 1$ is a constant ("standard CES-preferences"), a unique per-period Nash equilibrium with the level of aggregate employment being given by

$$(\text{I.22}) \qquad L_t^E = \left[\left(\left(\frac{\overline{\sigma}\psi_t}{(\overline{\sigma}-1)A} \right)^{\overline{\sigma}-1} \right) \overline{\sigma} f^P \left((L)^{-\xi_t(\overline{\sigma}-1)} \right) \right]^{\frac{1}{1-\xi_t(\overline{\sigma}-1)}}$$

exists if that value for aggregate employment is smaller than or exactly equal to L and if $\xi_t \neq \frac{1}{\overline{\sigma}-1}$. If $\xi_t \neq \frac{1}{\overline{\sigma}-1}$ but the value for aggregate employment from (I.22) is strictly greater than L, no per-period Nash equilibrium exists. If $\xi_t = \frac{1}{\overline{\sigma}-1}$, there exists either no per-period Nash equilibrium or a continuum of per-period Nash equilibria depending on the values of the remaining parameters.[25]

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[25] The EE-curve in this special case with standard CES-preferences can be written in closed form and is given by $L_t^E = \left(\left(\frac{\overline{\sigma}}{(\overline{\sigma}-1)A} \right)^{\overline{\sigma}-1} \right) \overline{\sigma} f^P \left((w_t)^{\overline{\sigma}-1} \right) \forall t$. If $\xi_t = \frac{1}{\overline{\sigma}-1}$, the WD-curve and the EE-curve either exactly coincide or they do not exhibit any intersection at a strictly positive level of aggregate employment.

I.4 Results and Discussion

I.4.1 Major Results in Formal Terms and Geometric Intuition

I now turn to applying the model to gain insights into the question whether supply-side or demand-side policies are required for raising aggregate employment. Since dynamic equilibrium paths in this model simply consist of sequences of per-period Nash equilibria, one can study the effect of policy-changes by means of comparing how a given per-period Nash equilibrium changes as one moves from θ_t to θ_{t+1} between periods t and $t+1$. For these "dynamic comparative statics" it is crucial to keep the following aspects in mind: Recall that it is assumed that any policy-change that changes the values of the parameters contained in the vector θ over time is realized *between* periods and hence, once a policy-change is engineered, the per-period Nash equilibrium in the next period – as well as in all remaining ones unless there is any further policy-change – will be different. Due to the absence of dynamic elements of decision-making and because of the instantaneous adjustment of the mass of producers at the beginning of each period as discussed in section I.2.6 and inasmuch as the model-economy consists of a series of unlinked per-period games, a new per-period Nash equilibrium is reached immediately in the period following a policy-change. Hence, there are no transitional dynamics[26] and issues of equilibrium stability do not arise, either, because agents essentially engage in a series of unrelated "one shot"-games that characterize outcomes within periods.[27] Thus, in my exposition I will focus on discussing how the per-period outcome changes (over time) as a result of changes in values of labor market parameters between periods. In doing so, one of course needs to take into account that there may be multiple equilibria and that in addition to changes in the values of labor market parameters equilibrium switching may occur as one moves from one period to the next. I will discuss that issue further below. For now, I will restrict attention to the following two cases: First, I will study the case in which the per-period Nash equilibrium is unique both before and after the policy-change so that such issues of equilibrium switching cannot arise by construction. Although the uniqueness of per-period Nash equilibrium for a given set of values of the parameters in the vector θ can in general not be guaranteed, the case of standard CES-preferences along with an

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[26] I will turn to a discussion of transitional dynamics in section I.5.

[27] In related open-economy work (part II of this dissertation) I make alternative assumptions on firm entry and allow for out-of-equilibrium dynamics and study issues related to equilibrium stability which under those alternative assumptions may arise.

isoelastic WD-curve as in (I.4) falls into that category as discussed in COROLLARY I.1. Second, I will study the case of marginal – by which I mean arbitrarily small – changes in the value of one parameter contained in the vector θ from one period to the next so that the number of per-period Nash equilibria remains the same as one moves from period t to period $t + 1$ so that one can focus on how any *given* equilibrium is affected by the policy-change from one period to the next assuming that equilibrium switching does not occur in response to the policy-change. These two cases are dealt with in the following two propositions, respectively:

PROPOSITION I.3 (*Global Effects of Demand-Side and Supply-Side Policies for the Case of a Unique Per-Period Nash Equilibrium*): Consider two vectors θ_t and θ_{t+1} such that the EE-curve has a unique intersection on $L_t^E \in (0, L]$ and $L_{t+1}^E \in (0, L]$, respectively, with both corresponding WD-curves defined by $w_t = g_{\theta_t}\left(\frac{L_t^E}{L}\right)$ and $w_{t+1} = g_{\theta_{t+1}}\left(\frac{L_{t+1}^E}{L}\right)$, respectively. Such a change from θ_t to θ_{t+1} which qualifies as a supply-side policy (as a demand-side policy) according to DEFINITION I.1 implies strictly higher aggregate employment in the unique per-period Nash equilibrium of period $t + 1$ than in the unique per-period Nash equilibrium of period t if and only if $\frac{\partial h(L_t^E)}{\partial L_t^E} <$

$\frac{\partial g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{\partial L_t^E}$ (if and only if $\frac{\partial h(L_t^E)}{\partial L_t^E} > \frac{\partial g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{\partial L_t^E}$) holds at the level of aggregate employment L_t^E in the unqiue per-period Nash equilibrium of period t characterized by θ_t, i.e. if and only if in the unique per-period Nash equilibrium of period t the EE-curve is flatter (steeper) than the WD-curve in the space with aggregate employment on the horizontal axis.

Proof: In appendix I.A. ∎

PROPOSITION I.4 (*Marginal Effects of Demand-Side and Supply-Side Policies*): Consider two vectors θ_t and θ_{t+1} where the vector θ_t is associated with a finite number of per-period Nash equilibria in period t and suppose that the distance between θ_t and θ_{t+1} in parameter space is arbitrarily small such that the change from θ_t to θ_{t+1} may be called "marginal"[28] and such that the finite number of per-period Nash equilibria is the same in period $t + 1$ as it is in period t. Any distinct per-period Nash equilibrium of period $t + 1$ then has a corresponding distinct one in period t where this corresponding per-period Nash equilibrium of period t is defined for any per-period Nash

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[28] In particular, consider the case in which only the value of one single parameter contained in θ changes by an arbitrarily small amount $\epsilon > 0$.

equilibrium of period $t + 1$ to be the one that exhibits the smallest difference in the equilibrium values of aggregate employment when comparing those across periods t and $t + 1$. It then follows that such a marginal change from θ_t to θ_{t+1} which qualifies as a supply-side policy (as a demand-side policy) according to DEFINITION I.1 implies strictly higher aggregate employment in a given per-period Nash equilibrium of period $t + 1$ than in the respective corresponding per-period Nash equilibrium of period t if and only if $\frac{\partial h(L_t^E)}{\partial L_t^E} < \frac{\partial g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{\partial L_t^E}$ (if and only if $\frac{\partial h(L_t^E)}{\partial L_t^E} > \frac{\partial g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{\partial L_t^E}$) holds at the level of aggregate employment L_t^E in that corresponding per-period Nash equilibrium of period t, i.e. if and only if in that corresponding per-period Nash equilibrium of period t the EE-curve is flatter (steeper) than the WD-curve in the space with aggregate employment on the horizontal axis.

Proof: In appendix I.A. ∎

To understand the geometric argument that gives rise to the results summarized in PROPOSITION I.3 and PROPOSITION I.4 and on which the proofs of these propositions are built, it is useful to look at Figure I.2 and at Figure I.3 which illustrate that argument for the simplest case in which the model exhibits a unique per-period Nash equilibrium before and after the policy-change.[29] In both figures, the new WD-curve resulting from a change in the values of the parameters contained in θ between periods t and $t + 1$ qualifying as a supply-side policy is marked with a single prime, while the new WD-curve resulting from a change in the values of the parameters contained in θ between periods t and $t + 1$ qualifying as a demand-side policy is marked with two primes. The WD-curve without any prime is meant to reflect the WD-curve of period t.

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[29] Depending on parameter values the EE- and WD-curves may be convex, concave or linear or a mixture of convex and concave, but in any case they are non-decreasing everywhere. Rather than going through many different cases, I only draw the case where both curves are everywhere concave for the purpose of illustration in this paper. The geometric arguments of course go through in the remaining cases, too.
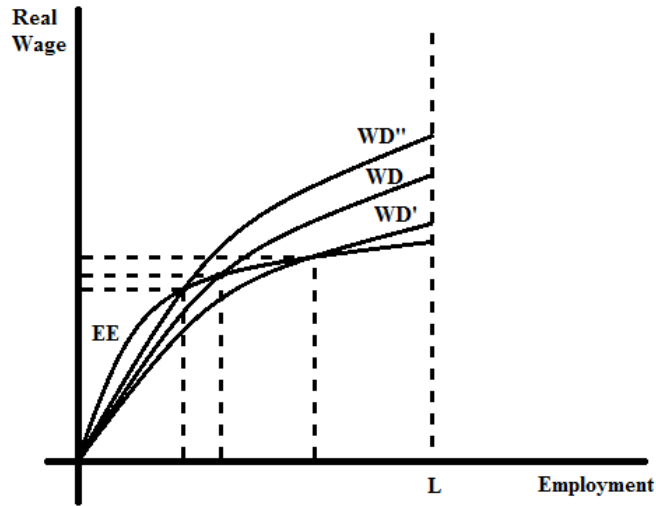
Figure I.2: The effects of labor market reforms if the WD-curve is steeper in the initial equilibrium.
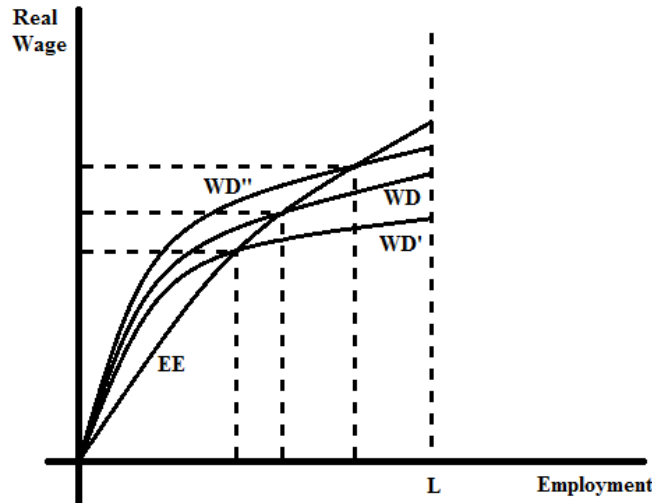
Figure I.3: The effects of labor market reforms if the EE-curve is steeper in the initial equilibrium.

As stated in PROPOSITIONS I.3 and I.4 it is the case that whenever in the initial per-period Nash equilibrium the EE-curve is flatter than the WD-curve (as drawn in Figure I.2), a (marginal) change in the values of the parameters contained in θ qualifying as a supply-side policy by means of inducing a downwards-rotation/shift of the WD-curve relocates the initial per-period Nash equilibrium along the stable and upwards-sloping EE-curve such that

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aggregate employment is higher, while a (marginal) change in the values of the parameters contained in θ qualifying as a demand-side policy by means of inducing an upwards-rotation/shift of the WD-curve leads to a relocation of the initial per-period Nash equilibrium along the stable EE-curve such that aggregate employment is lower. Figure I.3 illustrates the case where in the initial per-period Nash equilibrium the EE-curve is steeper, so that demand-side policies (but not supply-side policies!) are capable of raising aggregate employment (locally or globally, respectively, according to the respective proposition).

Note that PROPOSITIONS I.3 and I.4 apply regardless of the exact shape of the two loci as long as both the WD-curve and the EE-curve are continuous and non-decreasing, where the latter must necessarily be true for the WD-curve by the assumption that the pecuniary externality is always such that a tighter labor market (or higher aggregate employment, higher aggregate labor demand, etc.) implies *higher* real wages all else equal. The EE-curve in this model has those properties as shown in PROPOSITION I.1.

I.4.2 Economic Interpretation and Meaning of the Results

PROPOSITION I.3 and PROPOSITION I.4 clearly imply that whether supply-side or demand-side policies implemented between two periods t and $t + 1$ are capable of raising aggregate employment (globally in the case of a unique equilibrium or, in the case of multiple equilibria, in the neighborhood of a given equilibrium) comes down to $\frac{\partial h(L_t^E)}{\partial L_t^E} \gtreqless \frac{\partial g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{\partial L_t^E}$ at the level of aggregate employment L_t^E in the per-period Nash equilibrium of period t which is characterized by the parameter values in the vector θ_t. For an economic interpretation of that condition, it will be useful to re-write it in terms of elasticities: Thus, for the WD-curve of any given period t let $\eta_{WD,t}(L_t^E) = \frac{dg_{\theta_t}\left(\frac{L_t^E}{L}\right)}{dL_t^E} \frac{L_t^E}{g_{\theta_t}\left(\frac{L_t^E}{L}\right)}$ henceforth denote the elasticity of the economy-wide real wage in period t, w_t, with respect to the level of aggregate employment in period t, L_t^E, evaluated at a given level of aggregate employment L_t^E. Likewise, for the EE-curve let $\eta_{EE}(L_t^E) = \frac{dh(L_t^E)}{dL_t^E} \frac{L_t^E}{h(L_t^E)}$ denote the elasticity of the economy-wide real wage, w_t, with respect to the level of aggregate employment, L_t^E, evaluated at a given level of aggregate employment L_t^E. Hence, $\eta_{WD,t}(L_t^E)$ and $\eta_{EE}(L_t^E)$ can be interpreted as the elasticity of the WD-curve of period t and as the elasticity of the EE-curve, respectively. Note that the WD-curve changes from one period to the next as the values of labor market parameters

change between periods. Hence, the elasticity of the WD-curve may change from one period to the next even at a

given level of aggregate employment, which is why I index the elasticity of the period t WD-curve by t. Such an

indexation of the EE-curve is not necessary inasmuch as the EE-curve does not contain any of the labor market

parameters from the vector θ and since – until further notice – any other parameters of the model are assumed to

take on the same values over time. Hence, the EE-curve will be the same in each period as long as attention is

restricted to changes in labor market parameters and therefore, its elasticity at a given level of aggregate

employment will be constant over time. Furthermore, it is important to note that for my analysis it does not make

any difference whether $\eta_{WD,t}(L_t^E)$ and $\eta_{EE}(L_t^E)$ are defined as above or based on the corresponding *partial*

derivatives, namely as $\eta_{WD,t}(L_t^E) = \dfrac{\partial g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{\partial L_t^E} \dfrac{L_t^E}{g_{\theta_t}\left(\frac{L_t^E}{L}\right)}$ and $\eta_{EE}(L_t^E) = \dfrac{\partial h(L_t^E)}{\partial L_t^E} \dfrac{L_t^E}{h(L_t^E)}$, respectively. This is due to two

aspects of the model which imply that $\dfrac{d g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{d L_t^E} = \dfrac{\partial g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{\partial L_t^E}$ and that $\dfrac{dh(L_t^E)}{dL_t^E} = \dfrac{\partial h(L_t^E)}{\partial L_t^E}$, respectively: First, as implied

by PROPOSITIONS I.3 and I.4, what matters for the question which type of policy is required to increase

aggregate employment is which of the two curves is steeper at a given intersection of the two curves for *given*

period t values of all labor market parameters as summarized in θ_t as well as for given values of all remaining

parameters of the model. Hence, one needs to look at the slopes of the EE-curve and the WD-curve for *given* period

t values of all parameters. But for *given* period t values of all parameters, the period t WD-curve given by $w_t = $

$g_{\theta_t}\left(\frac{L_t^E}{L}\right)$ and the (period t) EE-curve given by $w_t = h(L_t^E)$ contain on their right-hand sides only one element that

can move within period t, namely aggregate employment L_t^E. To summarize, a very convenient aspect of this model

is that for characterizing the effects (in the sense of the direction in which endogenous variables move) of changes

in parameter values between periods t and $t+1$, one only needs to look at the slopes of two period t curves, so that

one only needs to know period t values of any parameters. It is almost needless to say that this aspect of the model

is of course extremely convenient for possible empirical implementations of it. Second and relatedly, parameter

values of the model are generally only allowed to change *between* periods while the elasticities of the EE-curve and

the WD-curve, respectively, are defined as elasticities of curves that represent a relationship between the real wage

and aggregate employment *within* a given period and hence for the stable parameter values that apply within that

respective period. This is another way to see why $\dfrac{d g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{d L_t^E} = \dfrac{\partial g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{\partial L_t^E}$ and $\dfrac{dh(L_t^E)}{dL_t^E} = \dfrac{\partial h(L_t^E)}{\partial L_t^E}$.

With the help of the elasticities of the WD-curve and of the EE-curve one can now give an alternative interpretation to PROPOSITIONS I.3 and I.4. In order to do this, first note that both elasticities are non-negative for any level of aggregate employment $L_t^E \in (0, L]$. This is a direct implication of the fact that both curves are non-decreasing everywhere. Second, note that the higher any of those two elasticities is at given levels of aggregate employment and the real wage, the *steeper* is the corresponding curve at that point in the space with aggregate employment on the horizontal axis and the real wage on the vertical axis.[30] The following proposition then obtains immediately:

<u>PROPOSITION I.5</u> (*Relationship of the Slopes of EE-Curve and WD-Curve at their Intersection(s)*): The WD-curve of period t is steeper than the EE-curve in a given intersection of the two curves with a level of aggregate employment L_t^* for which $0 < L_t^* \le L$ if and only if

$$(\text{I.23}) \qquad \qquad \eta_{WD,t}(L_t^*) > \eta_{EE}(L_t^*)$$

and the WD-curve of period t is flatter than the EE-curve in a given intersection of the two curves with an employment-level L_t^* for which $0 < L_t^* \le L$ if and only if that strict inequality is reversed.

<u>Proof:</u> Because $g_{\theta_t}\left(\frac{L_t^*}{L}\right) = h(L_t^*)$ must hold in a per-period Nash equilibrium of period t (i.e. at an intersection of the two curves) with a level of aggregate employment L_t^*, this result follows straight from the definitions of the two elasticities whereby for $g_{\theta_t}\left(\frac{L_t^*}{L}\right) = h(L_t^*)$, $\eta_{WD,t}(L_t^*) > \eta_{EE}(L_t^*)$ ($\eta_{WD,t}(L_t^*) < \eta_{EE}(L_t^*)$) implies directly that

$\frac{dg_{\theta_t}\left(\frac{L_t^E}{L}\right)}{dL_t^E} > \frac{dh(L_t^E)}{dL_t^E}$ (that $\frac{dg_{\theta_t}\left(\frac{L_t^E}{L}\right)}{dL_t^E} < \frac{dh(L_t^E)}{dL_t^E}$) holds at $L_t^E = L_t^*$. ∎

Hence, in light of PROPOSITION I.3 and PROPOSITION I.4 the inequality (I.23) is the condition for supply-side policies implemented between periods t and $t + 1$ to be able to raise aggregate employment starting from a per-period Nash equilibrium of period t with a level of aggregate employment L_t^*, while that strict inequality must go in

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[30] Note that under the convention for drawing those two curves adopted for this paper I am looking at an elasticity of the variable on the vertical axis (w_t) with respect to changes in the variable on the horizontal axis (L_t^E). Hence, higher elasticities at a given point translate into *steeper* curves. This must not be confused with usual supply and demand diagrams where elasticities of supply and demand are usually calculated as changes in the variable on the horizontal axis (quantity) with respect to changes in the variable on the vertical axis (price) so that higher elasticities (in absolute value) in such diagrams translate into flatter curves.

the opposite direction for demand-side policies implemented between periods t and $t + 1$ to be able to induce higher aggregate employment starting from such a per-period Nash equilibrium of period t.

A nice aspect of this simple formula in terms of the elasticities of the two curves is that these elasticities can be shown to have straightforward economic interpretations: Since the WD-curve is exclusively capturing wage-determination at the firm-level, the elasticity of real wages with respect to the level of aggregate employment coming out of the WD-curve is capturing only and exclusively the strength of the pecuniary externality in the labor market as it captures the sensitivity of real wages at the firm-level with respect to aggregate labor market conditions in the form of the level of aggregate employment (which is directly and strictly monotonically related to the employment rate written into the WD-curve in (I.3) for a constant exogenous level of labor supply L). Hence, the elasticity of the WD-curve $\eta_{WD,t}(L_t^E)$ has a very clean interpretation as it is driven exclusively by the strength of this pecuniary externality. In the case of the isoelastic functional form for the WD-curve from (I.4) that elasticity is constant (in a given period t): $\eta_{WD,t}(L_t^E) = \xi_t \; \forall t$. The elasticity of the EE-curve has a very clean economic interpretation, too, as it can be written as follows:

PROPOSITION I.6 (*Elasticity of the EE-Curve*): The elasticity of the EE-curve at any given level of aggregate employment $L_t^E \in (0, L]$ is given by

(I.24) $$\eta_{EE}(L_t^E) = \left(\left| \eta_\mu\big(N_t(L_t^E)\big) \right| + \left| \eta_V\big(N_t(L_t^E)\big) \right| \right)\big(\eta_X(L_t^E)\big) \quad \forall t$$

where $\eta_\mu(N_t) = \frac{\partial(\mu(N_t))}{\partial N_t} \frac{N_t}{\mu(N_t)}$ denotes the elasticity of the equilibrium mark-up $\mu(N_t)$ with respect to the mass of available varieties N_t with $\left|\eta_\mu(N_t)\right|$ being its absolute value, where $\eta_V(N_t) = \frac{\partial(V(N_t))}{\partial N_t} \frac{N_t}{V(N_t)}$ is the elasticity of the variety-effect-term $V(N_t)$ with respect to N_t with $\left|\eta_V(N_t)\right|$ being its absolute value, where $N_t(L_t^E)$ denotes the differentiable function linking the equilibrium values of N_t and L_t^E which is implicitly defined over $L_t^E \in [0, \infty)$ by (I.15) and where $\eta_X(L_t^E) = \frac{d(N_t(L_t^E))}{dL_t^E} \frac{L_t^E}{N_t(L_t^E)}$ denotes the elasticity of N_t with respect to L_t^E coming out of this function $N_t(L_t^E)$.[31]

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[31] See the proof of PROPOSITION I.1 for the argument that the function $N_t(L_t^E)$ is differentiable. Since all parameters except for the labor market parameters contained in θ are assumed to exhibit constant values over time

Proof: In appendix I.A. ∎

The expression for the elasticity of the EE-curve as presented in (I.24) is fairly simple and intuitive because it only consists of three elasticities that have clean economic interpretations: It contains $\left|\eta_\mu(N_t)\right|$ as the (absolute value of the) elasticity of equilibrium mark-ups with respect to the toughness of competition in product markets as measured by the mass of available varieties N_t, it contains $\left|\eta_V(N_t)\right|$ as the (absolute value of the) elasticity which measures the change in the "cost of living"-index due to a pure product-variety-effect, i.e. the change in the "cost of living"-index for given prices at the variety-level that comes from more/less choice being available, and finally, it contains $\eta_X(L_t^E)$ which is the elasticity of the mass of producing firms with respect to aggregate employment and which is simply a measure of the extent to which changes in aggregate employment are driven by the extensive margin of employment. To see this last point most clearly, note that simple accounting implies that the elasticity $\eta_X(L_t^E) = \frac{d\left(N_t(L_t^E)\right)}{dL_t^E} \frac{L_t^E}{N_t(L_t^E)}$ plus the elasticity of employment at the firm-level with respect to aggregate employment necessarily add up to unity with homogeneous firms, so the elasticity $\eta_X(L_t^E)$ can directly be interpreted as capturing the fraction of a (marginal) change in aggregate employment that is accounted for by the extensive rather than the intensive margin.[32]

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until further notice in the context of additional applications of the model in section I.5, for now it is not necessary to index the elasticities $\eta_\mu(N_t)$, $\eta_V(N_t)$ and $\eta_X(L_t^E)$ by time as the labor market parameters do not show up neither in the expression for equilibrium mark-ups $\mu(N_t)$, nor in the one for the variety-effect-term $V(N_t)$, nor in equation (I.15), based on which the three elasticities are defined, respectively. And even when I allow for the values of other parameters of the model to change *between* periods in section I.5, note that for the definition of the elasticity $\eta_X(L_t^E)$, too, it would still not make any difference if one used the partial derivative instead of $\frac{d\left(N_t(L_t^E)\right)}{dL_t^E}$ and the reasons for that are similar to what has been said about the definitions of $\eta_{WD,t}(L_t^E)$ and $\eta_{EE}(L_t^E)$ above: $\eta_X(L_t^E)$ is defined based on (I.15) and in accordance with the definition of the elasticity of the EE-curve for a given period, the definition of $\eta_X(L_t^E)$ looks at the relationship between N_t and L_t^E *within* a given period t, i.e. *given* the period t values of any parameters of the model and for given period t values of the parameters of the model, (I.15) implies a stable function $N_t(L_t^E)$ for which it thus follows that $\frac{d\left(N_t(L_t^E)\right)}{dL_t^E} = \frac{\partial\left(N_t(L_t^E)\right)}{\partial L_t^E}$. If one wishes to empirically estimate $\eta_X(L_t^E)$ using variation over time, one would thus need to use variation in the values of parameters which do not show up in (I.15) which defines the function $N_t(L_t^E)$ with respect to which the elasticity $\eta_X(L_t^E)$ is defined. Looking at (I.15) one notices that promising candidates thus consist of the labor market parameters and of the technology parameter A and this turns out to be similar for the analogues of equation (I.15) in other versions of the model I will study below.

[32] To see this formally, note that simple accounting with homogeneous firms implies that in any given period $L_t^E = N_t l_t$ is true, where I use l_t in this footnote to denote firm-level employment at producing firms in period t. Looking at the total differential of this expression for aggregate employment implies that changes in aggregate

But why is it true that exactly these three elasticities matter for the elasticity of the EE-curve? Recall that the EE-curve comes out of merging (I.14) and (I.15) with each other. In light of the expression for real wages from (I.14) it is clear that – given the parameters of the model – real wages are completely pinned down by the mass of producers/available varieties through the product-variety-channel and the mark-ups-channel. Therefore, it is intuitive that the corresponding elasticities $\eta_\mu(N_t)$ and $\eta_V(N_t)$ that describe the sensitivity of the price-index and hence (when written in absolute value) of real wages to changes in the mass of producers through those two channels show up as a sum in the expression for the elasticity of the EE-curve in (I.24). But inasmuch as the elasticity of the EE-curve is defined as an elasticity of real wages with respect to aggregate employment rather than with respect to N_t, the elasticity $\eta_X(L_t^E)$ accounting for the extensive margin response of production to changes in aggregate employment as captured in (I.15) comes into play, too, and it does so very naturally in a multiplicative way. Thus, the reason for which the EE-curve is non-decreasing and will typically be upwards-sloping can be directly inferred from the formula for its elasticity in (I.24): As aggregate employment increases and as at least some part of this increase happens along the extensive margin so that the mass of producing firms increases, real wages rise both through the product-variety-channel and through the variable-mark-ups-channel as described in the context of equation (I.14). The slope of the EE-curve is thus entirely driven by the extensive margin of production, which can be seen from the fact that the EE-curve can be shown to be flat as soon as the extensive margin is shut

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employment can be approximated as follows: $dL_t^E = l_t dN_t + N_t dl_t$. Note that on the right-hand side of this expression the first summand evidently accounts for changes in aggregate employment along the extensive margin (i.e. changes that come from changes in the mass of producing firms, N_t) while the second summand accounts for changes in aggregate employment along the intensive margin (i.e. changes that come from changes in the level of employment at the firm-level, l_t). Dividing by dL_t^E yields $l_t \frac{dN_t}{dL_t^E} + N_t \frac{dl_t}{dL_t^E} = 1$, where the first (second) summand still accounts for changes in aggregate employment along the extensive (intensive) margin. And the fact that the two summands add up to unity once this expression is scaled by the change in aggregate employment implies that the first (second) summand represents the *fraction* of changes in aggregate employment that is due to the extensive (intensive) margin. Using the accounting identity $L_t^E = N_t l_t$ in each of these summands one then arrives at $\frac{dN_t}{dL_t^E} \frac{L_t^E}{N_t} + \frac{dl_t}{dL_t^E} \frac{L_t^E}{l_t} = 1$. But since the first summand now corresponds to the elasticity η_X, this elasticity can be given the interpretation of capturing the fraction of changes in aggregate employment that are due to the extensive margin, so it is a measure of the relative importance of the extensive margin in accounting for changes in aggregate employment. These arguments would of course be similar with heterogeneous firms – one then just works with *average* firm-level employment in defining l_t for the purpose of characterizing the intensive margin.

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down, i.e. as soon as N_t is exogenously fixed rather than endogenously determined from a zero-profit-condition.[33],[34]

Hence, combining the insights from the last four propositions one arrives at the following "sufficient statistics"-formula which represents a necessary and sufficient condition for a supply-side policy implemented between periods t and $t + 1$ to be capable of raising aggregate employment from period t to period $t + 1$ in the sense of PROPOSITION I.3 or I.4 starting in a per-period Nash equilibrium of period t with aggregate employment $L_t^* \leq L$:

$$(I.25) \qquad \eta_{WD,t}(L_t^*) > \left(\left| \eta_\mu \left(N_t(L_t^*) \right) \right| + \left| \eta_V \left(N_t(L_t^*) \right) \right| \right) \left(\eta_X(L_t^*) \right)$$

In the opposite case (and only in that case), a demand-side policy would work. This also means that the formula in (I.25) can be given the interpretation of a threshold-rule that indicates whether it takes a supply-side or a demand-side reform of labor markets in order to increase aggregate employment where the threshold is defined in terms of the strength of the pecuniary externality in the labor market around the (current) equilibrium level of aggregate employment as the strength of this externality alone determines the value of $\eta_{WD,t}(L_t^*)$.

The formula in (I.25) is a central part and result of this paper and it nicely summarizes the main insights gained so far. Let me now apply this formula and hence the insights from PROPOSITIONS I.3 through I.6 to analyze which factors make supply-side policies more promising for raising aggregate employment and which factors favor demand-side policies. The following obtains as an immediate corollary of PROPOSITIONS I.3 through I.6:

COROLLARY I.2 (*Effects of Various Elasticities*): Suppose that the economy is in a per-period Nash equilibrium of period t with a level of aggregate employment L_t^* and a corresponding mass of producing firms N_t^* which are

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[33] This follows directly from (I.14): Once N_t is assumed to be exogenous, the zero-profit-condition in (I.13) drops out of the model and hence, equation (I.15) no longer holds but equation (I.14) alone becomes the EE-curve which determines the equilibrium levels of aggregate employment and the real wage along with the WD-curve in a per-period Nash equilibrium of the model. Once one knows aggregate employment and real wages in equilibrium, aggregate consumption can then be calculated residually by means of deriving an expression for aggregate employment analogously to the derivation of (I.15) but without making use of (I.13).

[34] One must absolutely *not* think about the EE-curve as a labor demand schedule: The EE-curve is an equilibrium relationship which serves as a "melting pot" that summarizes all equilibrium conditions and accounting relationships in the model except for the wage-determination schedule. Labor demand curves at the firm-level in my model are nicely decreasing in the real wage given variables at the aggregate level and hence, the same is true in this model for an "aggregate labor demand curve" which obtains if one aggregates labor demand across a *fixed* mass of firms given variables at the aggregate level. Along the EE-curve, by contrast, the mass of firms is not constant, but it varies such that the free-entry-condition is satisfied.

both known to all economic agents. Further, suppose that at least one of the following four equilibrium values is also known but that at least one of the remaining three is not: $\eta_{WD,t}(L_t^*)$, $|\eta_\mu(N_t^*)|$, $|\eta_V(N_t^*)|$ and $\eta_X(L_t^*)$. Given any prior distribution(s) over any unknown value(s) from the set $\{\eta_{WD,t}(L_t^*), |\eta_\mu(N_t^*)|, |\eta_V(N_t^*)|, \eta_X(L_t^*)\}$, the implementation of a supply-side (demand-side) policy according to DEFINITION I.1 between periods t and $t+1$ is *ceteris paribus* more likely to increase aggregate employment from period t to period $t+1$ in the sense of PROPOSITION I.3 or PROPOSITION I.4 …

- … the lower (higher) the known value of $|\eta_V(N_t^*)|$ is.
- … the lower (higher) the known value of $|\eta_\mu(N_t^*)|$ is.
- … the lower (higher) the known value of $\eta_X(L_t^*)$ is.
- … the higher (lower) the known value of $\eta_{WD,t}(L_t^*)$ is.

COROLLARY I.2 thus implies that higher values of $|\eta_V(N_t^*)|$, $|\eta_\mu(N_t^*)|$ and $\eta_X(L_t^*)$ make a stronger case for demand-side policies. In economic terms this means that stronger product-variety-effects (i.e. a stronger role for either "love for variety" in preferences or for "returns to specialization" (or external economies of scale) in technology), a higher sensitivity of mark-ups with respect to the toughness of competition or a stronger relative role of the extensive margin of employment make a stronger case for demand-side policies if one's intention is to raise aggregate employment. By contrast, a higher value of $\eta_{WD,t}(L_t^*)$ makes a stronger case for supply-side policies. In economic terms this means that a stronger pecuniary externality in the labor market whereby real wages at the firm-level are more sensitive to aggregate labor market conditions (which can be thought of as real wages being more flexible) makes a stronger case for supply-side approaches to labor market reform. In a nutshell, labor markets with strong pecuniary externalities favor supply-side policies, while product markets with strong product-variety-effects and with highly sensitive mark-ups and a relatively high importance of the extensive margin of employment/production compared to the intensive margin make a stronger case for demand-side policies. These insights can also be re-stated in terms of necessary conditions which obtain as another corollary of PROPOSITIONS I.3 through I.6:

COROLLARY I.3 (*Necessary Conditions*): Suppose that the economy is in a per-period Nash equilibrium of period t with a level of aggregate employment L_t^* and a corresponding mass of producing firms N_t^*. A supply-side policy

implemented between periods t and $t + 1$ cannot lead to an increase in aggregate employment from period t to period $t + 1$ in the sense of PROPOSITION I.3 or PROPOSITION I.4 if $\eta_{WD,t}(L_t^E) = 0$. Hence, the presence of a pecuniary externality in the labor market whereby $\eta_{WD,t}(L_t^E) > 0$ over at least some range – including the period t equilibrium employment-level L_t^* – is a necessary condition for supply-side policies to be able to raise aggregate employment. A demand-side policy implemented between periods t and $t + 1$ cannot lead to an increase in aggregate employment from period t to period $t + 1$ in the sense of PROPOSITION I.3 or PROPOSITION I.4 if $\eta_X(L_t^E) = 0$. Moreover, a demand-side policy implemented between periods t and $t + 1$ cannot lead to an increase in aggregate employment from period t to period $t + 1$ in the sense of PROPOSITION I.3 or PROPOSITION I.4 if $\eta_V(N_t) = 0$ *and* $\eta_\mu(N_t) = 0$. Hence, the presence of an endogenous extensive margin of production whereby $\eta_X(L_t^E) > 0$ over at least some range *and* the presence of either variable mark-ups or product-variety-effects so that either $\left|\eta_\mu(N_t)\right| > 0$ over at least some range and/or $\left|\eta_V(N_t)\right| > 0$ over at least some range – where these ranges again all need to include the period t equilibrium employment-level L_t^* and the associated equilibrium mass of producers in period t, N_t^*, respectively – both represent necessary conditions for demand-side policies to be able to raise aggregate employment.

Geometrically, the necessary conditions established in COROLLARY I.3 obtain because the case in which a pecuniary externality in the labor market of period t is entirely absent so that $\eta_{WD,t}(L_t^E) = 0$ corresponds to a horizontal WD-curve, while the case in which there is no extensive margin of employment and production so that $\eta_X(L_t^E) = 0$ and the case in which mark-ups are constant ($\eta_\mu(N_t) = 0$) *and* there is no "love for variety"/"returns to specialization"-feature in preferences/technology ($\eta_V(N_t) = 0$) both correspond to a horizontal EE-curve.[35] Note that there are still economies of scale in the model if the EE-curve is horizontal as marginal costs are constant and as there are still quasi-fixed costs, so the presence of economies of scale is *not* driving the slope of the EE-curve!

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[35] Another way of seeing how an endogenous extensive margin *and* either an element of variable mark-ups or product-variety-effects are necessary for demand-side policies to be able to increase aggregate employment is to look at (I.14) for either a fixed value of N_t or for $\mu(N_t)$ and $V(N_t)$ both being constants. In both cases, real wages are then directly given by (I.14) so that equation (I.14) alone (rather than in combination with (I.15)) characterizes the EE-curve in these two special cases, which means that it is horizontal: In these two special cases, (I.14) and the WD-curve jointly determine aggregate employment and real wages in a per-period Nash equilibrium and equation (I.15) is either not valid (which is the case for exogenous N_t as the zero-profit-condition behind (I.15) is not used in that case) or it just pins down N_t residually given the equilibrium values of real wages and aggregate employment (which is the case if $\mu(N_t)$ and $V(N_t)$ are constants).

While $\eta_{WD,t}$, η_V and η_μ are all directly linked to parameters or functional form assumptions of the model and are all either zero or strictly positive for obvious reasons, the elasticity η_X is a more complicated object. To gain insights into what is driving the size of that elasticity which indicates to which extent changes in aggregate employment happen along the extensive rather than the intensive margin, note that η_X can be calculated directly from (I.15): Applying the implicit function theorem to that equation to calculate $\frac{d(N_t(L_t^E))}{dL_t^E}$ and making use of the definition of η_X yields:[36]

(I.26)
$$\eta_X(L_t^E) = \frac{1}{1 + \left(\frac{\partial(\sigma(N_t))}{\partial N_t}\bigg|_{N_t(L_t^E)}\right)\frac{N_t(L_t^E)}{\sigma(N_t(L_t^E))}} \quad \forall t$$

Now consider two versions of this model which only differ insofar as one version has variable mark-ups so that $\frac{\partial(\sigma(N_t))}{\partial N_t} > 0 \ \forall \ N_t > 0$ and one has constant mark-ups with $\sigma(N_t) = \overline{\sigma} \ \forall \ N_t > 0$ where one picks $\overline{\sigma}$ in a way such that it equals $\sigma(N_t^*)$ (i.e. $\sigma(N_t(L_t^*))$ in light of (I.15)) from the version with variable-mark ups, i.e. such that the two models have a common per-period Nash equilibrium of period t with the same level of aggregate employment denoted by L_t^*, the same mass of available varieties denoted by N_t^* and – due to $\overline{\sigma} = \sigma(N_t^*)$ – the same level of mark-ups. From (I.26) and the fact that the two versions have the same mark-ups, same levels of aggregate employment and same levels of product variety in the per-period Nash equilibrium of period t under consideration, it then follows directly that $\eta_X(L_t^*)$ is strictly lower in the version of the model with variable mark-ups than with constant mark-ups. In particular, in the case of variable mark-ups one has $\eta_X(L_t^*) < 1$, while in the case of constant mark-ups – and thus also in the case of standard CES-preferences – one obtains $\eta_X(L_t^*) = 1$, which means that any movement in aggregate employment induced by labor market reform in the sense of PROPOSITION I.3 or I.4 would happen exclusively along the extensive margin. With variable mark-ups, however, an increase in aggregate employment along the extensive margin always entails an increase in aggregate employment along the intensive margin as it reduces mark-ups and thus induces firms to operate at larger scale. Consequently, the mark-ups-

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[36] I use $\frac{\partial(\sigma(N_t))}{\partial N_t}\bigg|_{N_t(L_t^E)}$ to denote the partial derivative of the function $\sigma(N_t)$ with respect to N_t evaluated at a given value $N_t(L_t^E)$, i.e. evaluated at some value for N_t that is itself a function of some value for L_t^E. Further, note that $N_t(L_t^E)$ in that expression for $\eta_X(L_t^E)$ denotes the value of N_t that obtains for a given value of L_t^E from the function $N_t(L_t^E)$ which is implicitly defined by (I.15).

channel plays an important role in determining the value of $\eta_X(L_t^*)$, too, and in particular, higher sensitivity of mark-ups to the mass of competitors in equilibrium, i.e. a greater value of $\left|\eta_\mu(N_t^*)\right|$, tends to be associated with a lower equilibrium value of the extensive margin elasticity $\eta_X(L_t^*)$.[37]

As I have argued that both the WD-curve and the EE-curve are generally non-decreasing, it necessarily follows that real wages either remain constant or increase as aggregate employment increases along the EE-curve due to a suitable shift of the WD-curve, i.e. due to a suitable labor market reform. But recall that a supply-side policy is defined as *reducing* real wages given aggregate employment. However, whenever the condition for a supply-side policy to be capable of raising aggregate employment is satisfied, the net result of implementing a policy which would reduce real wages if aggregate employment did not change is still that real wages remain at least constant (which would happen only in the aforementioned special cases of a horizontal EE-curve) or increase and this effect is brought about by the pecuniary externality in labor markets as well as by the product-variety-effects and reductions in mark-ups associated with increases in aggregate employment. Conversely, even though a demand-side policy raises real wages conditional on aggregate employment by definition, the same forces imply that whenever the conditions for such a policy to be capable of raising aggregate employment are *not* satisfied, aggregate employment declines and real wages end up being *lower* (unless the EE-curve is horizontal in which case real wages would not change). Further, this necessarily (weakly) positive co-movement of real wages and aggregate employment and the fact that aggregate consumption is just the product of real wages and aggregate employment (cf. (I.16)) imply that aggregate consumption as a welfare-measure necessarily increases whenever aggregate employment is raised. And even if one dropped the assumption of perfect consumption insurance, the analysis would go through in the exact same way because of the homotheticity of the consumption-aggregator in (I.1) that would then be assumed to apply to each single household in the economy where utility at the household-level would be given by the quantity of the aggregate consumption good consumed by the household and where C_t would

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[37] This can be seen by means of changing the value of $\frac{\partial(\sigma(N_t))}{\partial N_t}$ in the neighborhood of an equilibrium of the model with a mass of producing firms N_t^* and a level of aggregate employment L_t^* in a way that leaves $\sigma(N_t^*)$ unchanged and noting that a greater value of $\frac{\partial(\sigma(N_t))}{\partial N_t}$ at N_t^* for $\mu(N_t) = \frac{\sigma(N_t)}{\sigma(N_t)-1}$ implies a greater value of $\left|\frac{\partial(\mu(N_t))}{\partial N_t}\right|$ at N_t^* and hence a greater value of $\left|\eta_\mu(N_t^*)\right|$ and at the same time it reduces $\eta_X(L_t^*)$ as given in (I.26). Note, however, that there need not always be such an inverse relationship between the values of $\left|\eta_\mu(N_t^*)\right|$ and $\eta_X(L_t^*)$. In the context of a version of my model with Cournot competition which I study in section I.6.2, I find that η_X is constant and equal to $\frac{1}{2}$ while η_μ is endogenous so that its equilibrium value changes with changes in parameters of the model.

then represent the total quantity of the aggregate consumption good consumed in the economy which is a simple sum over all the quantities consumed by single households who – again because of the homotheticity of the aggregator – all have the same welfare-relevant price-index, which is the one in (I.2). And in such an alternative interpretation of the model, one could conclude that employment-enhancing policy-changes necessarily represent Pareto-improvements in the sense that they get more people into work and (weakly) raise the real wage for all employed workers and hence, all agents see a (weak) increase in the quantities of the aggregate good they consume.[38] Disregarding any issues related to potential turnover or reallocation of jobs associated with employment-enhancing policy-changes, through the lens of this model one would thus expect that implementing such policy-changes is unlikely to meet much resistance – at least if the true model and the equilibrium values of all relevant elasticities were perfectly known by all economic agents and in reality, that is obviously one of the challenges.

Finally, note that the results I have presented and in particular the simple and intuitive formula/threshold-rule in terms of a handful of well-defined elasticities (i.e. the formula in (I.25)) apply in any equilibrium of the model. If one's interest is on an empirical implementation of that formula to figure out which type of policy might be required to raise equilibrium employment in practice, one thus does not have to worry too much about uniqueness of equilibrium.[39]

I.4.3 The Case of Standard CES-Preferences and the Isoelastic WD-Curve: Additional Intuition

In the simple case of the isoelastic WD-curve from (I.4) along with standard CES-preferences, i.e. $\sigma(N_t) = \overline{\sigma} > 1$ and $v = \frac{1}{\overline{\sigma}-1}$, PROPOSITION I.3 is applicable so that one can discuss non-marginal policy-changes since COROLLARY I.1 implies that per-period Nash equilibrium – if it exists – is unique in this special version of the

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[38] In part III of this dissertation where I study structural changes in the labor market in open economies, I argue that terms-of-trade-effects may change that picture so that aggregate employment and real wages may move in opposite directions in response to unilateral labor market reform, which then entails the potential for distributional conflicts within countries even if one disregards any issues related to turnover and reallocation that may be associated with changes in aggregate employment.

[39] Equilibrium switching might of course be an issue, but due to the upwards-sloping nature of the two curves, equilibria can be Pareto-ranked in this type of model and it might be a reasonable assumption that the economy coordinates on the Pareto-dominant equilibrium and will continue to do so after the policy-change. In any case, if a policy-change is implemented carefully and step by step and is thus sufficiently close to the "marginal" changes I analyze in PROPOSITION I.4, it is not clear why it should interfere with the equilibrium selection mechanism in the economy and induce equilibrium switching.

model if one imposes that $\xi_t \neq \frac{1}{\overline{\sigma}-1}$ $\forall t$, which I will do throughout this paper whenever discussing the case of

standard CES-preferences and the isoelastic WD-curve. Under standard CES-preferences $\eta_\mu(N_t) = 0$ holds as

mark-ups are constant and $\eta_V(N_t) = -v = -\frac{1}{\overline{\sigma}-1}$. Further, for the case $\sigma(N_t) = \overline{\sigma} > 1$, (I.15) implies $\eta_X(L_t^E) = 1$,

which means that aggregate employment exclusively changes along the extensive margin as one changes the values

of labor market parameters of the model between periods and thus moves instantaneously from one unique per-

period equilibrium to a new one. As already explained, the fact that $\eta_X(L_t^E) = 1$ holds in this special case has to do

with the fact that mark-ups do not vary with the mass of competitors. As the isoelastic WD-curve from (I.4)

exhibits $\eta_{WD,t}(L_t^E) = \xi_t$, directly applying the previous results and propositions leads to the following very simple

threshold-rule which represents a necessary and sufficient condition for a supply-side policy implemented between

periods t and $t+1$ to lead to an increase in aggregate employment from period t to $t+1$ in the sense of

PROPOSITION I.3:

(I.27) $$\xi_t > \frac{1}{\overline{\sigma}-1}$$

Demand-side policies implemented between periods t and $t+1$ raise aggregate employment in this version of the

model if and only if that strict inequality goes in the opposite direction.[40] This simple formula, which corresponds

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[40] Suppose that in an alternative version of the model, one has standard CES-preferences but that the quasi-fixed costs of production are to be incurred in terms of the aggregate good defined by the aggregator in (I.1), i.e. they are specified in terms of final output as is sometimes assumed. In that case, one finds $\eta_X = \frac{\overline{\sigma}-1}{\overline{\sigma}-2}$ and the threshold-rule from (I.27) becomes $\xi_t > \frac{1}{\overline{\sigma}-2}$. Under the assumption of $\overline{\sigma} > 2$ which this modified model requires to make economic sense for reasons which I will explain below, it thus follows that $\eta_X > 1$. The elasticity of the extensive margin response to changes in aggregate employment is greater than unity in that case due to the "returns to specialization" in the specification of the aggregator in (I.1) which – if that aggregator applies to quasi-fixed costs, too – lead to a decline in quasi-fixed costs (if expressed in terms of labor as the only scarce resource of the economy) as the mass of producers increases and hence, this is a new force which pushes towards a high value of η_X. This special version of the model with $\eta_X > 1$ relies obviously on strong assumptions, but it is useful for making the point that "returns to specialization" à la Ethier (1982) when appearing in the entry-technology (i.e. in quasi-fixed costs) push up η_X. To understand why this version of the model requires $\overline{\sigma} > 2$ to make economic sense, consider what would happen if the economy sought to scale up the mass of producing firms by a factor $x > 1$ holding the scale of operation at the firm-level fixed. Given the standard CES-aggregator for final output with an elasticity of substitution $\overline{\sigma} > 1$, total output of the final good would then be equal to $x^{\left(\frac{\overline{\sigma}}{\overline{\sigma}-1}\right)} > 1$ times its original value while total employment would be equal to x times its original value. Final output per unit of labor would thus be equal to $x^{\left(\frac{\overline{\sigma}}{\overline{\sigma}-1}-1\right)} > 1$ times its original value. Now ask how much labor – which is the only input in fixed supply and hence the only "scarce" input and at the same time the only primary input in the economy – the economy effectively uses to cover the quasi-fixed costs associated with the mass of producing firms. If the mass of producing firms would be equal to x times its original value, x times the original amount of final output would be

to (I.25) from the more general case, implies a highly interesting comparative static for $\overline{\sigma}$: As long as there is some pecuniary externality in the labor market, i.e. as long as $\xi_t > 0$, it follows that as the elasticity of substitution $\overline{\sigma}$ is increased – which means making products more alike and thus reducing market power and hence equilibrium mark-ups so that one moves closer to a world with perfect competition – one necessarily reaches a point beyond which the condition in (I.27) holds so that supply-side policies are required for raising aggregate employment from period t to period $t + 1$. Conversely, if one runs the thought experiment of reducing $\overline{\sigma}$, one finds that in light of (I.27) demand-side policies are eventually required to raise aggregate employment from period t to period $t + 1$ as $\overline{\sigma}$ becomes close enough to 1. Recall that the channels which push towards demand-side policies in the more general model are those related to mark-ups and product differentiation. A lower value of $\overline{\sigma}$ implies more product differentiation and higher mark-ups and hence it is very natural that lower values of $\overline{\sigma}$ make a stronger case for demand-side policies while higher values of $\overline{\sigma}$ which are associated with less severe "product market imperfections" make a stronger case for the supply-side view.

This simple concrete case of the more general model can be used to gain even further insights into the mechanisms of the model as one can use this version to go through an interesting perturbation argument that looks from a firm-level perspective at marginal effects of changes in the values of labor market parameters around the unique per-period Nash equilibrium: Note that with standard CES-preferences and with the isoelastic WD-curve from (I.4) one

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spent on those costs, but transforming this into units of labor one finds that as the mass of firms is increased to x times its original value, the amount of labor used to cover quasi-fixed costs becomes equal to $x^{\left(1 - \left(\frac{\overline{\sigma}}{\overline{\sigma}-1} - 1\right)\right)}$ times its original value where the first summand in the exponent accounts for the fact that more final output needs to be spent on covering quasi-fixed costs while the second summand accounts for the decline in units of labor required to produce one unit of final output if the total mass of firms is higher, which comes from the "returns to specialization"-feature in technology à la Ethier (1982). $x^{\left(1 - \left(\frac{\overline{\sigma}}{\overline{\sigma}-1} - 1\right)\right)}$ is greater than unity if and only if $\overline{\sigma} > 2$, i.e. to make the entry-problem in the economy well-behaved and meaningful, this restriction is required: If it was not satisfied, the economy could support a larger mass of firms using a *lower* total amount of its scarce input, namely labor, for covering the total amount of quasi-fixed costs. To put it in a nutshell, for the entry-part of the model to make sense, "entry must not be able to completely finance itself" and this is made sure by means of imposing $\overline{\sigma} > 2$ as soon as quasi-fixed costs are denoted in terms of final output rather than labor. But if those costs are denoted in terms of labor, such a restriction is not needed.

can write equilibrium firm-level profits in real terms (i.e. nominal profits $\Pi_t(\omega)$ divided by P_t) as a function of aggregate employment L_t^E:[41]

$$(I.28)\ \frac{\Pi_t(\omega)}{P_t} = \psi_t \left(\left(\frac{L_t^E}{L} \right)^{\xi_t} \right) \left[\frac{1}{\overline{\sigma}-1} \left((\psi_t)^{1-\overline{\sigma}} \right) \left(\left(\frac{(\overline{\sigma}-1)A}{\overline{\sigma}} \right)^{\overline{\sigma}-1} \right) \left((L)^{\xi_t(\overline{\sigma}-1)} \right) \left((L_t^E)^{1-\xi_t(\overline{\sigma}-1)} \right) - \frac{\overline{\sigma}}{\overline{\sigma}-1} f^P \right] \quad \forall \omega \in \Upsilon_t \ \forall t$$

In the unique per-period Nash equilibrium, this expression of course must be equal to zero due to free entry. But consider what happens if the economy is in the unique per-period Nash equilibrium and this equilibrium is then perturbed by a marginal change in ψ_t (for this perturbation argument I am essentially looking at a change in ψ_t within a period thus stepping – just for the purpose of building additional intuition – outside my general timing assumptions which would not allow for that to happen): The partial derivative of the expression for firm-level profits in real terms from (I.28) with respect to ψ_t evaluated at the equilibrium-level of aggregate employment from (I.22) is always negative. This is just saying that firm-level profits near the unique per-period Nash equilibrium decline in a ceteris paribus sense when a demand-side policy is implemented. This is intuitive as demand-side policies raise real wages (and hence the costs for firms) conditional on aggregate employment. Conversely, a supply-side policy by reducing ψ_t implies higher profits near equilibrium in a ceteris paribus sense. Since equilibrium must exhibit zero profits, however, aggregate employment L_t^E must adjust whenever ψ_t changes. Calculating the partial derivative of the expression for firm-level profits in real terms from (I.28) with respect to L_t^E evaluated at the equilibrium-level of aggregate employment from (I.22) reveals that this partial derivative is negative if and only if $\xi_t > \frac{1}{\overline{\sigma}-1}$ (i.e. if and only if the condition in (I.27) is satisfied) and positive if and only if the reverse is true. This implies that if ψ_t is increased marginally (demand-side policy), an increase in aggregate employment is required to restore zero profits if $\xi_t < \frac{1}{\overline{\sigma}-1}$ and a decline in aggregate employment is required otherwise. Conversely, if ψ_t is reduced marginally (supply-side policy), an increase in aggregate employment is

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[41] To arrive at this expression one begins with the expression for equilibrium firm-level profits from (I.12) which one divides by P_t. One gets rid of C_t in that expression as follows: First, one calculates equilibrium firm-level employment by using $l_t(\omega) = \frac{y_t(\omega)}{A} + f^P \ \forall \omega \in \Upsilon_t \ \forall t$ and the expression for firm-level output from (I.10), then one aggregates this to find an expression for aggregate employment in equilibrium with identical decisions by firms. Rearranging that yields an expression for C_t. Next, one eliminates all terms containing N_t with the help of (I.14). Finally, one gets rid of any terms involving the real wage w_t by resorting to the isoelastic WD-curve from (I.4). This then implies the expression for firm-level profits in (I.28). In all those steps one of course uses $\sigma(N_t) = \overline{\sigma} > 1$ and $v = \frac{1}{\overline{\sigma}-1}$. Note that during the derivation one makes use of most parts involved in solving this model, but one does not touch anything that is based on the zero-profit-condition. Instead, one can calculate equilibrium-employment as stated in (I.22) by imposing zero profits on (I.28).

required to restore zero profits if $\xi_t > \frac{1}{\sigma-1}$ and a decline in aggregate employment is required otherwise. This

represents another way of looking at the condition in (I.27) which is a special case of the formula in the more

general model, (I.25).[42]

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[42] One might be worried that if firm-level profits are increasing in aggregate employment near the unique per-period Nash equilibrium, equilibrium might be "unstable" so that such a case would have to be ruled out based on a standard tâtonnement-argument which would assert that in such a case, the entry of further firms by means of increasing aggregate employment would drive up profits even further which – according to a tâtonnement-argument – would lead to additional incentives for further entry and so forth. However, this concern is not justified since such a tâtonnement-argument cannot be applied under the timing assumptions I have made (cf. section I.2.6): Under those assumptions, firms decide about entry period by period in a simultaneous, economy-wide "one shot"-game, so that zero profits obtain necessarily in each single period as the mass of producers adjusts ("jumps") instantaneously at the beginning of each single period to the (unique) value consistent with zero profits given the economic fundamentals which are relevant for the respective period. And since there is only a single equilibrium of this entry-game in this version of the model with standard CES-preferences and the isoelastic WD-curve, one can be sure that it will represent the outcome of the economy-wide entry-game taking place at the beginning of each single period – regardless what a tâtonnement-argument would say. In a nutshell, under my timing assumptions, which arguably make much sense given empirical results on firm entry and exit as discussed in section I.2.6, there is no room for non-zero profits and out-of-equilibrium dynamics on which a tâtonnement-argument would have to rely by asserting that positive profits attract entry and negative profits induce exit. Instead, firms can be expected to play the (unique) Nash equilibrium of the per-period game period by period regardless of the relationship between firm-level profits and aggregate employment in the vicinity of the corresponding equilibrium point, so equilibria which in their vicinity exhibit an increasing relationship between profits and aggregate employment are still meaningful. And even if one worked with an alternative dynamic model of entry where the mass of firms which could produce is a (potentially slowly moving) state-variable so that a tâtonnement-argument could reasonably be applied, one still cannot rule out cases in which demand-side policies are required to raise aggregate employment. A single example of a model of this class with a unique equilibrium that requires a demand-side policy to boost aggregate employment and is still tâtonnement-stable is sufficient to prove that claim and such an example is contained in part II of this dissertation where I explore an open-economy version of the present model with standard CES-preferences and an isoelastic WD-curve and where I show that if one makes assumptions about firm entry in the spirit of Hopenhayn (1992) and Melitz (2003) and models entry as a two-step process, the model may have a unique equilibrium in which demand-side policies in the labor market are required to raise aggregate employment and which is stable according to a standard tâtonnement-argument. To see this point in that related open-economy paper, one simply needs to consider the limiting case of $f^X \to \infty$ which goes back to a closed economy. These arguments are elaborated in detail in section II.6.1 and most notably in footnote 173 in part II of this dissertation. Intuitively, and as I discuss in detail in that related work, tâtonnement-stability obtains in that case as expected profits from the pre-entry perspective may at the same time be increasing in aggregate employment but decreasing in the mass of firms which have completed the first stage of the entry-process and which therefore *could potentially* produce. That mass serves as the (slowly moving) state-variable for the stability argument (and is denoted by N^A in that paper). Aggregate employment and the mass of firms which *actually* produce (by completing the second stage of the entry-process, too), however, remain positively related across equilibria so that that modified model still features a positive co-movement between the mass of producers and aggregate employment, which is the element that gives rise to upwards-sloping EE-curves and which – as explained above – is driving the right-hand side of my central elasticity-formulas in the present paper as well as in that related work. These points are discussed in detail in footnote 174 in part II of this dissertation. Finally, tâtonnement-arguments have their own serious problems, which is why they are not necessarily a good choice for restricting the parameter space or selecting equilibria: By positing that the entry/exit-decisions of a firm are guided by the profits the firm could earn (avoid earning) when entering (exiting) given what all others do, such tâtonnement-arguments implicitly assume that firms are not fully rational and forward-looking in their decision-making since a fully rational firm would of course have to take into account that other firms may enter/exit at the same time and taking that into account would require computing the level of profits that is relevant for the entry/exit-decision in a different way rather than just

More broadly, what this example reveals is a very simple and intuitive mechanism: Marginal changes in labor market institutions – by affecting the level of real wages firms need to pay conditional on aggregate employment – change firm-level profits near equilibrium all else equal. But since free entry requires zero profits in equilibrium, adjustments in aggregate variables such as aggregate employment are required to maintain equilibrium. In particular, firm-level profits are affected by the level of aggregate employment through up to four channels which all operate through externalities that are related to the four elasticities showing up in the crucial formula in (I.25): First, inasmuch as the mass of producing firms changes with aggregate employment (this is the extensive margin), firm-level profits are also affected by "product-variety-effects" and – once one leaves the standard CES-case – by "pro-competitive effects", i.e. changes in mark-ups due to changes in the toughness of competition. These effects play out via residual demand curves and thus affect firm-level profits by changing how much a firm could sell at a given price: The product-variety-channel means that the mass of producers affects residual demand either directly via the presence of the variety-effect-term in the residual demand curve or indirectly (e.g. through the price-index) as can be seen from the expression for residual demand curves in (I.5) and – unless one is in a world of standard CES-preferences – the "variable-mark-ups-channel" typically shows up in residual demand curves, too (e.g. through the endogenous elasticity of substitution which in turn affects the optimal mark-ups firms charge). These two channels are clearly connected to the elasticities η_μ, η_V and η_X, where the last one is important inasmuch as it links N_t to L_t^E while the former two are only defined with respect to N_t. Second, the pecuniary externality in the labor market affects firm-level profits via two channels – a "cost-channel" and an "aggregate-demand-channel": Obviously, as aggregate employment rises, a higher value of $\eta_{WD,t}(L_t^E)$, i.e. a stronger pecuniary externality in the labor market, implies that real wages increase by more, which – all else equal – has obviously negative effects on the profitability of firms (cf. equation (I.12)). This is the "cost-channel" associated with the pecuniary externality in the labor market. But as (I.12) also reveals, the level of aggregate demand as captured by C_t matters for the profitability of firms, too, and since it has been shown that $C_t = w_t L_t^E$ is true in equilibrium due to zero profits,

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looking at the level of profits currently active firms earn. In fact, the level of profits currently earned by producing firms should be irrelevant to a fully rational and forward-looking firm that contemplates whether or not it wants to produce in the next period. And in light of the fact that there is a lot of turnover at the firm-, plant- and product-level in the data (cf. the discussion in section I.2.6) such a restriction of rationality whereby firms do not take into account that others may enter/exit simultaneously with them seems to be a very bad modelling choice and similarly, assuming that the mass of producers is a slowly moving state-variable (so that rational firms in their entry/exit-decisions could in fact make use of the level of profits currently earned by active firms) seems not to square at all with reality, either.

making use of the WD-curve from (I.3) to substitute out w_t then implies that the elasticity of aggregate demand C_t with respect to changes in aggregate employment L_t^E is $1 + \eta_{WD,t}(L_t^E)$. Hence, while a higher value of $\eta_{WD,t}(L_t^E)$ tends to reduce firm-level profits via the "cost-channel" as aggregate employment increases, it at the same time pushes towards higher firm-level profits through this "aggregate-demand-channel" that is associated with the pecuniary externality in the labor market, too. Consequently, the pecuniary externality in the labor market operates through two channels which work in opposing directions. As precisely the externalities which are related to the four elasticities appearing in my central formula, (I.25), shape the relationship between firm-level profits and aggregate employment, it is very intuitive why the relationship between these four elasticities as implied by (I.25) is crucial for determining whether supply-side or demand-side policies are required for increasing aggregate employment if one recalls that aggregate employment needs to adjust to maintain zero profits at the firm-level when changes in labor market institutions would lead to an increase or decline in firm-level profits all else equal.

This simple example with CES-preferences and the isoelastic WD-curve is also interesting for the purpose of studying the effects of population growth in this model in a very transparent way: Suppose exogenous labor supply L increases between any two consecutive periods. In that case, the rate of aggregate employment, $\frac{L_t^E}{L}$, and the level of aggregate employment, L_t^E, increase from the old to the new unique per-period Nash equilibrium if and only if the condition in (I.27) is satisfied and decrease otherwise, which means that increases in aggregate labor supply affect aggregate employment exactly like a supply-side policy. This follows straight from (I.22) and it is very intuitive given that an increase in L reduces real wages conditional on aggregate employment due to the specification of the WD-curve, but a reduction of real wages conditional on the level of aggregate employment is just the definition of a supply-side policy and hence, the intuition as to why an increase in labor supply may – depending on parameter values – result in lower aggregate employment is similar to what has been said about supply-side policies, too: By working like a supply-side policy an increase in aggregate labor supply puts downwards-pressure on real wages thus implying a negative effect on aggregate demand which translates into lower aggregate employment if the condition in (I.27) is not satisfied so that this effect dominates the one through which firms are more profitable when wages decline. Note, however, that in the more general setting a decline in aggregate employment in response to an increase in L can only result if the product-variety-channel and/or the variable-mark-ups-channel operate: Whenever those channels are absent so that η_μ and η_V are both zero, it is

necessarily the case that changes in L lead to exactly proportional changes in the level of aggregate employment thus leaving the (un)employment rate unaffected.[43]

I.4.4 Remarks on the Nature of Unemployment through the Lens of this Model

EE-curves represent the locus of all possible per-period Nash equilibria of the model when disregarding only the wage-determination process.[44] Inasmuch as EE-curves are generally non-decreasing, it follows that whenever unemployment arises in this type of model, it represents a *coordination failure*. To see this, note that at points on the EE-curve which are located farther to the "northeast", i.e. associated with higher employment and (weakly) higher real wages, everyone can be (weakly) better off (or can at least be made better off by means of lump-sum transfers to overcome distributional issues) than at points on the EE-curve located farther in the "southwest": Along that curve profits are zero anyway, so producers are indifferent, but aggregate consumption will be higher in the "northeast" than in the "southwest" of the EE-curve. Hence, whenever labor market institutions are such that the wage-determination process captured in the WD-curve induces the economy to coordinate on a point on the EE-curve with less than full-employment, it selects an equilibrium which is not Pareto-optimal. The question then is why the economy can actually fail to coordinate on the point on the EE-curve that has full-employment if agents actually agree on that point being the most desirable one. That is, why do agents not all agree on the real wage that is implied by the EE-curve for full-employment? The answer has to do with the fact that – as assumed in my model and as captured in the firm-specific wage-determination schedules in (I.3) – wages are usually determined in a highly decentralized manner and *given* what everyone else does, any single firm and any single worker – who are all of negligible size relative to the whole economy and thus do not have to internalize the effect of their actions in the wage-determination process on aggregate outcomes – have an incentive to exercise in the wage-determination process the full bargaining power the institutional details of the labor market give to them (either explicitly or

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[43] To see this, recall that the EE-curve is horizontal if η_μ and η_V are both zero and thus, real wages are effectively pinned down by the EE-curve. Hence, if the only change in the WD-curve results from a shift in L, aggregate employment needs to adjust such that the real wage coming out of the WD-curve is consistent with the unchanged one coming out of the EE-curve. And since WD-curves are assumed to be monotonically increasing in the rate of aggregate employment, this thus requires that the (un)employment rate must remain unchanged as L changes.

[44] In this sense my model is closely related to an earlier vintage of models of unemployment with imperfect competition in product markets and with economies of scale in technology based on the works by Weitzman (1982) and Solow (1986). In appendix I.B I discuss in greater detail the two major dimensions along which my work improves upon works in that earlier literature.

implicitly), where these institutional details are captured in the WD-curve as described above. Thus, the problem that induces this coordination failure leading to unemployment is that the institutional details of the labor market might be such that the bargaining weights they effectively (i.e. explicitly or implicitly) allocate to the two sides of any labor-agreement (firms and workers) as captured by the position of the WD-schedule might not be optimal in the sense of not resulting in full-employment under decentralized wage-determination at the firm-level.

My analysis in this paper implies that this coordination failure can be solved without centralizing wage-determination: What needs to be done is designing institutional details of labor markets in a way such that the relative bargaining power for the two sides of any labor-agreement as summarized in the WD-curve and as captured by the values of the parameters in the vector θ is exactly such that the WD-curve intersects with the EE-curve exactly at full-employment (or at least at a moderate level of unemployment for practical matters). What my analysis also shows is that such a favorable shift in the WD-curve for resolving the coordination failure which leads to unemployment may require different policies depending on the structure of the economy and the simple threshold-rule in (I.25) can offer guidance for figuring out what kind of policy is required.

I.5 Additional Applications of the Theory

I.5.1 Technological Improvements and Product Market (De-)Regulation

Up to this point the analysis has dealt with shifts in the WD-curve while the EE-curve has been stable over time inasmuch as the only changes in parameter values I have allowed for so far are changes in the values of the labor market parameters contained in the vector θ. There are, however, important reasons for which the EE-curve might shift, too. The leading candidates are improvements in technology and changes in the regulation of product markets. Technological progress can show up in this model either as an increase in the technology shifter A over time or as a decline in the level of quasi-fixed costs f^P over time as such changes allow firms to produce a given quantity of output using a lower quantity of inputs. Further, declines in the level of quasi-fixed costs f^P over time may also capture deregulation of product markets as regulatory requirements may impose quasi-fixed costs on active firms. In this subsection, I will study the effects of such changes in the values of the parameters f^P and A over time. In order to keep the notation simple, however, in this subsection as well as in the remainder of the paper I will still not

index these two parameters by time. Likewise, I will continue to refrain from indexing the elasticity of the EE-curve or the EE-curve $w_t = h(L_t^E)$ itself or any elasticities the elasticity of the EE-curve is composed of by time. However, it should be understood that once values of parameters other than the ones contained in θ are allowed to change between periods, the values of these elasticities – even at a given level of L_t^E or N_t – may differ across periods. But as argued in the context of my definition of the elasticities of the EE-curve and of the WD-curve in section I.4.2, the period t elasticities of those curves (as well as η_X which is defined based on (I.15)) are defined based on the period t values of all parameters of the model, i.e. given that parameters are constant within periods these period t elasticities are defined based on stable period t equilibrium relationships of the model so that partial derivatives of these relationships are all one needs in order to characterize the various period t elasticities. Furthermore, similar arguments as in the proofs of PROPOSITIONS I.3 and I.4 imply that for the purpose of characterizing the effects of changes in the values of the parameters A and f^P between periods t and $t + 1$ (recall that I restrict any changes in parameter values to happen between periods) on endogenous variables in terms of the direction in which they move, everything one needs to know are the slopes and hence the elasticities of the EE-curve and of the WD-curve in the per-period Nash equilibrium of period t, which can be figured out based on the period t values of all parameters. Hence, for the purpose of coming up with the values of the relevant elasticities $\eta_{WD,t}$, η_X, η_μ and η_V in the per-period Nash equilibrium of period t one only needs the period t values of all parameters. These points are technically important and need to be understood for the purpose of the exercise I am about to conduct. But as only period t values of parameters will matter, one does not lose much from neglecting the time-indices which the EE-curve, its elasticity as well as the elasticities behind the elasticity of the EE-curve would need in the context of the application studied in this section.

With these technical remarks and remarks about notation (which I will continue to use in other sections when talking about changes in the values of the parameters A and f^P) in mind, one can now analyze the effects of changes in the values of the parameters A and f^P between periods: Note that in the model studied up to this point and in any version of it that will be studied in section I.6 below, an increase in the value of A or a decline in the value of f^P between any two consecutive periods affects the EE-curve $w_t = h(L_t^E)$ in a way such that it implies a (weakly) higher real wage for any given level of aggregate employment $L_t^E \in (0, L]$, i.e. technological progress or product market deregulation induce an upwards-shift/rotation of the EE-curve from one period to the next – heavier

product market regulation in the form of increasing the value of f^P obviously implies the opposite.[45] As technological progress and product market (de-)regulation obviously do not affect the WD-curve, assuming that the only change between two consecutive periods is a change in the value of either A or f^P one can now make similar geometric arguments as contained in the proofs of PROPOSITIONS I.3 and I.4 to arrive at the following conclusion: An increase in A or a decline in f^P from period t to period $t+1$ leads to higher aggregate employment in the spirit of the exercises conducted for the labor market parameters in PROPOSITIONS I.3 and I.4[46] if and only if the following condition in terms of elasticities evaluated at the initial equilibrium level of aggregate employment in period t, L_t^*, is satisfied, while a reduction in aggregate employment results if that inequality is reversed:

$$(I.29) \qquad \eta_{WD,t}(L_t^*) > \left(\left| \eta_\mu \big(N_t(L_t^*) \big) \right| + \left| \eta_V \big(N_t(L_t^*) \big) \right| \right) \big(\eta_X(L_t^*) \big)$$

This is the exact same condition as stated in (I.25) for the case of changes in the values of structural parameters of the labor market – which one can of course think about as "labor market reform". Hence, one can conclude that technological progress is only beneficial and product market deregulation is only helpful in the sense of increasing aggregate employment if the pecuniary externality in the labor market is sufficiently strong so that the elasticity of the WD-curve is sufficiently high relative to the elasticities describing the sensitivity of mark-ups to the toughness of competition, the strength of product-variety-effects in preferences or technology and the extent to which changes in aggregate employment happen along the extensive rather than the intensive margin.[47] The same aspects which in

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[45] To see this point, note that A only appears in (I.14) (and its analogues in the various versions of the model which will follow in section I.6) but not in (I.15) (and its analogues) while the opposite is true for f^P. An increase in the value of A in (I.14) (or its analogues) implies a strictly higher w_t conditional on N_t and since (I.15) (or its respective analogue) defines an increasing function $N_t(L_t^E)$, a higher value of A must imply a strictly higher value for w_t conditional on L_t^E, so that in fact, the EE-curve that is defined by (I.14) and (I.15) (or their analogues in variants of the model) implies a higher real wage for any given admissible level of aggregate employment if the value of A increases. A lower value of f^P implies through (I.15) (or its respective analogue) that a higher value of N_t is required for any given level of L_t^E. But as (I.14) (or its respective analogue) implies a non-decreasing function $w_t(N_t)$, the claim about what happens to the EE-curve in response to a change in the value of f^P follows immediately, too.

[46] I.e. aggregate employment is higher in the per-period Nash equilibrium of period $t+1$ than in the corresponding one of period t (in the sense of PROPOSITION I.4) if marginal changes in the values of those two parameters are considered while aggregate employment is higher in the unique per-period Nash equilibrium of period $t+1$ than in the unique one of period t if per-period Nash equilibrium is unique both before and after a potentially non-marginal change in the value of A or f^P.

[47] The intuition for these results is exactly the same as the one for structural changes in the labor market which I have discussed in the context of the example with CES-preferences and an isoelastic WD-curve: Changes in the

the sense of COROLLARY I.2 make supply-side approaches to labor market reform more likely to raise aggregate employment thus make it also more likely that technological progress and product market deregulation bring about higher aggregate employment. In the spirit of the necessary conditions established in COROLLARY I.3 for the case of changes in the values of structural parameters of the labor market, one can thus conclude that for product market deregulation or technological progress to have detrimental effects on aggregate employment, the presence of an endogenous extensive margin of production and of either variable mark-ups and/or product-variety-effects in technology or preferences is a necessity. Conversely, in that same spirit, the presence of a pecuniary externality in the labor market that makes real wages endogenous to aggregate labor market conditions is a necessary condition for beneficial effects of technological progress and of product market deregulation on aggregate employment. An implication of these results is that heavier regulation of product markets might be a desirable objective for economic policy as soon as real wages are not very sensitive to aggregate labor market conditions or if product markets exhibit strong variety-effects and/or a high sensitivity of mark-ups to the toughness of competition along with a sufficiently important extensive margin.

These findings challenge those of a preceding literature on the employment-effects of product market deregulation: Blanchard and Giavazzi (2003) and Ebell and Haefke (2009) have argued that product market deregulation in the sense of lower quasi-fixed costs of production or lower entry-costs generally raises aggregate employment. Felbermayr and Prat (2011) have argued that it might be necessary to raise quasi-fixed costs of production for reducing unemployment, but their argument is based on a pure "selection effect" that only operates with heterogeneous firms, while they agree with the earlier literature that product market deregulation in the form of reducing quasi-fixed costs is needed to raise aggregate employment in the case of homogeneous firms. Making less strong assumptions on technology, preferences and labor market institutions than in that literature, I show that the conclusions may be different depending on the values of the various elasticities in (I.29).

I.5.2 "Transitional Dynamics"

Let me now explore some alternative assumptions on dynamics. I will go through two interesting exercises: First, I will explicitly allow for entry by firms to take time (which could represent "time to build" following the general

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values of A or f^P change firm-level profits all else equal, so aggregate employment needs to adjust to restore zero profits.

idea in Kydland and Prescott (1982)) and discuss how this changes the effects of changes in structural parameters of the labor market over shorter time-horizons.[48] Second, I will study the implications of labor market institutions being endogenous to lags of the state of technology in the economy and explain how my framework can be used to understand why technological improvements may reduce aggregate employment on impact.

Thinking about these issues does not require big changes of the basic model: Let me begin with the case in which entry takes time. To study that case, one can simply look at a version of the basic model in which any change in the value of a structural parameter included in θ from period t to period $t+1$ becomes known only after firms have made commitments about entry for period $t+1$ but before any other type of decision or action occurs in period $t+1$, where it is still assumed that firms decide about entry at the very beginning of any given period. Hence, under these slightly modified timing assumptions firms still make their entry-decisions period by period, but they make their entry-decisions for any given period t based on expected period t values of the parameters of the model. In particular, for simplicity let me assume that any change in parameter values is unexpected and that once it is realized, firms expect parameter values to remain at their new values in all future periods. Under that modification of the model, there is still no inter-temporal decision-making, so one remains in the world of "per-period equilibrium" studied above, but now there is a transition phase of exactly one period. To analyze the effect of structural change in the labor market under these alternative timing assumptions, let me conduct the following thought experiment which isolates the effects of a single structural change in the best possible way: Suppose that there is a change in the value of some parameter in θ between periods $t-1$ and t but no change in any parameter values between periods $t-2$ and $t-1$ and no change in any parameter values between periods t and $t+1$. These assumptions on the dynamic structure of structural change in the labor market make sure that the economy is in a per-period Nash equilibrium with zero profits in periods $t-1$ and $t+1$, respectively, i.e. the equilibria in those two periods resemble the ones from the basic version of the model as expected and actual parameter values coincide for those two periods. Making sure that the economy is in such a type of equilibrium in those two periods allows tracing out how the economy moves from a standard per-period Nash equilibrium of the type analyzed above in period $t-1$ to a new (and different) per-period Nash equilibrium of the type analyzed above in period $t+1$ with a transition phase of exactly one period, namely period t. The effect of such structural change when

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[48] The analysis of the implications of "time to build" in firm entry would be similar for changes in the values of A or f^P, but I restrict the discussion to changes in values of the parameters in the vector θ in the interest of brevity.

comparing the equilibria of periods $t - 1$ and $t + 1$ (one might want to think of this as the "long-run effect") is thus

exactly as described above and is governed by the same elasticity formulas as established above for the basic

version of my timing assumptions which does not allow for a transition period.[49] Hence, it remains to characterize

the behavior of the economy during that transition period by answering the question whether aggregate employment

in the transition period t is higher or lower than in period $t - 1$. Under my assumptions on timing and expectations,

for the particular dynamic structure of structural change in the labor market I adopt for the purpose of my thought

experiment it follows that $N_t = N_{t-1}$ holds, i.e. the mass of producers in period t (the transition period) will be

equal to the mass of producers in period $t - 1$ before that mass finally adjusts ("jumps") to a new value in period

$t + 1$.[50] That transition period then works exactly as if N_t was assumed to be exogenous (and equal to the value of

N_{t-1}) so that the EE-curve is horizontal as argued above.[51] This immediately implies the following results for the

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[49] Technically, it also needs to be assumed that equilibrium switching does not occur in the case in which per-period Nash equilibrium is not unique in periods $t - 1$ and $t + 1$ as the results from the basic version of the model only apply to the case of unique per-period Nash equilibria or to the case of "corresponding" per-period Nash equilibria as defined in PROPOSITION I.4 for marginal changes in the value of a parameter of the model. Hence, my analysis in this subsection is restricted to those two cases, too.

[50] Note that unless per-period Nash equilibrium is unique under the parameter values prevailing in period $t - 1$, the assumption of "no equilibrium switching" is required to obtain $N_t = N_{t-1}$ in this thought experiment: As there is no change in parameter values between periods $t - 2$ and $t - 1$ and as the change in parameter values between periods $t - 1$ and t is unexpected, $N_t = N_{t-1}$ obtains under the assumption of "no equilibrium switching" from the entry-process taking place at the beginning of period t before the change in parameter values between periods $t - 1$ and t is learned by agents. Further, note that during the transition period profits will typically not be zero. However, whether they are positive or negative has no implications for whether the mass of producing firms will be higher or lower in the period after the transition period, i.e. positive (negative) profits during the transition period do not necessarily imply an increase (a decline) in the mass of producing firms from the transition period to the next period. The reason for that is that profits during the transition period do not matter for the entry/exit-decisions firms make for the subsequent period when those profits/losses are already sunk. Those entry/exit-decisions for the subsequent period will necessarily be such that zero profits obtain again in that subsequent period (in actual terms if there is no further change in parameter values after the transition period as I assume for the present thought experiment and in expectation if there was one) and that may require an increase or a decline in the mass of producers regardless of the level of profits during the transition period.

[51] In particular, one can characterize the behavior of the economy in the transition period t by means of looking at a version of the basic model studied above where N_t is exogenously fixed at the value of N_{t-1}. In that case, the zero-profit-condition in (I.13) is irrelevant for period t and the EE-curve is simply given by equation (I.14) and is therefore horizontal. More precisely, the EE-curve in period t is horizontal at the equilibrium level of the real wage from period $t - 1$. To see this, recall that $N_t = N_{t-1}$ applies, but for a given level of the mass of producers (I.14) directly implies a level for the real wage and since the parameters in (I.14) do not change between periods $t - 1$ and t, the EE-curve during the transition period is horizontal at the equilibrium level of the real wage from period $t - 1$. This horizontal EE-curve thus fully pins down the level of the real wage during the transition period and as a consequence, the real wage in the transition period is the same as in the preceding period. The intersection of this horizontal EE-curve with the WD-curve of period t then determines aggregate employment during the transition period. Note that due to $N_t = N_{t-1}$ there will generally be a unique equilibrium during the transition period since the EE-curve is horizontal but the WD-curve is strictly increasing. As explained above, equation (I.15) does not

effects of a change in the value of some parameter in the vector θ on aggregate employment during the transition period which is present under these alternative timing assumptions which allow for "time to build" in firm entry: Changes of structural parameters of the labor market qualifying as supply-side policies have beneficial effects during the transition period in the sense that regardless what their long-run (i.e. beyond the transition period) implications are, supply-side policies increase aggregate employment during the transition period, i.e. aggregate employment during the transition period t is higher than in period $t-1$. Conversely, demand-side changes in the structure of the labor market necessarily reduce aggregate employment during that transition period. Such negative effects happen in the case of demand-side policies even though such policy-changes might entail benefits in the long-run as shown above. Hence, the major conclusion from this study of "transitional dynamics" resulting from "time to build"-elements in firm entry is that supply-side policies in the labor market do not entail lower employment during the transition phase, while demand-side policies – even though they might be beneficial after the transition phase – bring about lower aggregate employment until the mass of producers adjusts to the new structure of the economy.

Let me now go back to the original timing assumptions but let me turn to a case where the labor market parameters in the vector θ are at least in part endogenous to parameters capturing technology or regulatory requirements (such as A and f^P) and where the values of the parameters in the vector θ adjust to changes in the values of those other parameters with a lag of at least one period. Making parameters in θ endogenous to lagged values of A, for instance, again introduces "transitional dynamics" without introducing inter-temporal decision-making but preserving the "one shot"-nature of the game played within periods. As an example of what such an alternative modelling choice could represent, consider the "search and matching"-model of the labor market as discussed by

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apply if N_t is exogenous, but if one derives an expression for aggregate employment analogously to the derivation of (I.15) but without imposing the zero-profit-condition from (I.13), one can recover aggregate consumption in period t once one knows aggregate employment and real wages. The effects of supply-side and demand-side policies which are implemented between periods $t-1$ and t on aggregate employment during the transition period t are now straightforward to characterize noting first that if the WD-curve did not shift from period $t-1$ to period t, there would not be any difference in aggregate employment between periods $t-1$ and t (simply because the EE-curve implies $w_t = w_{t-1}$ as a result of $N_t = N_{t-1}$). But since a supply-side policy reduces real wages conditional on aggregate employment and thus leads to a downwards-shift/rotation of the WD-curve, a higher level of aggregate employment is required during the transition period than in period $t-1$ as the real wage remains unchanged between those two periods. Conversely, as demand-side policies increase real wages conditional on aggregate employment and thus lead to an upwards-shift/rotation of the WD-curve, a lower level of aggregate employment than during period $t-1$ obtains during the transition period. The equilibrium in period $t+1$ is then calculated exactly as in the basic version of the model as the mass of producers then adjusts to the change in parameter values that occurred between periods $t-1$ and t and as there is no further change by assumption.

Pissarides (2000): As is well known, models of this type typically require search costs to be increasing with labor productivity to generate constant steady-state unemployment along with economic growth. Hence, they require a labor market parameter (in that case the level of search costs) to be endogenous to labor productivity, which is related to A in my model. Conversely, in business cycle applications of the "search and matching"-model with technology shocks – i.e. with variation in A over time – that assumption is typically dropped (e.g. Shimer (2005)) to generate fluctuations in aggregate employment over the cycle. Hence, the "search and matching"-literature tends to assume that the level of search costs as an important labor market parameter only adjusts one for one to changes in technology over longer horizons, but not necessarily over shorter ones.

In the context of my model assuming that at least one parameter contained in θ is a function of a lag of A implies that if one looks at a single increase in the value of A between two consecutive periods ("technological progress") and then traces out the effects of such a "shock" over time without allowing for any other structural changes in the economy (except for the adjustment in the values of the parameters contained in θ that will occur at some point in response to the change in the value of A), the WD-curve remains unchanged during a transition phase that lasts until the values of the parameters in θ adjust to that change in the level of A, while the EE-curve is rotated/shifted upwards immediately (and will remain there) in the space with aggregate employment on the horizontal axis – exactly for the reasons explained above. Depending on the values of the various elasticities showing up in the central threshold-rule in (I.25) in the initial per-period Nash equilibrium, aggregate employment may thus decline during the transition period(s) after the technology shock when the WD-curve has not shifted, yet. In particular and for the reasons explained in the last subsection, aggregate employment declines on impact when the technology improvement is realized between periods t and $t + 1$ if the value of $\eta_{WD,t}$ in the per-period Nash equilibrium of period t is sufficiently low. But under the assumption that θ is endogenous to some lag of A, a shift in the WD-curve will occur in a subsequent period and that shift will change aggregate employment again, where the direction depends first on how one specifies the link between θ and A and second on the values of the various elasticities showing up in the central threshold-rule in (I.25) in the per-period Nash equilibrium that occurs during the transition period(s). In particular, if one chooses specifications as in the "search and matching"-literature that imply that changes in A leave aggregate employment unaffected in the long-run, one can generate a pattern according to which technological improvements lead to reductions in aggregate employment during a transition phase and do not

affect aggregate employment in the long-run. Hence, to the extent that one can think of reasons for which labor market institutions as summarized in the parameters contained in θ may be endogenous in a suitable way to lags of the state of technology as captured by A, my analysis can explain why technological improvements might have contractionary effects on aggregate employment in the short-run – as found by a large empirical literature following upon seminal contributions by Shea (1999), Galí (1999) and Basu, Fernald and Kimball (2006). In contrast to most of the other explanations for this phenomenon which have been proposed, my model neither requires nominal rigidities to yield such a result,[52] nor are the employment-fluctuations it implies in response to changes in technology driven by the intra-temporal labor-supply-decisions and/or the inter-temporal savings-decisions by an optimizing representative household, which would make it hard to consider such employment-fluctuations as "involuntary" and "inefficient".[53] In appendix I.C I show that my model is closely related to a static version of the "search and matching"-model of the labor market à la Mortensen and Pissarides (1994) if that model is augmented by imperfect competition, product differentiation and economies of scale firms can exploit. Consequently, my analysis also implies that a "search and matching"-model may in fact be consistent with technology improvements being contractionary in the short-run.[54] More broadly, my analysis implies that imperfect competition and labor market frictions can jointly explain that phenomenon, which has not found much emphasis in the literature to this date.[55]

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[52] The contributions by Galí (1999), Basu, Fernald and Kimball (2006) and Liu and Phaneuf (2007) represent examples of attempts to explain this phenomenon with the help of nominal rigidities.

[53] Examples of explanations for the contractionary effect of technology shocks resorting to "adjustment frictions" in purely real RBC-type models with a labor-leisure-choice include the works by Vigfusson (2004), Francis and Ramey (2005) and Wang and Wen (2011). The contribution by Michelacci and Lopez-Salido (2007) also contains an element of endogenous preference-driven labor supply in spite of building in "search and matching"-frictions. Further, their analysis is not based on imperfect competition and thus emphasizes different channels.

[54] In the "search and matching"-model I study in appendix I.C, the relationship between the level of search costs (which I denote by ϑ in appendix I.C) and the technology shifter A that is required to ensure that changes in A do not affect aggregate employment is that ϑ_t needs to be proportional to $(A_t)^{\frac{\sigma-1}{\sigma-2}}$. Hence, if one posits that $\vartheta_t = \kappa\left((A_{t-s})^{\frac{\sigma-1}{\sigma-2}}\right)$ with $s \geq 1$ and $\kappa > 0$ being constants, changes in the value of A over time do not change aggregate employment in the long-run (i.e. after the transition phase of s periods), but lead to increases or declines in aggregate employment within s periods after the policy-change, where the condition under which aggregate employment increases/declines during that transition phase of s periods is the same as the one discussed in detail in appendix I.C for the case of technological progress with ϑ being independent from A.

[55] Basu, Fernald and Kimball (2006) review different categories of explanations for the contractionary effect of technology shocks in their paper. My approach is related to previous models of "adjustment frictions", though, in

I.6 Extensions and Robustness-Checks[56]

I.6.1 A Different Demand System

I will now present an example of an alternative and quite general demand system and show that my results go through and thus do not depend at all on the somewhat special assumptions of the CES-demand-system extended along the lines of Blanchard and Giavazzi (2003) and Benassy (1996, 1998) as posited in (I.1). An alternative demand system which is still tractable enough is the "quadratic mean of order r (QMOR) expenditure function" which has recently been analyzed and adopted to general equilibrium models of monopolistic competition by Feenstra (2014) in a trade-context. That system nests the standard CES-case as a limiting case and comprises several other prominent demand systems as special cases, too.[57] Feenstra (2014) analyzes this system in quite general terms, but I will restrict attention to the two major cases he discusses, namely $r < 0$ and $0 < r \leq 2$, and ignore the limiting cases he goes through. That demand system is defined by an expression for the consumption-based price-index and in terms of the notation I use in the present paper, the QMOR expenditure function can be written as follows for $r \neq 0$:

(I.30)
$$P_t = \left[\alpha \int_{\omega \in \Omega}((P_t(\omega))^r)d\omega + \beta\left(\left(\int_{\omega \in \Omega}\left((P_t(\omega))^{\frac{r}{2}}\right)d\omega\right)^2\right)\right]^{\frac{1}{r}} \quad \forall t$$

According to Feenstra (2014) the following restrictions on parameter values are required: If $r < 0$, then $\alpha > 0$ and $\beta < 0$, while if $0 < r \leq 2$, then $\alpha < 0$ and $\beta > 0$. Further, the set of varieties which could in principle be produced – which I still denote by Ω – needs to be bounded and I follow Feenstra (2014) in denoting the mass of varieties in this set by $\widetilde{N}$. As Feenstra (2014) points out, it is also necessary to assume that parameter values are such that $0 < \left[\widetilde{N} + \frac{\alpha}{\beta}\right] < N_t$ in equilibrium whenever $0 < r \leq 2$ and such that $\left[\widetilde{N} + \frac{\alpha}{\beta}\right] < 0$ if $r < 0$. Feenstra (2014) proves that under these restrictions the expenditure function in (I.30) has the properties one needs in order to apply it to a setting with monopolistic competition and he shows that the residual demand curves obtaining from this demand system are as follows (in terms of my notation):[58]

$$(I.31) \qquad d_t(\omega) = \alpha C_t \left[\left(\frac{P_t(\omega)}{P_t}\right)^{r-1}\right]\left[1 - \left(\left(\frac{\overline{P_t}}{P_t(\omega)}\right)^{\frac{r}{2}}\right)\right] \quad \forall \omega \in \Omega \; \forall t$$

$\overline{P_t}$ denotes the reservation price above which demand is zero, which – in contrast to the CES-system – is finite for this demand system. A useful analytical expression for $\overline{P_t}$ derived by Feenstra (2014) can be found in appendix I.D of my paper.

Everything else is assumed to be as specified in section I.2. This slightly modified version of the basic model can then be solved for per-period Nash equilibrium in a way that is completely analogous to what has been done in section I.3. The only minor difference consists in the fact that one cannot aggregate up firm-level output as a closed-form expression for the aggregator for the aggregate consumption good does not exist. However, given homotheticity, this aggregation step can be carried out with the help of the expenditure function defining the demand system, (I.30), using the equilibrium prices at the firm-level.[59] Equilibrium prices at the firm-level coming out of profit maximization are:[60]

$$(I.32) \qquad P_t(\omega) = \frac{\frac{r}{2}N_t - (r-1)\left[\widetilde{N} + \frac{\alpha}{\beta}\right]}{\frac{r}{2}N_t - r\left[\widetilde{N} + \frac{\alpha}{\beta}\right]} \frac{w_t(\omega)}{A} P_t \quad \forall \omega \in \Upsilon_t \; \forall t$$

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[58] As in the basic version of my model, I set per-period utility by the representative household equal to C_t.

[59] Recall that in the basic version of the model the aggregator is homothetic, too, so aggregation can be carried out in either way, too, in that basic version.

[60] In deriving this one makes use of the fact that in equilibrium all firms charge the same price and one uses the expression for $\overline{P_t}$ presented in appendix I.D.

Hence, under the production technology I have assumed, the equilibrium mark-up over nominal marginal costs at

the firm-level is given by $\mu(N_t) = \frac{\frac{r}{2}N_t-(r-1)\left[\tilde{N}+\frac{\alpha}{\beta}\right]}{\frac{r}{2}N_t-r\left[\tilde{N}+\frac{\alpha}{\beta}\right]}$. Thus, once again $\mu(N_t)$ is completely pinned down by parameter

values characterizing the demand system and by the mass of producing firms, N_t. In particular, as that mass

increases, $\mu(N_t)$ can be shown to decline.[61] Consequently, a mark-ups-channel is clearly operating and the

elasticity of $\mu(N_t)$ with respect to N_t, $\eta_\mu(N_t)$, is negative $\forall\ N_t > 0$. To see the product-variety-channel at work in

this model, one starts from an expression for P_t which contains only the prices of the varieties that are actually

available in the market which Feenstra (2014) derives and which can be found in appendix I.D of the present paper.

That expression implies that in an equilibrium in which all producing firms charge the same price $P_t(\omega)$, one can

write the price-index as $P_t = \left(V(N_t)\right)\left(P_t(\omega)\right)$ where $V(N_t) = \left[\alpha N_t - \frac{\alpha((N_t)^2)}{N_t-\left[\tilde{N}+\frac{\alpha}{\beta}\right]}\right]^{\frac{1}{r}}$ thus denotes the "variety-effect-

term" and it is straightforward to show that $V(N_t)$ is declining in N_t, i.e. if more varieties are available, the "cost of

living"-index P_t declines for a given level of prices at the product-level. Defining the elasticity $\eta_V(N_t)$ as before as

the elasticity of $V(N_t)$ with respect to changes in N_t and thus as the elasticity of the "cost of living"-index P_t with

respect to N_t given the level of prices at the product-level one obtains $\eta_V(N_t) = -\frac{1}{r}\frac{\tilde{N}+\frac{\alpha}{\beta}}{N_t-\left[\tilde{N}+\frac{\alpha}{\beta}\right]} < 0$.

The model can be solved further in a very similar way as in section I.3 to arrive at two equations that exactly

correspond to equations (I.14) and (I.15) in the basic version. Those equations are:

(I.33) $$w_t = \frac{1}{\mu(N_t)}A\frac{1}{V(N_t)}\ \ \forall t$$

(I.34) $$L_t^E = f^P\frac{\frac{r}{2}N_t-(r-1)\left[\tilde{N}+\frac{\alpha}{\beta}\right]}{\tilde{N}+\frac{\alpha}{\beta}}N_t\ \ \forall t$$

In fact, equation (I.33) is exactly identical to equation (I.14) – only the terms $\mu(N_t)$ and $V(N_t)$ are now different

under the different preference specification. But the major insight still holds according to which real wages are

inversely related to mark-ups and are also affected by a product-variety-channel and other than that only by

technology. Equation (I.34) is the analogue of equation (I.15) from the basic version of the model. The function

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[61] Further, note that the model also requires $N_t > 2\left[\tilde{N}+\frac{\alpha}{\beta}\right]$ to be well-behaved in the case $0 < r \leq 2$ as mark-ups
would not be positive otherwise. Such an additional condition is not required for the case $r < 0$.

$L_t^E(N_t)$ defined by (I.34) is strictly increasing over the range of admissible values for N_t and it is differentiable, which means that its inverse function $N_t(L_t^E)$ (which is implicitly defined by (I.34) over the corresponding range of admissible values for L_t^E) is differentiable, too, and further, this function $N_t(L_t^E)$ is strictly increasing over the range of admissible values for L_t^E.[62] The elasticity $\eta_X(L_t^E)$ is defined as above with respect to that function $N_t(L_t^E)$ in this version of the model, too. Furthermore, as (I.33) defines a differentiable, strictly increasing function $w_t(N_t)$ over the range of admissible values for N_t, it follows that (I.33) and (I.34) jointly define a differentiable and strictly increasing function $w_t(L_t^E)$ which takes on only strictly positive values on the range of admissible values for L_t^E. This is the EE-curve of this modified version of the model and as just argued, it retains all the properties from the one from the basic version: It is differentiable and non-decreasing everywhere over the relevant range and it is composed of two functions which are (implicitly) defined by (I.33) and (I.34), which have the same structure as (I.14) and (I.15) from the basic version of the model, respectively. Thus, an argument analogous to the proof of PROPOSITION I.6 implies that the elasticity of the EE-curve under this alternative demand system can again be written as in (I.24). As per-period Nash equilibrium is again given by any intersection of EE-curve and WD-curve (which is implied by (I.3) along with $w_t(\omega) = w_t \ \forall \omega \in Y_t \ \forall t$) for which $L_t^E \leq L$ holds and for which the implied values for N_t satisfy the relevant restrictions and as $C_t = w_t L_t^E$ holds again in any per-period Nash equilibrium, it thus follows that PROPOSITIONS I.3 through I.6 and COROLLARIES I.2 and I.3 go through without any further modification and in particular, the central formula in (I.25) still holds. Hence, my analysis is robust to different assumptions about demand systems.

I.6.2 Firms of Non-Negligible Size and Homogeneous Products: Cournot Competition

In this subsection I demonstrate that my results do not depend on the assumption of monopolistic competition and that they do not depend on having product differentiation, either. Obviously, with homogeneous products there will no longer be a product-variety-effect, but that only means that $\eta_V = 0$ and in light of the formula for the elasticity of the EE-curve from (I.24) this still leaves ample room for a mark-ups-channel along with an endogenous

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[62] The ranges of admissible values for N_t differ depending on whether one is in the case $r < 0$ or in the case $0 < r \leq 2$. In the case $r < 0$, the only restriction is $N_t > 0$ so that all strictly positive values for L_t^E are admissible from the perspective of (I.34). Conversely, in the case $0 < r \leq 2$, the restriction $N_t > 2\left[\tilde{N} + \frac{\alpha}{\beta}\right]$ is required, which translates into a lower bound on admissible values for L_t^E via (I.34) so that L_t^E needs to lie above that lower bound. In addition, for the purpose of the EE-curve L_t^E must not exceed L in either case for the same reasons as discussed in the context of the basic version of the model.

extensive margin to give rise to an upwards-sloping EE-curve. In fact, I will show in this subsection that a simple general equilibrium model of Cournot oligopoly can be represented in terms of a differentiable and upwards-sloping EE-curve whose elasticity is described by the formula from (I.24) with $\eta_V = 0$.

To make that argument, I modify my basic model from section I.2 by incorporating elements from the macroeconomic general equilibrium model of Cournot competition analyzed by Dos Santos Ferreira and Dufourt (2006). The basic idea in their model is that firms are large with respect to their respective sectors but not with respect to the economy so that firms still take variables at the economy-wide (i.e. aggregate) level as given when making their decisions but internalize the impact of their decisions on sectoral outcomes. To model this, I follow these authors in assuming that there is a fixed finite but very large number of sectors M in the economy where I will index sectors by j. These sectors produce different products but within sectors products are homogeneous. As I keep the number of sectors exogenously fixed, there are no product-variety-effects by construction. Aggregate consumption C_t is now specified according to the same simple Cobb-Douglas aggregator as in Dos Santos Ferreira and Dufourt (2006):

$$(I.35) \qquad\qquad C_t = M \left(\prod_{j=1}^{M} \left((Y_t(j))^{\frac{1}{M}} \right) \right) \ \forall t$$

$Y_t(j)$ denotes the total output of sector j in period t, which – due to the homogeneity of products within sectors – is the simple sum over all the period t output-levels of all the single firms producing in sector j. In a Cournot-Nash-equilibrium all firms will sell all of their output in any given period and thus, one can write $Y_t(j)$ directly into (I.35). Further, it is clear that all firms within a sector will charge the same price in a Cournot-Nash-equilibrium in a given period, so let $P_t(j)$ denote the equilibrium price in sector j in period t. P_t again denotes the welfare-relevant price-index associated with the Cobb-Douglas aggregator for C_t from (I.35). Regarding technology, the labor market and timing I make the same assumptions as in the basic version of the model. In this setting with multiple sectors it is still assumed that there is a single economy-wide labor market, so firms are assumed to take the WD-curve from (I.3) as given, i.e. they do not internalize any impact that their hiring-decisions might have on real wages.[63] In solving the model, for simplicity I will not restrict the number of producing firms in sector j in period t,

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[63] In general I assume that no firm internalizes the impact of any of its decisions on economy-wide outcomes. This is a slight deviation from full rationality inasmuch as with a finite number of sectors M firms should in principle

$N_t(j)$, to be an integer, i.e. it will be assumed that zero profits hold exactly due to free entry within sectors.[64] As all sectors are symmetric, sectoral variables will take on the same value across sectors in equilibrium.

Appendix I.E provides details on how to solve for per-period Nash equilibrium in this version of my model. It can be shown that equilibrium mark-ups over marginal costs are simply given by $\mu(N_t) = \frac{N_t}{N_t - 1}$ $\forall t$ where I drop the sectoral index as mark-ups are the same across sectors in a symmetric equilibrium. Thus, the elasticity of mark-ups with respect to N_t, which I still denote by $\eta_\mu(N_t)$, is negative $\forall N_t > 0$ reflecting the fact that mark-ups decline as N_t increases, which is a well-understood property of Cournot competition and which implies that the "variable-mark-ups-channel" is operating. Moreover, one can establish that the following needs to be true in per-period Nash equilibrium:

(I.36)
$$w_t = \frac{1}{\mu(N_t)} A \quad \forall t$$

Hence, as in the previous versions of the model with monopolistic competition and product differentiation one finds that with Cournot competition and homogeneous products, too, the real wage is proportional to the inverse of the equilibrium mark-up times the technology shifter A. The previous versions only had an additional variety-effect-term showing up in the corresponding equations (e.g. (I.14) for the basic version of the model), but such a term is absent here inasmuch as there are no product-variety-effects by construction. Furthermore, one can establish the following equilibrium relationship between L_t^E and N_t in any per-period Nash equilibrium:

(I.37)
$$L_t^E = M f^P ((N_t)^2) \quad \forall t$$

This equation plays the same role as (I.15) in the basic version of the model and it exhibits the same major properties: For $N_t \in [0, \infty)$ and $L_t^E \in [0, \infty)$, respectively, it defines strictly increasing and differentiable functions $L_t^E(N_t)$ and $N_t(L_t^E)$, so that (I.36), which defines a differentiable and strictly increasing function $w_t(N_t)$ for

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take general equilibrium effects of their decisions into account. However, if M is sufficiently large, this deviation from rationality is minor and in the limit of a continuum of sectors one would be back to full rationality.

[64] Since firms within sectors are symmetric, that assumption means that all "full firms" produce the same amount and one "fraction of a firm" produces proportionally less. Dos Santos Ferreira and Dufourt (2006) solve their model (which in contrast to mine abstracts away from labor market frictions) imposing an integer constraint.

$N_t > 1$,[65] and (I.37) jointly give rise to a function $w_t(L_t^E)$ defined over $L_t^E \in (Mf^P, L]$ which represents the EE-curve and which is differentiable and strictly increasing $\forall\, L_t^E \in (Mf^P, L]$.[66] Furthermore, any intersection of this EE-curve with the WD-curve (which is implied by (I.3) along with $w_t(\omega) = w_t\ \forall \omega \in Y_t\ \forall t$) on $L_t^E \in (Mf^P, L]$ represents a per-period Nash equilibrium of the model while there are no other per-period Nash equilibria. Hence, all geometric arguments from the basic version of the model go through so that PROPOSITIONS I.3 through I.5 and COROLLARIES I.2 and I.3 go through with (I.36) and (I.37) taking the places of (I.14) and (I.15) from the basic version of the model, respectively. Furthermore, similar arguments as in the proof of PROPOSITION I.6 imply that the formula for the elasticity of the EE-curve in this version of the model is given by:

(I.38)
$$\eta_{EE}(L_t^E) = \left(\left| \eta_\mu \big(N_t(L_t^E) \big) \right| \right) \left(\eta_X(L_t^E) \right)$$

This corresponds to (I.24) in PROPOSITION I.6 for $\eta_V(N_t) = 0$ reflecting the fact that there are not any product-variety-effects in the present case. Therefore, the central formula from (I.25) which indicates whether a supply-side or a demand-side policy is required to raise aggregate employment is still valid with $\eta_V(N_t) = 0$ and as a consequence, my results do not depend on firms competing in terms of differentiated products and on firms being of negligible size with respect to their markets. In this simple Cournot model, it also turns out that $\eta_X(L_t^E) = \frac{1}{2}$, which means that in response to (marginal) changes in structural parameters of the labor market, half of the resulting change in aggregate employment is accounted for by the intensive margin and half is accounted for by the extensive margin as the economy moves from the old to the new per-period Nash equilibrium.

I.6.3 Production Networks and Additional Non-Labor Inputs in Production

The formula for the elasticity of the EE-curve as presented in (I.24) has turned out to be quite robust so far. In this subsection, I will discuss one additional element that may show up in that formula and that in fact increases the elasticity of the EE-curve thereby making the EE-curve steeper for given values of $\eta_\mu(N_t)$, $\eta_V(N_t)$ and $\eta_X(L_t^E)$, which then implies a stronger case for demand-side approaches to labor market reform: Production networks, i.e.

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[65] The assumption $N_t > 1$ is required to make sure that the mark-up is non-negative and economically, it makes sure that one is in an oligopoly model as it implies that there has to be more than one firm per sector.

[66] The lower bound for L_t^E results from the requirement $N_t > 1$ and (I.37). The EE-curve is only valid for $L_t^E \leq L$ for the same reasons as discussed in the context of the basic version of the model. A necessary but not sufficient condition for the existence of per-period Nash equilibrium is thus that parameter values satisfy $L > Mf^P$.

the fact that firms buy the outputs of other firms and use them as inputs in their own production processes. As I will demonstrate, such a network structure may very well amplify the effects of variable mark-ups and "returns to specialization" in technology on real wages, which suggests that the formula for the elasticity of the EE-curve as presented in (I.24) may represent a lower bound on the actual elasticity in an economy characterized by production networks. For a simple model of such an economy, I will provide a generalization of that formula.

In order to do this, I will follow Basu's (1995) simple but highly tractable approach to modelling network production structures with intermediate goods: Let me consider a variant of the basic model from section I.2 in which quasi-fixed costs are still specified in terms of labor,[67] but where the part of the production process that actually determines how much output is produced now requires two inputs: labor and an intermediate good. In particular, let $l_t^y(\omega) = l_t(\omega) - f^P$ now denote the quantity of labor firm ω uses in period t for purposes other than covering quasi-fixed costs which are still f^P units of labor and let $m_t(\omega)$ denote the amount of the intermediate good firm ω employs in period t. Following the approach by Basu (1995) I assume that the intermediate good consists of the same aggregate of all varieties that can be produced in the economy as the aggregate consumption good, i.e. for simplicity, the aggregator in (I.1) with the exact same parameter values and functional forms is assumed to characterize both the intermediate good every single firm uses as an input and the aggregate consumption good the representative household uses for consumption. The intermediate good and the final consumption good are thus the same. There are definitely more sophisticated ways of modelling network production structures and intermediate goods,[68] but this simple one is sufficient for illustrative purposes. The production function which applies conditional on incurring the quasi-fixed costs in a given period is assumed to exhibit the following functional form which is inspired by Basu's (1995) modelling choice and keeps the model highly tractable:

(I.39) $$y_t(\omega) = A\left(\left(l_t^y(\omega)\right)^{\delta}\right)\left(\left(m_t(\omega)\right)^{1-\delta}\right) \quad \forall \omega \in \Omega \ \forall t$$

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[67] In light of the issues that might emerge as soon as quasi-fixed costs are not specified fully in terms of labor (cf. footnote 40) I choose to keep them entirely in terms of labor for the purpose of this example of network production.

[68] See Oberfield (2013) for a recent example of a model where an input-output-structure is endogenously determined. An alternative way of thinking about the model of intermediate goods I adopt for this paper is to interpret the aggregator in (I.1) as a "production function" according to which firms producing the horizontally differentiated varieties assemble the intermediate good using the varieties of all their competitors (and their own one) and according to which a perfectly competitive final good sector assembles the final consumption good.

$y_t(\omega)$ still denotes firm-level output in period t for firm ω, $A > 0$ is still a productivity shifter and the parameter δ is assumed to satisfy $0 < \delta \leq 1$. To find the factor demands of firms one has to solve a straightforward cost-minimization problem of choosing inputs in a cost-minimizing way given a target for firm-level output and given the Cobb-Douglas function in (I.39). As is well understood, the solution implies that a firm would optimally choose inputs such that a fraction δ of its *variable* costs are spent on labor while the remaining fraction of *variable* costs consists of costs for the intermediate good. Thus, the parameter δ has a very straightforward interpretation: The lower it is, the more important is the role for intermediate goods and hence for the network production structure of the economy.[69]

Solving the remaining parts of the model for per-period Nash equilibrium in a way that is completely analogous to what has been done for the basic version of the model in section I.3 just noting that instead of C_t the term $\Big(C_t + \int_{\omega \in \Upsilon_t}(m_t(\omega))d\omega\Big)$ now appears in the residual demand functions of period t, one finds that the two equations corresponding to (I.14) and (I.15) from the basic version of the model are now given by:[70]

$$(\text{I.40}) \qquad\qquad w_t = \delta\left((1-\delta)^{\frac{1-\delta}{\delta}}\right)\left(\left(\frac{1}{\mu(N_t)}A\frac{1}{V(N_t)}\right)^{\frac{1}{\delta}}\right) \quad \forall t$$

$$(\text{I.41}) \qquad\qquad L_t^E = f^P\left(\delta\big(\sigma(N_t)\big) + (1-\delta)\right)N_t \quad \forall t$$

Similar arguments as in the proof of PROPOSITION I.1 then imply that (I.40) and (I.41) jointly define a non-decreasing and differentiable EE-curve. The results in PROPOSITIONS I.2 through I.5 and in COROLLARIES I.2

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[69] By solving that cost-minimization problem for firms one can also show that for given values of economy-wide variables other than the real wage and given its desired level of output, any given firm would employ less labor and more of the intermediate good as the real wage increases – just as one would expect. Further, one can also show that given the levels of aggregate variables other than the real wage, any given firm would choose to produce less as the real wage is higher – as one would expect. Hence, by studying this modified version of the model I also address the following additional concern one might have regarding my analysis: In all versions of the model studied up to this point, labor has been the only factor of production, so one might wonder whether a positively sloped EE-curve might still emerge if firms are able to substitute away from labor to some extent and can thus employ other factors more intensively when real wages rise. It turns out that this is still the case. And in fact, the concept of an intermediate good I work with is not too different from a notion of capital inasmuch as a widespread assumption in economic models is that capital is also a produced input and that the production function for it is the same as for the aggregate consumption good.

[70] $\mu(N_t)$ and $V(N_t)$ are the same as in section I.3: The equilibrium mark-up over marginal costs is still $\mu(N_t) = \frac{\sigma(N_t)}{\sigma(N_t)-1}$ and the variety-effect-term is still $V(N_t) = (N_t)^{-\upsilon}$. $C_t = w_t L_t^E$ $\forall t$ still holds in equilibrium, too.

and I.3 thus go through with (I.40) and (I.41) taking the place of (I.14) and (I.15) from the basic version of the model, respectively. The presence of production networks and the possibility for firms to substitute between labor and other factors of production thus do not affect any of my conclusions in a qualitative sense, but they do affect the quantitative predictions of the model by means of giving rise to an augmented formula for the elasticity of the EE-curve that nests the previous formula for the case in which labor is the only input: Applying the argument from the proof of PROPOSITION I.6 to (I.40) and (I.41) one arrives at the following expression for the elasticity of the EE-curve in this modified model:

(I.42)
$$\eta_{EE}(L_t^E) = \frac{1}{\delta}\left(\left|\eta_\mu\big(N_t(L_t^E)\big)\right| + \left|\eta_V\big(N_t(L_t^E)\big)\right|\right)\big(\eta_X(L_t^E)\big)$$

Note that for $\delta = 1$ this expression is identical to the one from (I.24) from the basic version of the model and in fact, setting $\delta = 1$ makes this model identical to the basic model studied above in all respects including assumptions on production structure. But as one takes δ below unity and thus introduces a role for intermediate goods and a network production structure, the EE-curve becomes more elastic everywhere. In particular, the elasticity is higher, the higher the share of intermediate goods in variable costs of production is, i.e. the lower δ is. That means that in the spirit of COROLLARY I.2 one may conclude that a stronger role for production networks and intermediate goods (i.e. a lower δ) makes a stronger case for *demand-side* policies and a weaker one for supply-side policies and this is due to the fact that such production structures amplify the effect of variable mark-ups as well as product-variety-effects by having them play out at different stages of a multi-stage production process: With network production firms also buy the varieties which are priced at a mark-up over marginal costs so that lower mark-ups also reduce production costs and thereby reduce prices at the product-level even beyond the direct effect lower mark-ups have on prices and similarly, with a network production structure the product-variety-effect from the "returns to specialization"-feature à la Ethier (1982) in the definition of the intermediate good reduces production costs and hence prices at the product-level, which adds to the product-variety-effect in consumers' preferences.[71] Given that Basu (1995) argues that the cost share of intermediate goods in U.S.

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[71] Note that this argument is conceptually very different from the role Basu (1995) attributes to such production structures as he works with an exogenous mass of producers/varieties, while the effects I emphasize are driven by the extensive margin.

manufacturing is likely well above 50%,[72] taking intermediate goods into account may thus easily lead to a more than doubling of realistic values for the elasticity of the EE-curve and hence to a more than doubling of the threshold for the strength of the pecuniary externality in the labor market above which supply-side policies are capable of raising aggregate employment.

I.7 Remarks on Quantitative Evidence

Let me add some remarks on how the central elasticity-formula I have provided could be connected to empirical work. As I am not aware of direct estimates of all relevant elasticities, I will discuss some pieces of indirect evidence which in part rely on parametric assumptions within the modelling framework I have developed. Thus, my goal in this section is only to provide some rough first ideas regarding potentially realistic values for those elasticities. I will begin with the elasticity of the EE-curve which can be expressed in terms of the three elasticities η_μ, η_V and η_X as equation (I.24) indicates.

To get an idea of realistic values for η_μ, one can look at the case of Cournot competition from section I.6.2 which is exclusively driven by the mark-ups-channel associated with η_μ and where equilibrium mark-ups are $\mu(N_t) = \frac{N_t}{N_t-1}$. This implies an elasticity $\eta_\mu(N_t) = -\frac{1}{N_t-1}$. In their baseline calibration of their general equilibrium model of Cournot competition on which my version which adds labor market frictions is built, Dos Santos Ferreira and Dufourt (2006) pick the equilibrium value for N_t to be between 3 and 5 based on empirical estimates of overhead costs and increasing returns. This would translate into an equilibrium value of $|\eta_\mu|$ between $\frac{1}{2}$ and $\frac{1}{4}$. Higher values for the equilibrium value of N_t would obviously lead to lower values of $|\eta_\mu|$. In order to get an idea of realistic values for η_V, one can work with the case of standard CES-preferences within the baseline model where $\eta_V = -\frac{1}{\overline{\sigma}-1}$ as argued in section I.4.3. The case of CES-preferences is particularly interesting to calibrate the "variety-effect-elasticity" η_V since Anderson, De Palma and Thisse (1989) have shown that CES-preferences can be derived from a standard model of discrete consumer choice where consumers pick their most preferred varieties in product space. Further, estimates for $\overline{\sigma}$ are readily available in the literature: For instance, Bernard, Eaton, Jensen and Kortum (2003) using bilateral U.S. trade data suggest a value close to 4 for $\overline{\sigma}$, which would imply a value of $\frac{1}{3}$ for

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[72] Acemoglu, Carvalho, Ozdaglar and Tahbaz-Salehi (2012) find similar results using more recent U.S. data.

$|\eta_V|$. The business cycle literature in macroeconomics, however, typically works with values of $\overline{\sigma}$ around 6,[73] which would translate into a value of $\frac{1}{5}$ for $|\eta_V|$. To learn about realistic values for η_X, one can make use of results reported in the aforementioned study by Lee and Mukoyama (2015) who also provide some evidence regarding the fractions of job creation and job destruction in U.S. manufacturing plants which are accounted for by "startups" and "shutdowns", respectively, and obviously, one can use those fractions to calibrate the equilibrium value of the elasticity η_X, which has been shown to have the interpretation of representing the fraction of changes in aggregate employment accounted for by the extensive margin. The numbers reported in Table 3 in Lee and Mukoyama (2015) suggest an equilibrium value of η_X between 0.15 and 0.25. Using the aforementioned numbers for the equilibrium values of $|\eta_\mu|$, $|\eta_V|$ and η_X in the formula for the elasticity of the EE-curve from (I.24) one would conclude that a realistic value for the elasticity of the EE-curve at the equilibrium level of aggregate employment may be roughly between 0.06 and 0.21. If one in addition takes into account the role that production networks play as discussed in section I.6.3 and thus works with the augmented formula for the elasticity of the EE-curve from (I.42), likely values for the elasticity of the EE-curve at the equilibrium employment-level would at least double and thus lie (at least) between 0.12 and 0.42 given that the aforementioned results by Basu (1995) and by Acemoglu, Carvalho, Ozdaglar and Tahbaz-Salehi (2012) suggest that $\delta \leq \frac{1}{2}$.

Let me now turn to the case of the elasticity of the WD-curve and let me discuss two major strands of the economics literature one of which would suggest a value that would be well above the range of values that I have suggested for the EE-curve, while the results in the other strand of the literature make a case for an elasticity of the WD-curve that is close to zero and hence probably lower than the one of the EE-curve. One way to identify the elasticity of the WD-curve consists in making use of the "search and matching"-example I discuss in appendix I.C where I show that modelling the labor market in the "search and matching"-tradition à la Mortensen and Pissarides (1994) and Pissarides (2000) with a constant-returns-to-scale Cobb-Douglas matching function that is widely used in the literature and performs well empirically as argued by Petrongolo and Pissarides (2001) gives rise to an isoelastic WD-curve whose constant elasticity corresponds to the ratio of the exponents in the Cobb-Douglas matching function. Those exponents have been estimated in various studies and Petrongolo and Pissarides (2001) survey that literature. Combining the range of values they suggest with my derivation of the WD-curve based on

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[73] Cf., for instance, the textbook exposition of New Keynesian macroeconomics by Galí (2008).

such a matching function in appendix I.C implies a constant elasticity of the WD-curve between 1.00 and 2.33.[74] This is obviously well above the aforementioned range of possibly plausible values for the elasticity of the EE-curve at the equilibrium level of aggregate employment, which would thus make a strong case for supply-side policies. However, a different and very prominent literature in macroeconomics suggests values for the elasticity of the WD-curve around the equilibrium level of aggregate employment which are very close to zero: A major issue in the literature on "real business cycles" in the spirit of the highly influential works by Kydland and Prescott (1982) and Prescott (1986) is that while these models are consistent with the fact that productivity is procyclical, they tend to have problems with replicating the fact that there are substantial procyclical movements in aggregate employment over the business cycle while the real wage does not exhibit much co-movement with the business cycle.[75] How is this connected to the elasticity of the WD-curve? To the extent that business cycles are driven by changes in the values of productivity-parameters such as the parameter A in my model, which seems plausible at least in so far as productivity is procyclical, business cycles show up as shifts/rotations of the EE-curve in my model. And if labor market institutions are stable – which seems to be a plausible assumption at business cycle frequencies – such movements in the EE-curve can be used to identify the slope of the WD-curve around the equilibrium level of aggregate employment. But inasmuch as the empirical literature documents strong procyclical movements in aggregate employment along with virtually no cyclical movements in real wages, one would conclude from that approach that the elasticity of the WD-curve must be close to zero such that changes in aggregate employment do not induce changes in real wages. On a more formal level but very much in the spirit of the argument that I have just laid out in the context of my model, Danthine and Kurmann (2010) estimate a general equilibrium business cycle model for the U.S. that is driven by several shocks including shocks to technology where they explicitly allow various factors including past wages, rent-sharing motives and aggregate labor market conditions to affect wage-determination and they summarize their findings regarding the effect of aggregate labor market conditions on wage-determination by noting that "[…] external labor market conditions are estimated to matter only marginally." (p. 838). Recall that the elasticity of the WD-curve captures precisely the sensitivity of

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[74] Petrongolo and Pissarides (2001) argue that a plausible range for the exponent $1 - \gamma_t$ in the matching function specified in appendix I.C of the present paper is from 0.5 to 0.7 and that constant returns are reasonable empirically, which implies that the sum of the exponents has to equal 1.

[75] See Stock and Watson (1999) for empirical evidence. See Hansen (1985) and Christiano and Eichenbaum (1992) for discussions of this point in the context of such models and for possible ways to make these models more consistent with the empirical patterns.

real wages with respect to aggregate labor market conditions in my model. Hence, the findings by Danthine and Kurmann (2010), too, suggest a very low value for the elasticity of the WD-curve. Consequently, this alternative "calibration strategy" based on business-cycle-evidence points to values for the elasticity of the WD-curve which are close to zero and thus very likely below those of the EE-curve at the equilibrium level of aggregate employment, which would imply that a demand-side policy is required for raising aggregate employment. And as Shimer (2005) argues, "search and matching"-models of the labor market if augmented by productivity shocks fail to generate large movements in aggregate employment with only small movements in real wages, too, which casts some doubt on the aforementioned alternative "calibration strategy" for the elasticity of the WD-curve based on a "search and matching"-model and standard estimates of the matching function.

Because of these huge differences in the values for the elasticity of the WD-curve coming out of these two alternative approaches to getting a first idea of a plausible value for the elasticity of the WD-curve in the vicinity of the equilibrium level of aggregate employment, it is not possible to provide even a tentative answer to the question whether it is more likely that demand-side or supply-side policies may be required to boost aggregate employment in practice. The numbers I have presented can give at most a very preliminary idea of what the values of the elasticities of the WD-curve and the EE-curve in the per-period equilibrium could plausibly be. And it is important to keep in mind that the preceding "calibration" of the various elasticities which matter for the elasticity of the EE-curve is based on mutually exclusive versions of my model – such as the case of standard CES-preferences and monopolistic competition and the case of homogeneous products and Cournot competition – so the discussion in this section is not a substitute for serious empirical work that aims at estimating these elasticities, which is, however, beyond the scope of this paper. But I hope that my theoretical analysis has made a strong case for the view that estimating these elasticities could lead to interesting and highly policy-relevant insights and my decomposition of the elasticity of the EE-curve hopefully provides a way to get at it empirically by means of estimating the elasticities it is composed of.

I.8 Concluding Remarks

How to raise aggregate employment – supply-side or demand-side policies? The answer that this paper gives is: "It depends." My analysis was aimed at sharpening our understanding under which conditions the answer is more

likely to be on either side and I have provided a simple "sufficient statistics"-formula that summarizes the theoretical insights into that question which this paper has revealed. This simple formula can potentially guide empirical work on that question that is not too dependent on concrete models because ultimately, this important question of how to reform labor markets in order to boost employment is an empirical one. As I have demonstrated, my results apply to product market (de-)regulation, too, and also to non-policy issues such as the effects of technological progress. It thus seems that the simple formula this paper has established captures some very basic and powerful macroeconomic forces.

Appendices for Part I

Appendix I.A – Proofs of Some Propositions

<u>Proof of PROPOSITION I.1:</u> For any given value of $N_t > 0$, (I.14) returns one strictly positive value of w_t, while (I.15) implies for any given value of $L_t^E > 0$ a *unique* and strictly positive value of N_t in the sense that no level of $L_t^E > 0$ is associated with more than one level of $N_t > 0$ according to (I.15). This clearly implies that there exists a function $w_t = h(L_t^E)$ where $h(L_t^E) \geq 0 \; \forall \; L_t^E \in (0, L]$. To prove that $h(L_t^E)$ is differentiable and hence continuous one first needs to note that the functions $w_t(N_t)$ and $L_t^E(N_t)$ which are defined over $N_t \in (0, \infty)$ and over $N_t \in [0, \infty)$, respectively, by (I.14) and (I.15), respectively, are differentiable. This follows essentially from the product rule and from using that $\sigma(N_t)$ is assumed to be a differentiable function so that the same applies to any quotients and sums involving it. Next, note that $L_t^E(N_t)$ as defined by (I.15) over $N_t \in [0, \infty)$ is a strictly monotonically increasing function which takes on the value 0 for $N_t = 0$ and converges to infinity as N_t goes to infinity. Hence, $L_t^E(N_t)$ defined by (I.15) is a bijective function on $\mathbb{R}^+$. And as this function is differentiable everywhere on $N_t \in [0, \infty)$ and can be shown to exhibit a non-zero first-order derivative for any level of $N_t \geq 0$, it follows that its inverse function $N_t(L_t^E)$ implicitly defined by (I.15) over $L_t^E \in [0, \infty)$ is a differentiable function, too. But that implies by the chain rule that the function $w_t = h(L_t^E)$ that obtains by nesting the two differentiable functions $w_t(N_t)$ and $N_t(L_t^E)$ defined by (I.14) and (I.15), respectively, is differentiable and this function is the function $w_t = h(L_t^E)$. To show that $\frac{\partial h(L_t^E)}{\partial L_t^E} \geq 0 \; \forall \; L_t^E \in (0, L]$ must be true one simply applies the chain rule to that expression

that nests the function $N_t(L_t^E)$ defined by (I.15) within the function $w_t(N_t)$ defined by (I.14): Note that for the

function $N_t(L_t^E)$ which is (implicitly) defined by (I.15) $\frac{\partial N_t(L_t^E)}{\partial L_t^E} > 0 \; \forall \; L_t^E \geq 0$ must hold since $\frac{\partial \sigma(N_t)}{\partial N_t} \geq 0 \; \forall \; N_t \geq 0$.

But $\frac{\partial \sigma(N_t)}{\partial N_t} \geq 0 \; \forall \; N_t \geq 0$ and $v \geq 0$ imply $\frac{\partial w(N_t)}{\partial N_t} \geq 0 \; \forall \; N_t > 0$ for the function $w_t(N_t)$ defined by (I.14). Hence,

by the chain rule $\frac{\partial h(L_t^E)}{\partial L_t^E} \geq 0 \; \forall \; L_t^E \in (0, L]$ must be true. ∎

Proof of PROPOSITION I.3: I will make a geometric argument and for the purpose of this proof I will work with representations of the WD-curve and the EE-curve in a space with aggregate employment L_t^E on the horizontal axis and with the economy-wide real wage w_t as defined in the main part of the text on the vertical axis, so that whenever it is said that one curve lies above the other one over some range, this means that this curve implies a higher level for the real wage than the other one for any given level of aggregate employment within that respective range of values for aggregate employment. To understand the geometric argument that gives rise to PROPOSITION I.3 one first needs to recall that as demonstrated in section I.3 of the main part of the text, within any given period t, the model can be reduced to two equilibrium relationships (WD-curve and EE-curve) in two endogenous variables (aggregate employment and the real wage in period t) where the intersection(s) of these curves determine(s) the per-period Nash equilibrium/equilibria of period t. Further, recall that the WD-curve is assumed to be differentiable and that according to PROPOSITION I.1 the EE-curve is differentiable, too, so both of them are continuous. Moreover, according to the assumptions made regarding the WD-curve and according to PROPOSITION I.1 both curves are non-decreasing at any level of aggregate employment $L_t^E \in (0, L]$ in the space with the level of aggregate employment on the horizontal axis and the real wage on the vertical axis. In that space, supply-side (demand-side) policies in the sense of DEFINITION I.1 which are implemented between periods t and $t + 1$ relocate the WD-curve such that the period $t + 1$ WD-curve characterized by θ_{t+1} lies strictly below (above) the period t WD-curve characterized by θ_t and thus implies strictly lower (higher) real wages given any level of aggregate employment $L_t^E \in (0, L]$. All these geometric properties jointly give rise to the proposition. To see this, first note that the EE-curve is identical in periods t and $t + 1$ as it is not affected by changes in the values of the parameters contained in θ and these are the only parameters whose values are allowed to change for the purpose of this proposition. Now let me go through two major cases each of which has two subcases. The two major cases correspond to the relationship of the slopes of the WD-curve and the EE-curve in the unique per-period Nash

equilibrium of period t, while the two sub-cases for each of the two major cases consist in the consideration of a demand-side policy and a supply-side policy being implemented between periods t and $t+1$, respectively. For the first major case it is assumed that in the unique intersection of the EE-curve with the WD-curve of period t that represents the unique per-period Nash equilibrium of period t, the EE-curve is flatter, i.e. it is assumed that

$\frac{\partial h(L_t^E)}{\partial L_t^E} < \frac{\partial g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{\partial L_t^E}$ holds at the level of aggregate employment L_t^E in the unqiue per-period Nash equilibrium of

period t. Since both curves are continuous and since, according to the assumptions of the proposition, they have

only a unique intersection for $L_t^E \in (0, L]$, $\frac{\partial h(L_t^E)}{\partial L_t^E} < \frac{\partial g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{\partial L_t^E}$ in the intersection then means that the period t WD-

curve must lie strictly below the EE-curve (in the sense of $g_{\theta_t}\left(\frac{L_t^E}{L}\right) < h(L_t^E)$) for any level of aggregate

employment that is smaller than the one associated with the unique intersection of the period t WD-curve and the

EE-curve and that the period t WD-curve must lie strictly above the EE-curve (in the sense of $g_{\theta_t}\left(\frac{L_t^E}{L}\right) > h(L_t^E)$)

for any level of aggregate employment that is greater than the one associated with the unique intersection of the

period t WD-curve and the EE-curve. For this first major case in which this is true, let me now distinguish between

the two subcases, which correspond to the implementation of a demand-side policy and of a supply-side policy

between periods t and $t+1$, respectively. First, suppose that the WD-curve of period $t+1$ lies strictly above the

one of period t (in the sense of $g_{\theta_{t+1}}\left(\frac{L_t^E}{L}\right) > g_{\theta_t}\left(\frac{L_t^E}{L}\right) \forall L_t^E \in (0, L]$) and hence implies a strictly higher real wage

for any strictly positive rate of aggregate employment. According to DEFINITION I.1 this is the case of a demand-side policy being implemented between periods t and $t+1$. This relationship between the two WD-curves of periods t and $t+1$, respectively, along with what has been said about the relationship between the EE-curve and the period t WD-curve in this first major case then necessarily implies that the unique intersection of the EE-curve with the WD-curve of period $t+1$ (where this unique intersection is known to exist according to the assumptions of the proposition) cannot be located at a level of aggregate employment that is greater than or equal to the one that comes out of the unique intersection of the EE-curve with the WD-curve of period t.[76] Therefore, the unique

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[76] More precisely, this follows from the fact that the period $t+1$ WD-curve lies strictly above the period t WD-curve for any $L_t^E \in (0, L]$, but the period t WD-curve has in turn been shown to lie strictly above the EE-curve for all admissible levels of aggregate employment which are strictly greater than that which comes out of the unique intersection of the period t WD-curve with the EE-curve. Hence, there cannot be any intersection of the period

intersection of the EE-curve with the WD-curve of period $t + 1$ must be located at a level of aggregate employment that is strictly lower than the one that comes out of the unique intersection of the EE-curve with the WD-curve of period t. This proves that a demand-side policy being implemented between periods t and $t + 1$ necessarily reduces aggregate employment from the unique per-period Nash equilibrium of period t to the unique per-period Nash equilibrium of period $t + 1$ if $\frac{\partial h(L_t^E)}{\partial L_t^E} < \frac{\partial g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{\partial L_t^E}$ holds at the level of aggregate employment L_t^E in the unqiue per-period Nash equilibrium of period t. As the second subcase of this first major case now consider the case in which the WD-curve of period $t + 1$ lies strictly below the one of period t (in the sense of $g_{\theta_{t+1}}\left(\frac{L_t^E}{L}\right) < g_{\theta_t}\left(\frac{L_t^E}{L}\right) \forall L_t^E \in (0, L]$) and hence implies a strictly lower real wage for any strictly positive rate of aggregate employment. According to DEFINITION I.1 this is the case of a supply-side policy being implemented between periods t and $t + 1$. This relationship between the two WD-curves of periods t and $t + 1$, respectively, along with what has been said about the relationship between the EE-curve and the period t WD-curve in this first major case implies that the unique intersection of the EE-curve with the WD-curve of period $t + 1$ (which is known to exist according to the assumptions of the proposition) cannot be located at a level of aggregate employment which is smaller than or equal to the one that comes out of the unique intersection of the EE-curve with the WD-curve of period t.[77] Therefore, the unique intersection of the EE-curve with the WD-curve of period $t + 1$ must be located at a level of aggregate employment which is strictly greater than the one that comes out of the unique intersection of the EE-curve with the WD-curve of period t, which proves that a supply-side policy being implemented between periods t and $t + 1$ necessarily increases aggregate employment from the unique per-period Nash equilibrium of period t to the unique per-period Nash equilibrium of period $t + 1$ if $\frac{\partial h(L_t^E)}{\partial L_t^E} < \frac{\partial g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{\partial L_t^E}$ holds at the level of aggregate employment L_t^E in the unqiue per-period Nash equilibrium of period t. The second major case which is to be considered in order to complete the proof of PROPOSITION I.3 is the case where in the unique intersection of

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$t + 1$ WD-curve with the EE-curve for levels of aggregate employment which are equal to or greater than that which comes out of the unique intersection of the period t WD-curve with the EE-curve.

[77] The details behind this argument are analogous to those in footnote 76: The key is to note that the period $t + 1$ WD-curve now lies below the one of period t and to recall that for this first major case it has been shown to be true that the period t WD-curve lies strictly below the EE-curve for all strictly positive levels of aggregate employment which are strictly smaller than that which comes out of the unique intersection of the period t WD-curve with the EE-curve.

the EE-curve with the WD-curve of period t the EE-curve is steeper, i.e. where $\frac{\partial h(L_t^E)}{\partial L_t^E} > \frac{\partial g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{\partial L_t^E}$ holds at the level

of aggregate employment L_t^E in the unqiue per-period Nash equilibrium of period t. Since both curves are

continuous and have only a unique intersection for $L_t^E \in (0, L]$, this means that the period t WD-curve must lie

above the EE-curve (in the sense of $g_{\theta_t}\left(\frac{L_t^E}{L}\right) > h(L_t^E)$) for any level of aggregate employment that is smaller than

the one associated with the unique intersection of the period t WD-curve and the EE-curve and that the period t

WD-curve must lie below the EE-curve (in the sense of $g_{\theta_t}\left(\frac{L_t^E}{L}\right) < h(L_t^E)$) for any level of aggregate employment

that is greater than the one associated with the unique intersection of the period t WD-curve and the EE-curve.

Within this second major case, one then distinguishes once again between the same two subcases as for the first

major case, namely between the implementation of a demand-side policy and of a supply-side policy between

periods t and $t + 1$, respectively. Arguments which are analogous to those made for the first major case (and which

I therefore omit in the interest of brevity) then prove the remaining two claims of PROPOSITION I.3: That a

demand-side policy implemented between periods t and $t + 1$ necessarily increases aggregate employment from

the unique per-period Nash equilibrium of period t to the unique per-period Nash equilibrium of period $t + 1$ if

$\frac{\partial h(L_t^E)}{\partial L_t^E} > \frac{\partial g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{\partial L_t^E}$ holds at the level of aggregate employment L_t^E in the unique per-period Nash equilibrium of

period t and that a supply-side policy implemented between periods t and $t + 1$ necessarily reduces aggregate

employment from the unique per-period Nash equilibrium of period t to the unique per-period Nash equilibrium of

period $t + 1$ if $\frac{\partial h(L_t^E)}{\partial L_t^E} > \frac{\partial g_{\theta_t}\left(\frac{L_t^E}{L}\right)}{\partial L_t^E}$ holds at the level of aggregate employment L_t^E in the unqiue per-period Nash

equilibrium of period t. Figure I.2 and Figure I.3 in the main part of the text illustrate the geometric argument

behind this formal proof. ∎

Proof of PROPOSITION I.4: The proof is analogous to the one of PROPOSITION I.3 and is again based on the

fact that both the WD-curve and the EE-curve are differentiable, continuous and (weakly) monotonically

increasing: The same arguments as presented in the proof of PROPOSITION I.3 for $L_t^E \in (0, L]$ can be applied

locally, i.e. in the neighborhood of the level of aggregate employment in any given per-period Nash equilibrium of

period t: As soon as the number of per-period Nash equilibria in period t is finite as is assumed for the purpose of

PROPOSITION I.4, any given per-period Nash equilibrium of period t is unique on a sufficiently narrow interval of levels of aggregate employment around the equilibrium level of aggregate employment in the respective given per-period Nash equilibrium of period t. And whenever policy-changes are marginal in the sense of PROPOSITION I.4, the level of aggregate employment in any per-period Nash equilibrium of period $t + 1$ lies within such a sufficiently narrow interval around the equilibrium level of aggregate employment in the per-period Nash equilibrium of period t which in the sense of PROPOSITION I.4 corresponds to the respective per-period Nash equilibrium of period $t + 1$, but on the other hand, if such intervals around the per-period Nash equilibria of period t are chosen to be sufficiently narrow, no level of aggregate employment that is associated with a per-period Nash equilibrium of period $t + 1$ will lie in any sufficiently narrow interval around the level of equilibrium employment in a per-period Nash equilibrium of period t that does not correspond to the respective per-period Nash equilibrium of period $t + 1$. Hence, the exact same arguments as in the proof of PROPOSITION I.3 go through on such a sufficiently narrow interval around any given per-period Nash equilibrium of period t, which directly proves PROPOSITION I.4. ∎

Proof of PROPOSITION I.6: Recall that the EE-curve is implicitly defined by (I.14) and (I.15): In particular, as shown in the proof of PROPOSITION I.1, (I.15) defines a differentiable function $N_t(L_t^E)$ over $L_t^E \in [0, \infty)$ and the EE-curve is obtained by nesting that function $N_t(L_t^E)$ within the function $w_t(N_t)$ that is defined by (I.14) over $N_t \in (0, \infty)$. Hence, because of the chain rule, the elasticity of the EE-curve can be obtained as the product of the elasticities of the two functions it consists of and this is the logic exploited in this proof. To see this, note that the total differential for the (nested) function $w_t\big(N_t(L_t^E)\big)$ which represents the EE-curve is given by $dw_t = \frac{\partial(w_t(N_t))}{\partial N_t} \frac{\partial\big(N_t(L_t^E)\big)}{\partial L_t^E} dL_t^E$ where the first factor on the right-hand side is the partial derivative of the function $w_t(N_t)$ that is defined by (I.14) over $N_t \in (0, \infty)$ and where the second factor on the right-hand side represents the partial derivative of the function $N_t(L_t^E)$ that is defined by (I.15) over $L_t^E \in [0, \infty)$. Rearranging that expression for the total differential directly yields an expression for the elasticity of the EE-curve: $\frac{dw_t}{dL_t^E} \frac{L_t^E}{w_t} = \left(\frac{\partial(w_t(N_t))}{\partial N_t} \frac{N_t}{w_t}\right)\left(\frac{\partial\big(N_t(L_t^E)\big)}{\partial L_t^E} \frac{L_t^E}{N_t}\right)$. Note that the right-hand side indeed consists of the product of the elasticities of the two functions that jointly form the EE-curve. In particular, the last term in that expression is simply $\eta_X(L_t^E)$

since $\eta_X(L_t^E) = \frac{d\left(N_t(L_t^E)\right)}{dL_t^E}\frac{L_t^E}{N_t(L_t^E)}$ is defined with respect to the differentiable function $N_t(L_t^E)$ defined by (I.15) over

$L_t^E \in [0, \infty)$ for which $\frac{d\left(N_t(L_t^E)\right)}{dL_t^E} = \frac{\partial\left(N_t(L_t^E)\right)}{\partial L_t^E}$ holds for reasons discussed in the main part of the text. Hence, it

remains to calculate $\frac{\partial(w_t(N_t))}{\partial N_t}\frac{N_t}{w_t}$ based on the function $w_t(N_t)$ that is defined by (I.14) over $N_t \in (0, \infty)$. For that

function which is defined for stable period t parameter values, too, $\frac{\partial(w_t(N_t))}{\partial N_t}$ equals $\frac{d(w_t(N_t))}{dN_t}$, so calculating the total

differential of (I.14) and rearranging yields: $\frac{dw_t}{dN_t}\frac{N_t}{w_t} = -\frac{\partial(\mu(N_t))}{\partial N_t}\frac{N_t}{\mu(N_t)} - \frac{\partial(V(N_t))}{\partial N_t}\frac{N_t}{V(N_t)}$. Now using the definitions

$\eta_\mu(N_t) = \frac{\partial(\mu(N_t))}{\partial N_t}\frac{N_t}{\mu(N_t)}$ and $\eta_V(N_t) = \frac{\partial(V(N_t))}{\partial N_t}\frac{N_t}{V(N_t)}$ and noting that both of these elasticities are negative since

$\mu(N_t) = \frac{\sigma(N_t)}{\sigma(N_t)-1}$ where $\frac{\partial\sigma(N_t)}{\partial N_t} \geq 0 \ \forall \ N_t \geq 0$ and since $\eta_V(N_t) = -v$ as shown in the main part of the text where

$v \geq 0$, one arrives at $\frac{dw_t}{dN_t}\frac{N_t}{w_t} = \left|\eta_\mu(N_t)\right| + \left|\eta_V(N_t)\right|$. Combining the preceding arguments and noting that by (I.15)

N_t is a function of L_t^E then implies the expression for the elasticity of the EE-curve in PROPOSITION I.6. ∎

Appendix I.B – Relationship to Models à la Weitzman (1982) and Solow (1986)

My analysis is linked to the seminal work on unemployment in the presence of imperfect competition in product

markets, endogenous entry and economies of scale by Weitzman (1982) and its extension by Solow (1986).

Readers familiar with those works might note that all that can be done in order to solve their models is deriving an

equilibrium relationship which corresponds to what I call the EE-curve in my model and hence, a continuum of

equilibria – namely any given point on the EE-curve in terms of my terminology – arises in their models as there is

no force such as my WD-curve which would induce a finite number of equilibria or even a unique equilibrium.[78]

Inasmuch as the "EE-curves" are upwards-sloping in their models, too, all their equilibria can be Pareto-ranked (in

the sense that an equilibrium in which aggregate employment and real wages are higher is Pareto-dominating one in

which both variables are lower), where the full-employment equilibrium is the most desirable outcome. This casts

severe doubt on the ability of their models to explain the existence of unemployment.[79] While their contributions

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[78] Solow (1986) manages to select a unique equilibrium by introducing government spending in a way that pins down the scale of the economy.

[79] Note that each single one of these equilibria exhibits zero profits and thus, potential entrants would be indifferent between entering or not in any of these equilibria, which is the observation that led Weitzman (1982) and Solow

are very important to the extent that they pointed out the necessity to have some sort of economies of scale to explain unemployment, they do not yet provide a fully satisfactory theory of unemployment because of those issues related to the coexistence of full-employment and unemployment equilibria in their models along with the upwards-sloping nature of what I call EE-curves. Labor market frictions which motivate well-defined wage-determination mechanisms – which I aim to capture in my WD-curve – and thus pin down real wages seem to be an important additional ingredient that is absolutely required for understanding unemployment.

A second dimension along which my analysis improves upon this earlier literature inspired by the works by Weitzman (1982) and Solow (1986) consists in my explanation as to why what I call the EE-curve is typically upwards-sloping: Weitzman (1985) claimed that "In most reasonable models of an economy with non-trivial increasing returns to scale, there is going to be a theorem showing that higher levels of equilibrium employment are associated with higher real wages. […] I believe it obtains under fairly general circumstances." (p. 407). My analysis, however, reveals that thinking about "increasing returns to scale" is not a correct way of understanding why the EE-curve is increasing. To see this, note that even though marginal costs for each single firm are constant in my model, the model exhibits increasing returns in the sense of declining average costs at the firm-level due to the presence of the quasi-fixed costs captured by f^P. But as discussed in the main part of the text, the EE-curve can be flat in spite of this feature whenever the extensive margin is exogenously fixed or whenever there is neither an element of variable mark-ups nor of "love for variety"/"returns to specialization" in the specification of preferences and technology. Hence, increasing returns are clearly *not* driving the slope of the EE-curve in contrast to what Weitzman (1985) suggested. Instead, it is the extensive margin of production which matters for this and which may play out through a channel of variable mark-ups and/or through product-variety-effects on price-indices for given

(1986) to the conclusion that each of those equilibria can be sustained and that unemployment can thus result in equilibrium. A serious problem with that view, however, is that the equilibria can be Pareto-ranked and it is not clear at all why agents would ever coordinate on an equilibrium value of N_t being less than the maximum possible value which implies full-employment and the highest possible real wage, i.e. it is not clear why a non-optimal situation would ever emerge in the first place. And even if one selects a unique equilibrium by bringing in the government as in Solow (1986), it is still not clear why any government would not choose the Pareto-optimal outcome in its choice set. As discussed in the main part of the text, my approach that resorts to labor market frictions and decentralized wage-determination in the form of the (firm-level) WD-curve(s) does not only yield a finite number of equilibria, but it also provides an explanation as to why such a coordination failure is possible. Another problem with the works by Weitzman (1982) and Solow (1986) is that they do not provide any theory of wage-determination from the labor-market-side of the model (i.e. a theory that goes beyond what the EE-curve implies for real wages). This raises the issue that if wage-determination was Walrasian, there would still not be any reason for unemployment to occur in their models as the Walrasian labor market would essentially select the full-employment equilibrium.

prices at the micro-level. And in fact, those elements instead of anything related to "increasing returns" are showing up in the formula for the elasticity of the EE-curve I have presented in (I.24).

Appendix I.C – Micro-Foundations for the WD-Curve

The purpose of this appendix is to derive explicit micro-foundations for the WD-curve in (I.3). I will go through three different examples putting the main emphasis on the "search and matching"-model à la Mortensen and Pissarides (1994) and Pissarides (2000) which is also the example I begin with in this appendix: Suppose the labor market is characterized by a "search and matching"-process which takes place once per period and generates matches between vacancies and units of labor that last only until the end of the period for simplicity. Also for simplicity, I assume labor to be infinitely divisible so that in period t firm ω attains exactly $\left(\frac{M_t}{V_t}\right)\left(v_t(\omega)\right)$ matches by posting $v_t(\omega)$ vacancies where M_t denotes the total mass of matches generated by the matching mechanism in period t and where $V_t = \int_{\omega \in \Omega}\left(v_t(\omega)\right)d\omega$ denotes the total mass of vacancies posted in the economy in period t. Suppose further that the period t matching process is described by the standard constant-returns-to-scale Cobb-Douglas matching function widely used in the literature:[80] $M_t = k_t\left((V_t)^{\gamma_t}\right)\left((L)^{1-\gamma_t}\right) \forall t$ where L is the mass of job-seeking workers which is exogenously fixed as it is optimal for all workers to search for a job.[81] γ and k are labor market parameters, the period t realizations of which I again write with a time-subscript to indicate that the values of these parameters may change over time as a result of institutional change in the labor market. It is assumed that $\gamma_t \in (0,1) \forall t$ and that $k_t > 0 \forall t$. Consequently, the number of matches attained by firm ω in period t is given by $m_t(\omega) = k_t\left(\left(\frac{L}{V_t}\right)^{1-\gamma_t}\right)\left(v_t(\omega)\right)$. To keep the analysis simple, I will work with the standard CES-case for the purpose of this appendix, i.e. $v = \frac{1}{\overline{\sigma}-1}$ and $\sigma(N_t) = \overline{\sigma} > 2$ is assumed in (I.1) for the purpose of this appendix.[82]

Search costs are introduced in a standard way: Posting $v_t(\omega)$ vacancies entails search costs of $\vartheta_t\left(v_t(\omega)\right)$ units of

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[80] Petrongolo and Pissarides (2001) survey the literature on the matching function.

[81] I will disregard issues related to $M_t \geq L$ as is standard in the literature. The rationale for neglecting such issues is to assume that Cobb-Douglas is a reasonable functional form as long as M_t is sufficiently lower than L, but that the actual matching mechanism would look different in a vicinity of $M_t = L$ and never matches all units of labor with vacancies, i.e. frictions are assumed to be such that not all labor can be matched.

[82] The rationale for the restriction $\overline{\sigma} > 2$ is given in footnote 40 since I will specify quasi-fixed costs in terms of final output to keep the analysis tractable.

final output (i.e. units of the aggregate consumption good that is defined by the aggregator in (I.1) for $v = \frac{1}{\overline{\sigma}-1}$ and

$\sigma(N_t) = \overline{\sigma} > 2$) in period t for firm ω where ϑ is another labor market parameter, where period t values of this

parameter are denoted by ϑ_t and where $\vartheta_t > 0\ \forall t$ is assumed. This parameter has the interpretation of capturing the

level of search costs and its value is also allowed to change over time as a result of institutional change in the labor

market. Search costs are assumed to be sunk immediately upon posting vacancies. Further, to keep the model with

wage-bargaining as the mode of wage-determination tractable, I will also assume that quasi-fixed costs for firms

consist of $f^P > 0$ units of the aggregate consumption good (i.e. final output) rather than labor. These quasi-fixed

costs are also assumed to be sunk before wage-bargaining occurs. Wage-bargaining occurs in this model after

matches have been formed and both sides have bargaining power for the simple reason that there is only a single

round of matching per period.[83] Regarding the bargaining protocol itself I follow the pioneering work by Ebell and

Haefke (2009) and Helpman and Itskhoki (2010) on "search and matching"-models with monopolistically

competitive firms and assume that bargaining happens according to the setup proposed and analyzed by Stole and

Zwiebel (1996a, 1996b).[84] The reader is referred to those papers for more details on that bargaining model.[85] In a

nutshell, that bargaining model assumes that firms bargain with units of labor separately in pairwise sessions in

which the (marginal) surplus from their relationship is split given the outcomes in all other sessions of that firm

where the order of sessions plays no role. Rather than assuming that marginal surplus is split in equal proportions in

these bargaining sessions, I will assume that an exogenous fraction $\phi_t \in (0,1)\ \forall t$ of it goes to labor where this

fraction may change over time as a result of institutional change. ϕ thus represents a fourth labor market parameter

whose period t value is denoted with the corresponding subscript.

The outcome of the bargaining game à la Stole and Zwiebel (1996a, 1996b) is such that each firm will end up

hiring all the labor it is matched with so that $l_t(\omega) = m_t(\omega)\ \forall \omega \in \Upsilon_t\ \forall t$ holds in equilibrium and given the

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[83] Even if that was relaxed, the presence of search costs and matching frictions (or simply equilibrium unemployment) would give bargaining power to both workers and firms.

[84] If one assumed that firms bargain bilaterally according to simple Nash bargaining with the *collective* of workers they are matched with, very similar results would obtain.

[85] Since I work under the assumption of infinitely divisible labor, I will technically study the case of "continuous labour" from section 2.3. in Stole and Zwiebel (1996b).

demand system I have assumed, the nominal wage $W_t(\omega)$ firm ω will end up paying in period t is determined by the following differential equation:[86]

$$(I.43) \qquad \frac{\partial}{\partial(l_t(\omega))}\left(P_t\left((D_t)^{\frac{1}{\bar{\sigma}}}\right)\left(\left(A(l_t(\omega))\right)^{\frac{\bar{\sigma}-1}{\bar{\sigma}}}\right) - (W_t(\omega))(l_t(\omega)) \right) = \frac{1-\phi_t}{\phi_t}(W_t(\omega)) \quad \forall \omega \in Y_t \; \forall t$$

Solving that differential equation implies:[87]

$$(I.44) \qquad W_t(\omega) = \frac{\phi_t(\bar{\sigma}-1)}{\bar{\sigma}-\phi_t} P_t\left((D_t)^{\frac{1}{\bar{\sigma}}}\right)\left((A)^{\frac{\bar{\sigma}-1}{\bar{\sigma}}}\right)\left((l_t(\omega))^{-\frac{1}{\bar{\sigma}}}\right) \quad \forall \omega \in Y_t \; \forall t$$

Hence, wages at the firm-level are decreasing in firm-level employment in a *ceteris paribus* sense, which provides firms with an incentive to "over-hire" in order to strategically depress wage-bills as Stole and Zwiebel (1996a, 1996b) and Ebell and Haefke (2009) for the case of monopolistic competition discuss in detail. It will turn out that in spite of the presence of such a motive (which is not explicitly accounted for in my more general theory presented in the main part of my paper) the more general "EE-WD-model" analyzed in the main part of my paper is still able to replicate the major properties of this concrete labor market model. Understanding that bargaining will lead to a nominal wage as given by (I.44) firms thus maximize the following objective function when choosing their level of employment:[88]

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[86] The left-hand side of that differential equation contains the fraction of the marginal surplus to be divided in wage-bargaining that goes to the firm, which is given by the difference between the revenues of a firm which is making optimal production-, pricing- and selling-decisions and its wage-bill. Search costs and quasi-fixed costs do not show up as they are already sunk at the stage where wage-bargaining occurs. The right-hand side contains $W_t(\omega)$ as the compensation of the marginal unit of labor and the factor $\frac{1-\phi_t}{\phi_t}$ accounts for the fact that a fraction ϕ_t of the surplus from the relationship between the firm and the marginal unit of labor goes to labor. See Ebell and Haefke (2009) and Helpman and Itskhoki (2010) for similar conditions in related models. D_t in that condition is the total quantity of the aggregate good produced in this economy in period t which now matters for residual demand instead of C_t since the aggregate good is also used for covering quasi-fixed costs and search costs. In particular, $D_t = C_t + \vartheta_t V_t + f^P N_t \; \forall t$ needs to hold in equilibrium as straightforward accounting reveals.

[87] Note that firms and workers bargain over the nominal wage, i.e. how real wages are defined does not affect the outcome of bargaining at the firm-level and hence, the derivation of the WD-curve from this model is not affected by the notion of price-indices firms and workers might have in the bargaining process.

[88] To arrive at this expression for firm-level profits, one takes the expression for nominal wages from (I.44) to the expression for the difference between equilibrium revenues and the wage-bill from the left-hand side of (I.43) and then subtracts quasi-fixed costs $P_t f^P$ as well as search costs which under the aforementioned specification of the matching process are $P_t \frac{\vartheta_t}{k_t}\left(\left(\frac{V_t}{L}\right)^{1-\gamma_t}\right)(l_t(\omega))$ for a firm which ends up hiring $l_t(\omega)$ workers.

$$(\text{I.45}) \ \Pi_t\big(l_t(\omega)\big) = \frac{\overline{\sigma}(1-\phi_t)}{\overline{\sigma}-\phi_t}\left((A)^{\frac{\overline{\sigma}-1}{\overline{\sigma}}}\right)P_t\left((D_t)^{\frac{1}{\overline{\sigma}}}\right)\left((l_t(\omega))^{\frac{\overline{\sigma}-1}{\overline{\sigma}}}\right) - P_t\frac{\vartheta_t}{k_t}\left(\left(\frac{V_t}{L}\right)^{1-\gamma_t}\right)(l_t(\omega)) - P_t f^P \quad \forall \omega \in \Upsilon_t \ \forall t$$

An expression for equilibrium firm-level employment can thus be obtained by maximizing this expression for firm-level profits – which is strictly concave in $l_t(\omega)$ – over $l_t(\omega)$. One finds:

$$(\text{I.46}) \qquad l_t(\omega) = \left(\left(\frac{(\overline{\sigma}-1)(1-\phi_t)}{\overline{\sigma}-\phi_t}\right)^{\overline{\sigma}}\right)\left((A)^{\overline{\sigma}-1}\right)\left(\left(\frac{k_t}{\vartheta_t}\right)^{\overline{\sigma}}\right)\left(\left(\frac{V_t}{L}\right)^{-\overline{\sigma}(1-\gamma_t)}\right)D_t \quad \forall \omega \in \Upsilon_t \ \forall t$$

Taking this solution for equilibrium employment at the firm-level back to (I.44) yields the following expression for the real wage any producing firm ω pays in equilibrium, i.e. for $w_t(\omega) = \frac{W_t(\omega)}{P_t}$:

$$(\text{I.47}) \qquad\qquad\qquad w_t(\omega) = \frac{\vartheta_t}{k_t}\frac{\phi_t}{1-\phi_t}\left(\left(\frac{V_t}{L}\right)^{(1-\gamma_t)}\right) \quad \forall \omega \in \Upsilon_t \ \forall t$$

Real wages are thus increasing in labor market tightness $\frac{V_t}{L}$: The more costly it is for firms to find workers,[89] the higher will real wages be. Hence, there is clearly a pecuniary externality in this labor market model whereby the decisions by other firms as to how many vacancies to post affect the level of real wages at any given firm. Now recall that $m_t(\omega) = l_t(\omega) \ \forall \omega \in \Upsilon_t \ \forall t$ in equilibrium. Combining this with the fact that the matching mechanism implies $m_t(\omega) = k_t\left(\left(\frac{L}{V_t}\right)^{1-\gamma_t}\right)(v_t(\omega)) \ \forall \omega \in \Upsilon_t \ \forall t$ yields $v_t(\omega) = \frac{1}{k_t}\left(\left(\frac{V_t}{L}\right)^{1-\gamma_t}\right)(l_t(\omega)) \ \forall \omega \in \Upsilon_t \ \forall t$. As firms make identical decisions in equilibrium it then follows that $V_t = \frac{1}{k_t}\left(\left(\frac{V_t}{L}\right)^{1-\gamma_t}\right)L_t^E \ \forall t$ which can be written as $\frac{V_t}{L} = \left(\frac{1}{k_t}\frac{L_t^E}{L}\right)^{\frac{1}{\gamma_t}} \ \forall t$. Combining this with (I.47) then yields:

$$(\text{I.48}) \qquad\qquad\qquad w_t(\omega) = \vartheta_t\frac{\phi_t}{1-\phi_t}\left(\left(\frac{1}{k_t}\right)^{\frac{1}{\gamma_t}}\right)\left(\left(\frac{L_t^E}{L}\right)^{\frac{1-\gamma_t}{\gamma_t}}\right) \quad \forall \omega \in \Upsilon_t \ \forall t$$

Consequently, this model makes it possible to write real wages at the firm-level as an increasing function of the economy-wide employment rate where all the parameters showing up in this function are labor market parameters – exactly as posited in the WD-curve in (I.3) where θ is a vector of labor market parameters shaping the functional

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[89] Note that the vacancy-filling rate $\frac{M_t}{V_t}$ is inversely related to labor market tightness $\frac{V_t}{L}$, which makes hiring more costly in a tighter labor market.

form of the increasing function $g_\theta\left(\frac{L_t^E}{L}\right)$ which specifies real wages at the firm-level. Here, the parameter vector θ would include the four labor market parameters ϑ, ϕ, k and γ. Consequently, a (static version of a) "search and matching"-model à la Mortensen and Pissarides (1994) represents a way of micro-founding my WD-curve. Another very notable point is that the WD-curve coming out of this "search and matching"-model is isoelastic and hence takes on the same functional form as the general isoelastic WD-curve from (I.4) that has been studied as a special case throughout this paper where ψ_t and ξ_t from my general formulation in (I.4) correspond to

$\vartheta_t \frac{\phi_t}{1-\phi_t}\left(\left(\frac{1}{k_t}\right)^{\frac{1}{\gamma_t}}\right)$ and $\frac{1-\gamma_t}{\gamma_t}$ in this "search and matching"-case, respectively. This correspondence between $\frac{1-\gamma_t}{\gamma_t}$ in

this concrete model and ξ_t in the isoelastic case of the general model – where these expressions represent the elasticity of the WD-curve, $\eta_{WD,t}$, respectively – means that according to a "search and matching"-perspective on labor markets the strength of the pecuniary externality in the labor market that determines the elasticity of the WD-curve, which is so central to my analysis, is determined by properties of the matching technology and hence by the various "congestion"-effects and "thick market"-effects it entails. Thus, the "search and matching"-perspective offers one possible way of thinking about where this pecuniary externality comes from and what determines its strength. Another nice aspect of this close relationship between my general EE-WD-model from the main part of the paper and this concrete "search and matching"-theory of the labor market is that one can use it to give a more "structural interpretation" to what supply-side or demand-side policies in the general model could actually be in

practice: Using the correspondence between $\vartheta_t \frac{\phi_t}{1-\phi_t}\left(\left(\frac{1}{k_t}\right)^{\frac{1}{\gamma_t}}\right)$ and ψ_t one finds that according to DEFINITION I.1

examples of supply-side policies include policies which reduce search costs (i.e. reduce the value of ϑ over time), make the "search and matching"-process more efficient (i.e. raise the value of k over time) or reduce workers' bargaining power (i.e. reduce the value of ϕ over time), while changes in those parameters in the respective opposite directions would qualify as demand-side policies.[90]

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[90] The intuition as to why such policies are supply-side policies is straightforward as they clearly help firms reducing their costs all else equal and it is also intuitively clear why an increase in the value of ϕ over time is a demand-side policy. It might be a little bit more challenging to see why increases in search costs or reductions in the efficiency of the matching mechanism as captured by the parameters ϑ and k, respectively, are "demand-side policies". To understand this, note that such changes in the values of the parameters ϑ and k over time make it more costly for firms to replace a worker, so they essentially shield employed (or at least matched) workers from competition from unemployed workers and thus raise the *effective* bargaining power of employed (or matched)

Straightforward aggregation and accounting steps as well as imposing zero profits in equilibrium make it possible to derive the "EE-curve" of this "search and matching"-version of my model, which also retains the major properties of the EE-curve from the general model explored in the main part of the paper:

(I.49)
$$L_t^E = \frac{\overline{\sigma}-\phi_t}{1-\phi_t}\left(\left(\frac{\overline{\sigma}-\phi_t}{\phi_t(\overline{\sigma}-1)}\right)^{\overline{\sigma}-2}\right)\left((A)^{1-\overline{\sigma}}\right)f^P\left((w_t)^{\overline{\sigma}-2}\right) \quad \forall t$$

(I.49) along with the WD-curve in (I.48) can be used for solving for the equilibrium values of L_t^E and w_t by calculating the intersection of those two curves at a strictly positive level of aggregate employment, which will generally be unique if one imposes that $\frac{1-\gamma_t}{\gamma_t} \neq \frac{1}{\overline{\sigma}-2}$ $\forall t$ so that this "search and matching"-version of my model has a unique per-period Nash equilibrium under this restriction as long as $L_t^E \leq L$ holds at the unique intersection. Further, (I.49) implicitly defines a monotonically increasing and differentiable function $w_t(L_t^E)$ – just like the EE-curve in the general model discussed in the main part of the paper. As in that more general case, the EE-curve in (I.49), too, exclusively captures the preference parameter $\overline{\sigma}$ and the technology parameters f^P and A, all of which do not show up in the WD-curve. The only conceptual difference from the general case from the main part of the paper is that one single labor market parameter, namely ϕ, shows up in the EE-curve for this "search and matching"-model, too, so that the EE-curve would change over time in response to changes in the value of this particular labor market parameter. This difference is due to the fact that the general EE-WD-model from the main part of the paper works under the assumption of firms taking wages as given while in this "search and matching"-example, wage-bargaining results in a compensation scheme that can be shown to be such that the wage-bill at the firm-level is a constant fraction of revenues, so in a sense, firms now take not the level of the real wage but the fraction of revenues they retain as given when making decisions regarding production or entry. Hence, ϕ_t also shows up in the period t EE-curve that captures (the aggregate implications of) all these non-labor-market-related decisions by firms.

But in spite of this small difference, the general EE-WD-model from the main part of this paper does a very good job in describing the qualitative response of aggregate employment to structural changes in this "search and

workers and hence induce higher real wages conditional on employment. Those arguments would apply more clearly in an explicitly dynamic "search and matching"-setting, but they are also present in this static version inasmuch as they limit the desire of firms to "over-hire" for the purpose of depressing real wages as discussed above.

matching"-model: The results regarding how aggregate employment changes in response to changes in the values of any of the structural labor market parameters – including the parameter ϕ even though it shows up in the EE-curve – or of any of the technology parameters work out in the same way as the general model would predict as soon as one knows the mapping between ψ and ξ from the general isoelastic WD-curve in (I.4) and the labor market parameters from this "search and matching"-model: All policies which have been qualified as "supply-side policies" in this "search and matching"-model as well as technological progress in the form of an increase in the value of A or product market deregulation in the form of a decline in the value of f^P if implemented between periods t and $t+1$ increase aggregate employment from period t to period $t+1$ if and only if the elasticitiy of the period t WD-curve from (I.48), $\eta_{WD,t} = \frac{1-\gamma_t}{\gamma_t}$, is strictly greater than the elasticity of the period t EE-curve from (I.49), $\eta_{EE} = \frac{1}{\bar{\sigma}-2}$.[91] If and only if the opposite is true, demand-side policies in the labor market and more regulation of product markets (i.e. an increase in the value of f^P) if implemented between periods t and $t+1$ increase aggregate employment from period t to period $t+1$. Hence, the central result from the general model studied in the main part of the paper goes through: In order to determine the effects of different types of labor market reform on aggregate employment – in terms of the direction in which aggregate employment will move – one needs to compare the elasticity of the EE-curve with that of the WD-curve and supply-side (demand-side) policies raise aggregate employment if and only if the elasticity of the WD-curve is higher (lower). Similar conclusions also apply to technological progress and product market (de-)regulation.

Note that the "comparative statics" of the "search and matching"-model with respect to labor market parameters may thus be different from what the literature on that model, which works mostly under the assumption of perfect competition, has emphasized to this date:[92] The standard view in the literature seems to be that an increase in k, a decline in ϑ, or a decline in ϕ, which all qualify as "supply-side policies", leads to higher aggregate employment.

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[91] Note from the discussion of the standard-CES-version of the basic model in the main part of the paper where entry-costs are in terms of final output (cf. footnote 40) that this expression for the elasticity of the EE-curve allows for a similar decomposition as in (I.24), so this part of my analysis goes through, too, in the "search and matching"-case.

[92] See, for instance, the textbook exposition in Pissarides (2000) for the standard view of the comparative statics. I am not aware of any preceding work which – following the pioneering contributions by Ebell and Haefke (2009) and Helpman and Itskhoki (2010) – merges imperfect competition in product markets with the "search and matching"-model and points out that the comparative statics may as a result be different. This may be due to the fact that much of the literature studies an explicitly dynamic version of the "search and matching"-model which generally does not have analytical solutions.

That does not necessarily hold in my version of the "search and matching"-model in which "demand-side policies" may be required to raise aggregate employment. That difference results from the fact that I allow for imperfect competition in product markets and for product differentiation which represent the central elements behind the channels pushing towards demand-side policies as the optimal mode of labor market reform. Further, the standard version of the "search and matching"-model predicts that an increase in the value of A for given levels of all other parameters leads to higher employment, and again, my analysis implies that this need not be the case depending on how the relevant elasticities $\frac{1-\gamma_t}{\gamma_t}$ and $\frac{1}{\bar{\sigma}-2}$ from the period t equilibrium in which the economy is prior to such structural change compare to each other. Hence, as soon as one makes the standard "search and matching"-model internally valid by allowing for economies of scale firms can actually exploit and if there is imperfect competition in the model – which is arguably a more realistic view of product markets than perfect competition – and if one allows for product-variety-effects (and/or variable mark-ups), the comparative statics of the model with respect to its standard labor market and productivity parameters may – but need not – change and the elasticity-formula I have established in the main part of the paper can be used for predicting in which way comparative statics with respect to labor market or technology parameters go.

A second way of micro-founding the WD-curve consists in turning to the case of endogenous choice of non-observable/verifiable effort and imperfect monitoring studied by Shapiro and Stiglitz (1984). Their paper actually establishes how a curve which implies an increasing relationship between real wages and aggregate employment comes out of the model if one studies the labor market part of the model in isolation: Equation 11 in their paper is essentially the "WD-curve" they derive. Shapiro and Stiglitz (1984) depict it graphically in figure 1 of their paper and this increasing "WD"-relationship emerges from the fact that when unemployment is lower, a fired worker can get a new job more quickly and therefore, in order to prevent shirking at work, firms need to pay higher real wages when aggregate employment is higher. Hence, their paper can be viewed as a direct micro-foundation of my WD-curve as their paper shows how labor market frictions alone give rise to such a curve and how this curve can be derived without specifying anything about technology and the demand-side of the model. Matusz (1996) actually shows how to embed the labor-market-setting from Shapiro and Stiglitz (1984) into a model with monopolistic competition, CES-preferences and economies of scale. Matusz (1996) obtains a representation of the model in terms of two increasing curves although he chooses to represent them in terms of the real wage and the number of

producing firms rather than the real wage and aggregate employment. Thus, micro-foundations for my "EE-WD-model" in terms of an "efficiency wage"-example à la Shaprio and Stiglitz (1984) are clearly out there in the existing literature and I have nothing new to offer in that regard other than noting how those earlier attempts are connected to the more general model I have developed in the present paper.[93] According to my definition, supply-side policies in those models typically comprise improvements in the monitoring technology or in the ability of firms to fire as well as reductions in unemployment benefits (such policy-changes shift the "WD-curve" of these models in a way that implies lower real wages conditional on aggregate employment), while demand-side policies consist in the opposite.

The third and final micro-foundation of the WD-curve I will discuss in this appendix is based on the idea that morale, fairness and social norms affect work effort and that morale, fairness and social norms are also influenced and shaped by the level of wages. These ideas were popularized by seminal works by Solow (1979) and Akerlof (1982) who argued that wages might affect workers' motivation which in turn affects productivity through (unconscious) effort-choice. The workhorse model in that strand of the literature is the model by Akerlof and Yellen (1990) which I will thus focus on: The central idea from Akerlof and Yellen (1990) is that the level of effort workers at firm ω put in at work in period t, which I denote by $e_t(\omega)$, matters for productivity and is given by $e_t(\omega) = \min\left\{1, \frac{w_t(\omega)}{w_t^*}\right\}$ $\forall \omega \in \Upsilon_t$ $\forall t$ where $w_t^* > 0$ denotes the level of the real wage which is perceived to be fair in the economy in period t.[94] For the remaining part of this appendix I will assume that producing $y_t(\omega)$ units of output in period t requires $\frac{y_t(\omega)}{A(e_t(\omega))}$ units of labor in period t in addition to f^P units of the aggregate consumption good ("final output"), which represent quasi-fixed costs as in the preceding "search and matching"-example. This formulation introduces a role for effort to affect productivity. The central idea behind the particular non-symmetric

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[93] In the models analyzed by Shapiro and Stiglitz (1984) and Matusz (1996) the real wage implied by the "WD-curve" converges to infinity as aggregate employment approaches full-employment since full effort could never be induced at full-employment. This has important consequences for comparative statics: In the Pareto-dominant equilibrium of their models the "WD-curve" will necessarily be steeper than the "EE-curve" so supply-side policies raise employment in such an equilibrium and technological progress leads to an expansion of employment. This property of their models is due to modelling the labor market in continuous time such that a fired worker could *immediately* find a new job if there was full-employment. Moving to discrete time and thus introducing the more realistic assumption that a fired worker remains unemployed for a non-zero minimum amount of time evidently overcomes this property and in that case, other equilibria might become interesting where demand-side policies might – but need not be – preferable.

[94] For this standard specification of the effort-function it obviously does not matter whether the fairness norm is specified in nominal or real terms. Hence, I will work with real wages throughout my analysis.

effort-function $e_t(\omega) = \min\left\{1, \frac{w_t(\omega)}{w_t^*}\right\}$ $\forall \omega \in \Upsilon_t$ $\forall t$ Akerlof and Yellen (1990) propose is that workers who feel

paid in an unfair manner, i.e. their actual real wage $w_t(\omega)$ falls short of the level w_t^* they perceive as fair,

compensate themselves for that by proportionally withdrawing effort at work, where this is interpreted to be an

unconscious psychological reaction. Whenever workers earn more than what they perceive to be fair, however, they

unconsciously react by updating their fairness norm or psychological evaluation of their own work until it is in line

with their actual earnings. Akerlof and Yellen (1990) present evidence and theories from the fields of psychology

and sociology which support this functional form of the effort-function. But what determines the fairness norm

captured in the level of the fair wage, w_t^*? Examples the literature has explored include past earnings, earnings of

reference groups including other types of workers or unemployed workers and aggregate labor market conditions

such as the unemployment rate. For my purposes, the most interesting candidates are those which imply that

aggregate labor market conditions affect fairness. To focus on this aspect, let me simply assume that w_t^* is an

increasing function of the aggregate employment rate in the same period: $w_t^* = g_*\left(\frac{L_t^E}{L}\right)$ $\forall t$ where $g_*(\cdot)$ is

monotonically increasing in its argument. Finally, let me follow Akerlof and Yellen (1990) in assuming that among

any levels of the real wage that would *ceteris paribus* imply the same level of profits as the fair real wage w_t^*, a

firm always prefers to pay the fair real wage (which does not contradict the maintained assumption that firms

choose to offer the real wage that maximizes their profits!). Under my assumptions about the effort-function and

the production technology it thus follows that period t labor costs (in real terms) associated with producing $y_t(\omega)$

units of output are given by $\left(w_t(\omega)\right)\frac{y_t(\omega)}{A(e_t(\omega))} = \left(w_t(\omega)\right)\frac{y_t(\omega)}{A\left(\min\left\{1,\frac{w_t(\omega)}{w_t^*}\right\}\right)} = \frac{y_t(\omega)}{A}\left(\max\{w_t(\omega), w_t^*\}\right)$ $\forall \omega \in \Upsilon_t$ $\forall t$.

Hence, cost-minimization by firms implies that a firm would never choose to pay a wage greater than w_t^* as long as

it can hire as much labor as it likes to at $w_t(\omega) = w_t^*$. But under the assumption that firms prefer the fair real wage

over any other wage-level implying the same profits, a firm would not choose any wage strictly less than w_t^*, either,

because wages lower than the fair wage imply the same level of production costs. Therefore, all firms will choose

to pay the same real wage w_t in equilibrium which is exactly equal to the fair real wage w_t^* as long as $L_t^E < L$. But

that then immediately implies that $w_t(\omega) = w_t = g_*\left(\frac{L_t^E}{L}\right)$ $\forall \omega \in \Upsilon_t$ $\forall L_t^E \in [0, L)$ $\forall t$,[95] which is a WD-curve as in

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[95] For $L_t^E = L$ the real wage cannot be less than w_t^*, either, but without further assumptions on wage-determination it could potentially be higher than that, which is why I exclude that level of aggregate employment from the

(I.3) and it is obvious how an isoelastic functional form as in (I.4) could arise from suitable functional form assumptions on $g_*\left(\frac{L_t^E}{L}\right)$.

It is worth emphasizing that my analysis implies that one of the major conclusions from the model by Akerlof and Yellen (1990) does not necessarily go through as soon as one introduces imperfect competition, endogenous entry, economies of scale (again to make the model internally consistent as fairness norms obviously do not matter for the self-employed) and either or both of variable mark-ups and product-variety-effects: A major result in the preceding literature is that fairness norms calling for too high real wages give rise to unemployment, so that fairness norms need to be relaxed for unemployment to decline, where lower unemployment necessarily entails lower real wages. This result need not be true according to my analysis as embedding the WD-curve of such a model into my general framework would imply that whenever the WD-curve is flatter than the EE-curve in a given per-period Nash equilibrium, adjusting fairness norms such that the WD-curve is rotated/shifted upwards would imply higher aggregate employment. But an upwards-rotation/shift of WD-curves would in this context require stronger rather than weaker fairness norms as it would require a higher level of the fair wage for any given level of aggregate employment. By contrast, whenever the relationship of the slopes of the two curves goes in the opposite direction in a given per-period Nash equilibrium, weaker fairness norms would be required to raise aggregate employment, so the question how fairness norms would have to change for aggregate employment to increase, too, comes down to the elasticities of the two curves that have been at the center of my analysis and that are summarized in my central

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definition of the WD-curve in this "fairness example" to avoid complicated notation. The reason for which in this example real wages at the frim-level could be higher than w_t^* at $L_t^E = L$ is that in the presence of full-employment firms might bid up wages beyond the fair level, which they would not do if $L_t^E < L$. To avoid this feature in such a model of "fairness norms" so that one gets a WD-curve that implies that the real wage at the firm-level is equal to w_t^* for all admissible levels of aggregate employment including $L_t^E = L$ one could do the following (which also provides one rationale for the assumption in the general case studied in the main part according to which the WD-curve does not become vertical as soon as full-employment is reached): One could assume that there is a frictionless and costless matching mechanism in the labor market that takes place once per period and matches vacancies with workers so that in each period any vacancy is matched with at most one worker and vice versa. Wage-determination would then be taking place at the firm-level after that matching process (note that the assumption of wage-determination taking place in a decentralized manner at the firm-level is closely in line with my assumptions behind the WD-curve in the main part of the paper). After matches have been formed, workers and firms would then be locked into their relationships for the remainder of the period and in that case, firms would have no incentive to pay a wage higher than w_t^* even at $L_t^E = L$ unless workers would have a level of bargaining power that would suggest that the bargained wage (for instance according to the bargaining model by Stole and Zwiebel (1996a, 1996b)) would be higher than that implied by the fairness norm. But in the particular case of that bargaining model, costless search would imply that if there was no fairness constraint, firms would keep posting vacancies and would keep hiring to depress the real wage all the way to zero, so the fairness constraint would in fact be binding and real wages at the firm-level would be equal to the fair real wage w_t^*.

formula in (I.25). And even if weaker fairness norms are required, my analysis does not fully agree with the preceding literature since for that case, too, my analysis predicts that real wages increase rather than decline as aggregate employment increases. This is due to the increasing EE-curve.

Appendix I.D – Technical Details regarding the QMOR Expenditure Function

The purpose of this appendix is to summarize some further technical results which Feenstra (2014) derives for the "quadratic mean of order r (QMOR) expenditure function" and which I use in my analysis: Feenstra (2014) shows that the reservation price $\overline{P}_t$ appearing in the residual demand function in (I.31) is finite and can be written as follows in terms of my notation:

(I.50)
$$\overline{P}_t = \left(\left(\frac{N_t}{N_t - \left[\tilde{N} + \frac{\alpha}{\beta} \right]} \right)^{\frac{2}{r}} \right) \left(\left(\int_{\omega \in \Upsilon_t} \frac{1}{N_t} \left((P_t(\omega))^{\frac{r}{2}} \right) d\omega \right)^{\frac{2}{r}} \right) \quad \forall t$$

A very useful result for performing aggregation in the process of solving my model is that Feenstra (2014) shows that one can write the price-index P_t as a function of the prices of only those varieties which are actually produced, i.e. of the prices of the varieties in the set I denote by Υ_t:

(I.51)
$$P_t = \left[\alpha \int_{\omega \in \Upsilon_t} \left((P_t(\omega))^r \right) d\omega - \frac{\alpha}{N_t - \left[\tilde{N} + \frac{\alpha}{\beta} \right]} \left(\left(\int_{\omega \in \Upsilon_t} \left((P_t(\omega))^{\frac{r}{2}} \right) d\omega \right)^2 \right) \right]^{\frac{1}{r}} \quad \forall t$$

Appendix I.E – Intermediate Steps for Solving the Cournot Model from Section I.6.2

Optimal consumption choices by the representative household who is again assumed to take prices and his/her income as given imply the following relationship:

(I.52)
$$Y_t(j) = \frac{P_t C_t}{M} \frac{1}{P_t(j)} \quad \forall j \ \forall t$$

$P_t C_t$ is total expenditure by the representative household in nominal terms in period t. Solving the optimization problem of any given firm in any given sector in any given period for the reaction function that characterizes the profit-maximizing output-level of that firm as a function of aggregate variables (including the economy-wide real wage) and as a function of the sum of the output-levels of all other firms in the same sector and then solving for the

symmetric Cournot-Nash-equilibrium within any given sector implies the following solution for equilibrium output-levels at the firm-level in sector j and period t:

(I.53)
$$y_t(j) = \frac{A}{M} \frac{N_t(j)-1}{(N_t(j))^2} \frac{C_t}{w_t} \quad \forall j \; \forall t$$

Multiplying this expression for equilibrium firm-level output by $N_t(j)$ to obtain sectoral output $Y_t(j)$ in equilibrium and taking that to (I.52) one can solve for the uniform price all firms producing in sector j in period t charge in equilibrium:[96] $P_t(j) = \frac{N_t(j)}{N_t(j)-1} \frac{w_t}{A} P_t \; \forall j \; \forall t$. This implies the expression for equilibrium mark-ups stated in the main part of the paper: $\mu(N_t) = \frac{N_t}{N_t-1} \; \forall t$. Aggregating up sectoral output $Y_t(j)$ with the help of the aggregator in (I.35) and imposing the symmetry of all sectors in equilibrium leads to (I.36). Finally, using the solution for $y_t(j)$ from (I.53) to find an expression for firm-level profits in equilibrium and setting those equal to zero (due to the free-entry-assumption) yields $C_t = M f^P ((N_t)^2) w_t \; \forall t$. Calculating firm-level employment in equilibrium based on equilibrium firm-level output from (I.53) and then aggregating up and making use of the expression for C_t derived from the requirement of zero profits leads to (I.37).

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[96] In fact, $P_t(j)$ and P_t are also the same in a symmetric equilibrium in this model, i.e. the uniform price at the product-level in all sectors is equal to the welfare-relevant price-index. This result reflects the absence of any product-variety-effects and follows from combining the last expressions for $P_t(j)$ and $\mu(N_t)$ with (I.36).

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Part II:

Trade Liberalization, Intra-Industry Reallocation and Welfare-Gains:

On the Role of the Labor Market

Abstract for Part II

I embed the simple and yet very general formulation of frictional labor markets from part I of this dissertation into a standard trade model à la Meltiz (2003). This allows me to identify a single aspect of the institutional setting of labor markets which – given technology and preferences – determines whether trade liberalization raises welfare and employment or reduces them: The strength of a pecuniary externality in the labor market. Only if this externality is sufficiently strong, trade liberalization leads to welfare-gains, while it reduces welfare and employment otherwise. I also make a strong case for the view that institutional details of the labor market do not play a role for shaping the reallocation patterns trade liberalization brings about in product markets. Further, I extend the analysis by Melitz and Redding (2015) to the case of frictional labor markets and argue that selection effects arising from the heterogeneity of firms amplify both welfare-gains and welfare-losses from trade liberalization. Relatedly, I argue that the welfare-formula due to Arkolakis, Costinot and Rodríguez-Clare (2012) systematically fails in frictional labor markets as it underestimates any actual welfare-gains and does not indicate any actual welfare-losses.

II.1 Introduction

Trade liberalization events lead to substantial reallocation of market shares across heterogeneous firms within industries as has been revealed by a large body of empirical research.[97] On the theoretical side, researchers have developed models to understand these reallocation patterns and to assess their welfare-implications. The theoretical research along these lines is dominated by the model proposed by Melitz (2003).[98] With its Walrasian labor market, this model generally implies welfare-gains from trade liberalization and – as argued by Melitz and Redding (2015) – due to reallocation between heterogeneous firms it implies gains which exceed those implied by related models of trade with homogeneous firms.[99] However, it goes without saying that actual labor markets are far from being Walrasian, so at least the welfare-results of such studies need to be interpreted with caution if one wants to draw conclusions for actual trade liberalization events from them. In addition, in the media one often encounters concerns that trade liberalization might lead to a reduction in aggregate employment and the benchmark model with its Walrasian labor market does not have anything to say about this by construction. Finally, one might be worried that the positive implications of the model for reallocation patterns induced by trade liberalization are driven by the assumption of a Walrasian labor market.

Researchers have tried to address these points by extending models in the spirit of Melitz (2003) in various ways to make the labor market appear more like what one might observe in reality. A non-exhaustive list of some prominent attempts in that direction includes models which have built in "search and matching"-frictions à la Mortensen and Pissarides (1994) and Pissarides (2000), such as works by Helpman and Itskhoki (2010), Helpman, Itskhoki and Redding (2010) and Felbermayr, Prat and Schmerer (2011), models which have introduced "efficiency wage"-frictions à la Shapiro and Stiglitz (1984), such as work by Davis and Harrigan (2011), and models which have allowed for "fairness"-frictions in the spirit of Akerlof (1982) and Akerlof and Yellen (1990), such as works by Egger and Kreickemeier (2009, 2012) and Amiti and Davis (2012).

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[97] For an overview over this empirical research see Bernard, Jensen, Redding and Schott (2012) and the handbook-chapter by Melitz and Redding (2014).

[98] The handbook-chapter by Melitz and Redding (2014) surveys this theoretical work and presents a by now standard version of this model.

[99] Arkolakis, Costinot and Rodríguez-Clare (2012) present an opposing view.

These studies generally take very particular views of the labor market which require a number of specific assumptions about its institutional details. In addition, some of them depart from the canonical static version of the model à la Melitz (2003) by adding additional specific assumptions on preferences, market structure and technology which make it difficult to disentangle whether differences in results across these studies are driven by differences in labor market frictions or by those additional elements. And the results obtained by these studies are in fact quite mixed regarding the effects of trade liberalization on aggregate employment and – to a lesser extent – on welfare.[100] Based on these studies, it does not seem to be possible to make general statements about which aspects of labor markets are crucial for ensuring welfare-gains from trade liberalization and for ensuring increases in employment and neither does it seem to be possible to derive a general message regarding to which extent labor markets matter for shaping the reallocation patterns trade liberalization induces in product markets.

In this paper, I make an attempt to provide a more general assessment of the role of labor markets in shaping the effects of trade liberalization on intra-industry reallocation patterns, on welfare (as measured by aggregate consumption) and on aggregate employment: I take the standard static version of the canonical trade model à la Melitz (2003) – also referred to as "the Melitz-model" henceforth – from the shelf and embed into it the very general formulation of frictional labor markets from part I of this dissertation which requires only a minimal set of quite general assumptions. As I argue in detail in part I of this dissertation, this formulation can accommodate several different views of frictional labor markets including the aforementioned "search and matching"-elements, "efficiency wage"-elements or elements of "fairness norms". I am able to solve this slightly modified version of the standard trade model analytically and I also provide an intuitive and straightforward graphical representation of the model. Using both the analytical results and the graphical representation of the model, I then study comparative statics with respect to declines in trade costs ("trade liberalization").

Three major sets of results stand out:[101] First and most importantly, I show that a pecuniary externality in the labor market is a central determinant for whether or not there are gains from trade liberalization: I argue that given

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[100] The literature tends to find welfare-gains from trade liberalization, but this is not the case in all contributions.

[101] In addition to the results regarding trade liberalization on which this paper puts the main emphasis, one may also read this paper as a set of additional robustness-checks on and extensions of my closed-economy analysis of labor market reform in part I of this dissertation: In the limiting case of infinite costs of accessing foreign markets, the

technology and preferences, sufficiently strong externalities in the wage-determination mechanism whereby hiring-decisions by other firms affect the wage-level at any given firm are required for welfare-gains from trade liberalization, while welfare-losses result from trade liberalization if these pecuniary externalities are not sufficiently strong in a well-defined sense. As welfare-losses are unavoidable if this type of pecuniary externality is absent, its presence can be viewed as representing a necessary condition for gains from trade liberalization. As I will explain in detail below, such a pecuniary externality in the labor market can be motivated in different ways from concrete institutional assumptions and it does show up in the aforementioned three leading examples of frictional labor markets that have been studied in the recent trade literature. My analysis thus reveals a single and central aspect common to all these models which is absolutely crucial for determining the direction of welfare- and employment-effects of trade liberalization. Thus, my analysis contributes to better understanding which of the many institutional details of labor markets are important for shaping the effects of trade liberalization. I am therefore able to provide a more general answer than the previous literature as to what it is that matters for the welfare-effects of trade liberalization in the presence of non-clearing labor markets. One might want to think of a stronger pecuniary externality in the labor market, whereby wage-determination is more strongly influenced by aggregate labor market conditions, as characterizing a more flexible labor market or a labor market with a higher degree of wage-flexibility. Making strong parametric assumptions I am able to provide simple threshold-rules that indicate how much "wage-flexibility" in that sense is required for trade liberalization to have beneficial effects, but also for more general cases I provide some guidance as to how one could empirically identify whether or not the pecuniary externality in the labor market is sufficiently strong to make trade liberalization beneficial.

Second, my analysis makes a strong case for the view that institutional details of the labor market are inconsequential for shaping the intra-industry reallocation patterns induced by trade liberalization: Consistent with the empirical evidence I find that trade liberalization leads to exit of the least productive firms and to an increase in average productivity within an industry and in particular, I demonstrate that those "selection effects" in product markets obtain regardless of what happens to aggregate employment[102] and welfare and regardless of what labor

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model studied in the present paper is equivalent to a closed economy with heterogeneous firms so that the model is directly comparable to the analysis in part I of this dissertation which works with homogeneous firms.

[102] Related results in the context of versions of the Melitz-model have been shown by Bernard, Redding and Schott (2007) and by Felbermayr, Prat and Schmerer (2011): These authors also demonstrate that it is possible to solve

market institutions look like. On the one hand, this implies that such "selection effects" are by no means indicative of beneficial effects of trade liberalization and on the other hand, it means that labor markets do not shape those reallocation patterns in product markets. Hence, I argue that there is some "disconnect" between what is going on in product markets and what is happening in labor markets in response to trade liberalization.

But third, building on the analysis by Melitz and Redding (2015) who have recently argued that in the case of Walrasian labor markets additional welfare-gains from trade liberalization obtain if firms are heterogeneous rather than homogeneous, I show that the selection effects associated with firm heterogeneity amplify both welfare-gains and welfare-losses from trade liberalization in my general framework of frictional labor markets. The bigger picture which emerges from that is that labor market details play a key role for determining the *direction* of welfare-effects of trade liberalization while selection effects in product markets do not depend on the direction in which welfare and employment move, but those selection effects still matter for the *size* of welfare-changes in terms of their absolute value and generally amplify it. I thus extend the argument by Melitz and Redding (2015) according to which firm heterogeneity and endogenous selection into different markets represents a new and independent welfare-channel and show that their argument also applies in frictional labor markets and in particular, I show that selection effects also amplify welfare-*losses* from trade liberalization. Arkolakis, Costinot and Rodríguez-Clare (2012), by contrast, have argued that firm heterogeneity per se does not represent a new welfare-channel and that a simple formula can capture the welfare-effects of changes in trade costs in a series of standard trade models. I connect my findings to their approach, too, and argue that their welfare-formula which is based on the assumption of a Walrasian labor market is seriously misleading as soon as one operates in a frictional labor market:[103] On the one hand, I find that whenever trade liberalization entails gains in my framework, that formula underestimates those gains and on the other hand, the formula still implies welfare-gains whenever there are actually welfare-losses in my model. The failure of this formula along both of these dimensions is not surprising given that it does not account for changes in aggregate employment in response to trade liberalization, which, however, seem to represent a crucial margin for welfare.

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for selection effects in product markets without pinning down what happens in the labor markets of their respective models.

[103] See Heid and Larch (2014) for a related argument in a different type of trade model.

My analysis is structured as follows: In section II.2 I present the economic model. In section II.3 I solve for equilibrium. In section II.4 I engage in comparative statics exercises to study the effects of trade liberalization and dig deeper into the underlying mechanisms of my model. That section also contains my discussion of the welfare-formula à la Arkolakis, Costinot and Rodríguez-Clare (2012). Section II.5 then turns to studying the welfare-contribution of selection effects and provides an experiment along the lines of Melitz and Redding (2015) for the case of frictional labor markets. Section II.6 contains some extensions including an explicit stability analysis and in section II.7 I conclude.

II.2 Description of the Basic Model

The model I will use throughout the formal analysis of this paper is basically the model proposed by Melitz (2003), which over the last decade – in a simplified and static form which will also be used in this paper – has become the standard model for analyzing intra-industry trade and intra-industry reallocation in response to trade liberalization (cf. Melitz and Redding (2014)) and which is based on closed-economy work by Hopenhayn (1992) as well as on the model of intra-industry trade suggested by Krugman (1980). The only non-standard element I introduce into the model is my approach to modelling the labor market.

II.2.1 Preliminaries, Labor Supply and Preferences

For simplicity, I study a static one-period model and following much of the literature I will only study the case of two identical countries/economies which may trade with each other.[104] I will call one of those countries the "domestic country" or "home country" and the other one the "foreign country". Subscript i is used to indicate to which country any given variable belongs where I use $i = H$ to denote the "domestic" economy and $i = F$ to denote the "foreign" economy. Each economy is populated by a representative household owning all the firms operating in his/her respective economy and thus receiving any profits those firms make. Households may not own any firms operating abroad and I do not allow for foreign direct investment of any kind, so firms can only serve foreign markets by means of exporting and firms can only hire labor from the country in which they produce. Further, it is assumed that each representative household supplies $L > 0$ units of labor in the labor market of his/her

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[104] In part III of this dissertation I study a related open-economy model allowing for a rich set of asymmetries across countries.

country of residence – labor is assumed to be immobile across borders.[105] Exogenous labor supply makes it possible to define unemployment as a market-failure as workers' time has no alternative use by assumption. The global economy produces a single aggregate consumption good which comes in a continuum of horizontally differentiated varieties. For simplicity, I will work under the assumption of single-product firms and the entry-process will make sure that any firm corresponds to a unique variety and vice versa. Varieties and the corresponding firms will thus be indexed by ω and it is assumed that any variety produced in the global economy is horizontally differentiated from all others even if it is only sold in one country. The aggregate consumption good is defined according to a standard CES-aggregator à la Dixit and Stiglitz (1977):

$$(II.1) \qquad C_i = \left[\int_{\omega \in \Omega} \left((c_i(\omega))^{\frac{\sigma-1}{\sigma}} \right) d\omega \right]^{\frac{\sigma}{\sigma-1}} \quad \forall i$$

C_i denotes total consumption by the representative household from country i and utility for the representative household from any given country i is assumed to be equal to C_i, so C_i will serve as the welfare-measure in my paper as there is no disutility from labor or utility from leisure by assumption.[106] $c_i(\omega)$ denotes the quantity of variety ω the representative household from country i consumes.[107] σ denotes the elasticity of substitution for which I make the standard assumption of $\sigma > 1$ which is required to ensure that there is "love for variety" so that the representative household chooses to buy different varieties of the aggregate consumption good. Ω denotes the

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[105] The assumptions of households not being able to own firms abroad and not being able to work abroad are inconsequential due to the perfect symmetry of the two countries.

[106] One can work with the concept of a representative household even though some of its members may be unemployed while others are not as employment-status does not affect utility. Using the concept of a representative household implicitly entails the assumption of perfect consumption insurance among households. However, that assumption could easily be dropped and the analysis would still go through in a very similar way if one instead assumed that the aggregator in (II.1) applied at the level of a single household and would thus state utility at the level of a single household: Due to the homotheticity of that aggregator, all households would share the same welfare-relevant price-index so that real wages could be defined in the same way as I will do it below. And since trade liberalization events will turn out to always move real wages and aggregate employment in the same direction, aggregate consumption in a given country defined as the simple sum of the individual quantities of the aggregate consumption good all households in that given country consume, which would still be equal to the product of the economy-wide real wage and aggregate employment in the respective country, would still be a meaningful welfare-measure – at least if one abstracted away from any changes in aggregate employment beyond net changes or if one applied a utilitarian welfare-criterion where all members of society are assigned the same weight.

[107] In equilibrium, some varieties will not be traded, but one can still think of consumption in the two countries as consisting of the same aggregate consumption good since it is "assembled" using the exact same "production function" in both countries, namely the aggregator in (II.1).

set of all varieties which could potentially be produced and that set is assumed to be unbounded so that there is no exogenous constraint on firm entry. In equilibrium, only a finite subset of all those conceivable varieties will be produced and I will use Υ to denote the set of varieties which are actually produced in the global economy and I will use N to denote the mass of varieties which are actually produced. Similarly, I will use Υ_i to denote the set of all varieties of which a strictly positive quantity is produced in country i and N_i will be used to denote the associated mass of varieties. Let me also introduce the operator $j(i)$ which can take on the values H and F to denote the *respective* foreign country and hence the potential export destination from the perspective of any given country i. Likewise, I will use the operator $i(\omega) \in \{H; F\}$ to denote the country in which the firm associated with variety ω produces and the operator $j(\omega) \in \{H; F\}$ to denote the country which is the potential export destination for firm ω. Finally, I will use Ξ_i to denote the set of all varieties which are exported from country i to country $j(i)$ and N_i^X is used to denote the mass of exporting firms producing in country i.

II.2.2 Production Technology, Firm Entry and Exporting

In order to be able to produce, a firm first needs to undergo the standard Hopenhayn-Melitz-entry-process consisting of two steps: The first step consists in making an entry investment of $f^A > 0$ units of labor from the country in which the firm enters. The country in which a firm chooses to enter will then be the country in which that firm needs to produce. Once that entry investment has been made, the firm learns which unique variety ω from the set of all conceivable varieties Ω it will be able to produce and it also learns about an idiosyncratic component of its labor productivity which I denote by $\lambda(\omega)$. For each entering firm $\lambda(\omega)$ is determined by an independent draw from a distribution described by the cumulative distribution function ("CDF" henceforth) $G(\lambda(\omega)) = 1 - \left(\left(\frac{\lambda_0}{\lambda(\omega)} \right)^K \right)$ where the parameters λ_0 and K are strictly positive and where $K > (\sigma - 1)$ is assumed, which is a technical requirement for making sure that means and hence aggregates are finite. I thus use the Pareto distribution for productivity-draws which can conveniently be applied in this type of model and which has found many useful applications in this context.[108] In addition, it generates a firm size distribution which resembles the actual one for

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[108] Cf. Melitz and Redding (2014) for a survey and for references to the literature.

the U.S.[109] Let N_i^A henceforth denote the mass of firms which complete the first stage of the entry-process in country i within the single period.

In order to produce $y(\omega)$ units of any variety $\omega \in \Omega$, the corresponding firm needs to employ $\frac{y(\omega)}{A(\lambda(\omega))}$ units of labor on top of any labor that is required for entry or for market access. $A > 0$ is a parameter. I will henceforth use $y(\omega)$ to denote the total quantity produced of variety ω. Once firms have learned about their production technology after completing the first stage of the entry-process, they can decide whether or not to complete the second stage of it and if so, for which countries they want to do that: If a firm wants to sell in "its" country, i.e. in country $i(\omega)$, it needs to incur an additional entry investment of $f^P > 0$ units of labor from that country. If the firm also wants to export, i.e. serve the market in country $j(\omega)$, it needs to incur yet another entry investment of $f^X > 0$ units of labor, which are to be hired from country $i(\omega)$.[110] In principle, firms are thus free to export without selling "at home", but I will make the natural assumption $f^X > f^P$, i.e. market access costs are greater abroad, which seems very reasonable for the case of (otherwise) identical countries. Given that countries are identical, an equilibrium will thus only feature firms which serve both countries and firms which sell only domestically, so I rule out the case of firms which only export and thus, I follow the literature in focusing on the empirically relevant case where the vast majority of exporters also sells domestically (at least as far as developed economies are concerned). Finally, exporting also involves transport costs which I model in the convenient "melting iceberg"-form: For one unit of its variety to arrive abroad, a firm needs to ship $\tau > 1$ units.

II.2.3 Timing Assumptions and Institutional Setup of Markets

Timing assumptions are very simple: Entry takes place prior to production and production occurs before output is shipped and sold, so consumption occurs at the very end of the period. The labor market is assumed to take place

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[109] Cf. Axtell (2001).

[110] That assumption is made for analytical convenience and does not play any role given the assumed symmetry of the two countries.

once within the single period, namely right after firms have made their first-stage entry-decisions and have learned about their productivity realizations.[111]

Regarding product markets, I assume that representative households can only go shopping in their respective countries of residence, so exporting firms can charge different prices in different locations, but this is the only form of price discrimination I allow for. In each country, the product market is assumed to be characterized by monopolistic competition, so firms set prices for their varieties which customers take as given and firms take market aggregates as given due to being of negligible size. The representative households seek to maximize utility taking labor income and income from firm profits as given. Any firm makes independent profit-maximizing decisions in all respects.

Labor income and firm profits can be used for purchases in product markets and firms can use their revenues to pay their wage-bills, so I assume some simultaneity of payments, which requires the implicit assumption of a frictionless credit system operating in the background. I will not elaborate on that issue any further and I will not pin down the absolute values of nominal prices and wages, either. Instead, I will assume that all nominal variables are denominated in a single currency and I will use the price-index for the aggregate consumption good in one country as the numeraire. Since I will only focus on symmetric equilibria where all aggregate variables take on the same values across countries, this choice of numeraire makes it possible to solve for prices and wages in terms of "real" units, i.e. welfare-relevant units of consumption in the two countries.

The most important aspect of the model – and in fact the only part of it where I really deviate from the canonical Melitz-model – consists in my approach to modelling the labor market which follows the route I have suggested in part I of this dissertation that allows introducing labor market frictions and pecuniary externalities in labor markets without taking a strong stance on what exactly labor markets institutions look like so that results will not be dependent on particular institutional assumptions. Another advantage of that approach is that it accommodates

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[111] On a formal level, this means that I assume that as far as the first-stage entry-costs are concerned, firms just irrevocably *commit* to incur them before learning about their productivity-draws and then *actually* incur those costs afterwards. In an explicitly dynamic model this would show up as a "time to build"-lag where entry-costs are incurred one period before the firm does anything else. To keep the analysis simple, I opt for this simpler set of assumptions in a static environment.

central aspects of several leading concrete theories of labor markets[112] including the cases of "search and matching"-frictions à la Mortensen and Pissarides (1994), "efficiency wage"-frictions à la Shapiro and Sitglitz (1984) and "fairness norms" à la Akerlof (1982) which have been analyzed in the context of the Melitz-model in recent years.[113] At this point, I will limit myself to a highly condensed (but fully self-contained) presentation of that labor market model. The reader is strongly encouraged to consult part I of this dissertation for an in-depth discussion of that framework and for explicit micro-foundations of it.

Aggregate employment in country i will be denoted by L_i^E. For the determination of equilibrium real wages at the firm-level (the real wage is measured in units of the aggregate consumption good) I assume the following "wage-determination schedule" or "WD-curve" where I use $w(\omega)$ to denote the real wage paid by any given producing firm ω:[114]

(II.2)
$$w(\omega) = \psi\left(\left(\frac{L_{i(\omega)}^E}{L}\right)^{\xi}\right) \quad \forall \omega \in \Upsilon$$

The parameters ψ and ξ are assumed to satisfy $\psi > 0$ and $\xi \geq 0$. The real wage any given firm pays is thus assumed to be increasing in the employment rate prevailing in the labor market in which the firm operates and in particular, real wages in a given country are assumed to be strictly positive even if the employment rate is strictly below unity, i.e. even if there is unemployment in that country. These two features introduce a pecuniary externality and labor market frictions, respectively: Following the approach in part I of this dissertation I ask the reader to think about labor market frictions as any kind of element that prevents real wages from dropping to zero in the presence of unemployment – which distinguishes a frictional labor market from a Walrasian one where in a situation with unemployment real wages must necessarily be zero. Further, a pecuniary externality is introduced into the labor market through the WD-curve in (II.2) as that specification makes real wages at the firm-level endogenous to the aggregate state of the labor market and hence makes the level of real wages at the firm-level a

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[112] Cf. the discussion in appendix I.C in part I of this dissertation.

[113] Examples using the first approach include contributions by Helpman and Itskhoki (2010), Helpman, Itskhoki and Redding (2010) and Felbermayr, Prat and Schmerer (2011). The paper by Davis and Harrigan (2011) is a leading example of the second approach, while examples of the third approach include works by Egger and Kreickemeier (2009, 2012) and Amiti and Davis (2012).

[114] This is the case called the "isoelastic WD-curve" in part I of this dissertation.

function of the hiring-decisions by other firms operating in that labor market. On a general level, this is meant to capture the idea that wage-determination at the firm-level is likely influenced by the "outside options" available to firms and workers, respectively, and those are clearly strongly influenced by how easily a firm can find an alternative worker and how easily a worker can find an alternative job, respectively – and both of these aspects in turn clearly depend on aggregate labor market conditions. The strength of this pecuniary externality is thus directly shaping the "flexibility" of real wages as it indicates how sensitive the level of real wages at the firm-level is to aggregate labor market conditions. In more concrete terms, the assumption of there being a pecuniary externality in wage-determination is meant to capture a central aspect which is present in the wage-determination mechanisms of any of the aforementioned three leading labor market models where real wages also depend on the aggregate state of the labor market: In "search and matching"-models à la Mortensen and Pissarides (1994), this central idea shows up as tighter labor markets increase workers' bargaining power thus leading to higher real wages. In the "efficiency wage"-approach à la Shapiro and Stiglitz (1984), all else equal lower unemployment implies lower expected costs of being detected shirking and thus being fired, so in order to induce full effort by workers, firms need to maintain sufficiently high expected costs of shirking, which they do by means of raising real wages when unemployment is lower. And in the "fairness"-approach à la Akerlof (1982), such a relationship between real wages and aggregate employment is directly assumed based on psychological considerations whereby lower unemployment implies that the wage-level workers perceive to be fair is higher and vice versa. All of these concrete labor market models also provide explanations as to why real wages can still be strictly positive in the presence of unemployment.

By using the WD-curve from (II.2) I am thus trying to capture two important elements of wage-determination which are central to several leading theories of the labor market while preserving as much generality about labor market institutions as possible. Note that the parameter ξ is directly related to the pecuniary externality in the labor market: The higher the value of ξ is, the more sensitive are real wages to changes in aggregate labor market conditions and hence, a higher value of ξ implies a stronger pecuniary externality in the labor market. Thus, the value of ξ can be interpreted as being a measure of the degree of "wage-flexibility". By setting $\xi = 0$ the model can also handle the limiting case of completely rigid real wages, i.e. the case where wages at the firm-level do not depend on aggregate labor market conditions at all. Further, for $\xi \to \infty$ my model of the labor market becomes arbitrarily close to the Walrasian benchmark where real wages are essentially exclusively determined by aggregate

labor market conditions in the form of (the position of) the aggregate labor demand curve. In part I of this dissertation I work with an arbitrary non-decreasing and differentiable functional form for the WD-curve. For the purpose of the present study, however, it will be more convenient to work under the concrete functional form assumption from (II.2), but as I will argue in section II.4, major results of my study are robust to making more general assumptions. Moreover, a WD-curve of the isoelastic form posited in (II.2) can be shown to come out of a "search and matching"-model or a "fairness"-model if one makes standard assumptions on functional forms in those models such as the functional form assumption Felbermayr, Prat and Schmerer (2011) make for the matching function or the functional form assumption Egger and Kreickemeier (2009) make for introducing the unemployment rate into the fairness constraint of their model.[115]

Regarding the determination of aggregate employment L_i^E and of employment at the firm-level I also make the exact same assumptions as in part I of this dissertation: For the case of total labor demand being either exactly equal to or falling short of labor supply L, it is assumed that aggregate employment is "demand-determined", i.e. that each firm is able to hire as much as it likes to given aggregate labor market conditions (which could also explicitly be allowed to include search costs, matching frictions and the like as I discuss in part I of this dissertation, which means that this assumption of employment being "demand-determined" is consistent with the assumptions made in leading models of frictional labor markets) and given the wage each firm needs to pay as implied by the WD-curve for given aggregate labor market conditions. Further, it is assumed that the rationing rule applying in the case of excess demand in a labor market is such that there does not exist any equilibrium with excess demand in labor markets. This allows me to focus on cases with excess supply (and hence unemployment) or exact market-clearing (i.e. full-employment), which is sufficient for my purposes inasmuch as the case of strictly positive unemployment is arguably the empirically relevant case. Further, as I discuss in part I of this dissertation, very mild concrete assumptions on rationing rules for labor markets with excess demand rule out equilibria for that case. This completes the description of the model.

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[115] Appendix I.C in part I of this dissertation provides further details on that.

II.3 Solving the Model

In solving the model I will take the timing of decisions as outlined in section II.2 explicitly into account and thus, I will employ the concept of subgame-perfect Nash equilibrium. In addition, I will restrict attention to equilibria in which a strictly positive mass of varieties is produced and sold at strictly positive prices. Recall further that I am assuming that the rationing rule applying whenever there would be excess demand in labor markets is such that no equilibrium exists in that case, which means that in any equilibrium any firm is able to hire exactly as many workers as it would optimally like to employ given the choices made by all others and the resulting aggregate outcomes and, most importantly, given the wage-level implied by the WD-curve. Further, given the assumed symmetry of the two countries at the aggregate level, attention is restricted to equilibria in which aggregate variables take on the same values across countries. Whenever I speak of "any equilibrium" or the like in the following I am only referring to equilibria in which all these requirements are satisfied and whenever there is only one Nash equilibrium satisfying all these requirements, I will refer to it as "unique".

To solve for the subgame-perfect Nash equilibria, one needs to start by means of characterizing optimal decisions given the decisions made by all others and in doing so, one needs to start with the last type of decision made within the single period and then move through the period using results for optimal behavior at later stages to characterize optimal play in the other subgames containing those later stages. Once that has been accomplished, one then uses those results on optimal decision-making and derives "fixed points" of optimal decision-making and hence the Nash equilibria by means of aggregation. This is thus the roadmap for this section.

Let me thus begin with the decisions the representative households make as customers in the product markets of their respective countries once they have observed which varieties are offered and which prices are charged. Their optimization problems consist in choosing quantities of all the different varieties in the way that yields the largest possible quantity of the aggregate consumption good given the aggregator from (II.1), given prices at the variety-level and given their respective total labor incomes and given any profits they receive from firms they own. Solving these optimization problems results in the following residual demand functions firms face in product markets:

(II.3) $$d_i(\omega) = \left(\left(P_i(\omega)\right)^{-\sigma}\right)\left((P_i)^{\sigma}\right)C_i \quad \forall \omega \in \Omega \; \forall i$$

where:

$$P_i = \left[\int_{\omega \in \Upsilon} \left((P_i(\omega))^{1-\sigma}\right) d\omega\right]^{\frac{1}{1-\sigma}} \quad \forall i$$

$d_i(\omega)$ denotes total demand for variety ω in country i and $P_i(\omega)$ denotes the nominal price charged for variety ω in country i which is set to infinity if variety ω is not offered in country i as this is the relevant reservation price. P_i represents the consumption-based price-index in country i, i.e. it captures the nominal costs of acquiring one unit of the aggregate consumption good in the cost-minimizing way in country i. Dividing nominal prices and wages in country i by P_i thus transforms them into welfare-relevant units of consumption which I call "real" units.[116]

Given that customers in product markets take prices as given, the optimal strategy for any firm which has completed the production stage and – if it exports to a foreign market – has shipped the amount it wants to sell (taking transport costs into account) consists for any given market in which the firm sells a strictly positive amount in choosing a combination of price and quantity sold which is located exactly on the residual demand curve the firm faces in the respective market: Combinations above the residual demand schedule from (II.3) are not available and combinations below it are clearly not optimal. This means that all customers in all product markets find themselves able to buy exactly as much of any given variety as they want to at the going prices, so $d_i(\omega)$ can henceforth also be used for the total quantity of variety ω which is *actually sold* in country i and given that households clearly find it optimal to use everything they buy for consumption purposes, the following must be true in any equilibrium:

(II.5) $$d_i(\omega) = c_i(\omega) \quad \forall \omega \in \Omega \; \forall i$$

Let $I(\omega)$ henceforth denote an indicator function which takes on the value 1 if firm ω exports and which equals 0 otherwise. The fact that firms choose combinations of price and quantity sold which are located on their residual

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[116] Note that the costs of acquiring any given amount $x > 0$ of the aggregate consumption good in country i are xP_i due to the homotheticity of the aggregator in (II.1), which makes total nominal expenditure in country i proportional to P_i, too, so one can denote it by P_iC_i, where the actual quantity of the aggregate consumption good consumed by the representative household from country i can be used for writing down total expenditure since firms will find it optimal to "price on residual demand curves" and hence, the representative households will be able to satisfy their demands for any given variety at the given prices. Thus, C_i can also be written into residual demand functions. Further, note that the real wages at the firm-level appearing in the WD-curve in (II.2) are nominal wages at the firm-level divided by $P_{i(\omega)}$, i.e. divided by the consumption-based price-index of the country where a firm produces and employs workers.

demand curves in any given market in which they sell implies that one can write equilibrium firm-level revenues

earned from selling in country $i(\omega)$ and from selling in country $j(\omega)$, respectively, as follows:

(II.6)
$$R_{i(\omega)}(\omega) = P_{i(\omega)}\left(\left(C_{i(\omega)}\right)^{\frac{1}{\sigma}}\right)\left(\left(d_{i(\omega)}(\omega)\right)^{\frac{\sigma-1}{\sigma}}\right) \quad \forall \omega \in Y$$

(II.7)
$$R_{j(\omega)}(\omega) = \left(I(\omega)\right)P_{j(\omega)}\left(\left(C_{j(\omega)}\right)^{\frac{1}{\sigma}}\right)\left(\left(d_{j(\omega)}(\omega)\right)^{\frac{\sigma-1}{\sigma}}\right) \quad \forall \omega \in Y$$

These expressions for revenues imply that marginal revenue from selling in a given market is always positive, so firms find it always optimal to sell all the output they have produced for and – in the case of export destinations – shipped to the respective market. Further, this implies that firms will use all their output to sell it and/or to cover iceberg transport costs associated with selling abroad, so the following must hold in any equilibrium:

(II.8)
$$d_{i(\omega)}(\omega) + \tau\left(d_{j(\omega)}(\omega)\right) = y(\omega) \quad \forall \omega \in Y$$

The assumption $f^P < f^X$ along with the symmetry of the two countries and the presence of the transport costs evidently implies that any exporting firm will also sell domestically and hence, in equilibrium any firm which produces will sell domestically. A firm which has produced $y(\omega)$ units of output seeks to maximize its total revenues under the constraint in (II.8) and given its earlier decision whether or not to enter the export market in addition to the market of the country in which it produces. Making use of the expressions for revenues for firms which make optimal pricing-decisions in (II.6) and (II.7), respectively, it follows that firms find it optimal to sell the following quantities of their respective varieties in the two markets, respectively:

(II.9)
$$d_{i(\omega)}(\omega) = \frac{\left(\left(P_{i(\omega)}\right)^{\sigma}\right)C_{i(\omega)}}{\left(\left(P_{i(\omega)}\right)^{\sigma}\right)C_{i(\omega)} + \left(I(\omega)\right)\left((\tau)^{1-\sigma}\right)\left(\left(P_{j(\omega)}\right)^{\sigma}\right)C_{j(\omega)}}\left(y(\omega)\right) \quad \forall \omega \in Y$$

(II.10)
$$d_{j(\omega)}(\omega) = \left(I(\omega)\right)\frac{\left((\tau)^{-\sigma}\right)\left(\left(P_{j(\omega)}\right)^{\sigma}\right)C_{j(\omega)}}{\left(\left(P_{i(\omega)}\right)^{\sigma}\right)C_{i(\omega)} + \left(I(\omega)\right)\left((\tau)^{1-\sigma}\right)\left(\left(P_{j(\omega)}\right)^{\sigma}\right)C_{j(\omega)}}\left(y(\omega)\right) \quad \forall \omega \in Y$$

Making use of these results on optimal selling-decisions and combining them with what one knows about the production technology available to firms and also making use of the fact that the WD-curve implies that real wages are strictly positive in any equilibrium in which a strictly positive mass of varieties is produced so that firms always

hire as few labor as possible to produce a given quantity of output, one then arrives at the following expression for equilibrium firm-level profits as a function of firm-level output $y(\omega)$:

(II.11) $\qquad \Pi(\omega) = \left(\left[\left((P_{i(\omega)})^\sigma \right) C_{i(\omega)} + \left(I(\omega) \right) \left((\tau)^{1-\sigma} \right) \left((P_{j(\omega)})^\sigma \right) C_{j(\omega)} \right]^{\frac{1}{\sigma}} \right) \left((y(\omega))^{\frac{\sigma-1}{\sigma}} \right)$

$\qquad\qquad\qquad - \frac{W(\omega)}{A(\lambda(\omega))} (y(\omega)) - (W(\omega)) f^P - (I(\omega))(W(\omega)) f^X - (W(\omega)) f^A \quad \forall \omega \in Y$

$W(\omega)$ in that expression denotes the nominal wage paid by firm ω which simply equals the real wage $w(\omega)$ as given from the relationship in (II.2) multiplied by the welfare-relevant consumption-based price-index of the country where the firm operates and hires labor, i.e.:

(II.12) $\qquad\qquad\qquad\qquad\qquad W(\omega) = (w(\omega)) P_{i(\omega)} \quad \forall \omega \in Y$

Since firms are of negligible size, they take $w(\omega)$ from (II.2) and hence also $W(\omega)$ as being exogenously given inasmuch as they have no impact on aggregate employment $L^E_{i(\omega)}$ and no impact on the price-index $P_{i(\omega)}$. The expression for firm-level profits from (II.11), which holds under optimal decisions at all later stages, is thus perceived by firms to contain a single choice variable for them, output $y(\omega)$, and it is strictly concave in that choice variable, so equilibrium firm-level output for any producing firm can be found by means of solving the first-order condition associated with maximizing the expression for profits from (II.11) over $y(\omega)$. One obtains:

(II.13) $\quad y(\omega) = \left(\left(\frac{(\sigma-1)A}{\sigma} \right)^\sigma \right) \left[C_{i(\omega)} + (I(\omega))((\tau)^{1-\sigma}) \left(\left(\frac{P_{j(\omega)}}{P_{i(\omega)}} \right)^\sigma \right) C_{j(\omega)} \right] ((w(\omega))^{-\sigma})((\lambda(\omega))^\sigma) \quad \forall \omega \in Y$

As one might have expected, optimal firm-level output is thus decreasing in the real wage a firm needs to pay in a *ceteris paribus* sense. The expression in (II.13) is the quantity of output a firm which has already made market-access-decisions aims at producing given what all others do and given the resulting outcomes at the aggregate level and thus, the firm will seek to hire a quantity of labor in the labor market of its country which allows attaining exactly this output-level. As it is assumed that rationing rules applying in labor markets with excess demand are such that there cannot be any equilibrium with excess demand in labor markets, any firm will in fact be able to attain the output-level from (II.13) in equilibrium. Taking that equilibrium output-level from (II.13) back to the

expression for firm-level profits in equilibrium from (II.11) thus yields the following new expression for equilibrium firm-level profits:

(II.14) $\Pi(\omega) = \frac{1}{\sigma}\left(\left(\frac{(\sigma-1)A}{\sigma}\right)^{\sigma-1}\right)((w(\omega))^{1-\sigma})P_{i(\omega)}\left[C_{i(\omega)} + (I(\omega))((\tau)^{1-\sigma})\left(\left(\frac{P_{j(\omega)}}{P_{i(\omega)}}\right)^{\sigma}\right)C_{j(\omega)}\right]((\lambda(\omega))^{\sigma-1})$

$$-(w(\omega))P_{i(\omega)}\left[f^P + (I(\omega))f^X + f^A\right] \quad \forall\omega \in \Upsilon$$

Hence, firm-level profits are *ceteris paribus* decreasing in the real wage the firm pays and increasing in its productivity-draw $\lambda(\omega)$. The expression for firm-level profits in (II.14) states the profits any firm can earn in equilibrium – given what all others do – as a result of completing the second stage of the entry-process for its own market and potentially also for its respective export market if the firm makes all further decisions in an optimal manner.[117] Hence, it is clear that given what all others do and given the resulting outcomes at the aggregate level, any firm ω which has completed the first stage of the entry-process (so that the term $(w(\omega))P_{i(\omega)}f^A$ represents costs which are already sunk) and which has received a productivity-draw $\lambda(\omega)$ that satisfies $\lambda(\omega) \geq \underline{\lambda}_{i(\omega)}$ where

(II.15) $\underline{\lambda}_i = \left[\left(\left(\frac{\sigma}{(\sigma-1)A}\right)^{\sigma-1}\right)\sigma f^P((w_i)^{\sigma})((C_i)^{-1})\right]^{\frac{1}{\sigma-1}} \quad \forall i$

will choose to incur the second-stage entry-costs for market $i(\omega)$ while all other firms will choose not to do that. w_i from now on denotes the real wage paid by all producing firms in country i which can be introduced inasmuch as the wage-determination-curve from (II.2) implies that in equilibrium there is no heterogeneity in real wages across firms in a given country.[118] Likewise, from profit-maximizing behavior by firms it then also follows that given what all others do and given the resulting outcomes at the aggregate level, any firm ω which has completed the first stage of the entry-process and which has received a productivity-draw $\lambda(\omega)$ that satisfies $\lambda(\omega) \geq \underline{\lambda}_{i(\omega)}^X$ where

(II.16) $\underline{\lambda}_i^X = \left[((\tau)^{\sigma-1})\left(\left(\frac{\sigma}{(\sigma-1)A}\right)^{\sigma-1}\right)\sigma f^X((w_i)^{\sigma})\left(\left(\frac{P_i}{P_{j(i)}}\right)^{\sigma}\right)((C_{j(i)})^{-1})\right]^{\frac{1}{\sigma-1}} \quad \forall i$

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[117] Again, one does not have to worry about firms not being able to hire enough labor due to my assumptions about rationing rules in labor markets with excess demand according to which no equilibrium with excess demand in labor markets exists.

[118] Wage-heterogeneity will be introduced in an extension in section II.6.

will choose to incur the second-stage entry-costs for market $j(\omega)$ (its export market) while all other firms will choose not to do that. I will also follow the standard approach in the literature and assume that parameter values are such that $\underline{\lambda}_i > \lambda_0 \; \forall i$ holds in equilibrium,[119] so that the marginal firm earns revenues from selling domestically which are exactly sufficient to cover its production costs and second-stage entry-costs for that market but insufficient to also cover its first-stage entry-costs. Since countries are assumed to be identical so that variables at the aggregate level take on the same values across countries, the assumption $f^P < f^X$ then in fact implies $\underline{\lambda}_i < \underline{\lambda}_i^X \; \forall i$, i.e. that any exporting firm will also sell domestically but not vice versa.[120]

The specification of the entry technology implies that the distribution of $\lambda(\omega)$ in the set of all firms which complete the first stage of the entry-process in any given country is described by the CDF $G(\lambda(\omega))$. In equilibrium, it is also the case that any firm which completes the second stage of the entry-process for either or both markets will actually produce.[121] And given what has been said regarding which firms will choose to incur the entry investments at the second stage for domestic markets and for export markets, respectively, and which firms will not, one obtains the following two distributional results which will play an important role for aggregation:[122] First, the distribution of $\lambda(\omega)$ in the set of all firms producing in a given country i, i.e. the distribution of $\lambda(\omega)$ in the set Υ_i for a given country i, is given by a Pareto distribution with location parameter $\underline{\lambda}_i$ as implied by (II.15) and shape parameter K. Second, the distribution of $\lambda(\omega)$ in the set of all firms producing in a given country i and exporting to country $j(i)$, i.e. the distribution of $\lambda(\omega)$ in the set Ξ_i for a given country i, is given by a Pareto distribution with location parameter $\underline{\lambda}_i^X$ as implied by (II.16) and shape parameter K. Making use of these distributional results which of course apply to both countries one can show that the following holds in equilibrium:

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[119] This basically requires assuming that f^P is sufficiently large relative to f^A (cf. (II.30)).

[120] The assumption $((\tau)^{\sigma-1})f^X > f^P$ which is weaker in light of $\tau > 1$ and $\sigma > 1$ would already be sufficient for that.

[121] To see this point, note that as soon as entry-costs at the second stage (or quasi-fixed costs as one can think of f^P and f^X in these terms, too) have been incurred and are sunk, production is always profitable for any firm as marginal revenues approach infinity for arbitrarily small quantities of output and as production costs are finite under the WD-curve specified in (II.2).

[122] The argument behind this makes use of the technical result from statistics according to which a Pareto distribution which is truncated from below (but above its location parameter) remains a Pareto distribution with the same shape parameter but with a new location parameter which is given by the truncation point.

$$\text{(II.17)} \qquad N_i = \left(\left(\frac{\lambda_0}{\underline{\lambda}_i}\right)^K\right) N_i^A \quad \forall i$$

$$\text{(II.18)} \qquad N_i^X = \left(\left(\frac{\lambda_0}{\underline{\lambda}_i^X}\right)^K\right) N_i^A \quad \forall i$$

Finally, one has to determine how many firms will choose to complete the first stage of the entry-process. The optimality condition which governs this is very simple: Since I assume firms to be risk-neutral and to make independent profit-maximizing decisions, expected profits of entering need to be zero in both countries from the ex-ante perspective (i.e. prior to completing the first stage of the entry-process and hence without knowledge of one's realization of $\lambda(\omega)$): If they were positive, additional firms would have an incentive to enter given what all others do and if they were negative, firms which choose to enter would not be optimizing given what all others do. Let me denote expected profits from the ex-ante perspective which are associated with entering in country i by Π_i^A. Hence, equilibrium requires:

$$\text{(II.19)} \qquad \Pi_i^A = 0 \quad \forall i$$

The previously derived results regarding all further decisions firms make within the single period in an equilibrium[123] along with the specification of the entry technology imply the following mathematical expression for Π_i^A:

$$\text{(II.20)} \quad \Pi_i^A = \int_{\underline{\lambda}_i}^{\infty} \left[\frac{1}{\sigma}\left(\left(\frac{(\sigma-1)A}{\sigma}\right)^{\sigma-1}\right)((\lambda(\omega))^{\sigma-1})((w_i)^{1-\sigma})P_i C_i - f^P w_i P_i\right] dG(\lambda(\omega))$$

$$+ \int_{\underline{\lambda}_i^X}^{\infty} \left[\frac{1}{\sigma}\left(\left(\frac{(\sigma-1)A}{\sigma}\right)^{\sigma-1}\right)\left((\lambda(\omega))^{\sigma-1}\right)((w_i)^{1-\sigma})P_i((\tau)^{1-\sigma})\left(\left(\frac{P_{j(i)}}{P_i}\right)^{\sigma}\right)C_{j(i)} - f^X w_i P_i\right] dG(\lambda(\omega)) - f^A w_i P_i \quad \forall i$$

Combining (II.19) and (II.20) with the expressions for $\underline{\lambda}_i$ and $\underline{\lambda}_i^X$ from (II.15) and (II.16), respectively, and bringing in the functional form assumption for the CDF $G(\lambda(\omega))$ and the assumption $K > (\sigma - 1)$, one arrives at the following modified version of the "ex-ante free-entry-condition" from (II.19): [124]

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[123] Most notably the results as to which firms will complete which parts of the entry-process at the second stage and the resulting expression for equilibrium profits from (II.14).

[124] $K > (\sigma - 1)$ has to be used to make sure that aggregation is possible. That assumption, which is standard in the literature, will also be imposed in several further aggregation steps, but I will not mention that explicitly any more.

$$(II.21) \qquad \left(\left(\underline{\lambda}_i\right)^K\right) = \frac{\sigma-1}{K-(\sigma-1)}\frac{f^P}{f^A}\left(1+\frac{f^X}{f^P}\left(\left(\frac{\lambda_i}{\underline{\lambda}_i^X}\right)^K\right)\right)\left((\lambda_0)^K\right) \quad \forall i$$

At this point of the analysis, optimal decision-making by single agents given the choices made by all others and given the aggregate outcomes has been fully characterized, so the next step consists in aggregation of the previously derived results to derive the "fixed points" of the optimal strategies for all single agents in this economy. From now on, I will also impose the symmetry of countries, i.e. for the purpose of further solving the model I will from now on assume that any variables at the economy-wide level take on the same values in both countries in equilibrium. The first aggregation step consists in using (II.5) and the solution for the equilibrium quantities sold in the two countries as implied by (II.9) and (II.10) in conjunction with (II.13) and in conjunction with the results as to which firms choose to sell in which countries to obtain values for the equilibrium quantities consumed of each variety in the two countries, respectively, which one then takes to the consumption aggregator in (II.1). Also making use of the aforementioned results for the distributions of $\lambda(\omega)$ in the sets Y_i and Ξ_i, respectively, and imposing the symmetry of countries as well as making use of the expressions for $\underline{\lambda}_i$, $\underline{\lambda}_i^X$, N_i and N_i^X from (II.15), (II.16), (II.17) and (II.18), respectively, where the symmetry of countries is imposed once again, one then arrives at the following expression for aggregate consumption:

$$(II.22) \qquad C_i = \frac{\sigma K}{K-(\sigma-1)}f^P\left[1+\left(\left(\frac{1}{\tau}\right)^K\right)\left(\left(\frac{f^P}{f^X}\right)^{\frac{K-(\sigma-1)}{\sigma-1}}\right)\right]N_i w_i \quad \forall i$$

In a similar way one can derive an expression for aggregate employment in the two countries: Starting from the solution for equilibrium firm-level output from (II.13) and then combining it with what one knows about the production technology, about transport costs, about the labor requirements involved in the different parts of the entry-process, about which firms will enter into which markets and about what the distributions of $\lambda(\omega)$ in the sets Y_i and Ξ_i are, and also making use of the expressions for $\underline{\lambda}_i$, $\underline{\lambda}_i^X$, N_i and N_i^X from (II.15), (II.16), (II.17) and (II.18), respectively, where the symmetry of countries is imposed, one arrives at the following expression for aggregate employment in equilibrium:

$$(II.23) \qquad L_i^E = \frac{\sigma K-(\sigma-1)}{K-(\sigma-1)}f^P\left[1+\left(\left(\frac{1}{\tau}\right)^K\right)\left(\left(\frac{f^P}{f^X}\right)^{\frac{K-(\sigma-1)}{\sigma-1}}\right)\right]N_i + f^A\left(\left(\frac{\lambda_i}{\lambda_0}\right)^K\right)N_i \quad \forall i$$

This completes aggregation. Imposing the symmetry of countries in equilibrium, one is now left with a system of eight equilibrium relationships and accounting identities which contain the eight endogenous variables C_i, L_i^E, w_i, N_i, N_i^X, N_i^A, $\underline{\lambda}_i$ and $\underline{\lambda}_i^X$.[125] For my purposes, it will be most useful to re-write this system in a particular way following the approach suggested in my related closed-economy work in part I of this dissertation: The following representation of the eight equilibrium conditions of the model can be obtained through straightforward algebra where the WD-curve remains untouched:

$$(\text{II.24}) \quad L_i^E = \sigma f^P \left(\left(\frac{\sigma}{(\sigma-1)\lambda_0 A} \right)^{\sigma-1} \right) \left(\left(\left(\frac{K-(\sigma-1)}{\sigma-1} \frac{f^A}{f^P} \right)^{\frac{\sigma-1}{K}} \right) \right) \left(\left[1 + \left(\left(\frac{1}{\tau} \right)^K \right) \left(\left(\frac{f^P}{f^X} \right)^{\frac{K-(\sigma-1)}{\sigma-1}} \right) \right]^{-\frac{\sigma-1}{K}} \right) ((w_i)^{\sigma-1})$$

$$(\text{II.25}) \qquad\qquad w_i = \psi \left(\left(\frac{L_i^E}{L} \right)^\xi \right)$$

$$(\text{II.26}) \qquad\qquad C_i = w_i L_i^E$$

$$(\text{II.27}) \qquad\qquad N_i = \frac{K-(\sigma-1)}{\sigma K f^P} \left(\left[1 + \left(\left(\frac{1}{\tau} \right)^K \right) \left(\left(\frac{f^P}{f^X} \right)^{\frac{K-(\sigma-1)}{\sigma-1}} \right) \right]^{-1} \right) L_i^E$$

$$(\text{II.28}) \qquad N_i^X = \frac{K-(\sigma-1)}{\sigma K f^P} \left(\left(\frac{1}{\tau} \right)^K \right) \left(\left(\frac{f^P}{f^X} \right)^{\frac{K}{\sigma-1}} \right) \left(\left[1 + \left(\left(\frac{1}{\tau} \right)^K \right) \left(\left(\frac{f^P}{f^X} \right)^{\frac{K-(\sigma-1)}{\sigma-1}} \right) \right]^{-1} \right) L_i^E$$

$$(\text{II.29}) \qquad\qquad N_i^A = \left(\frac{\sigma-1}{K-(\sigma-1)} \frac{f^P}{f^A} \right) \frac{K-(\sigma-1)}{\sigma K f^P} L_i^E$$

$$(\text{II.30}) \qquad \underline{\lambda}_i = \left(\left(\frac{\sigma-1}{K-(\sigma-1)} \frac{f^P}{f^A} \right)^{\frac{1}{K}} \right) \left(\left[1 + \left(\left(\frac{1}{\tau} \right)^K \right) \left(\left(\frac{f^P}{f^X} \right)^{\frac{K-(\sigma-1)}{\sigma-1}} \right) \right]^{\frac{1}{K}} \right) \lambda_0$$

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[125] Actually, there are of course 16 variables and 16 equilibrium conditions as each of these equations applies to both countries and as each variable exists in both countries. To streamline notation and to simplify the exposition, I will simply solve for equilibrium values in one country understanding that the variables in the other country take on the same values and hence, I will work with a system of eight equations. The eight equations forming this system are: The expression for C_i from (II.22), the expression for L_i^E from (II.23), the wage-determination schedule from (II.2) which pins down w_i as a function of the employment rate in the corresponding country, the expressions for N_i and N_i^X from (II.17) and (II.18), respectively, the ex-ante free-entry-condition from (II.21) which implicitly pins down N_i^A and the expressions for $\underline{\lambda}_i$ and $\underline{\lambda}_i^X$ from (II.15) and (II.16), respectively.

(II.31)
$$\underline{\lambda}_i^X = \tau \left(\left(\frac{f^X}{f^P} \right)^{\frac{1}{\sigma-1}} \right) \left(\left(\frac{\sigma-1}{K-(\sigma-1)} \frac{f^P}{f^A} \right)^{\frac{1}{K}} \right) \left(\left[1 + \left(\left(\frac{1}{\tau} \right)^K \right) \left(\left(\frac{f^P}{f^X} \right)^{\frac{K-(\sigma-1)}{\sigma-1}} \right) \right]^{\frac{1}{K}} \right) \lambda_0$$

This system has a very useful structure for my purposes: The first two equations in it represent two equations in two variables, which are aggregate employment, L_i^E, and the real wage, w_i. The remaining six equations state the equilibrium values of the remaining six endogenous variables as functions of parameter values and of L_i^E and w_i. Thus, I have broken the original system down to a system of two equations in two variables where these two equations make sure that all equilibrium conditions and relevant accounting identities of the model are satisfied. But one of those two, namely equation (II.25), is just the wage-determination-curve, which has not been used in re-writing the previous form of the system so that the equilibrium relationship in (II.24) is one that summarizes all equilibrium conditions and accounting identities of the model except for the WD-curve. Equation (II.24) is thus the locus of all combinations of the real wage and aggregate employment which are consistent with all the accounting identities of the model and with optimizing behavior in all respects except for wage-determination, which is captured exclusively by the WD-curve. Using the same terminology as in part I of this dissertation I will refer to (II.24) as the "EE-curve". Note, however, that just like the WD-curve, the EE-curve is only defined for employment-levels satisfying $L_i^E \leq L$. This is due to the fact that in the process of solving the model (and thus behind the derivation of the EE-curve) it has been assumed that all firms are able to hire as much labor as they would like to given aggregate conditions and the wage-level implied by the WD-curve and that could not be true for $L_i^E > L$.

It thus follows that any intersection of EE-curve (II.24) and WD-curve (II.25) which implies an employment-level L_i^E with $0 < L_i^E \leq L$ represents a (subgame-perfect) Nash equilibrium of the model, while any combination of w_i and L_i^E which is not located on both of these curves cannot be an equilibrium as long as it is assumed that rationing rules applying in labor markets with excess demand are such that there cannot be any equilibrium with rationing in labor markets.[126] Thus, the following result has been established:

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[126] This assumption directly implies that firms must be able to hire as much labor as they wish to at the real wage they pay and as only points on the EE-curve are consistent with that (optimal labor demand is one condition behind the EE-curve), all equilibria must be located on this curve.

PROPOSITION II.1 (*Existence and Uniqueness of Nash Equilibrium*): Under the assumptions made up to this point, a unique Nash equilibrium with the level of aggregate employment in both countries being given by

$$(\text{II.32}) \qquad L_i^E = \left[\sigma f^P \big((L)^{-\xi(\sigma-1)}\big) \left(\left(\frac{\sigma\psi}{(\sigma-1)\lambda_0 A} \right)^{\sigma-1} \right) \left(\left(\frac{K-(\sigma-1)}{\sigma-1} \frac{f^A}{f^P} \right)^{\frac{\sigma-1}{K}} \right) \right.$$

$$\left. \times \left(\left[1 + \left(\left(\frac{1}{\tau} \right)^K \right) \left(\left(\frac{f^P}{f^X} \right)^{\frac{K-(\sigma-1)}{\sigma-1}} \right) \right]^{-\frac{\sigma-1}{K}} \right) \right]^{\frac{1}{1-\xi(\sigma-1)}} \quad \forall i$$

exists if that value for aggregate employment is smaller than or exactly equal to L and if parameter values are such that $\xi \neq \frac{1}{\sigma-1}$. If $\xi \neq \frac{1}{\sigma-1}$ but the value for aggregate employment from (II.32) is strictly greater than L, no Nash equilibrium exists. If $\xi = \frac{1}{\sigma-1}$, there exists either no Nash equilibrium or a continuum of Nash equilibria (which is the case as soon as the EE-curve and the WD-curve exactly coincide) depending on the values of the remaining parameters.

Proof: This follows directly from the preceding arguments; the equilibrium value for L_i^E in (II.32) is obtained by means of calculating the intersection of the curves described by (II.24) and (II.25) at a strictly positive level of aggregate employment for $\xi \neq \frac{1}{\sigma-1}$. ∎

I will henceforth assume that parameter values are such that Nash equilibrium as described in PROPOSITION II.1 exists and is unique, which implies, most notably, that I assume $\xi \neq \frac{1}{\sigma-1}$.

II.4 Results and Discussion

II.4.1 The Effects of Trade Liberalization

Regarding intra-industry reallocation patterns the standard version of the canonical model due to Melitz (2003) with its Walrasian labor market makes the following major prediction which has found a lot of empirical

support:[127] Trade liberalization induces the least productive firms to exit and therefore leads to an increase in average productivity within any given industry affected by trade liberalization. This is what I refer to as the "selection effect" of trade liberalization and one major question I seek to answer is to which extent this selection effect is shaped by details of the labor market. In my model as well as in the standard version of the Meltiz-model, exit by the least productive firms shows up as an increase in the cut-off $\underline{\lambda}_i$ and an increase in average productivity (defined as the simple unweighted mean of $\lambda(\omega)$ in the set Υ_i, i.e. in the set of all producing firms within the single industry in a given country i)[128] is indicated by an increase in the cut-off $\underline{\lambda}_i$, too.[129] My model implies the following results regarding the selection effect of trade liberalization:

PROPOSITION II.2 (*Selection Effect of Trade Liberalization*): Consider a decline in variable trade costs τ so that Nash equilibrium as characterized in PROPOSITION II.1 exists and is unique both before and after the decline in trade costs. Regardless of the values of the parameters ψ and ξ within the admissible ranges of $\psi > 0$ and $\xi \geq 0$, such a decline in variable trade costs τ leads to a strictly higher equilibrium value of $\underline{\lambda}_i$ in the new unique symmetric Nash equilibrium, so that both the minimum level and the unweighted mean of $\lambda(\omega)$ in the set of firms which produce in a given country i, Υ_i, are strictly higher in the new equilibrium. In general, the equilibrium level of $\underline{\lambda}_i$ does not depend on the values of the parameters ψ and ξ.

Proof: This follows directly from inspection of the solution for the equilibrium value of $\underline{\lambda}_i$ presented in (II.30). ∎

Thus, the intra-industry reallocation patterns predicted by the model due to Melitz (2003) in the context of a Walrasian labor market remain the same even if one allows for unemployment and makes very general assumptions about wage-determination: Average productivity within industries increases due to trade liberalization and the least productive firms exit in response to trade liberalization. In fact, to arrive at PROPOSITION II.2 one does not even

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[127] Cf. the surveys by Bernard, Jensen, Redding and Schott (2012) and by Melitz and Redding (2014).

[128] Alternatively and without changing the results, one could define average productivity as any strictly monotone transformation of a mean of a strictly monotone transformation of $\lambda(\omega)$: For instance, one might want to multiply by the common productivity shifter A. Further, Melitz (2003) and Melitz and Redding (2015) use a concept of average productivity which is weighted by output shares, which I will resort to in section II.5 of the present paper, too. Using that concept in the present context, too, would yield the same results I obtain with the unweighted mean.

[129] This is due to the fact that the distribution of productivity-levels $\lambda(\omega)$ within a given set Υ_i is always described by a Pareto distribution with shape parameter K in this model, so changes in the location parameter of the distribution, which is $\underline{\lambda}_i$, imply changes in its mean going in the same direction as the change in the location parameter.

have to close the model by solving for what happens in the labor market and hence, one does not even have to specify any details about the labor market for that purpose.[130] This is due to the fact that arriving at (II.30) on which PROPOSITION II.2 is based does not require any assumptions about labor markets and wages other than that first, firms are able to hire as much as they would like to at the real wage they pay (i.e. the assumption that employment is "demand-determined") and that second, firms take the real wage they pay, w_i, as given. In particular, the WD-curve is not involved in deriving (II.30) and hence it is not involved in the proof of PROPOSITION II.2.[131]

Therefore, one can clearly conclude that labor market forces are not shaping the selection effects trade liberalization brings about in product markets. This can be seen in at least three ways: First, one can solve for the cut-off $\underline{\lambda}_i$ that characterizes selection effects in product markets without pinning down real wages and aggregate employment and that would even be true if one was in the Walrasian world of the standard model. Second, the equilibrium value of $\underline{\lambda}_i$ does not depend on the values of the parameters ψ and ξ which characterize the institutional details of the labor market, so that institutional details of the labor market do not affect firm selection in product markets. And third, as I will show below, aggregate employment and real wages may fall or rise in response to trade liberalization and regardless what happens to them, the movement in $\underline{\lambda}_i$ will always be the same. This means that any attempt to explain these selection patterns through factor markets – as originally proposed by Melitz (2003) in section 7.2 of his paper – is somewhat questionable: That type of explanation typically asserts that better opportunities for exporting brought about by a decline in trade costs lead to higher labor demand, which pushes up real wages in response to trade liberalization (which is necessarily true in a Walrasian labor market and would be true in a

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[130] I am not the first to present a result according to which reallocation patterns in product markets can be characterized without solving for labor market equilibrium in a model à la Melitz (2003). For instance, Felbermayr, Prat and Schmerer (2011) present a related "separability"-result in the context of a Melitz-model augmented by a "search and matching"-model of the labor market. Bernard, Redding and Schott (2007) also present a related result in a Melitz-model merged with Heckscher-Ohlin forces where firms use skilled and unskilled labor in production and where labor markets are Walrasian: These authors can characterize the cut-offs akin to $\underline{\lambda}_i$ in my model without pinning down the wages for the two types of labor (cf. equation 13 and the discussion of that equation in their paper). These papers mainly stress that type of result as an analytically convenient property of their models, while my more general approach to modelling (frictional) labor markets clearly reveals that it is conceptually very interesting, too.

[131] PROPOSITION II.2 does not depend on the assumption of the Pareto distribution: Looking jointly at (II.15), (II.16), (II.19) and (II.20) it is clear that there are other distributional assumptions for the CDF $G(\lambda(\omega))$ which would give rise to a similar result according to which labor market outcomes are irrelevant for determining the cut-off $\underline{\lambda}_i$.

frictional labor market with a pecuniary externality as soon as aggregate employment rises when trade is liberalized) so that all firms see an increase in their costs and the least productive firms are thus forced to exit. But if one does not have to solve for real wages to solve for the selection effects (which is true in the Walrasian case studied by Melitz (2003), too) and if – as I will show below – real wages can in fact decline in response to trade liberalization even though the same selection effects still operate, it is unclear how it can be the case that this "cost-channel" operating through factor markets is the true channel that induces these selection effects. Another way to see this is to note that this "cost-channel" relies on real wages being endogenous to aggregate labor market conditions (such as aggregate labor demand) and hence, it relies precisely on the type of pecuniary externality I emphasize in this paper. But even if one shuts down this externality by setting $\xi = 0$, one still obtains the same selection effects. In fact, it seems that these selection effects just come out of the model in a very mechanical way from the requirement that the three zero-profits-conditions (ex-post and at the margin for entry into the two markets, respectively, and ex-ante and in expectation for entry in general) from (II.15), (II.16) and (II.19) need to be satisfied simultaneously.

How about the welfare- and employment-effects of trade liberalization?

PROPOSITION II.3 (*Welfare- and Employment-Effects of Trade Liberalization*): Consider a decline in variable trade costs τ so that Nash equilibrium as characterized in PROPOSITION II.1 exists and is unique both before and after the decline in trade costs. Comparing the old to the new equilibrium the following is true: Such a decline in variable trade costs τ leads to an increase in aggregate consumption C_i if and only if

$$(\text{II.33}) \qquad\qquad\qquad \xi > \frac{1}{\sigma - 1}$$

and to a decline in C_i if the strict inequality in (II.33) is reversed. Similarly, such a decline in variable trade costs τ leads to an increase in aggregate employment L_i^E if and only if the strict inequality in (II.33) holds and to a decline in L_i^E if that strict inequality is reversed. Real wages w_i only respond to changes in trade costs τ if $\xi > 0$ and if they do, they move in the same direction as aggregate employment L_i^E.

Proof: This follows directly from combining the equilibrium conditions in (II.24), (II.25) and (II.26) with each other and making use of the fact that the model requires $\sigma > 1$ and $K > (\sigma - 1)$ to exhibit "love for variety" and to make aggregation possible. ∎

On a conceptual level, PROPOSITION II.3 means the following: Trade liberalization in the form of a decline in variable trade costs τ leads to an increase in aggregate employment and welfare as measured by aggregate consumption if and only if the pecuniary externality in the labor market through which hiring-decisions by firms affect real wages to be paid by other firms is sufficiently strong: Given that the value of ξ characterizes the strength of this externality, this turns out to be the case whenever $\xi > \frac{1}{\sigma-1}$. Otherwise, trade liberalization leads to a decline in welfare and aggregate employment. Put differently, if and only if there is a sufficiently high degree of wage-flexibility (in the sense of the inequality $\xi > \frac{1}{\sigma-1}$), trade liberalization leads to higher employment and welfare. In particular, for $\xi = 0$ trade liberalization unambiguously leads to welfare-losses and to lower aggregate employment, so the presence of a pecuniary externality in the labor market represents a *necessary condition* for welfare- and employment-gains from trade liberalization. With completely rigid real wages ($\xi = 0$) liberalizing trade is definitely a bad idea.

In addition, real wages and aggregate employment always move in the same direction (or real wages do not move at all in the special case of $\xi = 0$), so whenever trade liberalization induces an increase in welfare, it also represents a Pareto-improvement in the sense of more people being employed and earning (weakly) higher real wages, which eliminates an important source of distributional conflicts over trade liberalization.[132]

Finally, from combining the insights from PROPOSITION II.3 with my results on the reallocation patterns induced by trade liberalization (cf. PROPOSITION II.2) it follows that the occurrence of "selection effects" – and in particular of increases in average firm-level productivity in response to trade liberalization – does *not* represent a sufficient condition for welfare-gains from trade liberalization: I find that exit of the least productive firms and

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[132] There might still be some problems regarding the turn-over in jobs intra-industry reallocation brings about, but if aggregate consumption increases with aggregate employment, there would still be room for lump-sum redistribution which ensures that everyone can be better off, so it is in that sense that I speak of a Pareto-improvement. In my related open-economy work in part III of this dissertation I analyze the potential for distributional conflicts in open economies in greater detail.

increases in average productivity obtain regardless whether or not trade liberalization leads to increases in welfare and employment.

II.4.2 Geometric Analysis and Interpretation of the Results

One can gain a lot of intuition and insights into what brings about the aforementioned results by means of plotting the EE-curve and the WD-curve whose intersection determines the equilibrium of the model. The convention for drawing such graphs which I adopt for the present paper is to put the level of aggregate employment on the horizontal axis and the level of the real wage on the vertical axis. Recall that the EE-curve as stated in (II.24) represents the locus of all combinations of aggregate employment and the real wage which satisfy all equilibrium conditions and accounting identities of the model except for the wage-determination-condition in (II.2)/(II.25) and also recall that the EE-curve is only defined for levels of aggregate employment less than or equal to L. While it is clear that the WD-curve is increasing due to the presence of the pecuniary externality which drives up real wages as aggregate employment increases, drawing the EE-curve one notes that the EE-curve is increasing, too.[133] Why is that? This question is also relevant to the standard version of the canonical Melitz-model since the same increasing EE-curve obtains in the standard model: In deriving the EE-curve, I have not made use of the WD-curve which is the only difference from the standard model where the WD-curve is replaced by a labor-market-clearing-condition that would read $L_i^E = L \ \forall i$ in my notation.

The reasons for which the EE-curve is increasing[134] are actually exactly the same ones as analyzed in great detail in my related closed-economy work in part I of this dissertation: In that work, I argue that in general equilibrium models which feature imperfect competition, economies of scale due to quasi-fixed costs/entry-costs, an

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[133] Depending on whether σ is greater than/equal to/less than 2 the EE-curve represents an increasing concave/linear/convex curve through the origin in the space with aggregate employment on the horizontal and the real wage on the vertical axis. Given that Bernard, Eaton, Jensen and Kortum (2003) suggest $\sigma = 3.79$, I will only draw the concave case in the diagrams in this paper. But the geometric analysis is of course similar for other cases.

[134] It is important to be aware of the fact that the EE-curve is *not* an aggregate labor demand curve. Using what one knows about optimal firm-level output in equilibrium and the production technology, it is straightforward to show that labor demand curves at the firm-level are declining (i.e. labor demand is lower for higher levels of the real wage) given the values of the aggregate variables and thus, if one held the mass of firms fixed, the resulting aggregate labor demand curve in this model would also be decreasing given the levels of other aggregate variables. The same is true in the canonical Melitz-model. One important difference between such an aggregate labor demand curve and the EE-curve (but not the only one) is that along the EE-curve the mass of producing firms, N_i, is *not* constant but pinned down endogenously according to the various optimality conditions for firm entry.

endogenous extensive margin of production and a specification of preferences and technology that allows for "love for variety"/"returns to specialization" and/or variable mark-ups, EE-curves are generally upwards-sloping and in part I of this dissertation I also establish the following formula for the elasticity of real wages with respect to aggregate employment coming out of the EE-curve which characterizes the slope of the EE-curve at a given point and which I am now expressing in the notation of the present paper:

(II.34) $$\eta_{EE}(L_i^E) = \left(\left|\eta_\mu(L_i^E)\right| + \left|\eta_V(L_i^E)\right|\right)\left(\eta_X(L_i^E)\right)$$

In appendix II.A in the present paper I demonstrate that this formula from part I of this dissertation also applies in the present open-economy context, i.e. that it represents a valid description of the elasticity of the EE-curve in (II.24). $\eta_{EE}(L_i^E)$ in that formula denotes the elasticity of the real wage w_i with respect to aggregate employment L_i^E as implied by the EE-curve at an employment-level of $L_i^E \leq L$. $\left|\eta_\mu(L_i^E)\right|$ denotes the absolute value of the elasticity of equilibrium mark-ups with respect to the mass of firms competing in product markets, but as that mass can in turn be written as a differentiable function of aggregate employment in such models, the elasticity η_μ can directly be expressed as a function of the level of aggregate employment. $\left|\eta_V(L_i^E)\right|$ denotes the absolute value of the elasticity of the "cost of living"-index P_i with respect to the mass of available varieties in the product market of country i keeping the distribution of prices at the micro-level fixed – this elasticity thus captures "product-variety-effects" on welfare and again, one can write it as a function of aggregate employment due to the aforementioned close link between aggregate employment and the mass of producers which is in turn closely connected to the mass of available varieties. $\eta_X(L_i^E)$ is an elasticity that has the straightforward interpretation of being the fraction of a given change in aggregate employment which is accounted for by the extensive margin. The values of all these elasticities may in principle depend on the level of aggregate employment. The reader is referred to part I of this dissertation for an in-depth discussion and derivation of this formula and to appendix II.A in the present paper for a demonstration that this formula applies in the present open-economy context, too.

For my present purposes, this formula is only interesting inasmuch as it characterizes the slope of the EE-curve and thus shows why that curve may be increasing – namely for two reasons: First, looking at the formula in (II.34) one notes that one needs the extensive margin to be endogenous, i.e. $\eta_X(L_i^E) > 0$ is required for the EE-curve to be upwards-sloping, so the positive slope of the EE-curve is clearly driven by movements of employment along the

extensive margin.[135] And second, one needs product-variety-effects in technology (as "returns to specialization" or "external economies of scale" à la Ethier (1982)) or in preferences (as "love for variety") or one needs variable mark-ups, i.e. one needs at least one element that implies either $\left|\eta_\mu(L_i^E)\right| > 0$ or $\left|\eta_V(L_i^E)\right| > 0$. If these conditions are satisfied, the following channels give rise to the strictly positive slope of the EE-curve: Expansions in aggregate employment – which for $\eta_X(L_i^E) > 0$ always happen at least to some extent along the extensive margin – lead to an increase in product variety, which for $\left|\eta_V(L_i^E)\right| > 0$ raises real wages through product-variety-effects that depress the "costs of living"-index for given prices at the variety-level. This is the first channel behind the positive relationship between real wages and aggregate employment captured in the EE-curve. In addition, expansions in aggregate employment along the extensive margin reduce mark-ups if $\left|\eta_\mu(L_i^E)\right| > 0$, i.e. if mark-ups are sensitive to the mass of competitors in product markets. But since mark-ups and real wages are necessarily inversely related,[136] this also pushes towards a positive co-movement between real wages and aggregate employment. Thus, EE-curves are generally increasing if there is imperfect competition, if the extensive margin is endogenous and if either mark-ups are variable and/or preferences/technology allow for product-variety-effects. Note that all these elements are among the core ingredients of the current vintage of intra-industry trade models inspired by the work by Melitz (2003) – and also among the core ingredients of the previous vintage of intra-industry trade models inspired by the works by Krugman (1979, 1980). Thus, in light of the results from part I of this dissertation one can expect most models of intra-industry international trade to have increasing EE-curves. In the concrete case of the present model with standard CES-preferences, mark-ups are constant, so $\left|\eta_\mu(L_i^E)\right| = 0$, but $\left|\eta_V(L_i^E)\right| = \frac{1}{\sigma-1}$ and $\eta_X(L_i^E) = 1$ applies in this case (cf. appendix II.A in the present paper and related results in part I of this dissertation). Hence, according to the formula in (II.34) $\eta_{EE}(L_i^E) = \frac{1}{\sigma-1}$ must be true in this model and this is in fact what one also obtains by means of calculating the elasticity of the EE-curve directly from (II.24). Since $\left|\eta_\mu(L_i^E)\right| = 0$, the slope of the EE-curve in the model I analyze in this paper is entirely accounted for by the product-variety-effect

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[135] If there was no extensive margin, i.e. if the mass of firms was fixed, that elasticity would equal zero and thus, the elasticity of the EE-curve would be zero, too, which means that the EE-curve would be horizontal. See part I of this dissertation for more on this.

[136] Mark-ups describe a relationship between prices at the variety-level and nominal wages which are a major determinant of production costs. Real wages do the exact opposite as they describe a relationship between nominal wages and the "cost of living"-index, which is generally an increasing function of prices at the variety-level. This implies that mark-ups and real wages are generally inversely related. This inverse relationship is shown more explicitly in part I of this dissertation.

associated with the "love for variety"-feature in the CES-preferences, while under different preferences allowing for variable mark-ups there could be a second channel pushing into the same direction.

Having understood why EE-curves may be upwards-sloping and how general that result is, one wants to understand how trade liberalization affects the EE-curve – and that question of course goes beyond the closed-economy analysis in part I of this dissertation. Straightforward algebra using the expression for the EE-curve from (II.24) reveals that if variable trade costs τ decline, the EE-curve implies a higher real wage for any given (strictly positive) level of aggregate employment, i.e. the curve shifts/rotates upwards as illustrated in Figure II.1 where the new EE-curve obtaining as a result of trade liberalization is indicated by a prime.
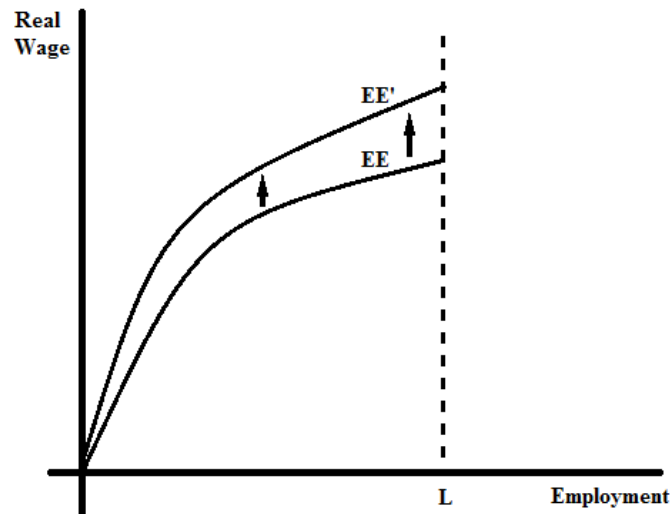
Figure II.1: The effect of trade liberalization on the EE-curve.

How can one understand this upwards-shift/rotation of the EE-curve in response to trade liberalization on a conceptual and intuitive level? One has to think about a decline in variable trade costs as representing a technological improvement: As less output is lost along the way due to the decline in trade costs, the two trading economies can produce more output for consumption purposes using the same total amount of labor – and they can increase the mass of available varieties without increasing aggregate employment – so their "production possibilities frontiers" shift out. But as all output which is not spent on trade costs is consumed and as profits net of all entry-costs are zero in the aggregate due to free entry, aggregate consumption equals aggregate labor income in

real terms (cf. (II.26) which obtains without using the WD-curve), so if aggregate employment is constant and aggregate consumption rises as less output is lost along the way, real wages must go up and an increase in real wages given aggregate employment implies an upwards-shift/rotation of the EE-curve.[137] Note that nothing in that argument relies on concrete assumptions about technology or preferences: A decline in physical trade costs will generally play out as an expansion of the production possibilities frontier for a global economy so that higher consumption for a given level of aggregate employment will generally be possible and as soon as free entry implies that profits are zero in the aggregate, this will translate into higher real wages conditional on aggregate employment. There are thus very good reasons to assume that under very general circumstances, trade liberalization induces an upwards-rotation/shift of the EE-schedule.

Now that the reasons for the slope of the EE-curve and the effect of trade liberalization on that curve have been examined, it is time to put the two curves together on a single diagram: Recall that the WD-curve as presented in (II.25) is clearly upwards-sloping, too,[138] and note that trade liberalization does not have any effect on the WD-schedule.[139] Figure II.2 portrays the effects of trade liberalization in a case in which $\xi > \frac{1}{\sigma-1}$ (i.e. the condition which is required for welfare-gains from trade liberalization according to PROPOSITION II.3) holds, while Figure II.3 illustrates the effects of trade liberalization in a case in which the opposite, namely $\xi < \frac{1}{\sigma-1}$, is true, so that

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[137] A different perspective involves noting the fact that due to the decline in trade costs (which under CES-preferences with constant mark-ups get fully passed through to customers in export markets), customers face lower prices for imports, which increases the purchasing power of their wages all else equal. Yet another perspective consists in invoking the reallocation effects of trade liberalization which have been shown to obtain regardless of the shape of the WD-curve and which are thus fully accounted for behind the EE-curve: As production is reallocated towards more productive firms in response to trade liberalization, total output produced increases for a given level of aggregate employment and hence, more output is available for consumption, which – through the aforementioned forces – must imply higher real wages for a given level of aggregate employment.

[138] Depending on whether ξ, the elasticity of real wages with respect to aggregate employment (or the employment rate) which describes the strength of the pecuniary externality in the labor market, is greater than, equal to or less than unity, the WD-curve is convex, linear or concave in the space with the real wage on the vertical axis and aggregate employment on the horizontal axis. For illustration purposes, let me only draw the case $\xi < 1$, i.e. the concave case.

[139] As long as one does not allow for foreign direct investment of any kind so that exporting is the only possible mode of serving a foreign market and as long as labor is not mobile internationally, there is no obvious reason why wage-determination should be directly affected by the level of trade costs. But even though the position of the WD-curve will not shift in response to trade liberalization by assumption, there will generally be a movement along that curve as trade costs change so that changes in the level of trade costs still affect real wages through general equilibrium effects including, most notably, the pecuniary externality in the labor market which gives rise to the WD-curve.

trade liberalization leads to reductions in employment and welfare. In both figures, the new EE-curve induced by trade liberalization is marked with a prime.

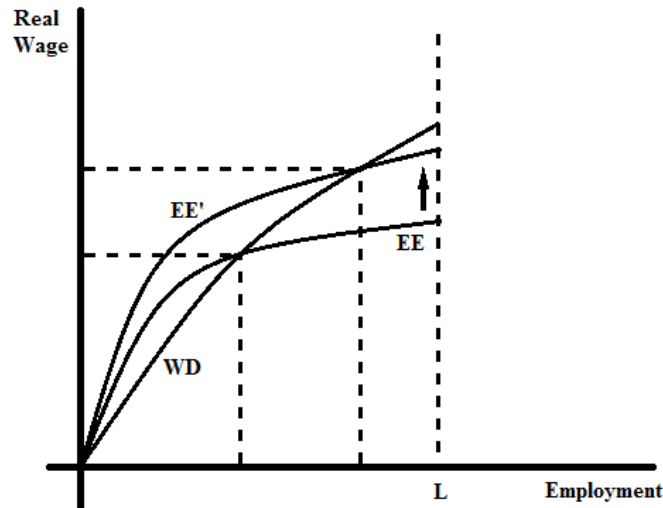Figure II.2: The effects of trade liberalization if the WD-curve is steeper in the initial equilibrium.
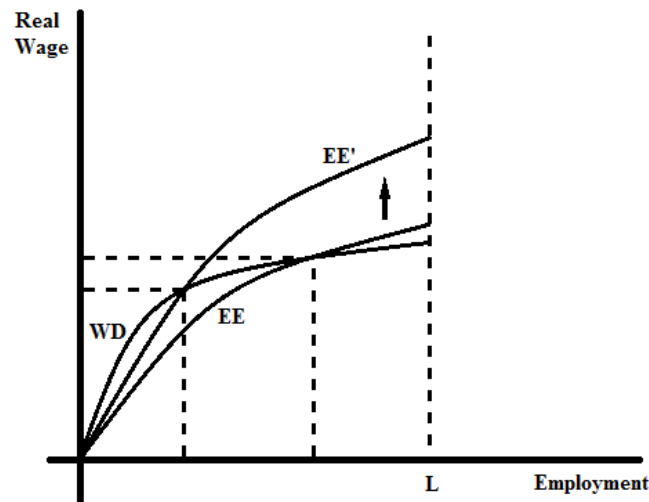

Figure II.3: The effects of trade liberalization if the EE-curve is steeper in the initial equilibrium.

Since aggregate consumption as the welfare-measure is equal to the product of the levels of the real wage and aggregate employment in this type of model (cf. (II.26)) and since the WD-curve is not affected by trade

liberalization, the direction in which the unique equilibrium moves along the stable WD-curve directly indicates the welfare-effects of trade liberalization. Figures II.2 and II.3 reveal the following geometric principle which is operating in this model:[140] As trade liberalization generally induces an upwards-shift/rotation of the EE-curve, whether the new equilibrium is located downwards and to the left or upwards and to the right from the old one depends on whether the EE-curve or the WD-curve is steeper in the initial equilibrium: Whenever the EE-curve is steeper (as in Figure II.3), the new equilibrium is located downwards and to the left from the initial one and hence, there are welfare-losses from trade liberalization. Conversely, whenever the WD-curve is steeper than the EE-curve in the initial equilibrium (as in Figure II.2), the new equilibrium is located upwards and to the right from the initial one and hence, there are welfare-gains from trade liberalization.

Given that WD-curves are upwards-sloping as soon as there is this pecuniary externality in wage-determination and since according to the arguments presented in part I of this dissertation EE-curves are upwards-sloping under conditions which are generally satisfied in intra-industry models of trade and inasmuch as EE-curves generally rotate/shift upwards if trade costs decline, this geometric argument applies very generally and does not depend on any of the functional form assumptions I have made for the WD-curve, for preferences, for technology or for the CDF $G\big(\lambda(\omega)\big)$.[141] Note that one can translate this general geometric insight into an elasticity-formula: Let $\eta_{WD}(L_i^E)$ denote the elasticity of real wages with respect to aggregate employment which is implied by the WD-curve at a given level of aggregate employment L_i^E and note that this elasticity describes the strength of the pecuniary externality in the labor market and hence, in a certain sense, the degree of wage-flexibility in the labor market. By definition the WD-curve is then steeper than the EE-curve at an intersection of the two curves with an employment-level L_i^E if and only if the following is true at that employment-level:

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[140] This is in fact the same geometric principle that also applies to the effects of technological improvements in closed economies which I discuss in part I of this dissertation.

[141] The functional form assumptions I have made rule out the case of multiple equilibria. Those might exist under different functional form assumptions, though. But even if there were multiple equilibria, the same geometric argument would remain valid locally, i.e. in the neighborhood of any given equilibrium, so unless there is equilibrium switching in response to trade liberalization, even in a case with multiple equilibria this geometric argument could still give a lot of guidance regarding the effects of (gradual) trade liberalization. Whether or not issues of equilibrium switching might arise, depends on the properties of equilibrium selection mechanisms. As one can make numerous assumptions in that regard and as it is not clear why declines in trade costs should have consequences for which equilibrium is preferred by an equilibrium selection mechanism, it does not appear to be very likely that an in-depth study of the possibility of multiple equilibria under different functional form assumptions would lead to major additional insights and therefore, I will not explore in greater detail the issue of multiple equilibria which might arise under different assumptions on functional forms.

(II.35) $$\eta_{WD}(L_i^E) > \eta_{EE}(L_i^E)$$

And only in this case trade liberalization is beneficial while it leads to lower employment and welfare if that strict inequality is reversed. Note that given my functional form assumption for the WD-curve from (II.2) $\eta_{WD}(L_i^E) = \xi$ is true and, as shown above, $\eta_{EE}(L_i^E) = \frac{1}{\sigma-1}$ holds with standard CES-preferences, so in light of (II.35) the condition for trade liberalization to be beneficial established in the context of PROPOSITION II.3, namely (II.33), can directly be interpreted as indicating the relationship of the slopes of the two relevant curves in their intersection.

The geometric analysis in this section suggests that – well beyond my concrete functional form assumptions – the elasticity-formula in (II.35) can give guidance as to whether or not trade liberalization is beneficial and using the formula for the elasticity of the EE-curve from (II.34) it might actually be possible to empirically identify the elasticity of the EE-curve in a concrete situation, which in light of (II.35) would then imply a threshold for how strong the pecuniary externality in the labor market would have to be for welfare- and employment-gains from trade liberalization and how much wage-flexibility would thus be required.[142]

In the case of the standard Melitz-model with its Walrasian labor market, the WD-curve is essentially vertical at full-employment.[143] As mentioned above, the EE-curve in the standard Melitz-model can be shown to be the same as in my version, i.e. it is also given by (II.24). I have drawn the effects of trade liberalization for the case of a Walrasian labor market in Figure II.4, which illustrates that there must necessarily be welfare-gains from trade liberalization in the canonical Melitz-model with its Walrasian labor market.

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[142] However, in part I of this dissertation I argue that production networks may amplify the elasticity of the EE-curve and I provide some guidance as to how this formula needs to be generalized to account for that, which seems particularly relevant in a trade context if a lot of trade is in intermediate goods.

[143] In the opposite extreme case where the pecuniary externality is completely absent, i.e. $\xi = 0$, the WD-curve is horizontal at $\psi > 0$ and in light of both the geometric argument and the equations of the model, it is clear that trade liberalization then necessarily entails welfare-losses, which is why wage-flexibility may be viewed as a necessary condition for welfare-gains from trade liberalization.
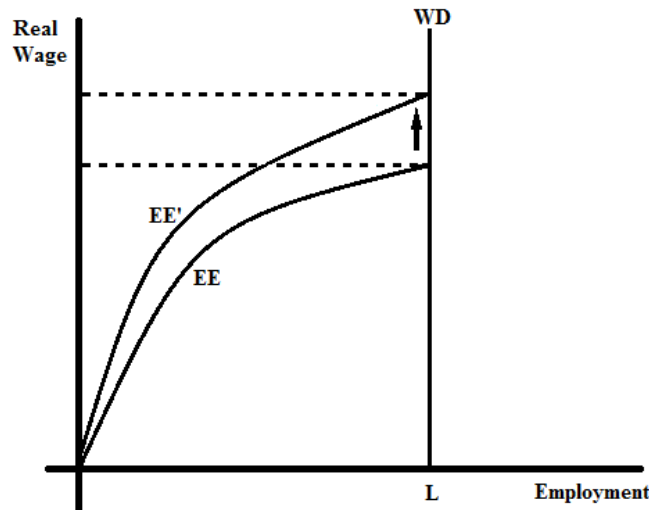
Figure II.4: The effects of trade liberalization with a Walrasian labor market.

II.4.3 Remarks about Policy-Implications and the ACR-Welfare-Formula

My analysis suggests that whether or not trade liberalization is beneficial depends crucially on the strength of pecuniary externalities in the wage-determination process. An elasticity of real wages with respect to aggregate employment characterizing these externalities could potentially be estimated – at least locally in the neighborhood of the initial equilibrium prior to trade liberalization – even without imposing the functional form assumption for the WD-curve I have used for my theoretical analysis. Similarly, the formula for the elasticity of the EE-curve in (II.34) could in principle be used to empirically identify the slope of the EE-curve in the neighborhood of a pre-trade-liberalization equilibrium without imposing parametric assumptions of an economic model.[144] Hence, in light of the threshold-rule in (II.35) my analysis can offer guidance for empirical work that seeks to inform policy prior to liberalizing trade as to whether that will likely result in welfare-gains or in welfare-losses.[145]

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[144] Alternatively, one can of course resort to a structural model and estimate the parameters which in that model determine the three elasticities showing up in (II.34).

[145] In addition, my results have some clear policy-implications related to trade liberalization from an ex-post perspective: Suppose some trade-liberalizing policy has been implemented or trade costs have gone down due to some technological innovation. Suppose further that empirical research from an ex-post perspective identifies a decline in aggregate employment that can be traced back to the trade liberalization event or to the technological

But is it also possible to provide a similarly simple and general formula that allows *quantifying* the welfare-gains or welfare-losses trade liberalization might entail rather than only indicating the direction of welfare-changes? In that context, one might wonder whether a welfare-formula such as the one provided by Arkolakis, Costinot and Rodríguez-Clare (2012) for the Melitz-model with a Walrasian labor market still holds in this model with a frictional labor market and unemployment. The formula provided by Arkolakis, Costinot and Rodríguez-Clare (2012), which I refer to as the "ACR-welfare-formula", expresses relative welfare under two different levels of variable trade costs as a function of two objects: The ratio of the "shares of domestic expenditure" associated with the two levels of trade costs, respectively, where the share of domestic expenditure is defined as the share of total expenditure of a country that goes to non-imported varieties, and the "trade elasticity" which is defined as the elasticity of the ratio of total spending on imports over total spending on non-imported varieties with respect to a change in bilateral variable trade costs (which are τ in my model). These two objects can very easily be computed within my model: For the "share of domestic expenditure of country i", which I will denote by Φ_i, one obtains:

(II.36) $$\Phi_i = \left[1 + \left(\left(\frac{1}{\tau}\right)^K\right)\left(\left(\frac{f^P}{f^X}\right)^{\frac{K-(\sigma-1)}{\sigma-1}}\right)\right]^{-1} \quad \forall i$$

The "trade elasticity" turns out to be simply given by $-K$, i.e. by the negative of the shape parameter of the distribution for productivity-draws.[146] Using the solution for aggregate employment from (II.32) and the WD-curve from (II.25) as well as (II.26) one can easily solve for the level of C_i in the symmetric equilibrium, which serves as my welfare-measure. Let C_i' and C_i'' denote the equilibrium levels of C_i coming out of two parameterizations of the

improvement which reduced trade costs. In terms of the theory I have developed, this then obviously reveals that the EE-curve must have been steeper than the WD-curve in the proximity of the initial equilibrium and thus the same is likely to be true in the new equilibrium, too. Given WTO-regulations trade-liberalizing policies may very well be irreversible and declines in trade costs stemming from technological improvements are typically irreversible, too, so a relevant policy-question from this ex-post perspective is how to raise employment and real wages again if trade policy cannot do the job. The results I have presented suggest a way to deal with that problem: If by means of changing the institutional structure of the labor market one can manage to rotate the WD-curve such that it implies higher real wages given aggregate employment, one can increase real wages and aggregate employment again to fix the negative consequences trade liberalization might have entailed. In part I of this dissertation where I study labor market reform with the help of WD-curves in closed economies, I provide explicit examples of what such policies, which I there qualify as "demand-side policies", might represent. It is important to note, though, that this policy-prescription refers to a symmetric bilateral policy-intervention in labor markets in both countries: From my analysis one cannot infer that a unilateral action in that direction would be beneficial, too.

[146] Note that in the standard Melitz-model with full-employment and a Pareto distribution for productivity-draws the "trade elasticity" which is relevant for the welfare-formula due to Arkolakis, Costinot and Rodríguez-Clare (2012) also equals the negative of the shape parameter of the underlying Pareto distribution for productivity-draws.

model in which the values of all parameters are the same except for the levels of variable trade costs, which –

within the admissible range for τ – are assumed to be τ' and τ'', respectively, and let Φ_i' and Φ_i'' denote the

associated equilibrium levels of the "shares of domestic expenditure in country i" as given from (II.36). One can

then show that the following is true:

(II.37)
$$\frac{c_i''}{c_i'} = \left(\frac{\Phi_i''}{\Phi_i'}\right)^{-\frac{1}{K} \times \frac{(1+\xi)(\sigma-1)}{\xi(\sigma-1)-1}}$$

Note that (II.37) would be exactly equivalent to the ACR-welfare-formula if $\frac{(1+\xi)(\sigma-1)}{\xi(\sigma-1)-1} = 1$ was true as $-\frac{1}{K}$ is the

inverse of what Arkolakis, Costinot and Rodríguez-Clare (2012) call the "trade elasticity". But $\frac{(1+\xi)(\sigma-1)}{\xi(\sigma-1)-1} = 1$ is

only true in the limit as $\xi \to \infty$. That limiting case has the natural interpretation of being the Walrasian case where

the WD-curve is arbitrarily close to being vertical at full-employment, i.e. at $L_i^E = L$. Hence, one may very well

conclude that the ACR-welfare-formula holds in my model in the limit as the model becomes arbitrarily close to the

Walrasian benchmark which is widely used in the literature inspired by Melitz (2003) and where that formula

would apply exactly as Arkolakis, Costinot and Rodríguez-Clare (2012) argue.[147] However, if one is not in that

limiting case and ξ is finite, the ACR-welfare-formula does not apply and is inaccurate for quantifying welfare-

changes induced by trade liberalization. A very interesting pattern of deviations from that formula emerges: If

$\xi > \frac{1}{\sigma-1}$ is true (which is the condition for welfare-gains from trade liberalization in my model), $\frac{(1+\xi)(\sigma-1)}{\xi(\sigma-1)-1} > 1$

necessarily holds. That means that in cases where my model exhibits welfare-gains from trade liberalization, the

ACR-welfare-formula *underestimates* those gains. This is intuitive in light of the fact that my model implies that

welfare-gains from trade liberalization come along with higher aggregate employment, while the original ACR-

formula has been established for the case of a Walrasian labor market where employment cannot adjust as trade is

liberalized. Higher aggregate employment is obviously beneficial and that is a welfare-channel the ACR-welfare-

formula cannot speak to by construction. Conversely, it is straightforward to show that if $\xi < \frac{1}{\sigma-1}$ is true (which is

the condition for welfare-losses from trade liberalization), $\frac{(1+\xi)(\sigma-1)}{\xi(\sigma-1)-1} < 0$ holds and thus, it follows that the ACR-

welfare-formula would still imply welfare-gains from trade liberalization when in fact trade liberalization induces

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[147] Exogenous and inelastic labor supply as well as labor-market-clearing are among the assumptions Arkolakis, Costinot and Rodríguez-Clare (2012) make for deriving their formula.

welfare-losses in my model. Evidently, this can at least in part be attributed to the fact that aggregate employment declines whenever trade liberalization implies losses in my framework but that is not something that is allowed for behind the scenes of the ACR-welfare-formula.[148]

II.4.4 Relationship to the Preceding Literature

How do my results compare to results that have previously been obtained in papers which have merged concrete models of frictional labor markets with the canonical Melitz-model? In particular, one might wonder why the preceding literature has not pointed out anything akin to my central result that a sufficiently strong pecuniary externality in the labor market is required for gains from trade liberalization. The relevant benchmark papers to look at in this context are obviously the theory-papers which have studied the implications of embedding a standard concrete labor market model into the canonical Melitz-model without adding other elements: The paper by Felbermayr, Prat and Schmerer (2011) for the case of the "search and matching"-model à la Mortensen and

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[148] Heid and Larch (2014) using a "search and matching"-approach to the labor market make related points about the ACR-welfare-formula in a different type of trade model that exhibits product differentiation only across countries (i.e. à la Armington (1969)), homogeneous firms, perfect competition and constant returns to scale: In that alternative framework, they also argue that the ACR-welfare-formula is inaccurate for quantifying welfare-effects of trade liberalization as it fails to account for changes in aggregate employment. They also provide a quantitative assessment of the effect of neglecting changes in aggregate employment in calculations of the welfare-effects of trade liberalization. There is, however, an important conceptual difference in the pattern of deviations from the original ACR-formula between my model and theirs: They argue that the right-hand side of the standard ACR-formula only needs to be multiplied by the change in aggregate employment in order to be able to accurately indicate welfare-changes in their model, which implies that the original parts of the ACR-formula in their framework still correctly describe the change in the real wage in response to trade liberalization because – as in my framework, too – welfare in their model consists of the product of aggregate employment and the real wage if trade is balanced. In my model such a simple extension of the standard ACR-welfare-formula is not available, i.e. it is not the case that (II.37) can be obtained by means of multiplying the original version of the ACR-formula (which is $\frac{c_i''}{c_i'} = \left(\frac{\Phi_i''}{\Phi_i'}\right)^{-\frac{1}{K}}$) by a term that accounts for the change in aggregate employment. To see this, note that (II.32) implies that the ratio of the levels of equilibrium aggregate employment corresponding to two different levels of variable trade costs τ' and τ'', respectively, is given by $\frac{L_i^{E''}}{L_i^{E'}} = \left(\frac{\Phi_i''}{\Phi_i'}\right)^{-\frac{1}{K} \times \frac{(\sigma-1)}{\xi(\sigma-1)-1}}$. Hence, making use of the WD-curve (or of $C_i = w_i L_i^E$) it follows that the ratio of equilibrium real wages corresponding to two different levels of variable trade costs τ' and τ'', respectively, is given by $\frac{w_i''}{w_i'} = \left(\frac{\Phi_i''}{\Phi_i'}\right)^{-\frac{1}{K} \times \frac{\xi(\sigma-1)}{\xi(\sigma-1)-1}}$ rather than by $\left(\frac{\Phi_i''}{\Phi_i'}\right)^{-\frac{1}{K}}$ which would need to be true for the standard ACR-welfare-formula to provide an accurate account of the change in equilibrium real wages in response to trade liberalization in my model. Hence, my results differ from those in Heid and Larch (2014) inasmuch as I find in a different type of trade model that the original ACR-welfare-formula fails not only because it does not take changes in aggregate employment into account (which is its only failure in the type of trade model Heid and Larch (2014) consider), but that on top of that the original formula in a trade model à la Melitz (2003) does not even provide an accurate account of the change in real wages in response to trade liberalization if labor market imperfections are taken into account.

Pissarides (1994) and the paper by Egger and Kreickemeier (2009) for the "fairness"-model à la Akerlof and Yellen (1990).[149]

There are two major reasons for which these authors did not come up with a result which – in their respective concrete models of the labor market – would correspond to my central result: First, both papers conduct the major part of their analyses using a version of CES-preferences which shuts down the product-variety-channel.[150] As I argue in part I of this dissertation and as is clearly reflected in the formula for the elasticity of the EE-curve in (II.34), EE-curves are horizontal if one uses such preferences: The reason for this is that mark-ups are constant under CES-preferences so that they do not vary with the mass of competitors and if one additionally shuts down the product-variety-channel, real wages cease to depend on aggregate employment through forces working through the product market, but real wages are then fully pinned down as soon as the product-market-part of the model is solved.[151] What these authors thus effectively do by shutting down the product-variety-channel in addition to the variable-mark-ups-channel is exogenously fixing the equilibrium real wage through product market forces so that the labor market is not even required for pinning down real wages. And the geometric argument I have presented above indicates that in the case of a horizontal EE-curve, trade liberalization necessarily leads to welfare-gains as it shifts the horizontal EE-curve up so that equilibrium moves in a "northeastern" direction along the upwards-sloping WD-curve towards higher levels of aggregate employment and real wages. And in fact, both papers claim that welfare-gains are the unambiguous result of a decline in variable trade costs in the case where fixed costs of accessing foreign markets are higher than fixed costs of accessing domestic markets, i.e. if $f^X > f^P$ in the notation of my model where this inequality is also assumed. But in an extension/appendix, both of these papers then also

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[149] For the case of "efficiency wages" à la Shapiro and Stiglitz (1984) the contribution by Davis and Harrigan (2011) would be the benchmark, but their model does not allow for analytical results, so that one cannot identify a (set of) parameter(s) corresponding to ξ in my general case. Matusz (1996) studies a trade model with a labor market à la Shapiro and Stiglitz (1984) but without heterogeneous firms. This model has an analytical solution. However, in his work one cannot identify a parameter corresponding to ξ which would make it possible to vary the strength of the pecuniary externality coming from the "efficiency wage"-friction, either. Further, he does not allow for trade costs but compares the cases of autarky and free trade. He obtains the unambiguous result that free trade is associated with higher aggregate employment and higher real wages, which is suggestive of the fact that some assumption in his labor market setting makes sure that the pecuniary externality arising from the framework à la Shapiro and Stiglitz (1984) is sufficiently strong. Further, his model features multiple equilibria, so his equilibrium selection criterion might play a role, too. See the discussion in appendix I.C in part I of this dissertation for more on all this.

[150] Cf. Benassy (1996, 1998) for a discussion of this type of CES-preferences and associated theoretical issues.

[151] See the discussion in part I of this dissertation for more details on this point.

briefly discuss the case of standard CES-preferences that would imply an upwards-sloping EE-curve. However, they still do not come up with any result akin to mine whereby sufficiently strong externalities in wage-determination are required for gains from trade liberalization. This seems to be due to the fact that both papers restrict the parameter from their respective model which corresponds to ξ in my general model so that it is sufficiently high. But as PROPOSITION II.3 of my paper implies, if ξ is sufficiently high, there should be welfare-gains from trade liberalization.[152]

II.5 More on the Role of Firm-Heterogeneity and Selection Effects

The analysis up to this point indicates that the occurrence of "selection effects" in response to trade liberalization, where these effects are due to the heterogeneity of firms, is disconnected from the question whether or not there are

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[152] In appendix I.C in part I of this dissertation I discuss a "search and matching"-model à la Mortensen and Pissarides (1994) and a "fairness"-model à la Akerlof and Yellen (1990) and show which parameters in those models correspond to ξ in my setting: In a "search and matching"-model with a standard constant-returns-to-scale Cobb-Douglas matching function, ξ corresponds to the ratio of the exponents in the matching function and in fact, in the context of such a model Felbermayr, Prat and Schmerer (2011) make an assumption that is such that the "implied" ξ in the sense of the results presented in appendix I.C in part I of this dissertation satisfies $\xi > \frac{1}{\sigma-2}$ where σ is the elasticity of substitution in their version with standard CES-preferences. In light of my results in the present study and the related ones in part I of this dissertation, such a restriction suggests that they are likely to find gains from trade liberalization (the restriction can be found in the statement of Lemma 2 in appendix B.2. in their paper). These authors motivate that assumption by arguing that it is a sufficient condition for existence and uniqueness of equilibrium in their model, but from my reading of their work it is not clear whether it is also a necessary condition for that. In the version of their standard "fairness"-model with standard CES-preferences, Egger and Kreickemeier (2009) also impose that the value of the parameter which – in light of appendix I.C in part I of this dissertation – corresponds to ξ in my model is sufficiently high (this assumption is made and explained in footnote 30 of their paper). They justify this assumption with a stability argument. However, this argument seems somewhat questionable for at least two reasons: First, as I explain in section II.6, in my model related stability arguments still imply stability in regions of the parameter space where ξ is low enough such that trade liberalization reduces aggregate employment and welfare. The only major difference between the stability analysis I conduct and the one in Egger and Kreickemeier (2009) is that these authors effectively choose what corresponds to N_i in my model as their state-variable because for their stability argument, they look at the effect on firm entry if the variable corresponding to N_i in my model is above its equilibrium value. However, a much more natural choice for the state-variable for a stability argument seems to be N_i^A so that one checks on what happens if N_i^A rather than N_i (which is then still taken to be endogenous) is above its equilibrium value and this is in fact the choice I make for stability analysis further below: The more natural choice for a state-variable is the mass of firms which have completed the first stage of entry since in the explicitly dynamic model in Melitz (2003), on which both my analysis and the analysis in Egger and Kreickemeier (2009) are built, the first-stage entry-costs as captured by f^A represent a one-time investment, while market access costs as captured by f^P and f^X are allowed to represent recurring costs to be paid in each single period. Second and at a more general level, it seems questionable to use stability arguments of this type to restrict the parameter space for reasons that I discuss in detail in section II.6.1. One aspect of the model by Egger and Kreickemeier (2009) which makes it not directly comparable to my setting, though, and which might thus explain some of the differences in findings is that they introduce a role for the average real wage in the fairness constraint which, as I show in appendix I.C in part I of this dissertation, is closely related to my WD-curve, while I do not introduce any independent role for the average real wage in the WD-curve.

welfare-gains from trade liberalization. In this section, I will further elaborate on this point in two ways: First, I will show that the same simple formula that indicates the direction of welfare-changes, namely $\xi \lessgtr \frac{1}{\sigma-1}$, comes out of an otherwise similar model in which firms are assumed to be homogeneous – i.e. out of a model in the spirit of Krugman (1980) rather than in the spirit of Melitz (2003). Second, I will argue that while the heterogeneity of firms and the associated selection effects do not affect the *direction* of welfare-effects, they are still important for determining the *size* of the welfare-effects of trade liberalization. In particular, I will argue that the selection effects associated with firm-heterogeneity amplify both welfare-gains and welfare-losses from trade liberalization.

To make these two points, I will closely follow the approach suggested by Melitz and Redding (2015) for constructing a model with homogeneous firms in which selection effects are absent by construction and which in autarky results in an allocation which is equivalent to the one the heterogeneous firm model studied up to this point yields in autarky, i.e. for the limiting case $f^X \to \infty$. In particular, I make the following assumptions: In a model which I will refer to as the "homogeneous firm model" henceforth everything is exactly as in the "heterogeneous firm model" laid out in section II.2 except for the following alternative assumption on the first stage of the entry technology: Suppose that the distribution from which firms draw their productivity-levels $\lambda(\omega)$ upon completing the first stage of the entry-process is bimodal where $\lambda(\omega) = \Lambda$ with probability $\delta \in (0,1)$ and where $\lambda(\omega) = 0$ with probability $1 - \delta$. $\Lambda > 0$ is a parameter. In light of the production technology that has been specified above, firms which draw $\lambda(\omega) = 0$ will obviously not be able to produce and thus do not complete the second stage of entry for any market. For the purpose of this section, it is assumed that all parameters showing up in both the "homogeneous firm model" and the "heterogeneous firm model" take on the same values and most importantly, it is assumed that both models share the same WD-curve, namely (II.2), and hence the same structure of labor markets.

This "homogeneous firm model" can be solved following the exact same steps as discussed for the heterogeneous firm model in section II.3 and again, throughout my analysis I restrict attention to the case where in equilibrium variables at the aggregate level take on the same values in both countries. Existence and uniqueness of Nash equilibrium in the homogeneous firm model requires the same assumptions as in the heterogeneous firm model: $\xi \neq \frac{1}{\sigma-1}$ (which I will thus continue to assume) and that the level of aggregate employment does not exceed L. The only major difference which is important to point out explicitly is that selection into export markets in the

homogeneous firm model is somewhat different: In that model, one can have two different types of equilibria (which never co-exist, though, so that the aforementioned assumptions ensure uniqueness): First, there can be an equilibrium in which no firm exports. This turns out to be the relevant equilibrium whenever parameter values are such that $f^X > \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$, i.e. whenever the fixed costs of accessing the export market are sufficiently high. In that case, the two economies (choose to) remain in autarky even though they would in principle be able to trade with each other. I will thus refer to this type of equilibrium as the "autarky equilibrium". Second, there can be what I call the "trade equilibrium" in the homogeneous firm model. This is an equilibrium in which all producing firms sell in both countries and thus incur the market access investments for both countries. This type of equilibrium is the relevant one whenever $f^X \leq \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$, i.e. whenever the fixed costs of exporting are sufficiently low. That type of equilibrium resembles the one in the classical analysis by Krugman (1980) with transport costs and identical countries very closely if one disregards the fact that I do not work with a Walrasian labor market. It is important to emphasize again that the two types of equilibria never co-exist in the homogeneous firm model.

For my purpose of studying the welfare-effects of trade liberalization, the key object of interest in this homogeneous firm model is its EE-curve. This is due to the fact that both in the autarky equilibrium and in the trade equilibrium $C_i = w_i L_i^E \ \forall i$ holds so that – because of the stable upwards-sloping WD-curve – aggregate employment and welfare always move in the same direction in response to trade liberalization, which makes it sufficient to solve for aggregate employment, which in turn can be done by means of calculating the unique intersection of WD-curve and EE-curve. The EE-curve in the homogeneous firm model depends on whether parameter values are such that $f^X > \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$ or such that $f^X \leq \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$. If parameter values are such that $f^X > \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$ (so that the countries would remain in autarky in equilibrium), the EE-curve in the homogeneous firm model for any of the two countries is:

(II.38)
$$L_i^E = \sigma \left(\left(\frac{\sigma}{\sigma-1} \right)^{\sigma-1} \right) ((\Lambda)^{1-\sigma})((A)^{1-\sigma}) \left[f^P + \frac{f^A}{\delta} \right] ((w_i)^{\sigma-1})$$

And if parameter values are such that $f^X \leq \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$ (so that the countries would trade with each other in equilibrium), the EE-curve in the homogeneous firm model for any of the two countries is:

(II.39) $\qquad L_i^E = \sigma\left(\left(\frac{\sigma}{\sigma-1}\right)^{\sigma-1}\right)((\Lambda)^{1-\sigma})((A)^{1-\sigma})\left(\left[1+\left(\left(\frac{1}{\tau}\right)^{\sigma-1}\right)\right]^{-1}\right)\left[f^P + f^X + \frac{f^A}{\delta}\right]((w_i)^{\sigma-1})$

Note that these two EE-curves have the same basic geometric properties as the one from the heterogeneous firm model studied in sections II.2 through II.4, namely (II.24): They go through the origin, are strictly increasing and exhibit a constant elasticity of real wages with respect to aggregate employment which equals $\frac{1}{\sigma-1}$ and which is thus exactly the same as in the basic version of the model with heterogeneous firms. Thus, all EE-curves studied up to this point are of the functional form

(II.40) $\qquad\qquad\qquad\qquad\qquad L_i^E = \alpha((w_i)^{\sigma-1})$

where $\alpha > 0$ is a constant that depends on the parameters of the model including – if applicable – trade costs. Comparing any two EE-curves of the type from (II.40) with each other one finds that the EE-curve with the *lower* value of α lies above the other one at any strictly positive level of aggregate employment in the space with aggregate employment on the horizontal axis and the real wage on the vertical axis, i.e. the EE-curve with the lower value of α implies a strictly higher real wage for any strictly positive level of aggregate employment. Merging this common representation of the EE-curves of all versions of the model studied so far with the WD-curve $w_i = \psi\left(\left(\frac{L_i^E}{L}\right)^\xi\right)$ and noting that $C_i = w_i L_i^E$ holds in all versions of the model studied so far, it follows that if α is higher, aggregate employment and welfare are lower (higher) in equilibrium if and only if $\xi > \frac{1}{\sigma-1}$ (if and only if $\xi < \frac{1}{\sigma-1}$) is true, i.e. welfare and aggregate employment are inversely related to the size of α in the case $\xi > \frac{1}{\sigma-1}$ and increasing in the value of α for $\xi < \frac{1}{\sigma-1}$.[153] This insight will play a central role for the results in this section. For example, it can be used to establish the following result:

PROPOSITION II.4 (*Effects of Trade Liberalization in the Homogeneous Firm Model*): Consider a decline in variable trade costs τ so that Nash equilibrium in the homogeneous firm model exists and is unique both before and after the decline in trade costs. Comparing the old to the new equilibrium the following is true: Such a decline in

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[153] Writing EE-curves as in (II.40) implies an equilibrium level of aggregate employment of $L_i^E = \left(\left(\frac{(L)^\xi}{\psi}\right)^{\frac{\sigma-1}{(\sigma-1)\xi-1}}\right)\left(\left(\frac{1}{\alpha}\right)^{\frac{1}{\xi(\sigma-1)-1}}\right)$.

variable trade costs τ leads to a change in aggregate consumption C_i if and only if $f^X < \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$ is satisfied after

the decline in τ. If welfare as captured by C_i changes in response to such a decline in variable trade costs τ, it

increases if and only if $\xi > \frac{1}{\sigma-1}$ is true and decreases if and only if that strict inequality is reversed. L_i^E only changes

in response to trade liberalization if C_i does and then moves in the same direction as C_i.

Proof: In appendix II.B. ∎

Hence, the first goal of this section has been accomplished as it has been shown that in the homogeneous firm

model the same formula as in the heterogeneous firm model, namely $\xi \lesseqgtr \frac{1}{\sigma-1}$, governs whether trade liberalization

(ending in a trade equilibrium) leads to higher or lower welfare and aggregate employment. This finding thus adds

to earlier insights from section II.4 and strengthens the case that firm-heterogeneity and selection effects are

inconsequential for shaping the *direction* of the welfare-changes induced by trade liberalization.

Next, let me establish that firm-heterogeneity and the associated selection effects do matter for the *size of the*

welfare-effects of trade liberalization, though: In order to do this, I will repeat the experiment from PROPOSITION

2 in Melitz and Redding (2015) under my alternative assumptions on the labor market and thus, I will extend and

qualify their results which only apply to Walrasian labor markets.[154] The first step for that consists in following

these authors in picking the values of the parameters δ and Λ such that the homogeneous firm model and the

heterogeneous firm model exhibit the same allocation in autarky, i.e. for an infinite level of f^X.[155] The calibration

which achieves this is the following one:

(II.41)
$$\delta = \frac{K-(\sigma-1)}{\sigma-1}\frac{f^A}{f^P}$$

(II.42)
$$\Lambda = \left(\left[\left(\frac{K}{K-(\sigma-1)}\right)\left(\left(\frac{\sigma-1}{K-(\sigma-1)}\frac{f^P}{f^A}\right)^{\frac{\sigma-1}{K}}\right)\right]^{\frac{1}{\sigma-1}}\right)\lambda_0$$

PROPOSITION II.5 (*Equivalence of Autarky Allocations*): Consider the limiting case of $f^X \to \infty$ for the heterogeneous firm model from sections II.2 through II.4, which implies autarky in that model, and suppose that parameter values are such that equilibrium in the heterogeneous firm model as characterized in PROPOSITION II.1 exists and is unique for this limiting case, which I will then refer to as the "(unique) autarky equilibrium of the heterogeneous firm model". Furthermore, suppose that parameter values are such that equations (II.41) and (II.42) are satisfied and that all parameters which appear in both the homogeneous and the heterogeneous firm model take on the same values. Comparing the unique autarky equilibrium of the heterogeneous firm model to the unique autarky equilibrium of the homogeneous firm model which obtains for $f^X \to \infty$, the following four statements are then true: First, the variables C_i, L_i^E, w_i, N_i^A and N_i take on the same values in the unique autarky equilibria of both versions of the model. Second, the EE-curve of the homogeneous firm model for the autarky case (which is (II.38)) and the EE-curve of the heterogeneous firm model (which is (II.24)) in the limit of $f^X \to \infty$ exactly coincide. Third, the ratio $\frac{N_i}{N_i^A}$ (i.e. the fraction of firms which actually end up producing from the set of all firms which complete the first stage of the entry-process) is the same in the unique autarky equilibria of both versions of the model and equals δ. And fourth, following Melitz and Redding (2015) in defining for the heterogeneous firm model a weighted average of $\lambda(\omega)$ as $\left[\int_{\underline{\lambda}_i}^{\infty}\left((\lambda(\omega))^{\sigma-1}\right)\frac{dG(\lambda(\omega))}{1-G(\underline{\lambda}_i)}\right]^{\frac{1}{\sigma-1}}$, it follows that $\Lambda = \left[\int_{\underline{\lambda}_i^a}^{\infty}\left((\lambda(\omega))^{\sigma-1}\right)\frac{dG(\lambda(\omega))}{1-G(\underline{\lambda}_i^a)}\right]^{\frac{1}{\sigma-1}}$ is true where $\underline{\lambda}_i^a$ denotes the limit of $\underline{\lambda}_i$ for $f^X \to \infty$ and hence the "idiosyncratic productivity cut-off in autarky" for the heterogeneous firm model so that $\left[\int_{\underline{\lambda}_i^a}^{\infty}\left((\lambda(\omega))^{\sigma-1}\right)\frac{dG(\lambda(\omega))}{1-G(\underline{\lambda}_i^a)}\right]^{\frac{1}{\sigma-1}} = \left(\left(\frac{K}{K-(\sigma-1)}\right)^{\frac{1}{\sigma-1}}\right)\underline{\lambda}_i^a$ is a suitable concept of the "average level of $\lambda(\omega)$ in autarky" in the heterogeneous firm model.

Proof: In appendix II.B. ∎

PROPOSITION II.5 – which is essentially an extension of PROPOSITION 1 in Melitz and Redding (2015) accounting for my concept of EE-curves and bringing in a frictional labor market – implies that under the calibration from (II.41) and (II.42) welfare is the same in autarky in both versions of the model where the autarky equilibrium of the heterogeneous firm model can conveniently be calculated by studying the limiting case of

$f^X \to \infty$ in all previous equations for that model. That calibration makes sure that all other major variables take on the same values in autarky in both models, too, and this is what has been targeted following the approach in Melitz and Redding (2015). As a by-product, however, one obtains that the EE-curves of the two versions of the model are the same in autarky, which will be very convenient and important for the further analysis. Further, as in Melitz and Redding (2015) it follows from that calibration that the fraction of unsuccessful entrants, i.e. firms which pay the first-stage entry-costs but then do not produce, is the same in both models in autarky and that in autarky Λ, which is the unique draw all producing firms have made in the homogeneous firm model, is equal to an average of the idiosyncratic productivity-draws $\lambda(\omega)$ of all producing firms in the heterogeneous firm model where that average is weighted according to a concept of "average productivity" used in Melitz (2003) and Melitz and Redding (2015).

Having established the equivalence of the two versions of the model in autarky under the calibration from (II.41) and (II.42), one can then further follow Melitz and Redding (2015) and compare welfare-levels across those two models as f^X is reduced from infinity (so that there is autarky in both models) to some finite level (which induces trade – at least in the heterogeneous firm model) and attribute any difference in welfare (or employment) across models which results from this type of trade liberalization to the heterogeneity-channel and hence to the selection effects associated with firm-heterogeneity. In doing so, one needs to distinguish between the two different types of equilibria the homogeneous firm model could exhibit for finite levels of f^X. Let me begin with the case where f^X is reduced to some finite level for which $f^X > \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$ holds. In that case, the homogeneous firm model would still not feature any international trade in equilibrium, but the heterogeneous firm model of course would. In particular, looking at the representation of the EE-curve from the heterogeneous firm model in (II.24), one notes that that curve rotates upwards in the space with aggregate employment on the horizontal axis as the value of f^X drops. Hence, in the sense of the common representation of EE-curves from (II.40), it is the case that for any finite value of f^X the EE-curve of the heterogeneous firm model exhibits a *lower* α than the EE-curve of the same model in the limit of $f^X \to \infty$, i.e. in autarky. But inasmuch as the EE-curve of the heterogeneous firm model in autarky is identical to the EE-curve of the homogeneous firm model in autarky under the calibration from (II.41) and (II.42) and inasmuch as the EE-curve of the homogeneous firm model remains the same if the value of f^X drops in a way

such that $f^X > \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$ is still true (it is then still given by (II.38)), it thus follows that under the calibration from

(II.41) and (II.42) for any finite value of f^X satisfying $f^X > \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$, the EE-curve of the heterogeneous firm

model lies above the EE-curve of the homogeneous firm model in the space with aggregate employment on the

horizontal axis and hence, it follows that under that calibration for any finite value of f^X satisfying $f^X > \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$,

the EE-curve of the heterogeneous firm model exhibits a strictly *lower* α than the EE-curve of the homogeneous

firm model.

The same can be shown to be true for $f^X \leq \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$: In that case, the homogeneous firm model would exhibit

international trade in equilibrium, too, and the relevant EE-curve for the homogeneous firm model is thus the one

from (II.39). Comparing (II.39) to the expression for the EE-curve of the heterogeneous firm model, (II.24), and

making use of (II.42) it follows that under the calibration from (II.41) and (II.42) the EE-curve of the

heterogeneous firm model exhibits a strictly *lower* α for any given value of f^X satisfying $f^X \leq \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$ and thus

lies above the one of the homogeneous firm model in the space with aggregate employment on the horizontal

axis if and only if the following condition is satisfied:

$$(II.43) \qquad \frac{K}{K-(\sigma-1)}f^P\left(\left[1+\left(\left(\tfrac{1}{\tau}\right)^K\right)\left(\left(\tfrac{f^P}{f^X}\right)^{\frac{K-(\sigma-1)}{\sigma-1}}\right)\right]^{-\frac{\sigma-1}{K}}\right)\left[1+\left(\left(\tfrac{1}{\tau}\right)^{\sigma-1}\right)\right] < f^P + f^X + \frac{f^A}{\delta}$$

In appendix II.C I show that this condition is in fact satisfied under the calibration from (II.41) and (II.42).

Thus, it has been established that under the calibration that makes the autarky allocations of the two models

equivalent, for any finite value of f^X the EE-curve associated with the heterogeneous firm model exhibits a strictly

lower α in the sense of the common representation of EE-curves from (II.40) than the EE-curve of the

homogeneous firm model which is relevant for the respective value of f^X: Under that calibration, for all finite

values of f^X and all levels of aggregate employment $L_i^E \in (0, L]$ the EE-curve of the heterogeneous firm model thus

lies above the EE-curve of the homogeneous firm model in the space with aggregate employment on the horizontal

axis. Inasmuch as the two models share the same EE-curve in autarky and since – as shown in the proof of

PROPOSITION II.4 – it is true that whenever the condition for the trade equilibrium in the homogeneous firm

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model is satisfied, the EE-curve of the homogeneous firm model applying in a trade equilibrium of that model (which is (II.39)) exhibits a lower α than the one applying in the autarky equilibrium of that model (which is (II.38)), my earlier arguments about the effects of different values of α (in the sense of the representation of EE-curves from (II.40)) on equilibrium welfare then immediately give rise to the following major conclusion:[156]

PROPOSITION II.6 (*Welfare-Implications of Firm-Heterogeneity*): Suppose that parameter values are such that there exists a unique autarky equilibrium in the heterogeneous firm model as defined in PROPOSITION II.5 and suppose that parameter values are such that equations (II.41) and (II.42) are satisfied and that all parameters which appear in both the homogeneous and the heterogeneous firm model take on the same values. Now consider a decline in the value of f^X from infinity – which implies autarky in both models – to some finite level so that both the heterogeneous firm model and the homogeneous firm model still exhibit a unique equilibrium after that change in the value of f^X. The following statements are then true: Whenever $\xi > \frac{1}{\sigma-1}$, both the homogeneous firm model and the heterogeneous firm model imply (weakly) higher welfare when moving from the unique autarky equilibrium to an equilibrium with a finite value of f^X, but the welfare-gains are strictly larger in the heterogeneous firm model. Conversely, whenever $\xi < \frac{1}{\sigma-1}$, both models imply (weakly) lower welfare when moving from the unique autarky equilibrium to an equilibrium with a finite value of f^X, but the welfare-losses are strictly larger (i.e. the welfare-change is strictly larger in absolute value) in the heterogeneous firm model.[157]

Proof: This follows directly from the preceding discussion. ∎

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[156] To summarize, it has been established that under the calibration from (II.41) and (II.42) the value of α is always lower in the EE-curve of the heterogeneous firm model than in the EE-curve of the homogeneous firm model (regardless whether or not there is trade in the homogeneous firm model) as soon as f^X is finite and the value of α in the EE-curve of the heterogeneous firm model is also lower than the value of α in the EE-curve applying under autarky in both models. Further, if f^X is so low that there is trade in the homogeneous firm model, too, the value of α in the EE-curve of a trade equilibrium of the homogeneous firm model is lower than the value of α in the common EE-curve of both models in the autarky equilibrium. This ranking of the αs is what gives rise to PROPOSITION II.6.

[157] The heterogeneous firm model always yields changes in welfare in response to changes in the values of f^X or τ. Only in the homogeneous firm model welfare may remain constant as the values of f^X or τ change, but that is only the case if the economy remains in an autarky equilibrium as trade costs change.

Consequently, this experiment has revealed that it is in fact the case that the selection effects associated with firm-heterogeneity amplify both welfare-gains and welfare-losses induced by trade liberalization and thus, selection effects still matter for the *size* of welfare-changes although they do not matter for the *direction* of welfare-changes.

Some intuition for the finding that the heterogeneity-channel amplifies both welfare-gains and welfare-losses from trade liberalization can be gained by looking at some graphs: Figure II.5 and Figure II.6 illustrate the theoretical and mathematical arguments which give rise to PROPOSITION II.6. Both figures are meant to reflect the case in which the value of f^X is reduced from infinity to some value that satisfies $f^X < \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$ so that after the decline in the value of f^X there is international trade in the homogeneous firm model, too. Thus, both figures contain three EE-curves: The one without any prime is meant to reflect the common EE-curve the heterogeneous firm model and the homogeneous firm model exhibit in autarky. The EE-curve with a single prime is meant to reflect the EE-curve of the homogeneous firm model in the equilibrium with international trade which obtains after the reduction in the value of f^X so that $f^X < \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$ holds and the EE-curve with two primes is meant to reflect the EE-curve the heterogeneous firm model exhibits after the reduction in the value of f^X. Recall that if $f^X < \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$ is true after the decline in the value of f^X, it must be the case that the EE-curve of the heterogeneous firm model which applies after the decline in the value of f^X lies above the EE-curve of the homogeneous firm model which applies after the decline in the value of f^X and that both lie above the common EE-curve in the autarky equilibrium. Further, recall that the WD-curve is the same in all scenarios and that it does not change in response to trade liberalization. Figure II.5 illustrates a case in which $\xi > \frac{1}{\sigma-1}$ is true, which means in geometric terms that the WD-curve is steeper in its unique intersection with any given EE-curve. Figure II.6 illustrates the opposite case of $\xi < \frac{1}{\sigma-1}$ where the WD-curve is flatter in its unique intersection with any given EE-curve.
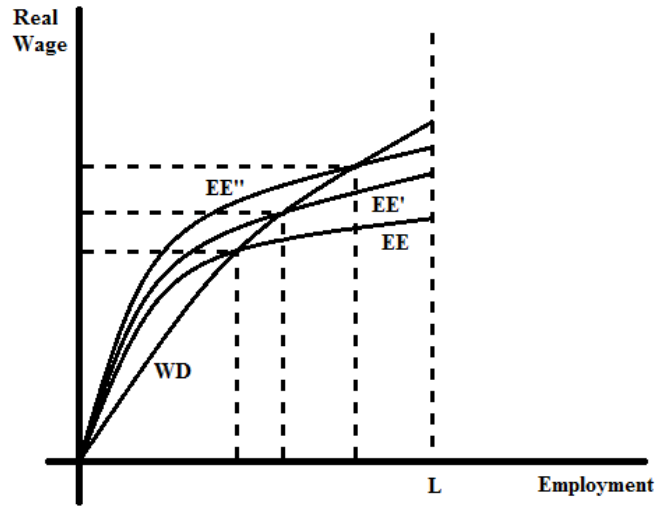
Figure II.5: Amplification of welfare-gains from trade through firm-heterogeneity.
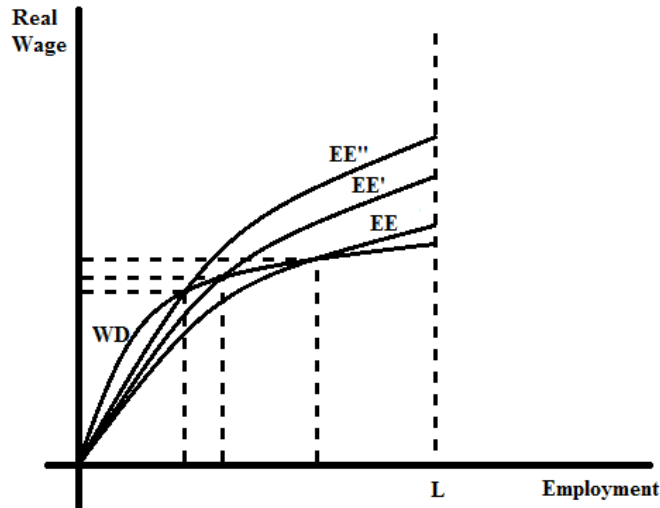
Figure II.6: Amplification of welfare-losses from trade through firm-heterogeneity.

These figures clearly illustrate the theoretical result that a "higher" EE-curve translates into higher aggregate employment and hence higher welfare if and only if $\xi > \frac{1}{\sigma-1}$, i.e. if and only if the pecuniary externality in the labor market is sufficiently strong so that real wages are sufficiently flexible. The intuition as to why EE-curves for lower levels of trade costs are generally located farther to the upper-left (i.e. associated with *lower* αs in the spirit of

(II.40)) has already been given above: Declines in trade costs – and that applies to f^X as it does to τ – play out like technological improvements and thus allow for higher real wages given aggregate employment, which is reflected in the EE-curve because the EE-curve captures the combinations of real wages and aggregate employment that are possible as equilibrium outcomes given preferences and the technology available to the economy and given product market structure and optimal decision-making by firms and households in all respects that do not pertain to wage-determination. With heterogeneous firms there is one additional margin of adjustment in the model whereby a decline in trade costs leads to an even stronger improvement of technology in comparison to the corresponding homogeneous firm model: The selection effect which is fully captured behind the EE-schedule[158] and whereby in response to trade liberalization productive resources (units of labor) are shifted from less productive to more productive firms given the level of aggregate employment. Hence, by inducing those additional selection effects, declines in trade costs look like an even stronger improvement of technology with heterogeneous firms so that EE-curves are shifted/rotated upwards by more in response to trade liberalization if firms are heterogeneous, which explains why the EE-curve for the heterogeneous firm model is located above the corresponding one for the homogeneous firm model after trade costs have fallen in the experiment discussed above. This also means that the technology- and product-market-side of the model as captured by the EE-curve implies that for a given level of trade costs, higher real wages for any given level of aggregate employment than in the corresponding homogeneous firm model are possible with firm-heterogeneity. However, the fact that product market structure, optimizing behavior by agents in all respects except for wage-determination, technology and preferences imply higher real wages for a given level of aggregate employment is only beneficial if the wage-determination-procedure in the economy implies that real wages are sufficiently sensitive to aggregate labor market conditions, i.e. if the WD-curve is sufficiently elastic such that $\xi > \frac{1}{\sigma-1}$ holds. In that case, which is the case of a sufficiently strong pecuniary externality in the labor market, the economy will settle on a new equilibrium with higher wages and employment as its "technology" improves, i.e. as trade costs decline and higher wages for a given level of aggregate employment become possible from the technology- and product-market-side of the model as captured by the EE-curve. Hence, with a sufficiently strong pecuniary externality in the labor market, selection effects amplify welfare-gains from trade liberalization as illustrated in Figure II.5. But in the opposite case with a weak pecuniary externality in the

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[158] To see that the selection effect is fully accounted for by the EE-curve recall from section II.4 that the selection effect can be characterized without using the WD-schedule, whereas solving for the cut-off characterizing the selection effect is in turn required for solving for the EE-schedule.

labor market so that real wages are relatively "rigid", declines in trade costs implying – through the preference-, technology- and product-market-side of the model – higher real wages given any level of aggregate employment represent a "curse": If the wage-determination-procedure does not allow for much flexibility, a new equilibrium with lower real wages and lower aggregate employment emerges in response to better opportunities from the technology- and product-market-side of the model. And as those opportunities are always better with heterogeneous firms than with homogeneous firms due to the additional adjustment margin associated with endogenous selection into markets and resource allocation across different types of firms, the "curse" of trade liberalization under *inflexible* wage-determination-procedures in the sense of $\xi < \frac{1}{\sigma-1}$ is stronger if firms are heterogeneous as illustrated in Figure II.6.

Finally, the analysis in this section has demonstrated that my central formula $\xi \lesseqgtr \frac{1}{\sigma-1}$ does not only apply to reductions in variable trade costs starting in an equilibrium that already exhibits trade, but that it can also be applied to figure out whether starting in autarky and opening up to trade entails benefits or losses and that it is also applicable to reductions in fixed costs of accessing foreign markets as captured by the parameter f^X. Furthermore, my conclusions also apply if one compares autarky to the opposite limiting case of free trade, which is the case of $\tau = 1$ and $f^X = f^P$ such that trade is just equivalent to an increase in market size. Hence, an additional conclusion which emerges is that mere increases in market size are beneficial if and only if the same condition, namely $\xi > \frac{1}{\sigma-1}$, is satisfied. The intuition for that result is that increases in market size, too, work like technological improvements and the arguments in this paper as well as the ones given in the context of a closed-economy-setting in part I of this dissertation clearly imply that technological improvements only entail benefits if the pecuniary externality in the labor market is sufficiently strong so that real wages are sufficiently flexible.

II.6 Further Extensions and Robustness-Checks

II.6.1 Stability Analysis and Additional Intuition

So far, the analysis has been completely static for simplicity. Let me now turn to a discussion of dynamics and to the related question whether the economy can be expected to reach the new unique equilibrium if – starting in the initial equilibrium – it is hit by a shock such as a trade liberalization event. In discussing such issues of equilibrium

stability in this section I seek to demonstrate that the unique equilibrium of the model may very well be stable according to a standard stability criterion regardless which curve is steeper in the unique equilibrium point. This finding makes a strong case for the view that even if trade liberalization implies lower welfare in equilibrium, the global economy is actually likely to settle down on that new equilibrium.[159] A second motivation for performing an explicit stability analysis is that it can also be used to build additional intuition for some of my major results. And finally, for the limiting case of $f^X \to \infty$, which implies a closed economy, the analysis in this subsection complements my related closed-economy work in part I of this dissertation and shows how under the dynamic assumptions on firm entry I will make in this section of the present paper,[160] both equilibria in which raising aggregate employment would require a "demand-side policy" and equilibria in which raising aggregate employment would require a "supply-side policy" as defined in part I of this dissertation[161] may be tâtonnement-stable. This implies that based on ideas of tâtonnement-stability it is not possible to conclude that "demand-side policies" may never be required to increase aggregate employment and likewise, it is not possible to conclude that "supply-side policies" may never be required to increase aggregate employment. I will discuss those points which are related to the analysis of labor market reform in my related closed-economy work in greater detail below[162] after studying stability in the context of the open-economy questions that are central to the present paper.

One way to introduce dynamics into the model studied up to this point would simply consist in assuming that there is a sequence of periods each of which works exactly like the single period described above. In that case, stability of equilibrium would not be an issue: Since there would be no inter-temporal decision-making and since the "per-period equilibrium" is unique and since all agents would re-optimize at the beginning of each period, the unique "per-period equilibrium" would be played period by period. However, given that in this paper I have worked with a static version of the model of firm entry à la Melitz (2003), this would not be a natural choice for introducing

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[159] Given this finding for a version of the model with a unique equilibrium it also seems quite unlikely that there would exist a general result in a version of the model with multiple equilibria that would say that it is always the case that only the equilibria in which the EE-curve is steeper are stable or that it is always the case that only the equilibria in which the WD-curve is steeper are stable.

[160] The assumptions on dynamics made in part I of this dissertation rule out out-of-equilibrium dynamics so that issues of equilibrium stability do not arise.

[161] According to that definition, a "demand-side policy" ("supply-side policy") would consist in an increase (decline) in the value of the labor market parameter ψ in the present setting.

[162] Cf. footnote 173.

dynamics, since in its explicitly dynamic form that model of firm entry assumes that the first-stage entry investment captured by f^A is a one-time investment while the costs captured by the parameters f^P and f^X could represent a type of costs applying period by period. To study dynamics and equilibrium stability in a way that is more consistent with that explicitly dynamic treatment in Melitz (2003) but which is still tractable, I will thus resort to standard ideas of "tâtonnement-stability" within the static model I have described above.

To understand the fairly standard criterion of "tâtonnement-stability" I will apply, first recall that equilibrium in the basic heterogeneous firm model I have studied so far requires that N_i^A is such that Π_i^A, namely profits from the ex-ante perspective (by which I mean the stage before a firm has made the first-stage entry investment so that its idiosyncratic productivity-draw $\lambda(\omega)$ is still unknown), are zero, i.e. N_i^A has to be such that given what all others do, any potential entrant expects zero profits from making the first-stage entry investment and optimal decisions at later stages within the period. For my purposes in this subsection, it will be more convenient to convert those profits into real terms by means of dividing them by P_i, so let π_i^A henceforth denote firm-level profits in real terms from the ex-ante perspective where $\pi_i^A = \frac{\Pi_i^A}{P_i}$. In the unique equilibrium studied so far, it obviously must be true that $\pi_i^A = 0$ since for entry-incentives it makes no difference whether one looks at Π_i^A or at π_i^A as $P_i > 0$ necessarily holds whenever there is meaningful economic activity. To check on "tâtonnement-stability" of the equilibrium that has been discussed so far, I will solve the basic heterogeneous firm model from sections II.2 through II.4 once again following similar steps as before but without imposing zero profits from the ex-ante perspective (i.e. without imposing $\pi_i^A = 0$). Instead, I will work with an exogenously fixed value of N_i^A which is assumed to satisfy $N_i^A > 0$: One can define equilibrium in an analogous way as above for an exogenous value of N_i^A which simply replaces the equilibrium condition in (II.19) and one can then solve this slightly modified model in a similar way as before for a unique outcome for any given value of $N_i^A > 0$ that would not imply $L_i^E > L$.[163] I will henceforth refer to this type of equilibrium which is characterized by the exogenous state-variable N_i^A as "short-run equilibrium", while the

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[163] Uniqueness of the type of equilibrium where N_i^A is exogenous requires assuming $\xi \neq \frac{1}{\sigma-1} - \frac{1}{K}$, so throughout section II.6.1 of this paper I will assume that this condition holds. Further, I will continue to assume that $\xi \neq \frac{1}{\sigma-1}$ holds, which, as discussed above, is required to make sure that the type of equilibrium discussed in sections II.2 through II.4 with endogenous N_i^A is unique conditional on existence and this condition for uniqueness of that type of equilibrium with endogenous N_i^A conditional on existence will remain the same under the slight modification of the model which I will introduce in the present subsection. Hence, I will work under the assumption of both $\xi \neq \frac{1}{\sigma-1} - \frac{1}{K}$ and $\xi \neq \frac{1}{\sigma-1}$ throughout section II.6.1.

type of equilibrium studied up to this point, where $\Pi_i^A = 0$ from (II.19) and hence $\pi_i^A = 0$ is assumed to hold instead of N_i^A being exogenous, will henceforth be referred to as "long-run equilibrium". Note that there is a close connection between these two types of equilibria: Since long-run equilibrium is unique as shown above, it corresponds to the short-run equilibrium associated with one particular value of the state-variable N_i^A, namely the one which is such that $\pi_i^A = 0$. I will then say that the unique long-run equilibrium of the model is "tâtonnement-stable" if and only if profits from the ex-ante perspective, π_i^A, are strictly positive in short-run equilibrium whenever the value of N_i^A is smaller than the unique strictly positive value of N_i^A that would be consistent with $\pi_i^A = 0$ and if and only if profits from the ex-ante perspective, π_i^A, are strictly negative in short-run equilibrium whenever the value of N_i^A is greater than the unique strictly positive value of N_i^A that would be consistent with $\pi_i^A = 0$. Put differently and in more technical terms, I will solve for π_i^A as a function of the state-variable N_i^A whose value characterizes any given short-run equilibrium and looking at this function $\pi_i^A(N_i^A)$ that can be derived from this concept of short-run equilibrium, I will then say that the unique long-run equilibrium of the model is "tâtonnement-stable" if and only if $\pi_i^A(N_i^A) > 0$ for all strictly positive values of N_i^A which are smaller than the unique strictly positive value of N_i^A that would imply $\pi_i^A(N_i^A) = 0$ and if and only if $\pi_i^A(N_i^A) < 0$ for all strictly positive values of N_i^A which are greater than the unique strictly positive value of N_i^A that would imply $\pi_i^A(N_i^A) = 0$. If this stability criterion is satisfied, the economy can be expected to exhibit a natural tendency to always converge to the value of N_i^A consistent with zero profits from the ex-ante perspective (and hence to always converge to the unique long-run equilibrium) whenever it is hit by a shock such as a trade liberalization event which changes the long-run equilibrium value of N_i^A, so that this state-variable immediately after the shock deviates from its new long-run equilibrium value: This natural tendency comes from the fact that whenever N_i^A is below (above) its value which is consistent with long-run equilibrium, a firm which contemplates entry or exit would expect positive (negative) profits if the stability criterion is satisfied and thus, on an intuitive level, there would be incentives for entry (exit)[164] pushing N_i^A to the value consistent with long-run equilibrium.

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[164] There would be incentives for exit if the entry investment was reversible. Alternatively, one could follow Melitz (2003) in assuming that the presence of an exogenous "death shock", which in each period forces a fraction of firms to exit, would imply a tendency to restore the long-run equilibrium whenever profits are negative from the ex-ante perspective.

For stability analysis according to that intuitive criterion and to replicate in a static setting the spirit of the explicitly dynamic model of firm entry used by Melitz (2003), it seems reasonable to posit that in each country at a given point in time there is a mass of firms N_i^A which have incurred the first-stage entry-costs at some point in the past and which are thus ready to produce without having to incur that first-stage investment again. Thus, for the purpose of stability analysis, I will drop the first-stage entry requirement from calculations of firm-level or aggregate employment but rather treat it as reflecting "shadow costs" of entry. This means on the one hand that the firms which by assumption have completed the first stage of the entry-process at some point in the past (and of which there is an exogenous mass N_i^A) do not actually employ the f^A units of labor associated with first-stage entry-costs in what I call the "short-run equilibrium" – but they still have to use labor for covering the quasi-fixed costs of serving the two markets as captured by the parameters f^P and f^X, respectively. But on the other hand, this "shadow costs"-assumption also means that any potential entrant in such a short-run equilibrium understands that entry in country i would require f^A units of labor from that country and would thus entail nominal costs of $f^A w_i P_i$. Hence, those costs still need to be included in calculating π_i^A, i.e. the level of profits a new firm which would complete the first stage of the entry-process starting in a given short-run equilibrium would earn in expectation given what all others do. However, note that when applying a standard tâtonnement-argument such as the one I will use, one only looks at the profits a single firm *would* earn if it entered, but one does not *actually* trace out the implications of entry/exit by a single firm, which is why the resources a single entrant would use for entry in a short-run equilibrium are not relevant for aggregate accounting, either, so that first-stage entry-costs still do not affect aggregate accounting relationships. And even if one actually traced out the implications of entry by such a single firm one looks at for the purpose of a tâtonnement-argument, aggregate accounting would remain unaffected due to the atomistic size of each single firm. Consequently, in this alternative version of the model with "shadow costs" at the first stage of entry, for the purpose of calculating a short-run equilibrium for a given exogenous mass of firms N_i^A which by assumption have completed the first stage of the entry-process at some point in the past and also for the purpose of calculating the corresponding long-run equilibrium (which is defined by the value of N_i^A being such that $\pi_i^A = 0$) for which first-stage entry-costs are assumed to lie in the past, too, those first-stage labor requirements are not taken into account when calculating employment-levels and hence, they do not appear in aggregate resource constraints.[165,166] The assumption that first-stage entry-costs lie in the past even in a long-run equilibrium slightly

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[165] Appendix II.D contains further details on how to solve the model under these different assumptions on the first-

changes the long-run equilibrium of the model, but as I will show below, it retains all major properties of the equilibrium studied in sections II.3 and II.4, so that this slight modification of the basic model which introduces a notion of dynamics does not change the results on the effects of trade liberalization from PROPOSITION II.3. Furthermore, moving to this concept of "shadow costs" at the first stage of the entry-process does not only make conceptual sense as just argued, but it is actually necessary to keep the stability analysis analytically tractable. In the next subsection, however, I will show that if f^A, f^P and f^X are specified in terms of final output rather than labor, the stability analysis is tractable even if f^A does not represent "shadow costs" and I will demonstrate that stability analysis in that case yields results which are qualitatively the same as the ones I will establish in the present subsection for a version of the model where f^A, f^P and f^X are specified in terms of labor and f^A represents "shadow costs". Hence, that "shadow costs"-assumption is unlikely to affect the results of the stability analysis in qualitative terms. For simplicity, throughout my stability analysis I will continue to focus on equilibria in which aggregate variables take on the same values in both countries, so whenever N_i^A is assumed to be exogenous, it is also assumed to take on the same value in both countries.

Before turning to the stability analysis itself, let me discuss how the long-run equilibrium of the model is affected by moving to the assumption of "shadow costs" at the first stage of the entry-process: If the first-stage entry-costs are specified as "shadow costs", PROPOSITION II.1 still holds, but the level of aggregate employment in the unique long-run equilibrium (and hence in the short-run equilibrium where the value of $N_i^A > 0$ is such that $\Pi_i^A = 0$ and $\pi_i^A = 0$) is now given by the following expression instead of the one in (II.32):

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stage entry-costs.

[166] If one still took those first-stage entry-costs into account for calculating aggregate as well as firm-level employment, one would conceptually be in a world where first-stage entry-costs do not lie somewhere in the past even for incumbent firms, which from a dynamic perspective would mean that one would assume that the first-stage entry requirement f^A applies period by period and firms thus make entry-decisions and receive new draws of productivity period by period. And in such a model, any equilibrium would be stable as long as it is unique because in that case, dynamics would simply consist of a series of "one shot"-games – one per period which would look exactly like the one analyzed in section II.3 – so that the new equilibrium would undoubtedly and immediately be reached in the period following a shock and hence, it would clearly be stable in a well-defined sense. To make stability analysis more interesting, I thus opt for this alternative treatment of the first-stage entry-costs as "shadow costs".

$$\text{(II.44)} \quad L_i^E = \left[\frac{\sigma K - (\sigma-1)}{K} f^P \left((L)^{-\xi(\sigma-1)} \right) \left(\left(\frac{\sigma \psi}{(\sigma-1)\lambda_0 A} \right)^{\sigma-1} \right) \left(\left(\frac{K-(\sigma-1)}{\sigma-1} \frac{f^A}{f^P} \right)^{\frac{\sigma-1}{K}} \right) \right.$$

$$\left. \times \left(\left[1 + \left(\left(\frac{1}{\tau} \right)^K \right) \left(\left(\frac{f^P}{f^X} \right)^{\frac{K-(\sigma-1)}{\sigma-1}} \right) \right]^{-\frac{\sigma-1}{K}} \right) \right]^{\frac{1}{1-\xi(\sigma-1)}} \quad \forall i$$

And the EE-curve in that slightly modified version of the model is not given by (II.24) any longer but by:[167]

$$\text{(II.45)} \quad L_i^E = \frac{\sigma K - (\sigma-1)}{K} f^P \left(\left(\frac{\sigma}{(\sigma-1)\lambda_0 A} \right)^{\sigma-1} \right) \left(\left(\frac{K-(\sigma-1)}{\sigma-1} \frac{f^A}{f^P} \right)^{\frac{\sigma-1}{K}} \right) \left(\left[1 + \left(\left(\frac{1}{\tau} \right)^K \right) \left(\left(\frac{f^P}{f^X} \right)^{\frac{K-(\sigma-1)}{\sigma-1}} \right) \right]^{-\frac{\sigma-1}{K}} \right) \left((w_i)^{\sigma-1} \right)$$

Since this EE-curve retains all the important geometric properties from the one in (II.24) – it goes through the origin, it is strictly increasing, it exhibits a constant elasticity of real wages with respect to aggregate employment that is still equal to $\frac{1}{\sigma-1}$ and it is shifted/rotated upwards in the space with aggregate employment on the horizontal axis when trade costs decline – all of my previous results from the basic model regarding the effects of trade liberalization still go through without modification when moving to this version where the first-stage entry-costs are treated as "shadow costs", so nothing is lost or gained from that change of the model other than being able to do stability analysis analytically.[168] Most notably, welfare-gains (welfare-losses) from trade liberalization still obtain if and only if $\xi > \frac{1}{\sigma-1}$ (if and only if $\xi < \frac{1}{\sigma-1}$).

Let me now turn to the actual stability analysis. Recall that my stability criterion asserts that the unique long-run equilibrium of the model is "tâtonnement-stable" if and only if $\pi_i^A(N_i^A) > 0$ for all strictly positive values of N_i^A which are smaller than the unique strictly positive value of N_i^A that would imply $\pi_i^A(N_i^A) = 0$ and if and only if

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[167] The derivations of this EE-curve and of the equilibrium value of aggregate employment in (II.44) consist of the exact same steps as in section II.3 where the only difference is that the last summand in (II.23) is dropped reflecting the treatment of the first-stage entry-costs as "shadow costs".

[168] In the unique long-run equilibrium of this modified version of the model there are now positive profits in the aggregate given that the first-stage entry-costs are turned into "shadow costs". This breaks the equivalence between aggregate consumption expenditure and aggregate labor income, but they are still proportional to each other as the following holds in the long-run equilibrium of this modified model: $C_i = \frac{\sigma K}{\sigma K - (\sigma-1)} w_i L_i^E$. Hence, given the stable WD-curve, movements along this curve in response to trade liberalization still indicate directly in which direction welfare moves – namely still in the same direction as aggregate employment.

$\pi_i^A(N_i^A) < 0$ for all strictly positive values of N_i^A which are greater than the unique strictly positive value of N_i^A that would imply $\pi_i^A(N_i^A) = 0$. To check on stability according to that criterion, one thus first needs to express π_i^A in a short-run equilibrium as a function of the exogenous state-variable N_i^A. Once that will have been accomplished, I will establish tâtonnement-stability according to the aforementioned criterion by means of two further steps: First, I will calculate the derivative of the function $\pi_i^A(N_i^A)$ with respect to N_i^A and evaluate that derivative at the value of N_i^A that implies $\pi_i^A(N_i^A) = 0$. If this expression is negative, one can say that the unique long-run equilibrium is *locally* tâtonnement-stable in the aforementioned sense as π_i^A is positive for values of N_i^A that are marginally below the unique strictly positive one which implies $\pi_i^A = 0$ and negative for values of N_i^A that are marginally above the unique strictly positive one which implies $\pi_i^A = 0$. If tâtonnement-stability holds locally in that sense, it then follows that the unique long-run equilibrium is also "globally", i.e. also for non-marginal deviations of the value of N_i^A from the unique strictly positive one which is consistent with $\pi_i^A = 0$, tâtonnement-stable according to the aforementioned criterion if the function $\pi_i^A(N_i^A)$ can be shown to be continuous $\forall N_i^A > 0$. This is due to the fact that inasmuch as long-run equilibrium is unique, there is only a single strictly positive value of N_i^A which implies $\pi_i^A(N_i^A) = 0$ and thus, if $\pi_i^A(N_i^A)$ can be shown to be continuous $\forall N_i^A > 0$ and if the derivative of $\pi_i^A(N_i^A)$ is negative at the single strictly positive value of N_i^A which satisfies $\pi_i^A(N_i^A) = 0$, it must necessarily be the case that $\pi_i^A(N_i^A) > 0$ for all strictly positive values of N_i^A which are smaller than the unique strictly positive value of N_i^A that would imply $\pi_i^A(N_i^A) = 0$ and that $\pi_i^A(N_i^A) < 0$ for all strictly positive values of N_i^A which are greater than the unique strictly positive value of N_i^A that would imply $\pi_i^A(N_i^A) = 0$. Hence, I will first seek to establish "local tâtonnement-stability" and then show that $\pi_i^A(N_i^A)$ is in fact continuous.

(II.15), (II.16) and (II.20), which all need to hold in a short-run equilibrium, too, jointly imply the following expression for π_i^A which is valid in any symmetric short-run equilibrium (and hence also in the symmetric long-run equilibrium which just represents one particular short-run equilibrium) of this modified model:

(II.46)
$$\pi_i^A = w_i \left[\left(\left(\frac{\lambda_0}{\underline{\lambda}_i} \right)^K \right) \frac{\sigma-1}{K-(\sigma-1)} f^P \left[1 + \left(\left(\frac{1}{\tau} \right)^K \right) \left(\left(\frac{f^P}{f^X} \right)^{\frac{K-(\sigma-1)}{\sigma-1}} \right) \right] - f^A \right] \quad \forall i$$

This expression for π_i^A does not explicitly contain N_i^A, yet — one still needs to solve for w_i and $\underline{\lambda}_i$ in a short-run equilibrium as functions of the exogenous state-variable N_i^A and then substitute to arrive at the desired expression

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for the function $\pi_i^A(N_i^A)$. Note, however, that in order to make the second step of the stability analysis which consists in calculating the derivative of $\pi_i^A(N_i^A)$ with respect to N_i^A evaluated at the value of N_i^A which implies $\pi_i^A = 0$, one only has to look at the second factor in (II.46), namely at the term $\left[\left(\left(\frac{\lambda_0}{\underline{\lambda}_i}\right)^K\right)\frac{\sigma-1}{K-(\sigma-1)}f^P \times\right.$

$\left.\left[1 + \left(\left(\frac{1}{\tau}\right)^K\right)\left(\left(\frac{f^P}{f^X}\right)^{\frac{K-(\sigma-1)}{\sigma-1}}\right)\right] - f^A\right]$. This is due to the fact that because of the WD-curve, which implies that w_i is strictly positive as soon as L_i^E is strictly positive, $w_i(N_i^A) > 0$ must be true in any short-run or long-run equilibrium of the model with $L_i^E \in (0, L]$.[169] Hence, $\left[\left(\left(\frac{\lambda_0}{\underline{\lambda}_i}\right)^K\right)\frac{\sigma-1}{K-(\sigma-1)}f^P\left[1 + \left(\left(\frac{1}{\tau}\right)^K\right)\left(\left(\frac{f^P}{f^X}\right)^{\frac{K-(\sigma-1)}{\sigma-1}}\right)\right] - f^A\right] = 0$ needs to hold in the unique long-run equilibrium, i.e. for the unique strictly positive value of N_i^A that implies $\pi_i^A = 0$. And if one now uses the product rule from calculus to calculate the derivative of the expression for π_i^A in (II.46) with respect to N_i^A understanding that w_i and $\underline{\lambda}_i$ are both functions of the exogenous state-variable N_i^A and if one then evaluates the resulting expression at the unique long-run equilibrium value of N_i^A for which $\left[\left(\left(\frac{\lambda_0}{\underline{\lambda}_i(N_i^A)}\right)^K\right)\frac{\sigma-1}{K-(\sigma-1)}f^P \times\right.$

$\left.\left[1 + \left(\left(\frac{1}{\tau}\right)^K\right)\left(\left(\frac{f^P}{f^X}\right)^{\frac{K-(\sigma-1)}{\sigma-1}}\right)\right] - f^A\right] = 0$ must hold as just argued and if one then also uses that because of the WD-curve $w_i(N_i^A) > 0$ necessarily holds in any meaningful equilibrium of the model (i.e. in any equilibrium in which N_i^A is such that $L_i^E \in (0, L]$), one finds that the sign of the derivative of the function $\pi_i^A(N_i^A)$ with respect to N_i^A evaluated at the unique strictly positive value of N_i^A that implies $\pi_i^A = 0$ is given by the sign of the derivative of the term $\left[\left(\left(\frac{\lambda_0}{\underline{\lambda}_i(N_i^A)}\right)^K\right)\frac{\sigma-1}{K-(\sigma-1)}f^P\left[1 + \left(\left(\frac{1}{\tau}\right)^K\right)\left(\left(\frac{f^P}{f^X}\right)^{\frac{K-(\sigma-1)}{\sigma-1}}\right)\right] - f^A\right]$ with respect to N_i^A evaluated at the value of N_i^A that implies $\pi_i^A = 0$. And calculating the derivative with respect to N_i^A of that crucial term using that $\underline{\lambda}_i(N_i^A) > 0$ must necessarily be true in any reasonable short-run equilibrium,[170] one finds that that derivative is negative if and

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[169] In fact, using the equilibrium conditions for short-run and long-run equilibrium in this version of the model as presented in appendix II.D, one can show that $w_i = \kappa'\left((N_i^A)^{\frac{\xi}{1+K\left(\xi-\frac{1}{\sigma-1}\right)}}\right)$ is true in any short-run and long-run equilibrium of this version of the model where $\kappa' > 0$ is a constant. Hence, $w_i(N_i^A) > 0$ is in fact true for any strictly positive value of N_i^A.

[170] $\underline{\lambda}_i(N_i^A) > 0$ follows directly from (II.47) below for any strictly positive value of N_i^A.

only if the function $\underline{\lambda}_i(N_i^A)$, which expresses $\underline{\lambda}_i$ in a short-run equilibrium as a function of the exogenous state-variable N_i^A, is an increasing function, i.e. if and only if $\frac{\partial \underline{\lambda}_i(N_i^A)}{\partial N_i^A} > 0$, which would mean that short-run equilibria with a higher value of N_i^A are associated with a higher value of $\underline{\lambda}_i$. Thus, if $\frac{\partial \underline{\lambda}_i(N_i^A)}{\partial N_i^A} > 0$ can be shown to be true at the unique strictly positive value of N_i^A that implies $\pi_i^A = 0$, it immediately follows that the derivative of $\pi_i^A(N_i^A)$ with respect to N_i^A evaluated at the unique strictly positive value of N_i^A that implies $\pi_i^A = 0$ is negative, which then implies "local tâtonnement-stability" according to the aforementioned criterion. Therefore, to complete the second step of the stability analysis, one needs to express the value of $\underline{\lambda}_i$ in a short-run equilibrium as a function of the underlying exogenous state-variable N_i^A. In appendix II.D I have summarized the equilibrium conditions for this modified version of the model (both for the case of short-run equilibrium and for the case of long-run equilibrium) where first-stage entry-costs are "shadow costs". Working with those equilibrium conditions it is in fact possible to come up with an expression which establishes a unique link between $\underline{\lambda}_i$ and N_i^A in any equilibrium of this version of the model (both long-run and short-run) and which thus implicitly defines the function $\underline{\lambda}_i(N_i^A)$:

$$(\text{II.47}) \qquad\qquad (\underline{\lambda}_i)^{1+K\left(\xi - \frac{1}{\sigma-1}\right)} = \kappa \left((N_i^A)^{\xi - \frac{1}{\sigma-1}} \right)$$

where κ is a strictly positive constant.[171] Using (II.47) it is straightforward to show that $\frac{\partial \underline{\lambda}_i(N_i^A)}{\partial N_i^A} > 0$ is true (at the unique strictly positive value of N_i^A that implies $\pi_i^A = 0$) if and only if $\text{sign}\left(1 + K\left(\xi - \frac{1}{\sigma-1}\right)\right) = \text{sign}\left(\xi - \frac{1}{\sigma-1}\right)$ and given what has been said so far, it thus follows that local tâtonnement-stability of the unique long-run equilibrium obtains whenever $\text{sign}\left(1 + K\left(\xi - \frac{1}{\sigma-1}\right)\right) = \text{sign}\left(\xi - \frac{1}{\sigma-1}\right)$. Hence, local tâtonnement-stability of that equilibrium obtains whenever $\xi < \frac{1}{\sigma-1} - \frac{1}{K}$ or $\xi > \frac{1}{\sigma-1}$.[172]

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[171] $\kappa = \left(\frac{\sigma \psi}{(\sigma-1)A}\right)\left(\left(\frac{K-(\sigma-1)}{K}\right)^{\frac{1}{\sigma-1}}\right)\left(\left(\frac{\sigma K-(\sigma-1)}{K-(\sigma-1)}\right)^{\xi}\right)\left(\left(\frac{f^P}{L}\right)^{\xi}\right)\left((\lambda_0)^{K\left(\xi - \frac{1}{\sigma-1}\right)}\right)\left(\left[1 + \left(\left(\frac{1}{\tau}\right)^K\right)\left(\left(\frac{f^P}{f^X}\right)^{\frac{K-(\sigma-1)}{\sigma-1}}\right)\right]^{\xi - \frac{1}{\sigma-1}}\right)$.

[172] Recall from footnote 163 that $\xi \neq \frac{1}{\sigma-1} - \frac{1}{K}$ and $\xi \neq \frac{1}{\sigma-1}$ is assumed to make sure that both "short-run equilibrium" for a given value of N_i^A and "long-run equilibrium" are unique conditional on existence.

To show that local tâtonnement-stability implies tâtonnement-stability also in all cases in which the value of N_i^A deviates non-marginally from its unique value which is consistent with long-run equilibrium, it remains to show that the function $\pi_i^A(N_i^A)$, which is defined by the expression for π_i^A from (II.46) along with the functions $\underline{\lambda}_i(N_i^A)$ and $w_i(N_i^A)$ which apply in a short-run equilibrium, is continuous $\forall\, N_i^A > 0$. To see that this is in fact true, note that these functions $\underline{\lambda}_i(N_i^A)$ and $w_i(N_i^A)$ as (implicitly) stated in (II.47) and in footnote 169, respectively, are differentiable $\forall\, N_i^A > 0$ under the assumption $\xi \neq \frac{1}{\sigma-1} - \frac{1}{K}$ which is required for uniqueness of short-run equilibrium. But that in conjunction with the expression for π_i^A from (II.46) and the fact that $\underline{\lambda}_i(N_i^A) > 0\ \forall\, N_i^A > 0$ then implies that the function $\pi_i^A(N_i^A)$ which is defined by the expression for π_i^A from (II.46) along with these functions $\underline{\lambda}_i(N_i^A)$ and $w_i(N_i^A)$ is differentiable $\forall\, N_i^A > 0$, too, and hence, it is continuous $\forall\, N_i^A > 0$. Consequently, tâtonnement-stability of the unique long-run equilibrium has been established "globally" for the cases $\xi < \frac{1}{\sigma-1} - \frac{1}{K}$ and $\xi > \frac{1}{\sigma-1}$.

Recall that in this modified version of the model, too, $\xi \lesseqgtr \frac{1}{\sigma-1}$ determines whether trade liberalization entails welfare-gains or welfare-losses. Since $\frac{1}{\sigma-1} - \frac{1}{K} > 0$ necessarily holds as the assumption $K > (\sigma - 1)$ is required to ensure that aggregation is feasible, $\xi < \frac{1}{\sigma-1} - \frac{1}{K}$ is possible and thus, it follows that tâtonnement-stability may hold both in cases where the value of ξ is such that the EE-curve is steeper in the unique long-run equilibrium so that trade liberalization induces welfare-losses and in cases where the value of ξ is such that the WD-curve is steeper in the unique long-run equilibrium so that trade liberalization induces welfare-gains. All in all, one can have three cases: Whenever $\xi < \frac{1}{\sigma-1} - \frac{1}{K}$, the unique long-run equilibrium is tâtonnement-stable and trade liberalization leads to welfare-losses. Whenever $\frac{1}{\sigma-1} - \frac{1}{K} < \xi < \frac{1}{\sigma-1}$, the unique long-run equilibrium is not tâtonnement-stable (but trade liberalization would still lead to welfare-losses if the new unique equilibrium could still be reached somehow). And whenever $\xi > \frac{1}{\sigma-1}$, the unique long-run equilibrium is tâtonnement-stable and trade liberalization leads to welfare-gains. As a consequence, there is no result available that – based on such a stability argument – would allow the conclusion that equilibria in which trade liberalization is not beneficial are necessarily unstable. Instead, I have shown that according to a standard and intuitive tâtonnement-criterion, there are definitely non-

trivial regions of the parameter space for which one can actually expect the economy to settle down on a worse unique equilibrium induced by trade liberalization.[173]

While such tâtonnement-arguments are intuitive, they still need to be interpreted with great caution because such arguments essentially assume that firms base their entry/exit-decisions on the level of profits which could be earned (in expectation) if no other agent changed his/her decisions. However, if firms really made decisions in that way, they would not be fully rational: A firm contemplating entry/exit which is fully rational and forward-looking needs to take into account that other agents – both active and inactive firms – might contemplate entry and exit at the same time. But this is not accounted for by a standard tâtonnement-argument such as the one I have used as

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[173] Note that these stability patterns are independent from which parameter value of the model is changed. Hence, the exact same stability patterns apply not only to changes in the level of variable trade costs, τ, but also to changes in the value of the labor market parameter ψ, which might represent labor market reforms as I argue in my related closed-economy analysis in part I of this dissertation: In particular, just like in the case of standard CES-preferences and an isoelastic WD-curve studied in part I of this dissertation for the case of a closed economy, in the present open-economy model which exhibits these features, too, it is also the case that an increase in the value of ψ is required to raise aggregate employment in long-run equilibrium if and only if $\xi < \frac{1}{\sigma-1}$, while a decline in the value of ψ is required to raise aggregate employment in long-run equilibrium if and only if $\xi > \frac{1}{\sigma-1}$ and this is true regardless whether one models the first-stage entry-costs as "shadow costs" or not. These comparative statics with respect to the labor market parameter ψ follow directly from inspecting the solutions for equilibrium employment in the two versions of the model ((II.32) and (II.44)), respectively. In the terminology introduced in part I of this dissertation, an increase in ψ represents a "demand-side policy" in the labor market, while a decline in ψ is called a "supply-side policy". Using that terminology in the present context, too, one thus obtains the following pattern regarding the combination of tâtonnement-stability and labor market reform: Whenever $\xi < \frac{1}{\sigma-1} - \frac{1}{K}$, the unique long-run equilibrium is tâtonnement-stable and raising aggregate employment requires a demand-side policy, i.e. an increase in the value of ψ. Whenever $\frac{1}{\sigma-1} - \frac{1}{K} < \xi < \frac{1}{\sigma-1}$, the unique long-run equilibrium is not tâtonnement-stable (and raising aggregate employment would still require a demand-side policy, i.e. an increase in the value of ψ, if the new unique equilibrium could still be reached somehow). And whenever $\xi > \frac{1}{\sigma-1}$, the unique long-run equilibrium is tâtonnement-stable and raising aggregate employment requires a supply-side policy, i.e. a reduction in the value of ψ. Hence, there exists a region of the parameter space where the unique long-run equilibrium is tâtonnement-stable and where a supply-side policy is required for increasing aggregate employment, but there also exists a region of the parameter space where the unique long-run equilibrium is tâtonnement-stable and where a demand-side policy is required for increasing aggregate employment. Consequently, based on a stability argument it is not possible to conclude at a general level that supply-side (demand-side) policies are never appropriate for raising aggregate employment: I have just provided an example where the unique equilibrium of the model may still require a demand-side policy or a supply-side policy in the labor market to boost aggregate employment even if the parameter space is restricted such that the equilibrium is tâtonnement-stable. Finally, recall that the limiting case of $f^X \to \infty$ gets back to a closed economy, which essentially makes the model studied in the present paper equivalent to the case of standard CES-preferences and an isoelastic WD-curve from part I of this dissertation where only the entry technology (which is now modelled as a two-step process à la Hopenhayn (1992) and Melitz (2003)) is different. In the context of the analysis in part I of this dissertation, considering this limiting case in the present model thus allows for an alternative way to study dynamics with a potentially slowly moving state-variable N_i^A by means of applying the concepts of short-run and long-run equilibrium and of tâtonnement-stability. But even with this alternative approach to dynamics, neither type of policy in the labor market can be ruled out based on a standard stability criterion as the arguments in this footnote imply.

arguments of that type assume that what matters for entry/exit are profits that could be earned/avoided (in expectation) by means of entering/exiting *given* what all others do. Hence, if one wishes to rule out the case $\xi \in \left(\frac{1}{\sigma-1} - \frac{1}{K}, \frac{1}{\sigma-1}\right)$ because for that region of the parameter space the unique equilibrium is not tâtonnement-stable, one needs to keep in mind that the criterion one uses for restricting the parameter space in such a way is not completely consistent with all economic agents being fully rational. Therefore, if one examined equilibrium stability numerically in an explicitly dynamic version of this model with fully rational and forward-looking agents, it might perhaps turn out that the region $\xi \in \left(\frac{1}{\sigma-1} - \frac{1}{K}, \frac{1}{\sigma-1}\right)$ is still (at least in part) stable. Anyway, it is very reassuring that this very intuitive criterion of tâtonnement-stability still leaves two regions of the parameter space that are stable where one is such that trade liberalization has beneficial effects and one is such that it has detrimental effects. And a nice aspect about tâtonnement-stability is that it provides a natural way of thinking about the underlying adjustment dynamics – even though that might require assuming some sort of bounded rationality in entry- and exit-decisions.

The notion of "short-run equilibrium" in this version of the model with "shadow costs" of entry at the first stage can also be used to gain additional intuition for what is driving a major result of this paper, namely the threshold-rule for the strength of the pecuniary externality in the labor market which determines whether or not trade liberalization entails benefits: Using the first four equilibrium conditions for this version of the model stated in appendix II.D one can express π_i^A from (II.46), i.e. expected firm-level profits in real terms from an ex-ante perspective in a short-run equilibrium, as a function of aggregate employment – one obtains:

$$(\text{II.48}) \quad \pi_i^A = \psi\left(\left(\frac{L_i^E}{L}\right)^\xi\right)\left[((\lambda_0)^K)^{\frac{\sigma-1}{K-(\sigma-1)}}\left((f^P)^{\frac{(\sigma-1)-K}{\sigma-1}}\right)\left(\left(\frac{\sigma\psi}{(\sigma-1)A}\right)^{-K}\right)\left(\left(\frac{K}{\sigma K-(\sigma-1)}\right)^{\frac{K}{\sigma-1}}\right)\right.$$

$$\times \left((L)^{\xi K}\right)\left[1 + \left(\left(\frac{1}{\tau}\right)^K\right)\left(\left(\frac{f^P}{f^X}\right)^{\frac{K-(\sigma-1)}{\sigma-1}}\right)\right]\left((L_i^E)^{K\left(\frac{1}{\sigma-1}-\xi\right)}\right) - f^A\right] \quad \forall i$$

This expression can be used to gain more intuition with the help of a perturbation argument: (II.48) implies that trade liberalization in the form of a *marginal* decline in the value of τ or f^X leads to an increase in π_i^A given the level of aggregate employment. This means that as trade is liberalized, profits from the ex-ante perspective increase conditional on aggregate employment, so it is more attractive to enter given aggregate employment. However, zero

profits from the ex-ante perspective are required in the long-run, so aggregate employment needs to adjust to restore zero profits from the ex-ante perspective. The question is only whether an increase or a decline in aggregate employment is required to restore zero profits from the ex-ante perspective when trade liberalization pushes them above zero all else equal. Computing the derivative of the expression for π_i^A in (II.48) with respect to L_i^E and evaluating that at the unique level of L_i^E which would be consistent with $\pi_i^A = 0$ (namely the one from (II.44)) reveals that π_i^A is increasing (decreasing) in L_i^E near the unique level of L_i^E consistent with $\pi_i^A = 0$ if and only if $\xi < \frac{1}{\sigma-1}$ (if and only if $\xi > \frac{1}{\sigma-1}$). This means that if $\xi < \frac{1}{\sigma-1}$ holds, it is the case that in the vicinity of the long-run equilibrium π_i^A increases as aggregate employment increases so that in that case, trade liberalization requires a reduction in aggregate employment to restore zero profits from the ex-ante perspective,[174] whereas for $\xi > \frac{1}{\sigma-1}$ it is

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[174] Note from comparing these results with the preceding stability analysis that it may very well be the case that firm-level profits from the ex-ante perspective, π_i^A, are increasing in L_i^E and at the same time decreasing in N_i^A in the vicinity of the unique long-run equilibrium where $\pi_i^A = 0$, which is why firm-level profits from the ex-ante perspective which are locally increasing in aggregate employment may still be consistent with tâtonnement-stability: In particular, if $\xi < \frac{1}{\sigma-1} - \frac{1}{K}$, then π_i^A is decreasing in N_i^A (which implies tâtonnement-stability), but increasing in L_i^E in the vicinity of the long-run equilibrium (which implies that trade liberalization brings about a reduction in aggregate employment). The remaining two possible cases are the following ones: First, one can have $\frac{1}{\sigma-1} - \frac{1}{K} < \xi < \frac{1}{\sigma-1}$ and in that case, π_i^A is increasing in N_i^A (which implies that this case is not consistent with tâtonnement-stability) and increasing in L_i^E in the vicinity of the long-run equilibrium (which implies that trade liberalization would bring about a reduction in aggregate employment if the new unique long-run equilibrium was actually reached). Second, one can have $\xi > \frac{1}{\sigma-1}$ and in that case, π_i^A is again decreasing in N_i^A (which implies tâtonnement-stability) but also decreasing in L_i^E in the vicinity of the long-run equilibrium (which implies that trade liberalization brings about an increase in aggregate employment). In particular, using the equilibrium conditions listed in appendix II.D which apply in any short-run and long-run equilibrium of this version of the model where first-stage entry-costs are "shadow costs" one can express L_i^E as a function of the state-variable N_i^A. One obtains: $L_i^E = \kappa'' \left((N_i^A)^{\frac{1}{1+K\left(\xi - \frac{1}{\sigma-1}\right)}} \right)$ where $\kappa'' > 0$ is a constant. This expression clearly indicates that L_i^E is higher in a short-run equilibrium which is associated with a higher value of the state-variable N_i^A if $\xi > \frac{1}{\sigma-1} - \frac{1}{K}$, but that in the case $\xi < \frac{1}{\sigma-1} - \frac{1}{K}$, L_i^E is actually *lower* in a short-run equilibrium which is associated with a higher value of the state-variable N_i^A. Intuitively, the reason for which in one region of the parameter space a higher mass of firms which have completed the first stage of entry translates into lower aggregate employment is that there is also a channel according to which firm selection into production has a negative effect on aggregate employment: More productive firms need less labor to produce a given amount of output by definition and hence, if firm selection into production (whereby I mean the second stage of entry where it is determined how many and which of the N_i^A firms actually produce) is very strong, the result may be that aggregate employment is lower the more firms of any given productivity-level could in principle produce, i.e. the higher N_i^A is. This happens for $\xi < \frac{1}{\sigma-1} - \frac{1}{K}$ and this makes the model tâtonnement-stable and at the same time it implies that trade liberalization reduces aggregate employment and welfare as measured by aggregate consumption. Finally, note that regardless whether or not L_i^E is inversely related to N_i^A, which is the mass of firms which *could potentially* produce, L_i^E and N_i, which is the mass of firms which *actually* produce, are always positively related to each other in any equilibrium of the model, i.e. (short-run) equilibria with a higher mass of *actually* producing firms are always associated with higher aggregate

the case that in the vicinity of the long-run equilibrium π_i^A decreases as aggregate employment increases so that trade liberalization would in that case have to result in higher aggregate employment to restore zero profits from the ex-ante perspective. The channels through which firm-level profits from the ex-ante perspective, π_i^A, depend on aggregate employment are discussed in great detail in part I of this dissertation and are all related to the slopes of the WD-curve and of the EE-curve: Regarding the WD-curve, higher aggregate employment boosts real wages through the pecuniary externality in the labor market and this implies higher costs for firms, which clearly reduces firm-level profits all else equal. On the other hand, as aggregate employment and real wages both increase, aggregate consumption expenditure necessarily increases and that is clearly good for firm-level profits all else equal. Finally and related to the EE-curve, firm-level profits are affected by higher aggregate employment as it entails greater product variety which affects the residual demand curves firms face through changes in the price-index for a given level of aggregate demand and given prices at the micro-level. These three channels thus connect firm-level profits to aggregate employment and they go in different directions. The condition $\xi \lesseqgtr \frac{1}{\sigma-1}$, by means of indicating the relationship of the slopes of the two curves in their unique intersection, then determines whether the net effect is such that firm-level profits from the ex-ante perspective increase or decline in aggregate employment in the vicinity of the long-run equilibrium and thus, this condition determines in which direction aggregate employment needs to move to restore zero profits from the ex-ante perspective when trade liberalization pushes towards positive profits from the ex-ante perspective.

II.6.2 Entry-Costs in Terms of Final Output and Heterogeneous Wages

Suppose that the various types of entry-costs/quasi-fixed costs captured by the parameters f^A, f^P and f^X are specified not in terms of labor but in terms of final output, i.e. in units of the aggregate consumption good as defined in (II.1) as is assumed in several models in the literature.[175] Such a version of the model requires the restriction $\sigma > 2$ to keep the entry-problem well-behaved because if that restriction is not satisfied, the effective

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employment and vice versa. Technically, this follows from (II.61) in appendix II.D. And conceptually, this result is very reasonable and reassuring inasmuch as it implies a positive co-movement of the extensive margin of aggregate employment with changes in aggregate employment and this positive co-movement is driving the major elasticity-formulas for the effects of trade liberalization in the present paper as well as for the effects of different types of labor market reform in part I of this dissertation as explained in greater detail in that related work as well as in section II.4.2 of the present paper.

[175] For instance, Egger and Kreickemeier (2009) and Felbermayr, Prat and Schmerer (2011) make this assumption.

total amount of labor the economy uses for covering entry-costs and quasi-fixed costs declines rather than increases as the mass of producers increases.[176] With that change of the model, my major results from section II.4 still hold qualitatively: In the space with aggregate employment on the horizontal axis and the real wage on the vertical axis, EE-curves are still increasing and they rotate upwards in response to trade liberalization and an increase in the threshold $\underline{\lambda}_i$ implying the reallocation patterns analyzed by Melitz (2003) occurs regardless whether or not there are welfare-gains from trade liberalization and regardless of the values of the parameters ψ and ξ and – most importantly – the strength of the pecuniary externality in the labor market as captured by the value of ξ needs to be sufficiently high for there to be increases in aggregate employment and welfare-gains from trade liberalization while welfare-losses and lower aggregate employment obtain in response to trade liberalization if the value of ξ is below a certain threshold. The exact parametric condition for gains from trade liberalization is slightly different from the one in (II.33), though: Instead of $\xi > \frac{1}{\sigma-1}$ the modified version of the model now requires $\xi > \frac{1}{\sigma-2}$, i.e. the threshold for gains from trade liberalization in terms of the strength of the pecuniary externality in the labor market is higher than in the baseline version. Further, it can be shown that the patterns established in the stability analysis for the basic version of the model still go through if f^A, f^P and f^X denote quantities of final output, respectively: Whenever $\xi > \frac{1}{\sigma-2}$ holds, tâtonnement-stability in the sense of section II.6.1 holds, i.e. stability is ensured whenever there are welfare-gains from trade liberalization, but there also exists a non-trivial area of the parameter space in which the unique equilibrium of the model is worse after trade liberalization and where this unique equilibrium is tâtonnement-stable in the aforementioned sense: This is the case for sufficiently small values of ξ. The exact condition is $\xi < \frac{K-(\sigma-1)}{K(\sigma-2)+(\sigma-1)}$ where the right-hand side is necessarily strictly positive under the assumptions on parameter values the model needs. In the present case where f^A, f^P and f^X denote quantities of final output rather than labor, it also turns out that to be analytically tractable, stability analysis does not require the "shadow costs"-assumption regarding f^A that is needed to obtain analytical results regarding tâtonnement-stability in the baseline version studied in section II.6.1: If one specifies f^A, f^P and f^X in terms of final output, regardless whether f^A represents "shadow costs" or units of final output that those firms of which there is an exogenous mass N_i^A in a short-run equilibrium *actually* use for entry-purposes in such a short-run equilibrium and which thus show up in aggregate accounting, one obtains the exact same results regarding the question which regions of the

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[176] These issues are discussed in greater detail in part I of this dissertation (cf. footnote 40).

parameter space exhibit tâtonnement-stability: Under both assumptions regarding f^A one finds that tâtonnement-stability obtains for $\xi > \frac{1}{\sigma-2}$ and for $\xi < \frac{K-(\sigma-1)}{K(\sigma-2)+(\sigma-1)}$. This finding – along with the fact that the results are qualitatively similar to the case with entry-costs in terms of labor – indicates that the stability-properties of the model do not depend on the "shadow costs"-assumption made in section II.6.1.[177]

Up to this point, I have abstracted away from any heterogeneity in real wages across firms of different productivity-levels. Given the importance of wage-determination in this model one might thus wonder whether the results would change if one introduced an element of heterogeneous wages according to which more productive firms pay higher wages than less productive ones.[178] To address this issue, let me discuss a version of my model with the following wage-determination-curve which replaces the one from (II.2):

(II.49)
$$ w(\omega) = \psi\big((\lambda(\omega))^{\varphi}\big)\left(\left(\frac{L^E_{i(\omega)}}{L}\right)^{\xi}\right) \quad \forall \omega \in \Upsilon $$

For the parameter φ one needs to assume that it satisfies $0 < \varphi < 1$ to make sure that firms with a higher level of $\lambda(\omega)$ are still more profitable than those with a lower level, i.e. real wages must not increase too strongly with firm performance. Further, for this version of the model with heterogeneous wages one wants to work with the case of f^A, f^P and f^X being specified in terms of the aggregate consumption good rather than labor so that the size of entry-costs and quasi-fixed costs does not depend on firm-specific real wages in order to preserve the property of the basic Melitz-model whereby all firms face the same entry-costs and quasi-fixed costs. Under these assumptions, one can then show that the major results remain exactly the same as in the version of the model with entry-costs in terms of final output but without heterogeneity in real wages across firms: Gains from trade liberalization – both regarding welfare as measured by aggregate consumption and regarding aggregate employment – still require a

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[177] Furthermore, the stability analysis in this case is of course applicable both to changes in the level of variable trade costs, τ, and to changes in the value of the labor market parameter ψ so that similar conclusions as in footnote 173 obtain: In this version of the model, an increase in the value of ψ ("demand-side policy") is required to raise aggregate employment whenever $\xi < \frac{1}{\sigma-2}$, while a reduction in the value of ψ ("supply-side policy") is required to raise aggregate employment whenever $\xi > \frac{1}{\sigma-2}$. Hence, there exists a region of the parameter space in which the unique equilibrium is tâtonnement-stable and where a demand-side policy is required to raise aggregate employment and there also exists a region of the parameter space in which the unique equilibrium is tâtonnement-stable and where a supply-side policy is required to raise aggregate employment.

[178] For instance, Egger and Kreickemeier (2009) explicitly introduce such an element.

sufficiently strong externality in the wage-determination mechanism as they obtain if and only if $\xi > \frac{1}{\sigma-2}$ is true, while increases in average firm-level productivity as captured by (some positive power of) $A\underline{\lambda}_i$ obtain in any case in response to trade liberalization.[179] Therefore, introducing heterogeneity in real wages across firms does not affect my major results.

II.7 Concluding Remarks

This paper has made a strong case for the view that wage-flexibility in the form of a pecuniary externality in labor markets is central for shaping the effects of trade liberalization. Rather than summarizing my major results, let me conclude by means of providing a little "back of the envelope"-calculation to get a sense of how much wage-flexibility it might take for trade liberalization to have beneficial effects: If the world was accurately described by my basic model and if the estimate of σ provided by Bernard, Eaton, Jensen and Kortum (2003) who suggest a value of 3.79 based on bilateral U.S. trade data was correct, the formula from (II.33) would imply that an elasticity of real wages at the firm-level with respect to aggregate employment of $\xi \geq 0.36$ would be necessary for gains from trade liberalization, i.e. the wage-determination process by which the labor market is characterized would have to be such that a 1 percent increase in aggregate employment leads to an increase of real wages at the firm-level by at least 0.36 percent alone through this externality-channel. In the modified version of the model where entry-costs are specified in terms of final output, the threshold would instead be $\xi \geq 0.56$ in light of the estimate of σ from Bernard, Eaton, Jensen and Kortum (2003). Whether or not that externality-channel in the labor market is so strong in real world settings is an empirical question. But my theoretical analysis has hopefully highlighted that this is a central question for understanding the effects of trade liberalization.

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[179] The equilibrium value of $\underline{\lambda}_i$ in this version of the model can be shown to be decreasing in φ. This essentially means that firm selection – which is characterized by the value of $\underline{\lambda}_i$ – is weaker if φ is higher, i.e. if the elasticity of real wages with respect to the idiosyncratic component of firm-level productivity is higher. This property of the model should not be surprising since a higher value of that elasticity effectively mutes the cost-advantage of firms with a higher level of $\lambda(\omega)$.

Appendices for Part II

Appendix II.A – Further Details regarding the EE-Curve

The purpose of this appendix is to demonstrate that the EE-curve in (II.24) has the exact same structure as the EE-curves studied in the closed-economy analysis in part I of this dissertation, which then implies that the formula for the elasticity of the EE-curve stated in (II.34) of the present paper – which is based on the results in part I of this dissertation – is a valid formula for the elasticity of the EE-curve in (II.24), too, so that this formula can in fact be used to understand the positive slope of the EE-curve in the present trade-context.

In part I of this dissertation EE-curves can generally be decomposed into two parts: A non-decreasing differentiable function which links the mass of producing firms in a country (which I denote by N_i in the present paper) to the level of aggregate employment (which I denote by L_i^E in the present paper) and an equation which has the following structure (in terms of the notation of the present paper):

$$(II.50) \qquad\qquad w_i = \frac{1}{\mu(N_i)} \overline{A} \frac{1}{V(N_i)}$$

where $\mu(N_i)$ denotes the equilibrium mark-up over nominal marginal costs charged by all firms (which may be a function of N_i), where $\overline{A}$ denotes how many units of output each firm produces per unit of labor-input disregarding the units of labor a firm uses for covering quasi-fixed costs or entry-costs and where $V(N_i)$ denotes the so-called "variety-effect-term" which measures the decline in the welfare-relevant price-index resulting from an increase in N_i keeping (the distribution of) prices at the variety-level fixed.

Hence, in order to establish that the EE-curve in (II.24) has the same structure as the EE-curves studied in part I of this dissertation so that the formula for the elasticity of the EE-curve from (II.34) applies in the present paper, too, one needs to show that the EE-curve in (II.24) can also be decomposed into those two pieces where one obviously needs to take some differences from a closed-economy-setting with homogeneous firms into account such as the fact that in the present paper firms have different productivity-levels and the fact that product variety in a given

country is not the same as the mass of firms which produce in a given country.[180] To see that in spite of these differences the same decomposition of EE-curves as in part I of this dissertation applies to (II.24) in a symmetric equilibrium, note that the EE-curve in (II.24) is jointly implied by the following two equations – namely if one takes the following expression for N_i as a function of L_i^E and plugs it into the following expression for w_i as a function of N_i:[181]

$$(\text{II.51}) \qquad N_i = \frac{K-(\sigma-1)}{\sigma K f^P}\left(\left[1 + \left(\left(\frac{1}{\tau}\right)^K\right)\left(\left(\frac{f^P}{f^X}\right)^{\frac{K-(\sigma-1)}{\sigma-1}}\right)\right]^{-1}\right)L_i^E$$

$$(\text{II.52}) \qquad w_i = \frac{\sigma-1}{\sigma}A\lambda_0\left(\left(\frac{K}{K-(\sigma-1)}\right)^{\frac{1}{\sigma-1}}\right)\left(\left(\frac{\sigma-1}{K-(\sigma-1)}\frac{f^P}{f^A}\right)^{\frac{1}{K}}\right)\left(\left[1 + \left(\left(\frac{1}{\tau}\right)^K\right)\left(\left(\frac{f^P}{f^X}\right)^{\frac{K-(\sigma-1)}{\sigma-1}}\right)\right]^{\frac{1}{K}+\frac{1}{\sigma-1}}\right)\left((N_i)^{\frac{1}{\sigma-1}}\right)$$

(II.51) evidently defines a strictly increasing and differentiable function $N_i(L_i^E)$, so regarding the first component, the EE-curve in (II.24) indeed has the same structure as the EE-curves studied in part I of this dissertation. Thus, it remains to establish that the relationship between w_i and N_i in (II.52) has the same structure as equation (II.50). To show that this is in fact true, let me discuss the three components of that equation separately.

First, using the solution for equilibrium output-levels in (II.13), the solutions for equilibrium quantities sold in the two markets ((II.9) and (II.10)) and the residual demand curves in (II.3), equilibrium mark-ups over nominal marginal costs charged by all firms in this model can be shown to be $\mu(N_i) = \frac{\sigma}{\sigma-1}$, where marginal costs for imported varieties of course include transport costs.

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[180] The elasticities $|\eta_V(L_i^E)|$ and $|\eta_\mu(L_i^E)|$ which appear in (II.34) are defined as the elasticities of the terms $V(N_i)$ and $\mu(N_i)$ with respect to N_i, respectively, but using the differentiable function $N_i(L_i^E)$ which constitutes one of the two components behind the EE-curve as I will show, the values of these elasticities can be written as functions of the value of L_i^E rather than as functions of the value of N_i. Further, the elasticity $\eta_X(L_i^E)$ which appears in (II.34) is defined as the elasticity of N_i with respect to L_i^E which comes out of this differentiable function $N_i(L_i^E)$ which constitutes one of the two components behind the EE-curve. See part I of this dissertation for further details regarding the definitions of these elasticities.

[181] Note that (II.51) is identical to (II.27) from the summary of the equilibrium conditions of the model in section II.3, so both (II.51) and (II.52) represent relationships which are satisfied in a symmetric equilibrium of the model as studied in sections II.2 through II.4. Further, note that $\eta_X(L_i^E) = 1$ as claimed in the main part of the text in fact comes out of (II.51).

Second, let me come up with the term that corresponds to $\overline{A}$. Recall that $\overline{A}$ in the case of a closed economy and with homogeneous firms denotes how many units of output each firm produces per unit of labor-input disregarding the units of labor a firm uses for covering quasi-fixed costs or entry-costs. In this model where firms are heterogeneous, disregarding the various fixed labor requirements it follows that a firm with an idiosyncratic productivity-draw of $\lambda(\omega)$ produces $A(\lambda(\omega))$ units of output per unit of labor if it sells domestically and $\frac{A(\lambda(\omega))}{\tau}$ units of output per unit of labor if it sells abroad since in that case, some output is lost due to transport costs. Hence, in accordance with the definition of "average productivity" in Melitz (2003) and Melitz and Redding (2015) which I use in PROPOSITION II.5 of the present paper, for the case of an equilibrium in which aggregate variables take on the same values in both countries one can define "average productivity" of all firms which are selling in the market of a given country as follows, where the first summand accounts for producers which produce in that same country and where the second summand accounts for the productivity of exporters from the other country:

(II.53)
$$\overline{A} = \left[\frac{N_i}{N_i + N_i^X} \int_{\underline{\lambda}_i}^{\infty} \left(\left(A(\lambda(\omega)) \right)^{\sigma-1} \right) \frac{dG(\lambda(\omega))}{1 - G(\underline{\lambda}_i)} + \frac{N_i^X}{N_i + N_i^X} \int_{\underline{\lambda}_i^X}^{\infty} \left(\left(\frac{A}{\tau}(\lambda(\omega)) \right)^{\sigma-1} \right) \frac{dG(\lambda(\omega))}{1 - G(\underline{\lambda}_i^X)} \right]^{\frac{1}{\sigma-1}}$$

Making use of the functional form assumption for the CDF $G(\lambda(\omega))$ as well as of the assumption $K > (\sigma - 1)$ which is required for aggregation and using that in a symmetric equilibrium $\underline{\lambda}_i^X = \tau \left(\left(\frac{f^X}{f^P} \right)^{\frac{1}{\sigma-1}} \right) \underline{\lambda}_i$ and $N_i^X = \left(\left(\frac{1}{\tau} \right)^K \right) \left(\left(\frac{f^P}{f^X} \right)^{\frac{K}{\sigma-1}} \right) N_i$ (cf. the summary of the equilibrium conditions in section II.3) and also making use of the equilibrium value of $\underline{\lambda}_i$ as stated in (II.30) one can write that expression for $\overline{A}$ as follows:

(II.54)
$$\overline{A} = \lambda_0 A \left(\left(\frac{K}{K - (\sigma-1)} \right)^{\frac{1}{\sigma-1}} \right) \left(\left(\frac{\sigma-1}{K - (\sigma-1)} \frac{f^P}{f^A} \right)^{\frac{1}{K}} \right)$$

$$\times \left(\left[1 + \left(\left(\frac{1}{\tau} \right)^K \right) \left(\left(\frac{f^P}{f^X} \right)^{\frac{K - (\sigma-1)}{\sigma-1}} \right) \right]^{\frac{1}{K} + \frac{1}{\sigma-1}} \right) \left(\left[1 + \left(\left(\frac{1}{\tau} \right)^K \right) \left(\left(\frac{f^P}{f^X} \right)^{\frac{K}{\sigma-1}} \right) \right]^{-\frac{1}{\sigma-1}} \right)$$

Third, for any variety which is produced let $P_{i(\omega)}(\lambda(\omega))$ denote the equilibrium price of variety ω in country $i(\omega)$, i.e. in the country where the respective variety is produced. That price is typically a function of $\lambda(\omega)$. Similarly, for

any variety which is exported, let $P_{j(\omega)}(\lambda(\omega))$ denote the equilibrium price of variety ω in country $j(\omega)$, i.e. in the country to which the respective variety is exported, and again that will typically be a function of $\lambda(\omega)$. In particular, one can show that $P_{i(\omega)}(\lambda(\omega)) = \frac{\sigma}{\sigma-1} \frac{1}{A} \frac{1}{\lambda(\omega)} w_i P_i$ and $P_{j(\omega)}(\lambda(\omega)) = \frac{\sigma}{\sigma-1} \frac{\tau}{A} \frac{1}{\lambda(\omega)} w_i P_i$ hold in a symmetric equilibrium where aggregate variables take on the same values in both countries. Using this notation and defining $\rho_i = \frac{N_i}{N_i + N_i^X}$ for the case of a symmetric equilibrium as the fraction of all varieties offered in the market of a given country i which are actually produced in that country i, it follows that in a symmetric equilibrium the welfare-relevant price-index P_i from (II.4) can be written as follows:

(II.55) $\quad P_i = \left((N_i + N_i^X)^{\frac{1}{1-\sigma}} \right)$

$$\times \left(\left[\rho_i \int_{\underline{\lambda}_i}^{\infty} \left(\left(P_{i(\omega)}(\lambda(\omega)) \right)^{1-\sigma} \right) \frac{dG(\lambda(\omega))}{1-G(\underline{\lambda}_i)} + (1 - \rho_i) \int_{\underline{\lambda}_i^X}^{\infty} \left(\left(P_{j(\omega)}(\lambda(\omega)) \right)^{1-\sigma} \right) \frac{dG(\lambda(\omega))}{1-G(\underline{\lambda}_i^X)} \right]^{\frac{1}{1-\sigma}} \right)$$

Note that if one keeps the level of prices at the micro-level fixed, i.e. if the levels of $P_{i(\omega)}(\lambda(\omega))$ and $P_{j(\omega)}(\lambda(\omega))$ conditional on $\lambda(\omega)$ are kept fixed, and if one further keeps the distribution of $\lambda(\omega)$ in the product market of a given country i fixed (which means keeping the distribution $G(\lambda(\omega))$ from which entrants draw fixed and keeping the levels of the cut-offs $\underline{\lambda}_i$ and $\underline{\lambda}_i^X$ according to which firms select into the two markets fixed and keeping the fraction of domestically produced varieties, ρ_i, fixed), but if one then increases the total mass of varieties which are available to consumers in country i in a symmetric equilibrium, namely $N_i + N_i^X$, the price-index P_i as stated in (II.55) declines for a given distribution of prices at the micro-level, which is a pure product-variety-effect and according to (II.55) the term which accounts for this effect is $\left((N_i + N_i^X)^{\frac{1}{1-\sigma}} \right)$. Hence, this is the "variety-effect-term" which corresponds in the present open-economy-setting with heterogeneous firms to the variety-effect-terms defined in part I of this dissertation for cases of closed economies with homogeneous firms and using that in a

symmetric equilibrium $N_i^X = \left(\left(\frac{1}{\tau}\right)^K\right)\left(\left(\frac{f^P}{f^X}\right)^{\frac{K}{\sigma-1}}\right) N_i$ applies, the variety-effect-term in the present model can be

written as $V(N_i) = \left(\left[1 + \left(\left(\frac{1}{\tau}\right)^K\right)\left(\left(\frac{f^P}{f^X}\right)^{\frac{K}{\sigma-1}}\right)\right]^{-\frac{1}{\sigma-1}}\right)\left((N_i)^{-\frac{1}{\sigma-1}}\right).$ [182]

But using that expression for $V(N_i)$ and the expression for $\overline{A}$ from (II.54) and also using $\mu(N_i) = \frac{\sigma}{\sigma-1}$ reveals that

$\frac{1}{\mu(N_i)}\overline{A}\frac{1}{V(N_i)}$ is in fact identical to the right-hand side of (II.52), so (II.52) in fact has the exact same structure as

(II.50), which completes the proof of my claim that the EE-curve in a symmetric equilibrium of this open-economy

model with heterogeneous firms, (II.24), has the exact same structure as the EE-curves in part I of this dissertation.

Thus, an argument which is analogous to the one in the proof of PROPOSITION I.6 in part I of this dissertation

implies that the formula for the elasticity of the EE-curve stated in (II.34) of the present paper is valid.

Appendix II.B – Proofs of Some Propositions

<u>Proof of PROPOSITION II.4:</u> First note that if τ is reduced starting from a value that satisfies $f^X > \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$ to a

value that still satisfies that inequality (or satisfies it with exact equality), the EE-curve remains unchanged and is

given by the expression in (II.38). In that case, since EE-curve and WD-curve remain unchanged even though trade

costs decline, aggregate employment and hence welfare (due to $C_i = w_i L_i^E$) do not change and the economy remains

in autarky. But if in that process of reducing τ the threshold for τ which is implicitly defined by $f^X = \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$ is

passed, it follows that the EE-curve from (II.38) is relevant prior to the decline in trade costs while the EE-curve

from (II.39) is relevant after the decline in trade costs, i.e. (II.39) is valid for $f^X < \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$ and for parameter

values satisfying that inequality, it can easily be shown that the EE-curve from (II.39) exhibits a *lower* α in the

sense of (II.40) than the EE-curve from (II.38). Therefore, given what has been said about the role of α in the main

part of the paper, it follows immediately that trade liberalization events that induce a switch from the autarky

equilibrium to the trade equilibrium in the homogeneous firm model in fact increase (decrease) welfare if and only

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[182] Note that this also implies $|\eta_V(L_i^E)| = \frac{1}{\sigma-1}$ as claimed in the main part of the text.

if $\xi > \frac{1}{\sigma-1}$ (if and only if $\xi < \frac{1}{\sigma-1}$) is true.[183] Next, note that the EE-curve from (II.39) – i.e. the one which applies in a trade equilibrium – is rotated upwards in the space with aggregate employment on the horizontal axis (i.e. its α *declines*) as trade costs decline, so it again immediately follows that starting in a trade equilibrium of the homogeneous firm model, further reducing trade costs leads to an increase (decrease) in welfare if and only if $\xi > \frac{1}{\sigma-1}$ (if and only if $\xi < \frac{1}{\sigma-1}$) is true. The fact that aggregate consumption C_i and aggregate employment L_i^E always move in the same direction in response to changes in trade costs follows from $C_i = w_i L_i^E$ along with the fact that the WD-curve is non-decreasing. ∎

Proof of PROPOSITION II.5: If equations (II.41) and (II.42) are satisfied, it is straightforward to verify that the EE-curve of the homogeneous firm model for the autarky case, (II.38), and the EE-curve of the heterogeneous firm model as given in (II.24) exactly coincide if one considers the limit of $f^X \to \infty$ in (II.24) to obtain the EE-curve in autarky for the heterogeneous firm model. But as both models share the same WD-curve, the fact that the two models have the same EE-curve in autarky then implies that as soon as the parameter values are such that there exists a unique autarky equilibrium in the heterogeneous firm model as posited in PROPOSITION II.5, autarky equilibrium will exist and be unique in both models and must exhibit the same values of w_i and L_i^E which can be obtained by means of calculating the unique intersection of EE-curve and WD-curve. Further, as $C_i = w_i L_i^E$ applies in both models, C_i must then take on the same value in autarky in both models. The fact that N_i takes on the same value in the autarky equilibria of both models can be verified by using the expression for N_i from (II.27) in combination with the EE-curve of the heterogeneous firm model as given in (II.24) again considering the limit of $f^X \to \infty$ to get an expression for N_i as a function of w_i in the heterogeneous firm model under autarky. Under the calibration from (II.41) and (II.42) it is then straightforward to verify that that expression for N_i as a function of w_i in the heterogeneous firm model under autarky is equivalent to the following one for N_i as a function of w_i in the homogeneous firm model under autarky which obtains in the process of solving the homogeneous firm model:

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[183] Note that for the purpose of showing what happens if the economy switches from the autarky equilibrium to the trade equilibrium, it is sufficient to compare the αs of the two EE-curves in (II.38) and in (II.39) for the case $f^X < \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$ since welfare and aggregate employment as implied by the intersection of the EE-curve from (II.38) with the WD-curve are the same regardless of $f^X \lessgtr \frac{\delta f^P + f^A}{\delta((\tau)^{\sigma-1})}$ and do not depend on the values of the various trade costs parameters at all.

$N_i = \left(\left(\frac{\sigma}{\sigma-1} \right)^{\sigma-1} \right) ((\Lambda)^{1-\sigma})((A)^{1-\sigma})((w_i)^{\sigma-1})$. As both models have the same value of w_i in their unique autarky

equilibria, it then immediately follows that they also share the same value of N_i in autarky. The fraction of firms

which actually end up producing among those which complete the first stage of entry is δ in the homogeneous firm

model and $\left(\left(\frac{\lambda_0}{\underline{\lambda}_i^a} \right)^K \right)$ under autarky in the heterogeneous firm model where $\underline{\lambda}_i^a = \left(\left(\frac{\sigma-1}{K-(\sigma-1)} \frac{f^P}{f^A} \right)^{\frac{1}{K}} \right) \lambda_0$ is simply the

value of $\underline{\lambda}_i$ that obtains for the autarky equilibrium by means of taking the limit of $f^X \to \infty$ in (II.30). Using that

expression for $\underline{\lambda}_i^a$ and (II.41) it is then straightforward to show that $\left(\left(\frac{\lambda_0}{\underline{\lambda}_i^a} \right)^K \right) = \delta$. Since both models in autarky

thus exhibit the same value of $\frac{N_i}{N_i^A}$, i.e. the same value for the ratio of the mass of producing firms over the mass of

firms completing the first stage of the entry-process, and since N_i is the same in the unique autarky equilibria of

both models, N_i^A takes on the same value in both models, too. Finally, $\left[\int_{\underline{\lambda}_i^a}^{\infty} \left((\lambda(\omega))^{\sigma-1} \right) \frac{dG(\lambda(\omega))}{1-G(\underline{\lambda}_i^a)} \right]^{\frac{1}{\sigma-1}} =$

$\left(\left(\frac{K}{K-(\sigma-1)} \right)^{\frac{1}{\sigma-1}} \right) \underline{\lambda}_i^a = \Lambda$ obtains directly by means of using the previous expression for $\underline{\lambda}_i^a$ along with the functional

form assumption for the CDF $G(\lambda(\omega))$ for the heterogeneous firm model and the assumption $K > (\sigma-1)$ which is

required for aggregation and the expression for Λ from (II.42). ∎

Appendix II.C – Proof that the Inequality in (II.43) Holds under the Calibration from (II.41) and (II.42)

To prove that the inequality in (II.43) holds under the calibration from (II.41) and (II.42) I follow the proof of

PROPOSITION 2 in Melitz and Redding (2015) very closely throughout this appendix: Using (II.15), (II.16) and

(II.20), the ex-ante free-entry-condition which needs to be satisfied in the version of the model with heterogeneous

firms, (II.19), can be written as follows:

(II.56) $\qquad f^P \int_{\underline{\lambda}_i}^{\infty} \left[\left(\left(\frac{\lambda(\omega)}{\underline{\lambda}_i} \right)^{\sigma-1} \right) - 1 \right] dG(\lambda(\omega)) + f^X \int_{\underline{\lambda}_i^X}^{\infty} \left[\left(\left(\frac{\lambda(\omega)}{\underline{\lambda}_i^X} \right)^{\sigma-1} \right) - 1 \right] dG(\lambda(\omega)) = f^A \quad \forall i$

Further, the following relationship is true: $\underline{\lambda}_i^a \leq \underline{\lambda}_i < \underline{\lambda}_i^X$, where the first (weak) inequality follows from comparing

the expression for $\underline{\lambda}_i^a$ stated in appendix II.B with the one for $\underline{\lambda}_i$ from (II.30) and where the second inequality

follows in a symmetric equilibrium from (II.15) and (II.16) recalling that $\tau > 1$ and that $f^X > f^P$. Moreover, it is

evidently true that $\left[\left(\left(\frac{\lambda(\omega)}{\underline{\lambda}_i}\right)^{\sigma-1}\right) - 1\right] < 0$ for $\lambda(\omega) < \underline{\lambda}_i$ and that $\left[\left(\left(\frac{\lambda(\omega)}{\underline{\lambda}_i^X}\right)^{\sigma-1}\right) - 1\right] < 0$ for $\lambda(\omega) < \underline{\lambda}_i^X$. These

results along with (II.56) then imply that the following must be true:

(II.57) $\qquad f^P \int_{\underline{\lambda}_i^a}^{\infty} \left[\left(\left(\frac{\lambda(\omega)}{\underline{\lambda}_i}\right)^{\sigma-1}\right) - 1\right] dG(\lambda(\omega)) + f^X \int_{\underline{\lambda}_i^a}^{\infty} \left[\left(\left(\frac{\lambda(\omega)}{\underline{\lambda}_i^X}\right)^{\sigma-1}\right) - 1\right] dG(\lambda(\omega)) < f^A \quad \forall i$

Making use of the functional form assumption for the CDF $G(\lambda(\omega))$ for the heterogeneous firm model and also

using $K > (\sigma - 1)$, one can write that inequality as follows:

(II.58) $\qquad f^P \left[\frac{K}{K-(\sigma-1)}\left(\left(\frac{\lambda_i^a}{\underline{\lambda}_i}\right)^{\sigma-1}\right) - 1\right] + f^X \left[\frac{K}{K-(\sigma-1)}\left(\left(\frac{\lambda_i^a}{\underline{\lambda}_i^X}\right)^{\sigma-1}\right) - 1\right] < \left(\left(\frac{\lambda_i^a}{\lambda_0}\right)^K\right) f^A \quad \forall i$

Using the fact that (II.15) and (II.16) imply $\frac{\lambda_i^X}{\underline{\lambda}_i} = \tau\left(\left(\frac{f^X}{f^P}\right)^{\frac{1}{\sigma-1}}\right)$ in a symmetric equilibrium to rewrite the last

inequality one then arrives at:

(II.59) $\qquad f^P \frac{K}{K-(\sigma-1)}\left(\left(\frac{\lambda_i^a}{\underline{\lambda}_i}\right)^{\sigma-1}\right)\left[1 + \left(\left(\frac{1}{\tau}\right)^{\sigma-1}\right)\right] < \left(\left(\frac{\lambda_i^a}{\lambda_0}\right)^K\right) f^A + f^X + f^P \quad \forall i$

Using the fact that $\left(\left(\frac{\lambda_i^a}{\lambda_0}\right)^K\right) = \frac{1}{\delta}$ holds under the calibration from (II.41) and (II.42) (cf. the proof of

PROPOSITION II.5) and making use of the expression for $\underline{\lambda}_i$ from (II.30) and of the one for λ_i^a stated in appendix

II.B then reveals that the inequality in (II.59) implies the one in (II.43). ∎

Appendix II.D – Summary of the Equilibrium Conditions of the Version of the Model with First-Stage Entry-Costs as "Shadow Costs"

The following collection of equations represents a summary of the equilibrium conditions for the case of a

symmetric equilibrium (i.e. aggregate variables taking on the same values in both countries) with first-stage entry-

costs as "shadow costs". In a long-run equilibrium as defined in section II.6.1 an additional condition is that the

expression for π_i^A from (II.46) has to equal zero. In a short-run equilibrium as defined in section II.6.1, by contrast,

the value of N_i^A is specified exogenously. This representation of the equilibrium conditions of this version of the

model can be reached by means of similar steps as outlined in section II.3 for the basic version of the model. The only difference is that the last summand in the accounting condition for aggregate employment from the basic version (which is (II.23)) is dropped.

$$(\text{II.60}) \qquad C_i = \frac{\sigma K}{K-(\sigma-1)} f^P \left[1 + \left(\left(\frac{1}{\tau}\right)^K\right)\left(\left(\frac{f^P}{f^X}\right)^{\frac{K-(\sigma-1)}{\sigma-1}}\right) \right] w_i N_i$$

$$(\text{II.61}) \qquad L_i^E = \frac{\sigma K-(\sigma-1)}{K-(\sigma-1)} f^P \left[1 + \left(\left(\frac{1}{\tau}\right)^K\right)\left(\left(\frac{f^P}{f^X}\right)^{\frac{K-(\sigma-1)}{\sigma-1}}\right) \right] N_i$$

$$(\text{II.62}) \qquad \underline{\lambda}_i = \left[\left(\left(\frac{\sigma}{(\sigma-1)A}\right)^{\sigma-1}\right) \sigma f^P ((w_i)^\sigma)((C_i)^{-1}) \right]^{\frac{1}{\sigma-1}}$$

$$(\text{II.63}) \qquad w_i = \psi\left(\left(\frac{L_i^E}{L}\right)^\xi\right)$$

$$(\text{II.64}) \qquad N_i = \left(\left(\frac{\lambda_0}{\underline{\lambda}_i}\right)^K\right) N_i^A$$

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Part III:

Labor Markets, Trade and International Spill-Overs of Structural Change

Abstract for Part III

Using the very general and tractable model of frictional labor markets from part I of this dissertation I study in great generality how labor market institutions and trade structure shape the effects of unilateral or multilateral reform in labor or product markets, of local or global technological progress and of trade liberalization on aggregate employment and real wages in both countries of a model which allows for asymmetries across countries. I characterize in detail two major channels which shape international spill-overs as well as distributional effects within open economies. I find that a stronger pecuniary externality in labor markets which implies more wage-flexibility as well as a stronger integration of the world economy push towards positive international spill-overs of unilateral labor market reform. Further, I argue that a trade-related channel can induce unilateral employment-enhancing labor market reforms to entail distributional conflicts within countries by causing a divergent response of real wages and aggregate employment that would not obtain in closed economies. I show that international coordination of labor market reform is a means to avoid both negative international spill-overs as well as distributional conflicts within countries. Moreover, I show that sufficiently strong wage-flexibility is a sufficient condition for an economy to benefit from technological progress or product market deregulation that happens entirely abroad. Finally, for the case of asymmetric open economies I revisit and confirm or qualify several results from the closed-economy study of labor market reform, product market reform and technological progress in part I of this dissertation as well as from the detailed study of trade liberalization between identical economies in part II of this dissertation.

III.1 Introduction

This paper studies the role of labor market frictions and institutions for shaping the response of economies which are connected through international trade in product markets to structural changes in the economic environment which happen either at home or abroad or at a global level. I will put the major emphasis on studying the effects of both unilateral and multilateral structural changes in labor markets, but I will also study technological progress, trade liberalization and product market deregulation as additional types of structural change in the economic environment. Among the effects of structural changes of any of these types I will study are first and foremost the effects on aggregate employment, but I will also put some emphasis on the response of real wages to structural changes inasmuch as divergent movements in aggregate employment and real wages within a given country in response to structural changes in the economic environment imply that some groups gain at the expense of others, which obviously entails the potential for distributional conflicts *within* countries, which in turn might represent an obstacle to policy-induced structural changes such as labor or product market reform.

In studying the effects of institutional change in the labor market, of technological change, of changes in product market regulation and of trade liberalization on aggregate employment and real wages, I seek to answer the following three major sets of questions: First, how do labor market institutions matter for the response of an economy to structural changes in that economy itself and how does the answer to that question depend on trade structure? Second, how do structural changes in an economy affect other economies which are connected to the former one through international trade in product markets and how are these international spill-overs of unilateral structural changes shaped by labor market frictions/institutions on the one hand and by trade structure on the other hand? And third, to the extent that policy-induced structural changes in one economy – such as unilateral labor market reform or unilateral product market deregulation – might have positive impacts on that economy but negative effects on its trade partners, can international coordination of labor market reform or of product market deregulation overcome these issues and thus achieve superior outcomes?

My paper is of course not the first to ask these questions or to suggest answers to them. How is my approach related to the preceding literature and what may be the (comparative) advantages of my approach? One of the major advantages of my approach is that I make use of the formulation of frictional labor markets from part I of this

dissertation which embraces the major aspects of several different leading theories of labor markets but which does not require taking a strong stance on what exactly labor market institutions look like and which concrete frictions are present in labor markets and which are not. I will thus be able to provide answers to the aforementioned questions that are more general than those of the preceding literature in the sense that they do not rely on a particular model of the labor market: For instance, Helpman and Itskhoki (2010) as well as Felbermayr, Larch and Lechthaler (2013) have studied international spill-overs of institutional change in the labor market in a "search and matching"-model à la Mortensen and Pissarides (1994). Davis (1998a, 1998b) has looked at international spill-overs of changes in labor market institutions and of technological change in an environment where labor market frictions are given by minimum wage constraints following the seminal analysis by Brecher (1974a). More recently, Egger, Egger and Markusen (2012) have studied international spill-overs of changes in minimum wages. Agell and Lundborg (1995) and Kreickemeier and Nelson (2006) have studied the impact of "fairness norms" in wage-determination in the spirit of Akerlof and Yellen (1990) in open-economy environments, where Kreickemeier and Nelson (2006) have also looked at spill-overs of changes in labor market institutions and at technological change. Copeland (1989) has examined trade policy and effects of changes in labor market parameters in an open-economy version of the "efficiency wage"-model proposed by Shapiro and Stiglitz (1984). Saint-Paul (1997) and Alessandria and Delacroix (2008) have studied changes in firing costs in an international context and have analyzed international spill-overs of unilateral labor market reform regarding firing costs. As I will explain below and as I demonstrate in even greater detail in part I of this dissertation, my more general approach to modelling the labor market is consistent with a "search and matching"-model à la Mortensen and Pissarides (1994) and Pissarides (2000), with minimum wage constraints, with "fairness norms" à la Akerlof (1982) and Akerlof and Yellen (1990) and also with "efficiency wages" in the spirit of Shapiro and Stiglitz (1984), so it allows for more general conclusions than much of the preceding literature which is typically working with one very concrete type of labor market frictions at a time.

Another major difference between my approach and much of the aforementioned literature is that I abstract away from the Heckscher-Ohlin-forces which play a prominent role in the preceding literature on labor market frictions and international spill-overs from structural change in labor markets or in technology. In particular, I will not endogenously pin down the pattern of specialization in the global economy I will study, but I will take it as

exogenously given from the specification of preferences and technology which involves a component of product differentiation across countries à la Armington (1969). This approach has both one major advantage and one major disadvantage: The downside is that I am not able to speak to the question how differences in labor market institutions across countries can play a role for shaping global patterns of specialization by working as a source of comparative advantage. This has recently been studied, for instance, by Cuñat and Melitz (2010) and by Helpman and Itskhoki (2010). But the advantage of my approach is that I am thus able to do comparative statics with respect to trade structure in a straightforward and meaningful way: My specification of preferences and technology allows me to vary the scope of international trade and the strength of terms-of-trade-related issues by adjusting the value of a single parameter of the model that is directly connected to these elements.[184] This enables me to provide very clean insights into how the openness of an economy and the degree to which the world economy is integrated shape the effects of structural changes in labor or product market institutions or in technology. Further, in contrast to much of the preceding literature which works under the assumption of perfect competition and homogeneous products, I will analyze carefully the implications of imperfect competition, product differentiation à la Krugman (1980) and associated "product-variety-effects" (and to some extent also effects of changes in mark-ups) for international spill-overs. This channel has not received much attention in the preceding literature which has mostly focused on a terms-of-trade-channel.[185] Due to having product differentiation à la Armington (1969) on top of product differentiation à la Krugman (1980), that terms-of-trade-channel, according to which increases in

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[184] By using specifications à la Armington (1969), Alessandria and Delacroix (2008) and Felbermayr, Larch and Lechthaler (2013) also opt for a model where trade structure is essentially specified exogenously and tied to a small set of parameters. Besides the fact that they work in more detailed models of the labor market thus taking a stance on which types of labor market frictions are present and which concrete types of labor market reform are available while I try to be more general regarding labor market institutions, my analysis crucially differs from those works inasmuch as I do not work under the assumption of perfect competition but introduce imperfect competition in product markets, which gives rise to additional important channels for international spill-overs as I will discuss below. By contrast, although they step outside the Heckscher-Ohlin-model, the results in Alessandria and Delacroix (2008) and in Felbermayr, Larch and Lechthaler (2013) are still mainly driven by a terms-of-trade-channel operating through product differentiation à la Armington (1969). While that channel is present in my work, too, the presence of an additional channel related to product differentiation à la Krugman (1980) makes my analysis different from those papers in terms of conclusions, too.

[185] Helpman and Itskhoki (2010) also allow for product differentiation and imperfect competition in product markets. However, by resorting to quasi-linear preferences with a perfectly competitive outside sector, they essentially assume away any income effects in the imperfectly competitive sector, so that in contrast to my analysis, terms-of-trade-effects do not affect that sector in their setting. Egger, Egger and Markusen (2012) allow for product differentiation and imperfect competition in product markets, too, but their results are not directly comparable to mine as they abstract away from a fully endogenous determination of the mass of producers which is crucial for my results (cf. footnote 209 for a more detailed discussion of the differences between their approach and mine).

aggregate employment in a given country may benefit the trading partners of that country rather than the country itself by means of worsening the terms-of-trade of that country and thus reducing (or even overturning) any gains from higher employment in that country, will be present in my analysis, too, but it will turn out that the additional channel related to product differentiation à la Krugman (1980) plays out in a way which is different from the traditional terms-of-trade-channel and consequently, I will argue that many answers to the questions I ask in this paper crucially depend on whether the traditional terms-of-trade-channel dominates the one related to imperfect competition or not. In that context it will turn out to be extremely useful to have the aforementioned single parameter that allows varying the strength of the terms-of-trade-channel in an exogenous way.

My analysis in the present paper is also closely related to two other works of mine: In part I of this dissertation I study in a closed economy the role of labor market frictions/institutions for shaping the effects of institutional change in the labor market, of technological progress and of product market deregulation. The present paper builds on the modelling framework developed in part I of this dissertation and asks related questions, but in an international context: It will turn out that while some of the closed-economy insights from part I of this dissertation go through in an open economy in which unilateral structural change takes place, some insights need to be qualified as soon as economies are open. In particular, I will argue that the effects of unilateral structural changes in the labor market on wages may be very different and more prone to entailing the potential for conflicts within countries as soon as economies are open. But in addition to revisiting questions from part I of this dissertation in an open-economy environment with asymmetric countries, I ask several questions that are entirely specific to open economies inasmuch as I study international spill-overs of unilateral structural changes and the related question of whether international coordination of reforms in labor or product markets might be superior to unilateral reform. Second, in part II of this dissertation I study in great depth the consequences of trade liberalization using the labor market setup from part I of this dissertation that also underlies the present paper. While in part II of this dissertation I focus mostly on the effects of trade liberalization, the present paper also (and mainly) looks at labor market reform, product market deregulation and technological change in open and asymmetric economies. An important aspect of the present paper is that it allows for structural changes that happen in only one country and that it analyzes international implications of that, whereas in part II of this dissertation I restrict attention to the case of two perfectly identical countries. Moreover, while one major objective of the work in part II of this dissertation is to analyze the impact of firm-heterogeneity and of the associated selection effects induced by trade liberalization on

employment, wages and welfare, in the present paper I abstract away from *firm*-heterogeneity to focus entirely on the implications of heterogeneity across *countries*.

My major findings are as follows: First, I identify and characterize in detail two channels which matter both for international spill-overs of unilateral structural change and for the effects of structural changes on real wages *within* a country. One is the traditional terms-of-trade-channel which – as one might expect – I show to affect countries asymmetrically and which is thus central for understanding negative international spill-overs of unilateral structural changes. But in addition to that, this terms-of-trade-channel pushes towards a negative relationship between real wages and aggregate employment *within* countries, which is why it will be central for understanding distributional conflicts *within* countries, too. The second channel is the "product-variety-channel" that arises from imperfect competition and product differentiation à la Krugman (1980). I show that this channel generally affects countries symmetrically and that also within countries, it moves aggregate employment and real wages into the same direction and hence, its relative strength when compared to the traditional terms-of-trade-channel will play a key role for my results regarding whether international spill-overs are positive or negative and whether or not structural change elicits distributional issues *within* countries that would not arise in closed economies where the terms-of-trade-channel is absent (as in part I of this dissertation, for instance).

Putting the model which is driven by those two channels to work I then show that if economies are sufficiently open so that terms-of-trade-effects are sufficiently strong, the insights from the closed-economy work in part I of this dissertation regarding the effects of unilateral labor market reform on aggregate employment go through: As long as economies are sufficiently integrated, I find that it is still the case that unilateral "supply-side" changes in the institutional structure of the labor market (i.e. any type of policy-intervention in the labor market that reduces real wages conditional on aggregate employment) raise aggregate employment in the country implementing them if and only if a pecuniary externality in the labor market that induces a positive link between real wages at the firm-level and aggregate employment is sufficiently strong, while "demand-side policies" in labor markets (defined as any type of policy-intervention in the labor market that increases real wages conditional on aggregate employment) are required to raise employment in one's country otherwise. For moderately open economies, however, I find that richer patterns obtain and that even with a weak pecuniary externality in the labor market supply-side policies might be required to raise aggregate employment. In general, one can think about the strength of this pecuniary

externality as measuring the degree of wage-flexibility in an economy as a stronger externality implies that real wages at the firm-level are more sensitive to aggregate labor market conditions. Turning to international spill-overs of unilateral labor market reform I show that more wage-flexibility in that sense and greater openness of the two economies make it more likely that an employment-enhancing unilateral labor market reform entails positive spill-over effects on the level of aggregate employment in the other country. Regarding the co-movement of real wages and aggregate employment in response to unilateral labor market reform, I argue that unilateral employment-enhancing demand-side policies in the labor market always push employment and real wages in the same direction, while this is not necessarily true for unilateral employment-enhancing structural changes in the labor market that qualify as supply-side policies – in particular if wage-flexibility is relatively low or economies are relatively open. I then show that a proportional multilateral labor market reform – i.e. one which changes labor market parameters in both countries proportionally starting at possibly different levels – represents a means to overcome a divergence in the movements of real wages and aggregate employment in response to labor market reform and the distributional conflicts this might entail. I argue that the reason for which multilateral labor market reform can overcome such issues is that it avoids terms-of-trade-effects if it is done in a proportional way. Likewise, I show that such proportional multilateral labor market interventions always move aggregate employment in both countries in the same direction, so international coordination of interventions in the labor market can also avoid negative international spill-overs of unilateral reforms and thus, international coordination represents a means to avoid conflicts not only within but also across countries.

Regarding trade liberalization, I find that the same simple formula as in part II of this dissertation indicates whether or not trade liberalization raises aggregate employment and welfare, so a major insight from this related paper of mine is confirmed by the present analysis where countries are allowed to be asymmetric: Sufficiently strong pecuniary externalities in labor markets and hence a sufficiently high degree of wage-flexibility represent a necessary and sufficient condition for gains from trade liberalization. Turning to technological progress and product market deregulation I show that a sufficiently high degree of wage-flexibility in the aforementioned sense is also a sufficient condition for a country to benefit from technological progress and product market deregulation taking place in that country itself. While this confirms a major insight from the closed-economy-setting from part I of this dissertation for the case of an open economy, a novel and highly interesting aspect of the present analysis is that I show that this insight goes through for technological progress and product market deregulation that happens

entirely abroad and only affects foreign firms directly: A sufficiently strong pecuniary externality in labor markets also represents a sufficient condition for country "A" to benefit from technological progress or product market deregulation which happens entirely in country "B" but which does not affect firms from country "A" directly. Likewise, greater openness and a more prominent role for international trade can be shown to make it more likely, too, that a country benefits from changes in technology and product market institutions that happen exclusively in foreign economies and that are beneficial for those foreign economies. Relatedly, I demonstrate that global and proportional improvements in technology or multilateral and proportional product market deregulation raise aggregate employment everywhere if and only if there is sufficiently high wage-flexibility in the aforementioned sense in the global economy. As with employment-enhancing demand-side interventions in labor markets, I find that neither trade liberalization nor technological progress nor product market deregulation may result in a divergent response of real wages and aggregate employment, so unilateral employment-enhancing supply-side interventions in labor markets are found to represent the only potential source of distributional conflicts *within* an open economy.

My analysis is structured as follows: In section III.2 I describe my analytical framework. In section III.3 I solve the model. Section III.4 contains my comparative statics exercises and a careful discussion of their results as well as of the underlying channels. Section III.5 offers concluding remarks.

III.2 Description of the Basic Model

III.2.1 Preliminaries, Labor Supply and Preferences

The model is static with only a single period.[186] For simplicity, I assume that the global economy consists of only two national economies ("countries"). The two countries are assumed to be identical in all respects except for some

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[186] I ask the reader to think about dynamics in the context of the framework I use in this paper in a way that is similar to the explicitly dynamic treatment of the related model I study in part I of this dissertation: As I argue in detail in section I.2.6 in part I of this dissertation, given the empirical evidence on firm-entry/exit and given the typical incompleteness of labor contracts, it is very natural to think about dynamics in this type of models as simply consisting of a sequence of periods such as the single one I study in the present paper. As there are no effective links in decision-making across periods in such a framework, dynamic equilibrium would thus simply consist of a sequence of the static "per-period equilibria" I will characterize below. To streamline the notation and exposition, I therefore refrain from an explicitly dynamic treatment in that spirit for the purpose of the present paper and I refer the reader to part I of this dissertation for an explicitly dynamic exposition of a related model. Inasmuch as in such

possible differences in preferences, technology, entry-costs/quasi-fixed costs and labor market institutions that I

will specify explicitly. Any given country is assumed to be populated by a mass $L > 0$ of identical households. To

distinguish variables at the country-level, I will employ subscript $i \in \{H; F\}$ where H is used for the country I will

refer to as the "home country" and F for the country I will call the "foreign country". Households only value

consumption and there is no utility from leisure or disutility from labor by assumption. Hence, labor supply is

exogenous and I normalize the amount of labor time any given household has available within the single period to

unity, so that total labor supply in any country i is fixed and inelastic at L. I assume that both product markets and

labor markets are separated across countries in the following sense: Any household can buy only what is offered in

the product market of his/her respective country of residence. Further, labor is assumed to be immobile at an

international level so that any household supplies labor only in his/her country of residence. Any given firm can

produce in only one country and must hire any labor it uses from the labor market of that respective country.

However, firms can serve the product markets of both countries as they are allowed to export to the country in

which they do not produce. For simplicity, I assume that firms are owned by households residing in the country

where they produce and households receive any profits which firms they own might earn as a lump-sum

reimbursement.[187]

Firms produce differentiated varieties where product differentiation has two dimensions: Following Armington

(1969) one is country-specific, which makes the aggregate consumption good different in the two countries, and an

additional one is entirely firm-specific and hence of the type studied by Krugman (1980): Let Ω_i denote the set of

all varieties which can in principle be produced in country $i \in \{H, F\}$ where the intersection of Ω_H and Ω_F is the

empty set by assumption. Further, let $\Omega \equiv \Omega_H \cup \Omega_F$. I assume Ω_i to be unbounded $\forall i$ so that firm entry is not

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a dynamic setting in which there is no inter-temporal decision-making agents re-optimize regarding their entry/exit-decisions and regarding any labor-market-related issues such as employment and wages (as well as regarding any other types of decisions) at the beginning of each period, the economy remains on an equilibrium-path all the time, i.e. there are no out-of-equilibrium dynamics by construction as the economy effectively coordinates period by period on a Nash equilibrium of the static game of which any period consists. Thus, issues of equilibrium stability do not arise under such timing assumptions, which is why I will ignore them for the purpose of the present paper. I refer the reader to my related open-economy work in part II of this dissertation for an exploration of issues related to equilibrium stability under alternative assumptions on dynamics within a model of the type I study in the present paper.

[187] Since free entry makes sure that profits are zero in equilibrium, there will not be any profit income in any country in equilibrium, so households could not derive any income from foreign firms anyway. Furthermore, this feature of the equilibrium of the model allows ignoring the question how ownership of any given firm is distributed among the households residing in the country where the respective firm produces.

restricted exogenously. I will index varieties by ω and assume that any single variety corresponds to one firm and vice versa, which is why I will use the index ω for the corresponding firms, too. But note that this index ω does not indicate to which set Ω_i a variety belongs, i.e. where it is (or could be) produced. The following definition of the aggregator for the aggregate consumption good of country i clarifies how the two dimensions of product differentiation play out:

(III.1) $$Z_i = \left(\left(\left[\int_{\omega \in \Omega_i} \left([z_i(\omega)]^{\frac{\sigma-1}{\sigma}} \right) d\omega \right]^{\frac{\sigma}{\sigma-1}} \right)^{\alpha} \right) \left(\left(\left[\int_{\omega \in \Omega_{j(i)}} \left([z_i(\omega)]^{\frac{\sigma-1}{\sigma}} \right) d\omega \right]^{\frac{\sigma}{\sigma-1}} \right)^{1-\alpha} \right) \quad \forall i$$

Z_i denotes the quantity of the aggregate consumption good of country $i \in \{H, F\}$ a household residing in that country i obtains if that household acquires all the varieties it has access to in quantities which are denoted by $z_i(\omega)$ for any given variety ω. Utility at the household-level in any given country i is assumed to be equal to the quantity of the aggregate consumption good of that country i as defined in (III.1) a household from that country i consumes. Hence, the aggregator in (III.1) effectively defines how in any given country i physical units of varieties a household acquires translate into utility for that household. Some additional explanations regarding that aggregator are necessary: I define the operator $j(i)$ which can take on the values H and F to indicate the respective other country from the perspective of country i (e.g. $j(H) = F$). The aggregator in (III.1) consists of two standard CES-aggregators in the spirit of Dixit and Stiglitz (1977) which are embedded into a Cobb-Douglas-aggregator at an upper tier: The CES-aggregators, each of which is aggregating over all varieties which could in principle be produced in a given country i, account for product differentiation at the firm-level à la Krugman (1980), where σ denotes the elasticity of substitution. For simplicity, I assume it to be the same across countries and I make the standard assumption $\sigma > 1$ to ensure "love for variety". The presence of the upper-tier Cobb-Douglas-aggregator introduces product differentiation across countries à la Armington (1969) into the model. The parameter α is assumed to satisfy $0 < \alpha \leq 1$ and represents the fraction of income which is spent on domestically produced varieties in equilibrium. Whenever $\alpha = 1$, the two countries would not trade with each other and thus, this specification of preferences nests the case of two closed economies for $\alpha = 1$. But the lower α is, the higher is the share of expenditure on imported varieties in total spending and hence, the lower α is, the more open are the two economies and the stronger is the role for international trade and related terms-of-trade-effects which play out via the role of imported varieties in the consumption basket. Having product differentiation across countries à la

Armington (1969) as captured in this upper-tier Cobb-Douglas-aggregator which is characterized by the parameter α will thus allow me to do comparative statics with respect to the strength of terms-of-trade-effects and the openness of the two economies in a very tractable way.

For the purpose of aggregation, it will be useful to define C_i as total consumption in country i (or "aggregate consumption in country i"), which is simply given by the sum (or, technically, the integral) over the respective quantities of the aggregate consumption good of country i as defined in (III.1) consumed by all households residing in country i. Similarly, for any country $i \in \{H, F\}$ and any variety $\omega \in \Omega$, let me define $c_i(\omega)$ to denote total consumption of variety ω in country i, which is given by the sum (integral) over the respective quantities of the given variety ω consumed by all households residing in the given country i.[188] Since the aggregator in (III.1) is homothetic, the income distribution will play no role for demand and hence, it is not necessary to make explicit assumptions regarding the extent of consumption insurance between households of a given country (or even to introduce the concept of a representative household).

Throughout my analysis I will use the following additional pieces of notation: Let Υ_i denote the set of all those varieties which are actually produced in strictly positive quantities in country i and let N_i denote the associated mass of varieties. $\Upsilon = \Upsilon_H \cup \Upsilon_F$ henceforth denotes the set of all varieties which are produced in strictly positive quantities anywhere in the global economy. Further, I will use the operator $i(\omega)$ which can take on the values H and F to indicate the country where firm ω produces, i.e. $i(\omega)$ indicates to which set Ω_i variety ω belongs. Similarly, I will use the operator $j(\omega)$ which can also take on the values H and F to indicate the country that would be the potential export destination for the firm producing variety ω.

III.2.2 Production Technology, Firm Entry and Exporting

Producing $y(\omega)$ units of output of any given variety $\omega \in \Omega$ is assumed to require $\frac{y(\omega)}{A_{i(\omega)}} + f^P_{i(\omega)}$ units of labor. A_i is meant to capture the level of technology in country i where $A_i > 0 \; \forall i$. All firms producing in a given country thus exhibit the same level of this technology-shifter, but I allow for differences in the value of A_i across countries to be

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[188] Note that in equilibrium, any household will use everything he/she buys for consumption, which follows directly from the specification of the aggregator in (III.1) and from my specification of utility at the household-level.

able to study the effects of technological progress in only one country. The parameter f_i^P introduces quasi-fixed costs of production in country i (or entry-costs which would be equivalent in my static setting), where $f_i^P > 0 \; \forall i$ is assumed and where the level of those costs is the same for all firms producing in a given country but where the level of those costs could be different across countries to reflect international differences either in technology or in regulation of product markets, which will allow me to study (international) effects of unilateral product market deregulation.

Firms decide about entry at the very beginning of the single period. If a firm decides to enter in country i, it learns which unique variety ω from the set Ω_i it will be able to produce and it is then committed to incur the quasi-fixed costs (or entry-costs) $f_{i(\omega)}^P$. Firms must produce in the country where they enter and they must hire any labor they use in the labor market of that country. For simplicity, I do not allow a single firm to enter in more than one country or to produce more than a single variety.

Exporting to country $j(\omega)$ entails transport costs for firm ω which are modelled in the standard "melting iceberg"-form: Only a fraction $\frac{1}{\tau} < 1$ of the quantity of its variety firm ω ships from country $i(\omega)$ to country $j(\omega)$ is assumed to arrive there while the rest is lost along the way.

III.2.3 Timing Assumptions and Institutional Setup of Markets

Regarding timing it is assumed that firms make their entry-decisions first, then the labor-market-process takes place in each country, then production occurs and firms ship output for the purpose of selling it abroad and finally, consumers go shopping.

I will assume that all nominal variables are denominated in a common currency. Further, I assume that there is some frictionless payment system operating within the single period so that consumers can use labor income to make purchases and firms can use revenues to pay wage-bills, but I do not specify any details about this payment system. As the levels of nominal variables do not matter for my purposes, I will only solve for relative prices.

Product markets work according to the assumptions of monopolistic competition where firms set prices and households take those – as well as their respective labor incomes and any income from profits of firms they own – as given when making decisions. Given the separation of product markets across countries I allow firms to charge

different prices in different locations. Firms are assumed to make independent and profit-maximizing decisions in all respects.

For modelling labor markets I directly follow the approach from part I of this dissertation: It is assumed that nominal wages at the firm-level are as follows:

(III.2) $$W(\omega) = \psi_{i(\omega)} \left(\left(\frac{L^E_{i(\omega)}}{L} \right)^{\xi} \right) P_{i(\omega)} \quad \forall \omega \in \Upsilon$$

$W(\omega)$ denotes the nominal wage paid by firm ω to any unit of labor it employs. L^E_i is henceforth used to denote aggregate employment in country i and P_i is henceforth used to denote the consumption-based price-index in country i, i.e. the price-index associated with the aggregator from (III.1) so that P_i measures the nominal costs of acquiring one unit of the aggregate consumption good of country i. An explicit expression for P_i will be derived below; for the moment it is only important that this is the price-index which is relevant for welfare in country i and hence the index to be used for transforming nominal variables into welfare-relevant units of consumption of country i. ψ_i and ξ are parameters. While ξ is assumed to take on the same value across countries to keep the analysis analytically tractable, I allow for differences in labor market institutions across countries by allowing ψ_i to take on different values in the two countries. It is assumed that $\psi_i > 0 \; \forall i$ and that $\xi \geq 0$.

The specification of nominal wages from (III.2) makes sure that wages do not drop to zero whenever there is strictly positive unemployment in the respective country and hence, it introduces a notion of labor market frictions by which I mean any kind of element in the institutional structure of the labor market which can explain non-zero wages in the presence of unemployment thus making the labor market clearly non-Walrasian. Second, the specification in (III.2) implies that wages are increasing in aggregate employment in the respective country whenever $\xi > 0$. This introduces a pecuniary externality into the labor market of any given country as it makes wages at the firm-level endogenous to the decisions other agents make in the labor market of the respective country. As I explain in detail in part I of this dissertation, such a pecuniary externality can easily be motivated from (and can explicitly be micro-founded with the help of) a "search and matching"-model à la Mortensen and Pissarides (1994) and Pissarides (2000), an "efficiency wage"-model in the spirit of Shapiro and Stiglitz (1984) or a

"fairness"-model of unemployment à la Akerlof (1982) and Akerlof and Yellen (1990).[189] On a broader level, one can think about this pecuniary externality as follows: For a variety of reasons, the "outside options" workers and firms have are likely to affect the outcome of the wage-determination-process at the firm-level, but these "outside options" are typically determined – at least to some extent – by how quickly and at which costs a firm can find an alternative worker and by how quickly and at which costs a worker can find an alternative employer and both of that certainly depends on the aggregate state of the labor market and on the activity by other firms and workers in the market. The value of the parameter ξ plays a crucial role as it captures the strength of this pecuniary externality: The higher the value of ξ is, the more sensitive are real wages in a given country to aggregate labor market conditions (as captured by the rate of employment) in the respective country and hence, a higher value of ξ implies a stronger pecuniary externality in the labor markets of both countries. One might thus also want to speak of wages being more "flexible", the higher the value of ξ is.[190] Allowing for differences in the value of ξ across countries would complicate the analysis a lot, but because of the discussion in appendix I.C in part I of this dissertation which suggests that the major policy-parameters in a "search and matching"-model of the labor market which can be used to micro-found my approach are captured by ψ_i rather than ξ, I do not view it as a major short-coming of my analysis that I need to restrict attention to the case where wages are equally "flexible" in both countries. The parameter ψ_i will thus be the policy-parameter regarding labor market reform in country i. Since an increase in the value of ψ_i raises real wages conditional on aggregate employment in country i, I will follow the terminology in part I of this dissertation and refer to this as a "demand-side (labor market) policy" in country i, while a decline in the value of ψ_i, which reduces real wages conditional on aggregate employment in country i, will be referred to as a "supply-side (labor market) policy" in country i. Note that the specification in (III.2) pins down real wages at the firm-level since the welfare-relevant price-index of the country a firm operates in shows up multiplicatively on the right-hand side. In part I of this dissertation a relationship between *real* wages and aggregate employment which is similar to (III.2) is directly assumed, but as price-indices may be different across countries in this open-economy model, I choose this slightly different specification in terms of nominal wages for the present paper. Following the

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[189] See appendix I.C in part I of this dissertation for detailed micro-foundations.

[190] It is straightforward to see that in the limit as ξ goes to infinity, this wage-determination-procedure becomes arbitrarily close to the Walrasian model. The opposite extreme case $\xi = 0$, by contrast, is a case in which wages are exogenously fixed and do not depend on labor market conditions, which one might want to interpret as the case of "completely rigid" wages or – as I will discuss below – as a case of (binding) minimum wage constraints.

terminology in part I of this dissertation I will refer to (III.2) as the "wage-determination-curve" or simply the "WD-curve".[191]

Having specified how wages are pinned down, let me finally specify the determination of employment-levels: I assume that employment is "demand-determined" by which I mean that as long as aggregate labor demand falls short of or is exactly equal to the exogenous amount of labor supply L in a given country, all firms in that country will be able to hire as much as they desire at the wage they would need to pay (which is implied by the WD-curve in (III.2)). I rule out cases with excess demand in labor markets by assuming that the rationing rules which would apply in such cases are such that there cannot be any equilibrium with excess demand in labor markets. In part I of this dissertation I discuss that it does not take very restrictive assumptions on rationing rules to accomplish that and I also discuss how this assumption of employment being "demand-determined" is closely reflecting assumptions in standard models of the labor market. These remarks complete the description of the model I use throughout this paper.

III.3 Solving the Model

In this section I will solve the model using the concept of subgame-perfect Nash equilibrium. Hence, I will take the timing of actions within the single period as outlined above explicitly into account and I will proceed by means of first characterizing optimal decision-making given the decisions made by others where I move backwards through the single period. In a second major step, I will then derive the aggregate implications of my findings on optimal decision-making, which will then result in a characterization of the Nash equilibria of the model. Besides disregarding cases with excess demand and hence rationing in labor markets, I will also restrict attention to equilibria in which there is strictly positive employment in each country so that a strictly positive mass of varieties is produced in both countries. Further, I will restrict attention to equilibria where trade between the two countries is balanced. This assumption is meant to reflect the long-run character of my analysis. Whenever I will henceforth

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[191] In part I of this dissertation I allow for a more general functional form of the WD-curve than in (III.2) of the present paper, but there I also show that this particular functional form comes out of well-established models of frictional labor markets under standard functional form assumptions within those concrete models, which is one motivation for working with this concrete functional form in the present paper. Further, this functional form enables me to obtain analytical results in a model with heterogeneous countries. I make use of the same functional form in my related open-economy work in part II of this dissertation, but there I do not allow for differences in labor market institutions across countries.

make use of the term "any Nash equilibrium of the model" or the like, this will refer only to Nash equilibria satisfying those requirements and if there is only one such Nash equilibrium, I will refer to it as "unique".

The first step in solving the model thus consists in solving the optimization problems of households in product markets who all seek to obtain the highest possible quantities of the aggregate consumption good of their respective countries as defined in the aggregator in (III.1) given prices and given their incomes. Solving such optimization problems has become standard in the literature, so I directly jump ahead to presenting the solution omitting intermediate steps of the derivation. Further, I present the solution at an aggregated country-wide level as this will be most convenient to work with henceforth. Some additional notation is required for understanding the residual demand functions and price-indices implied by those optimization problems households solve: Let E_i denote total nominal expenditure by households in country i, which is simply the sum (or, technically, the integral) over the individual levels of expenditure of all households residing in country i. Let $P_i(\omega)$ denote the nominal price firm ω charges for its variety in country i, which is set to infinity – the relevant reservation price – if the firm is not selling in that country. And let $d_i(\omega)$ denote total demand for variety ω in country i, which is the sum (integral) over what all single households residing in country i demand of variety ω. Solving the household optimization problems and aggregating using these pieces of notation yields the following residual demand functions:

(III.3)
$$d_i(\omega) = \left((P_i(\omega))^{-\sigma}\right)\left((P_{i,i})^{\sigma-1}\right)\alpha E_i \quad \forall \omega \in \Omega_i \ \forall i$$

where

(III.4)
$$P_{i,i} \equiv \left[\int_{\omega \in Y_i}\left((P_i(\omega))^{1-\sigma}\right)d\omega\right]^{\frac{1}{1-\sigma}} \quad \forall i$$

and

(III.5)
$$d_i(\omega) = \left((P_i(\omega))^{-\sigma}\right)\left((P_{j(i),i})^{\sigma-1}\right)(1-\alpha)E_i \quad \forall \omega \in \Omega_{j(i)} \ \forall i$$

where

(III.6)
$$P_{j(i),i} \equiv \left[\int_{\omega \in Y_{j(i)}}\left((P_i(\omega))^{1-\sigma}\right)d\omega\right]^{\frac{1}{1-\sigma}} \quad \forall i$$

Note that residual demand functions at the country-level depend on whether a variety is produced in the respective country or whether it is imported: In the first case, (III.3) is the relevant residual demand function, while in the second case, (III.5) applies. Further, in that process of solving the household optimization problems one finds the following expression for the welfare-relevant price-index in country i, P_i:

$$(III.7) \qquad P_i = \chi\left((P_{i,i})^{\alpha}\right)\left((P_{j(i),i})^{1-\alpha}\right) \quad \forall i$$

where:[192]

$$(III.8) \qquad \chi \equiv \left(\left(\frac{1}{\alpha}\right)^{\alpha}\right)\left(\left(\frac{1}{1-\alpha}\right)^{1-\alpha}\right)$$

P_i denotes the nominal costs for obtaining one unit of the aggregate consumption good (as defined in (III.1)) in the cost-minimizing way in country i. The total costs for obtaining any amount $x > 0$ of the aggregate consumption good in country i can be shown to be xP_i, which is due to the homotheticity of the aggregator. Hence, P_i is the welfare-relevant price-index for *any* household residing in country i (regardless how much the respective household consumes), so that "real units" for country i are defined with respect to P_i as dividing nominal units by P_i converts into units of consumption (and hence units of utility) of country i. It is important to keep in mind that real units in the two countries which are relevant for welfare are measured in units of the aggregate consumption good of the *respective* country, respectively, and the aggregate consumption goods are not the same across countries in light of the aggregator in (III.1).

In each country where a firm sells, it chooses a combination of quantity sold and price that is located on the residual demand curve for the respective country as given from (III.3) or (III.5) since combinations below it are not revenue-maximizing while combinations above it cannot be reached. But that means that all households find themselves able to buy exactly as much of any variety as they desire given prices and given income and as households consume everything they buy for obvious reasons,

$$(III.9) \qquad d_i(\omega) = c_i(\omega) \quad \forall \omega \in \Upsilon \; \forall i$$

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[192] Note that in the closed-economy case, i.e. for $\alpha = 1$, one needs to set $\chi = 1$.

must hold in equilibrium, i.e. total demand for any given variety ω in country i equals total consumption of that variety in country i. Thus, one can also use $d_i(\omega)$ henceforth to denote the total quantity of variety ω which is sold in country i. The result from (III.9) along with the fact that all households in a given country have the same welfare-relevant price-index further implies that the following must be true in equilibrium:

(III.10) $$E_i = P_i C_i \quad \forall i$$

Total expenditure in country i thus equals the product of the price-index and total consumption in that country.

Note that it must be optimal for all firms which have completed the production stage to sell all the output they have produced (or to spend it on the transport costs associated with selling abroad) inasmuch as residual demand curves in both countries ((III.3) and (III.5)) are such that marginal revenue at the firm-level in a given country is always strictly positive. Hence, all output of any variety is sold or spent on transport costs and consumers are able to buy as much as they want to of any variety, so all product markets clear exactly in equilibrium. The fact that all output of any variety is sold or spent on the associated transport costs also means that the following must be true in equilibrium, where $y(\omega)$ will henceforth be used for the total quantity produced of variety ω:

(III.11) $$d_{i(\omega)}(\omega) + \tau\left(d_{j(\omega)}(\omega)\right) = y(\omega) \quad \forall \omega \in \Upsilon$$

To determine the optimal fractions of total output $y(\omega)$ to be sold in the two countries, firms maximize revenues as implied by the residual demand functions from (III.3) and (III.5) subject to the constraint in (III.11) and given the levels of aggregate variables. That optimization problem implies that in equilibrium all producing firms will sell in both markets – as in Krugman (1980) – and in particular, the equilibrium quantities sold in the two markets as functions of firm-level output are given by:

(III.12) $$d_{i(\omega)}(\omega) = \frac{\left(\left(P_{i(\omega),i(\omega)}\right)^{\sigma-1}\right)\alpha E_{i(\omega)}}{\left(\left(P_{i(\omega),i(\omega)}\right)^{\sigma-1}\right)\alpha E_{i(\omega)}+\left((\tau)^{1-\sigma}\right)\left(\left(P_{i(\omega),j(\omega)}\right)^{\sigma-1}\right)(1-\alpha)E_{j(\omega)}}y(\omega) \quad \forall \omega \in \Upsilon$$

(III.13) $$d_{j(\omega)}(\omega) = \frac{\left((\tau)^{-\sigma}\right)\left(\left(P_{i(\omega),j(\omega)}\right)^{\sigma-1}\right)(1-\alpha)E_{j(\omega)}}{\left(\left(P_{i(\omega),i(\omega)}\right)^{\sigma-1}\right)\alpha E_{i(\omega)}+\left((\tau)^{1-\sigma}\right)\left(\left(P_{i(\omega),j(\omega)}\right)^{\sigma-1}\right)(1-\alpha)E_{j(\omega)}}y(\omega) \quad \forall \omega \in \Upsilon$$

Using these results on the quantities firms sell in equilibrium in the two countries, respectively, and the production technology one can derive the following expression for firm-level profits in equilibrium:

$$\text{(III.14)} \quad \Pi(\omega) = \left(\left[\left(\left(P_{i(\omega),i(\omega)} \right)^{\sigma-1} \right) \alpha E_{i(\omega)} + \left((\tau)^{1-\sigma} \right) \left(\left(P_{i(\omega),j(\omega)} \right)^{\sigma-1} \right) (1-\alpha) E_{j(\omega)} \right]^{\frac{1}{\sigma}} \right) \left(\left(y(\omega) \right)^{\frac{\sigma-1}{\sigma}} \right)$$

$$- \left(W(\omega) \right) \frac{y(\omega)}{A_{i(\omega)}} - \left(W(\omega) \right) f^{P}_{i(\omega)} \quad \forall \omega \in \Upsilon$$

Due to the specification of the WD-curve in (III.2) firms take nominal wages as given, so this expression for firm-level profits contains only a single choice-variable for firms, which is the output-level $y(\omega)$. Further, the expression for $\Pi(\omega)$ from (III.14) is concave in $y(\omega)$, so firm-level output in equilibrium obtains directly from the first-order condition for maximizing the expression for $\Pi(\omega)$ from (III.14) over $y(\omega)$:[193]

$$\text{(III.15)} \quad y(\omega) = \left(\left(\frac{\sigma-1}{\sigma} \right)^{\sigma} \right) \left(\left(A_{i(\omega)} \right)^{\sigma} \right) \left(\left(w(\omega) \right)^{-\sigma} \right) \left(\left(P_{i(\omega)} \right)^{1-\sigma} \right)$$

$$\times \left[\left(\left(P_{i(\omega),i(\omega)} \right)^{\sigma-1} \right) \alpha C_{i(\omega)} + \left((\tau)^{1-\sigma} \right) \left(\left(P_{i(\omega),j(\omega)} \right)^{\sigma-1} \right) (1-\alpha) \frac{P_{j(\omega)}}{P_{i(\omega)}} C_{j(\omega)} \right] \quad \forall \omega \in \Upsilon$$

In deriving this expression I have made use of (III.10). Further, from now on I will work with real wages at the firm-level: The real wage paid by firm ω, $w(\omega)$, is defined as $w(\omega) = \frac{W(\omega)}{P_{i(\omega)}}$, i.e. with respect to the welfare-relevant price-index of the country where the firm is producing and hiring workers. Taking the solution for equilibrium firm-level output from (III.15) back to the expressions for quantity sold in equilibrium from (III.12) and (III.13), respectively, and using (III.10) yields:

$$\text{(III.16)} \quad d_{i(\omega)}(\omega) = \left(\left(\frac{\sigma-1}{\sigma} \right)^{\sigma} \right) \left(\left(A_{i(\omega)} \right)^{\sigma} \right) \left(\left(P_{i(\omega),i(\omega)} \right)^{\sigma-1} \right) \alpha C_{i(\omega)} \left(\left(w(\omega) \right)^{-\sigma} \right) \left(\left(P_{i(\omega)} \right)^{1-\sigma} \right) \quad \forall \omega \in \Upsilon$$

$$\text{(III.17)} \quad d_{j(\omega)}(\omega) = \left(\left(\frac{1}{\tau} \right)^{\sigma} \right) \left(\left(\frac{\sigma-1}{\sigma} \right)^{\sigma} \right) \left(\left(A_{i(\omega)} \right)^{\sigma} \right) \left(\left(P_{i(\omega),j(\omega)} \right)^{\sigma-1} \right)$$

$$\times (1-\alpha) C_{j(\omega)} \left(\left(w(\omega) \right)^{-\sigma} \right) \frac{P_{j(\omega)}}{P_{i(\omega)}} \left(\left(P_{i(\omega)} \right)^{1-\sigma} \right) \quad \forall \omega \in \Upsilon$$

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[193] Due to my assumption which rules out any equilibria with rationing in the labor market, firms must necessarily be able to hire enough labor to attain these output-levels in equilibrium.

By taking these expressions for quantity sold back to the residual demand functions in (III.3) and (III.5), respectively, one obtains the following expressions for equilibrium prices:

(III.18)
$$P_{i(\omega)}(\omega) = \frac{\sigma}{\sigma-1}\frac{1}{A_{i(\omega)}}W(\omega) \quad \forall \omega \in \Upsilon$$

(III.19)
$$P_{j(\omega)}(\omega) = \tau\frac{\sigma}{\sigma-1}\frac{1}{A_{i(\omega)}}W(\omega) \quad \forall \omega \in \Upsilon$$

Optimal decision-making regarding production, shipping, pricing and also regarding the labor market has been characterized by now inasmuch as the solution for equilibrium output from (III.15) along with the specification of the production technology implies how much labor each firm will employ in equilibrium. The last type of decision to study is the entry-decision firms have to make at the very beginning of the period. Using the solution for equilibrium output from (III.15) as well as (III.10) one can re-write firm-level profits in equilibrium from (III.14) as follows:

(III.20) $\Pi(\omega) = P_{i(\omega)}(w(\omega)) \left[\frac{1}{\sigma}\left(\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\right)\left(\left(A_{i(\omega)}\right)^{\sigma-1}\right)\left(\left(P_{i(\omega)}\right)^{1-\sigma}\right)\left(\left(w(\omega)\right)^{-\sigma}\right)$

$$\times \left[\left(\left(P_{i(\omega),i(\omega)}\right)^{\sigma-1}\right)\alpha C_{i(\omega)} + \left((\tau)^{1-\sigma}\right)\left(\left(P_{i(\omega),j(\omega)}\right)^{\sigma-1}\right)(1-\alpha)\frac{P_{j(\omega)}}{P_{i(\omega)}}C_{j(\omega)}\right] - f_{i(\omega)}^{P}\right] \quad \forall \omega \in \Upsilon$$

Optimal decision-making regarding entry simply requires that profits as given in (III.20) are zero. This is due to the fact that the symmetry of firms within countries implies that all producing firms within a country when making optimal decisions will earn the same profits and if those were strictly positive or negative, a given firm would – given what all others do – have a profitable deviation which would consist either in entering rather than remaining inactive or in not producing rather than doing so. Hence, zero profits in both countries are required in equilibrium as a result of optimal decision-making.

Let me now turn to aggregation and derive the aggregate implications of optimal decision-making as characterized up to this point. For this purpose, it is useful to note that all firms producing in a given country pay the same nominal wage which I will denote by W_i for country i henceforth. Analogously, one can define an economy-wide real wage for any country i as $w_i = \frac{W_i}{P_i}$ where this wage is measured in the welfare-relevant units of consumption of country i. One can now take the solutions for equilibrium prices from (III.18) and (III.19) to (III.4) and (III.6),

respectively, and in doing so, one makes use of the fact that within any given country all producing firms make identical decisions and pay the same wages as well as of the fact that all firms export. This then results in the following equilibrium expressions for $P_{i,i}$ and $P_{i,j(i)}$, respectively:

(III.21)
$$P_{i,i} = \frac{\sigma}{\sigma-1} \frac{W_i}{A_i} \left((N_i)^{\frac{1}{1-\sigma}} \right) \quad \forall i$$

(III.22)
$$P_{i,j(i)} = \tau \frac{\sigma}{\sigma-1} \frac{W_i}{A_i} \left((N_i)^{\frac{1}{1-\sigma}} \right) \quad \forall i$$

Recall that I assume balanced trade in equilibrium. Balanced trade requires that total expenditure on imports is the same for both countries if denominated in a common currency. It is straightforward to show that the aggregator in (III.1) implies that in equilibrium each household spends a fraction $1 - \alpha$ of his/her income on imports and thus, this must be true at the country-level, too, which means that balanced trade requires $(1 - \alpha)E_i = (1 - \alpha)E_{j(i)}$. And using (III.10) the balanced-trade-condition becomes:

(III.23)
$$P_i C_i = P_{j(i)} C_{j(i)}$$

Thus, balanced trade essentially implies that nominal spending and hence nominal income is the same across countries in the aggregate, but this will generally not be true for welfare-relevant real variables as will become clear below. Using the expressions for $P_{i,i}$ and $P_{i,j(i)}$ from (III.21) and (III.22) as well as the balanced-trade-condition from (III.23) in the expression for equilibrium firm-level profits from (III.20), the condition for firm-level profits to be zero in both countries in equilibrium can be written as follows:

(III.24)
$$C_i = \sigma f_i^P w_i N_i \quad \forall i$$

Recall that the production technology implies that producing $y(\omega)$ units of output requires $\frac{y(\omega)}{A_{i(\omega)}} + f_{i(\omega)}^P$ units of labor. Using this, one can calculate equilibrium firm-level employment based on the solution for equilibrium firm-level output from (III.15) along with the expressions for $P_{i,i}$ and $P_{i,j(i)}$ from (III.21) and (III.22) as well as the balanced-trade-condition from (III.23). Multiplying equilibrium firm-level employment in country i by N_i then yields the following expression for aggregate employment in country i:

(III.25)
$$L_i^E = \frac{\sigma-1}{\sigma} \frac{C_i}{w_i} + f_i^P N_i \quad \forall i$$

The final aggregation step consists in aggregating up the quantities bought of any given variety in a given country: Rewriting the expressions for quantities sold/bought in equilibrium from (III.16) and (III.17) with the help of the expressions for $P_{i,i}$ and $P_{i,j(i)}$ from (III.21) and (III.22) and then taking them to the aggregator in (III.1) and making use of the fact that all firms producing in a given country make identical decisions yields:[194]

$$(\text{III.26}) \qquad \chi \frac{\sigma}{\sigma-1} ((\tau)^{1-\alpha}) \left(\left(\frac{w_i}{A_i} \right)^{\alpha} \right) \left(\left(\frac{w_{j(i)}}{A_{j(i)}} \right)^{1-\alpha} \right) \left(\left(\frac{P_{j(i)}}{P_i} \right)^{1-\alpha} \right) = \left((N_i)^{\frac{\alpha}{\sigma-1}} \right) \left((N_{j(i)})^{\frac{1-\alpha}{\sigma-1}} \right) \quad \forall i$$

Finally, as all firms within any given country face the same WD-curve, one can replace the WD-curves at the firm-level from (III.2) with two "economy-wide WD-curves in real terms" which pin down economy-wide real wages w_i in the two countries, respectively:

$$(\text{III.27}) \qquad\qquad\qquad w_i = \psi_i \left(\left(\frac{L_i^E}{L} \right)^{\xi} \right) \quad \forall i$$

At this stage, aggregation is complete and the model can be fully solved for its Nash equilibria by means of combining the various equilibrium conditions with each other. Those equilibrium conditions consist of the WD-curves from (III.27), the balanced-trade-condition from (III.23), the zero-profit-conditions from (III.24), the expressions for aggregate employment from (III.25), and the expressions in (III.26) which resulted from aggregation of quantities sold at the firm-level. These are nine equations in the nine endogenous variables w_H, w_F, L_H^E, L_F^E, C_H, C_F, N_H, N_F, $\frac{P_H}{P_F}$. Working only with the last seven conditions and leaving the two WD-curves untouched, one arrives at the following representation of these nine equilibrium conditions of the model:

$$(\text{III.28}) \qquad w_i = \frac{\sigma-1}{\sigma\chi} \left(\left(\frac{1}{\sigma} \right)^{\frac{1}{\sigma-1}} \right) \left(\left(\frac{1}{\tau} \right)^{1-\alpha} \right) ((A_i)^{\alpha}) \left((A_{j(i)})^{1-\alpha} \right) \left((f_i^P)^{-\frac{\alpha}{\sigma-1}} \right) \left((f_{j(i)}^P)^{-\frac{1-\alpha}{\sigma-1}} \right)$$

$$\times \left((L_i^E)^{\alpha\left(\frac{\sigma}{\sigma-1}\right)-1} \right) \left((L_{j(i)}^E)^{(1-\alpha)\left(\frac{\sigma}{\sigma-1}\right)} \right) \quad \forall i$$

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[194] Note that due to its homotheticity, the aggregator in (III.1) essentially also applies at a country-wide level so that one can directly aggregate up total quantities sold in a given country for the purpose of calculating total/aggregate consumption in a country. This is equivalent to first calculating how much a single household in a given country buys of a given variety, then calculating the quantity consumed of the aggregate consumption good at the household-level and then adding those quantities over all households within a given country. This equivalence can also be seen from the fact that (III.26) can be derived in an alternative way: It can also be derived by means of taking the expressions for $P_{i,i}$ and $P_{i,j(i)}$ from (III.21) and (III.22) to the expression for P_i in (III.7). This again reflects the homotheticity of the aggregator in (III.1) and its relationship to the corresponding price-index in (III.7).

(III.29) $$w_i = \psi_i\left(\left(\frac{L_i^E}{L}\right)^\xi\right) \quad \forall i$$

(III.30) $$C_i = w_i L_i^E \quad \forall i$$

(III.31) $$N_i = \frac{L_i^E}{\sigma f_i^P} \quad \forall i$$

(III.32) $$\frac{P_i}{P_{j(i)}} = \frac{w_{j(i)} L_{j(i)}^E}{w_i L_i^E}$$

This representation is very useful inasmuch as it consists of two blocks: (III.28) and (III.29) contain four equations which allow solving for the four endogenous variables w_H, w_F, L_H^E and L_F^E and once this has been accomplished, solutions for the other five endogenous variables can easily be obtained from (III.30), (III.31) and (III.32). Thus, it is sufficient to focus on (III.28) and (III.29) for the purpose of solving for Nash equilibria. Note that (III.29) just contains the two economy-wide WD-curves of the model. The equations in (III.28), by contrast, are based on the balanced-trade-condition, the zero-profit-conditions and the expressions resulting from aggregation of quantities sold (or optimal prices) at the firm-level on the one hand and of firm-level employment on the other hand. The WD-curves, however, have not been used in the derivation of the equations in (III.28), but all other optimality conditions, equilibrium relationships and accounting identities of the model have been used for that. Hence, the equations in (III.28) summarize the combinations of values for w_H, w_F, L_H^E and L_F^E which are consistent with equilibrium in all respects disregarding only the wage-determination-curves of the model. Thus, following the terminology I have used for similar curves in parts I and II of this dissertation I will refer to the equations in (III.28) as the "EE-curves" of the model where there is one EE-curve per country. As in my related closed-economy work in part I of this dissertation, those curves relate real wages to aggregate employment in the respective country, but now aggregate employment in the respective other country shows up, too, which reflects the interdependence of the two economies in the present setting.[195] Note that the derivation of these EE-curves is based on the fact that firms are able to hire as much labor as they would like to at the real wage they pay, so these EE-curves only apply to levels of aggregate employment satisfying both $L_H^E \le L$ and $L_F^E \le L$ because only as long as those inequalities hold,

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[195] In my related open-economy work in part II of this dissertation I restrict attention to identical countries and hence perfectly symmetric equilibria, which is why this interdependence does not show up explicitly and EE-curves in that work look more like those in the case of a closed economy studied in part I of this dissertation.

one can be sure that all firms are in fact able to hire exactly as much as they would like to given the real wage they pay. And inasmuch as it is assumed that rationing rules in labor markets with excess demand are such that there is no Nash equilibrium with rationing and since I restrict attention to cases in which there is strictly positive aggregate employment in both countries, any Nash equilibrium must be such that the equations in (III.28) (which define the EE-curves) are satisfied and such that the restrictions $0 < L_H^E \leq L$ and $0 < L_F^E \leq L$ hold. In addition, the equations in (III.29) (which represent the WD-curves) must hold in any Nash equilibrium of the model. These arguments immediately imply the following formal result:

PROPOSITION III.1 (*Existence and Uniqueness of Nash Equilibrium*): If and only if a set of values for w_H, w_F, L_H^E and L_F^E satisfies the equations in (III.28) and the equations in (III.29) and is such that $0 < L_H^E \leq L$ and that $0 < L_F^E \leq L$, it represents a Nash equilibrium of the model. If parameter values are such that $\xi \neq \frac{1}{\sigma-1}$ and that $\xi \neq \frac{1-\sigma(1-\alpha)}{\sigma-1}$ and that $\xi \neq \frac{1-2\sigma(1-\alpha)}{\sigma-1}$, Nash equilibrium is unique conditional on existence and exhibits the following levels of aggregate employment in the two countries:

$$(\text{III.33}) \quad (L_i^E)^{\left[\frac{\left(\xi+1-\alpha\left(\frac{\sigma}{\sigma-1}\right)\right)^2 - \left(\left((1-\alpha)\frac{\sigma}{\sigma-1}\right)^2\right)}{\xi+1-\alpha\left(\frac{\sigma}{\sigma-1}\right)}\right]} = \left(\left[\frac{\sigma-1}{\sigma\chi}\left(\left(\frac{1}{\sigma}\right)^{\frac{1}{\sigma-1}}\right)\left((L)^\xi\right)\right]^{\left[1+\frac{(1-\alpha)\frac{\sigma}{\sigma-1}}{\xi+1-\alpha\frac{\sigma}{\sigma-1}}\right]}\right)$$

$$\times \left(\left(\frac{1}{\tau}\right)^{\left[(1-\alpha)\left(1+\frac{(1-\alpha)\frac{\sigma}{\sigma-1}}{\xi+1-\alpha\frac{\sigma}{\sigma-1}}\right)\right]}\right)\left(\frac{1}{\psi_i}\right)\left(\left(\frac{1}{\psi_{j(i)}}\right)^{\left[\frac{(1-\alpha)\frac{\sigma}{\sigma-1}}{\xi+1-\alpha\frac{\sigma}{\sigma-1}}\right]}\right)(A_i)^{\left[\left(\alpha+\frac{((1-\alpha)^2)\frac{\sigma}{\sigma-1}}{\xi+1-\alpha\frac{\sigma}{\sigma-1}}\right)\right]}$$

$$\times \left((A_{j(i)})^{\left[\left((1-\alpha)+\frac{\alpha(1-\alpha)\frac{\sigma}{\sigma-1}}{\xi+1-\alpha\frac{\sigma}{\sigma-1}}\right)\right]}\right)(f_i^P)^{\left[-\frac{1}{\sigma-1}\left(\alpha+\frac{((1-\alpha)^2)\frac{\sigma}{\sigma-1}}{\xi+1-\alpha\frac{\sigma}{\sigma-1}}\right)\right]}(f_{j(i)}^P)^{\left[-\frac{1}{\sigma-1}\left((1-\alpha)+\frac{\alpha(1-\alpha)\frac{\sigma}{\sigma-1}}{\xi+1-\alpha\frac{\sigma}{\sigma-1}}\right)\right]} \quad \forall i$$

Proof: This follows directly from the preceding arguments; the equilibrium levels of aggregate employment as stated in (III.33) result from straightforward algebra using the EE-curves in (III.28) and the WD-curves in (III.29).∎

In what follows, I will assume that the conditions on parameter values for existence and uniqueness of Nash equilibrium as established in PROPOSITION III.1 are satisfied.

III.4 Results and Discussion

III.4.1 EE-Curves and Terms-of-Trade-Effects

Before applying the model to the major questions motivating this paper it is very useful to start with a closer examination of the EE-curves of the model as presented in (III.28). Those curves relate the real wage in a given country, w_i, to the levels of aggregate employment in both countries, L_i^E and $L_{j(i)}^E$. Hence, they closely resemble the EE-curve derived and analyzed in depth in a closed-economy context in part I of this dissertation: In that closed-economy work, the EE-curve relates the economy-wide real wage to aggregate employment in the economy, so one major new element of the present open-economy work consists in the fact that aggregate employment abroad shows up in the EE-curves, too.[196] But there is an additional important difference: In part I of this dissertation I make a very strong argument that EE-curves in closed economies are generally increasing (or at least non-decreasing), i.e. they imply a positive relationship between the real wage and aggregate employment so that higher levels of one variable are associated with higher levels of the other one. By contrast, treating the level of employment abroad, $L_{j(i)}^E$, as exogenously fixed the EE-curves in (III.28) may be either increasing or decreasing: Whenever

(III.34)
$$\alpha > \frac{\sigma - 1}{\sigma}$$

the EE-curve is increasing in the sense of implying a higher value for w_i as the value of L_i^E is raised and everything else is kept constant and it is decreasing in the sense of implying a lower value for w_i as the value of L_i^E is raised all else equal whenever the strict inequality from (III.34) is reversed. Before discussing where this difference from the closed-economy case comes from, it is very important to emphasize that whenever in this paper I will speak of the "slope of the EE-curve" or write that an EE-curve is "decreasing" or "increasing" in the present open-economy-setting, I mean the relationship between the values of w_i and L_i^E which is implied by (III.28) for a *given* value of $L_{j(i)}^E$. Further, I will speak of the "EE-curve of a given country" by which I mean the EE-curve from (III.28) which applies to the real wage in that respective country.

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[196] In my related open-economy work in part II of this dissertation aggregate employment abroad also affects EE-curves, but there this does not show up explicitly in my formulation of the EE-curves due to the fact that I focus on a world-economy with completely identical countries and impose symmetry across countries in equilibrium.

To see where this potential difference in the slope of the EE-curve of a given country between the closed-economy and the open-economy case comes from, first recall that α is the share of total expenditure that is spent on domestically produced varieties and thus, the value of α is inversely related to the openness of an economy and hence also inversely related to the importance of terms-of-trade-related considerations as a higher value of α implies that imports play a smaller role in the consumption basket and obviously, changes in the terms-of-trade affect purchasing power via the prices of imports. Hence, in economies which are sufficiently closed in the sense of exhibiting a sufficiently high value of α (in the sense of the inequality in (III.34)) and for which the terms-of-trade thus play a relatively small role, EE-curves are still unambiguously increasing as in the closed-economy case studied in part I of this dissertation. And the economic forces which push EE-curves towards being increasing in this open-economy-setting are also precisely the ones analyzed in detail in part I of this dissertation. To see this, note that for $\alpha = 1$ the present model is equivalent to the case of standard CES-preferences and an isoelastic WD-curve discussed in part I of this dissertation and in fact, if one sets $\alpha = 1$, the EE-curves in (III.28) become exactly identical to the one derived in part I of this dissertation for the case of standard CES-preferences.[197] Thus, abstracting away from international trade the forces which shape the slope of the EE-curve must be the ones discussed in part I of this dissertation and any deviation from those closed-economy patterns which occurs as soon as economies are open so that $\alpha < 1$ must be attributed to trade-related channels. But those trade-related channels necessarily make the EE-curve flatter in the space with the real wage on the vertical axis and aggregate employment in the same country on the horizontal axis: In the case of $\alpha = 1$, the elasticity of the real wage w_i with respect to aggregate employment L_i^E as implied by the EE-curve in (III.28) is $\frac{1}{\sigma-1}$. If $\alpha < 1$, however, the elasticity of w_i with respect to L_i^E as implied by the EE-curve in (III.28) keeping the level of aggregate employment in country $j(i)$, $L_{j(i)}^E$, fixed is $\alpha \frac{\sigma}{\sigma-1} - 1$ which is necessarily smaller than $\frac{1}{\sigma-1}$ for $\alpha < 1$. Hence, it follows that the EE-curve of any given country necessarily has a smaller elasticity (i.e. starting at a given point real wages increase by less for a given change in the level of aggregate employment in the same country and in particular, real wages may even decline) the more open the two economies are (i.e. the lower α is) and thus, the trade-related channels (at least

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[197] Cf. the expression for the EE-curve in footnote 25 in part I of this dissertation.

on net) must push towards a negative slope of the EE-curve so that a positive slope of the EE-curve can only be explained through the (closed-economy) channels from part I of this dissertation.[198]

To summarize, there are two types of forces behind the slopes of the EE-curves in this setting: First, there are forces which are independent from international trade and those must necessarily be the ones from part I of this dissertation and in addition, there are forces which are related to international trade. Let me now discuss both types of forces in greater detail and let me begin with the non-trade-related forces which push towards increasing EE-curves. As analyzed in part I of this dissertation, those forces are driven by the extensive margin of production: An increase in aggregate employment necessarily entails an increase in the mass of producing firms, which can be seen most clearly in the context of the present model by means of inspecting (III.31) which implies a unit-elasticity of the mass of producers with respect to changes in aggregate employment in the respective country. But inasmuch as the preference specification from (III.1) exhibits "love for variety" in the two CES-parts appearing in it, an increase in product variety through an increase in the mass of producers in a given country – all else equal – necessarily implies a decline in the consumption-based price-indices in both countries through a "product-variety-effect" even if nothing happens in terms of nominal wages and nominal prices at the variety-level in the global economy.[199] And inasmuch as the consumption-based price-index declines for given nominal wages in both countries as aggregate employment increases in one country, real wages in both countries increase all else equal. This explains the force which pushes towards a positive slope of the EE-curve in the aforementioned sense and moreover, this also explains one of the forces which account for the fact that increases in aggregate employment abroad, $L_{j(i)}^{E}$, necessarily and unambiguously imply a higher value of w_i from the EE-curve in (III.28) in a *ceteris paribus* sense. Hence, the product-variety-effects which I identify in part I of this dissertation as a major driving-force of the

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[198] A different way of making the point that trade-related channels push towards a negative slope of the EE-curve of any given country consists in noting that in the closed-economy case of $\alpha = 1$, the EE-curve becomes horizontal in the space with aggregate employment on the horizontal axis and the real wage on the vertical axis in the limit as $\sigma \to \infty$, which reflects the fact that the forces pushing towards positively sloped EE-curves are related to product differentiation and imperfect competition, while that limiting case corresponds to homogeneous products. But considering that limiting case in the present open-economy-setting with $\alpha < 1$ necessarily results in a negative slope of the EE-curve as the elasticity of real wages with respect to aggregate employment in the same country implied by the EE-curve becomes $\alpha - 1 < 0$ in this limiting case.

[199] The decline in the consumption-based price-indices of both countries for given nominal wages (and hence prices at the variety-level) through the product-variety-effect associated with an increase in the mass of producers in one country can also be seen directly from the expression for the price-index in (III.7) if one combines it with the expressions for $P_{i,i}$ and $P_{i,j(i)}$ from (III.21) and (III.22).

positive slope of EE-curves operate in this open-economy context, too, and they push towards a positive slope of these curves, too. Further, a new aspect is that these product-variety-effects also work across borders through the appearance of foreign aggregate employment, $L_{j(i)}^E$, in the EE-curves in (III.28) whereby these effects push towards a positive co-movement of real wages in country i with aggregate employment in country $j(i)$.

This product-variety-channel is the only channel behind the positive slope of the EE-curve. This follows from the fact that in part I of this dissertation I show that there are in principle two channels which may push into that direction, but only the product-variety-channel is present under standard CES-preferences and the version of nested CES I employ in the present paper. As I argue in that related work, under a different specification of preferences there could be a second force which also works through the extensive margin of employment and production and which would play out exactly like the product-variety-effect regarding the co-movement of w_i with L_i^E (and also regarding the co-movement of w_i with $L_{j(i)}^E$): In part I of this dissertation I show that preference specifications in which mark-ups change with the toughness of competition give rise to a "variable-mark-ups-channel" whereby increases in aggregate employment along the extensive margin reduce mark-ups and thereby increase real wages. However, with CES-preferences this channel is absent, so I will not elaborate further on this point. It is only important to keep in mind that with non-CES-preferences, the product-variety-effects I will emphasize throughout this paper can be complemented and reinforced by a "variable-mark-ups-channel".

Let me now turn to the trade-related channels, which – as argued above – must be responsible for the fact that EE-curves can be decreasing (in the sense of a negative relationship between w_i and L_i^E for a given level of $L_{j(i)}^E$ in (III.28)) and which generally push towards a lower (and thus possibly negative) slope of the EE-curves of the two countries. So what accounts for the fact that EE-curves can be declining as soon as the inequality in (III.34) is not satisfied? That inequality implies that it takes a sufficiently low value of α for EE-curves to be such that w_i is decreasing in L_i^E given the level of $L_{j(i)}^E$. But a lower value of α means that the economies are more open in the sense of spending a larger fraction of income on imports and hence, terms-of-trade-related issues must necessarily play a stronger role as α is lower due to the increased importance of imports in the consumption basket. In fact, it is clearly a terms-of-trade-effect that pushes towards a negative relationship between w_i and L_i^E in the EE-curves from (III.28). To see this, one can look at the factor content of international trade in this model: One can calculate the

total amount of labor which is embodied in the exports and imports of a country and see how that moves with changes in aggregate employment. It is straightforward to show that the total amount of labor contained in the exports of country i which actually arrive in country $j(i)$ is given by $\left(\frac{1-\alpha}{\tau}\right)\left(\frac{\sigma-1}{\sigma}\right)L_i^E$ $\forall i$.[200,201] To understand how the terms-of-trade affect the relationship between w_i and L_i^E as implied by the EE-curves in (III.28), the relevant thought-experiment thus consists in increasing L_i^E but keeping $L_{j(i)}^E$ – which also shows up in the EE-curves in (III.28) – fixed. If one does that, the fact that the total amount of labor contained in the exports of country i which actually arrive in country $j(i)$ is given by $\left(\frac{1-\alpha}{\tau}\right)\left(\frac{\sigma-1}{\sigma}\right)L_i^E$ $\forall i$ implies that the total amount of labor embodied in the exports of country i and thus imported by country $j(i)$ increases, while the total amount of labor country i in turn imports from country $j(i)$ is unchanged. But that necessarily means that the terms-of-trade move in favor of country $j(i)$ and against country i as the value of L_i^E increases for a given level of $L_{j(i)}^E$: Every worker employed in country $j(i)$ (where employment has remained constant) now effectively receives more foreign labor in exchange for his/her own labor, while every worker employed in country i (where employment has increased) receives less foreign labor in exchange for his/her own labor. This of course means that labor in country i depreciates relative to labor in country $j(i)$ as a higher supply of labor from country i in the form of finished products in world product markets resulting from the increase in aggregate employment in country i meets a given supply of labor embodied in finished products from country $j(i)$ in world product markets. And that depreciation of labor from country i relative to labor from country $j(i)$ of course means that *ceteris paribus* real wages in country i decline while real wages in country $j(i)$ increase. In the model where countries trade final goods rather than labor, this effect works through changes in import prices which affect the purchasing power of wages and thus real wages through the role of imports in the consumption basket. Finally, note that the value of the parameter α is inversely related to the

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[200] In calculating this I am disregarding labor which is lost along the way in terms of output that is used to cover transport costs and labor which is used for quasi-fixed costs. However, nothing in my qualitative argument about the terms-of-trade would change if one accounted for these types of costs differently.

[201] In order to show this, one first calculates the equilibrium ratio of total quantity sold abroad relative to firm-level output under balanced trade. This ratio can be obtained by means of combining (III.15), (III.17), (III.21), (III.22) and (III.23). Due to marginal costs being constant according to my specification of the production technology, this ratio is also the fraction of firm-level employment disregarding employment for the purpose of covering quasi-fixed costs which is embodied in the exports of that firm which actually arrive abroad. (III.31) along with the symmetry of firms within countries then yields the fraction of labor at the firm-level which is not spent on quasi-fixed costs. This is a constant and hence, one can obtain the fraction of overall firm-level employment which is embodied in the exports which actually arrive abroad. As firms from a given country are symmetric, multiplying this by total employment in the respective country then yields the result.

strength of this effect: Looking at two given levels of L_i^E it follows that the increase in the total amount of labor from country i which country $j(i)$ imports as a result of an increase in the value of L_i^E for a given level of $L_{j(i)}^E$ is higher, the *lower* the value of α is. This follows directly from the fact that the total amount of labor contained in the exports of country i which actually arrive in country $j(i)$ is given by $\left(\frac{1-\alpha}{\tau}\right)\left(\frac{\sigma-1}{\sigma}\right)L_i^E \ \forall i$ and inasmuch as a lower value of α implies greater openness, it is very intuitive that this terms-of-trade-effect is stronger if the value of α is lower.

This terms-of-trade-channel is of course special to a setting where countries trade with each other and where the structure of economies and the shocks hitting them are not assumed to be identical, which is why this channel does not appear in my related works in parts I and II of this dissertation. Whether or not this terms-of-trade-channel dominates the product-variety-channel, which also operates in closed economies or perfectly symmetric open economies, depends on the importance of terms-of-trade-related issues and hence on the importance of international trade, which is captured by (and inversely related to) the value of the parameter α in this model. In particular, the inequality in (III.34) defines a threshold for the value of α below which terms-of-trade-related issues are sufficiently important so that the terms-of-trade-channel dominates and brings about a negative relationship between w_i and L_i^E in the EE-curves in (III.28).

For my discussion of international spill-overs it is important to emphasize the following aspect of the terms-of-trade-channel: While the product-variety-channel associated with changes in aggregate employment in a given country pushes real wages in both countries into the same direction, the terms-of-trade-channel associated with changes in aggregate employment in a given country naturally affects real wages in the two countries in an asymmetric manner: As just argued, an increase in aggregate employment in country i moves the terms-of-trade against country i and thus pushes down w_i, but at the same time it moves the terms-of-trade in favor of country $j(i)$ and thus $w_{j(i)}$ is pushed up as L_i increases. Hence, both the product-variety-channel and the terms-of-trade-channel push up real wages abroad as aggregate employment in a given country rises and this clearly explains why aggregate employment abroad, $L_{j(i)}^E$, shows up with an unambiguously positive exponent in the EE-curves in (III.28). For my discussion of international spill-overs it is important to keep in mind what these arguments imply regarding shifts in the EE-curves in response to changes in aggregate employment in the respective foreign country:

An increase in $L_{j(i)}^E$ implies a relocation of the EE-curve of country i so that the new EE-curve of country i implies a higher real wage w_i for any given level of L_i^E than the old one, i.e. an increase in $L_{j(i)}^E$ leads to an upwards-rotation/shift of the EE-curve of country i if one puts aggregate employment in country i on the horizontal axis and the real wage in country i on the vertical axis as in the diagrams I will draw below.

Having understood the shape of EE-curves and how they interact across borders and having understood the two channels behind those curves, we are now ready to apply the theory to study the effects of structural changes in labor markets, of trade liberalization, of technological progress and of product market deregulation.

III.4.2 Structural Changes in the Labor Market

III.4.2.1 Unilateral Labor Market Reform

The first application I will study consists in the effects of changes in the institutional structure of labor markets as captured by the parameters ψ_i and $\psi_{j(i)}$, respectively. Let me begin with the case of a unilateral change in labor market institutions. Thus, suppose a given country i implements a labor market reform that changes the value of ψ_i by either reducing it (which is a "supply-side policy" according to the definition in part I of this dissertation) or increasing it ("demand-side policy") while the value of $\psi_{j(i)}$ remains unchanged.

PROPOSITION III.2 (*National Effects of Unilateral Labor Market Reform*): Suppose there is a decline (an increase) in the value of ψ_i, i.e. a "supply-side policy" ("demand-side policy") is implemented in the labor market of a given country i, while the values of all other parameters remain unchanged and suppose that the conditions for equilibrium to exist and to be unique as established in PROPOSITION III.1 are satisfied both before and after that change in the value of ψ_i. If parameter values are such that…

- … $\xi > \frac{1}{\sigma-1}$, then L_i^E is higher (lower) in the new equilibrium.

- … $\frac{1}{\sigma-1} > \xi > \frac{1-\sigma(1-\alpha)}{\sigma-1}$, then L_i^E is lower (higher) in the new equilibrium.

- … $\frac{1-\sigma(1-\alpha)}{\sigma-1} > \xi > \frac{1-2\sigma(1-\alpha)}{\sigma-1}$, then L_i^E is higher (lower) in the new equilibrium.

- … $\frac{1-2\sigma(1-\alpha)}{\sigma-1} > \xi$, then L_i^E is lower (higher) in the new equilibrium.

Proof: This follows from straightforward algebra using the solution for aggregate employment from (III.33). ∎

PROPOSITION III.2 is thus saying that for different degrees of the strength of the pecuniary externality in the labor market, i.e. for different degrees of wage-flexibility as captured by the value of the parameter ξ, different types of unilateral labor market reform are required for raising aggregate employment in the country implementing the reform: Whenever $\xi > \frac{1}{\sigma-1}$ or $\frac{1-\sigma(1-\alpha)}{\sigma-1} > \xi > \frac{1-2\sigma(1-\alpha)}{\sigma-1}$, the unilateral implementation of a supply-side policy will result in higher aggregate employment whereas the unilateral implementation of a demand-side policy would reduce aggregate employment in the respective country, while the unilateral implementation of a demand-side policy will result in higher aggregate employment in the reforming country (whereas a supply-side policy would reduce it) if $\frac{1}{\sigma-1} > \xi > \frac{1-\sigma(1-\alpha)}{\sigma-1}$ or $\frac{1-2\sigma(1-\alpha)}{\sigma-1} > \xi$. In part I of this dissertation where I study the case of a closed economy, I show that with standard CES-preferences and the isoelastic functional form for the WD-curve used in the present paper, supply-side policies raise aggregate employment if and only if $\xi > \frac{1}{\sigma-1}$ while demand-side policies work for that if and only if $\xi < \frac{1}{\sigma-1}$. The present open-economy environment thus exhibits some similarities but also some important differences from that closely related closed-economy environment when it comes to unilateral labor market reform: In both cases, $\xi > \frac{1}{\sigma-1}$ is a sufficient condition for supply-side policies in the labor market to be capable of raising aggregate employment in one's own country. However, while that condition is at the same time necessary in the closed-economy context studied in part I of this dissertation, the present setting with international linkages and spill-overs exhibits richer patterns as soon as $\xi < \frac{1}{\sigma-1}$: Even in that region of the parameter space, the present model may contain a (sub-)region, namely $\frac{1-\sigma(1-\alpha)}{\sigma-1} > \xi > \frac{1-2\sigma(1-\alpha)}{\sigma-1}$, where supply-side policies work for raising aggregate employment and demand-side policies do not. But recall that $\xi \geq 0$ is imposed on the model based on the idea that if anything, "outside options" in wage-determination play out such that in labor markets with higher aggregate employment and thus better opportunities for workers to find alternative jobs and worse opportunities for firms to hire alternative workers, real wages should be higher. While $\frac{1}{\sigma-1} > 0$ is always satisfied, $\frac{1-\sigma(1-\alpha)}{\sigma-1} > 0$ holds only as long as $\alpha > \frac{\sigma-1}{\sigma}$. This means that in sufficiently open economies in the sense of α being sufficiently low such that $\alpha < \frac{\sigma-1}{\sigma}$ holds, the last two regions of the parameter space stated in PROPOSITION III.2 are irrelevant. Hence, in sufficiently open economies where terms-of-trade-

effects are sufficiently strong (and in fact so strong that EE-curves are downwards-sloping as $\alpha < \frac{\sigma-1}{\sigma}$ is precisely the condition for that to be true), the exact same conclusions as in the corresponding closed-economy case from part I of this dissertation obtain according to which sufficiently strong pecuniary externalities in the labor market in the sense of $\xi > \frac{1}{\sigma-1}$ require (unilateral) supply-side policies to raise aggregate employment, while (unilateral) demand-side policies are required if $\xi < \frac{1}{\sigma-1}$. However, in the case $1 > \alpha > \frac{\sigma-1}{\sigma}$ where the economies are open, but not so much that terms-of-trade-effects would dominate product-variety-effects, unilateral supply-side policies might even be required in a region of the parameter space where the corresponding closed economy analyzed in part I of this dissertation would require demand-side policies to increase aggregate employment. As the two models are equivalent for $\alpha = 1$, this difference in results must obviously be attributed to the presence of international spill-overs and linkages, which I will now examine in greater detail by means of characterizing what happens to aggregate employment in country i if the only structural change is a change in labor market institutions abroad, i.e. a change in the value of $\psi_{j(i)}$:

PROPOSITION III.3 (*International Effects of Unilateral Labor Market Reform*): Suppose there is a decline (an increase) in the value of $\psi_{j(i)}$, i.e. a "supply-side policy" ("demand-side policy") is implemented in the labor market in country $j(i)$ while the values of all other parameters remain unchanged and suppose that the conditions for equilibrium to exist and to be unique as established in PROPOSITION III.1 are satisfied both before and after that change in the value of $\psi_{j(i)}$. If and only if parameter values are such that

(III.35) $$\xi > \frac{1-\sigma(1-\alpha)}{\sigma-1} \iff \xi > \alpha\frac{\sigma}{\sigma-1} - 1$$

then from the old to the new equilibrium, L_i^E moves in the same direction as $L_{j(i)}^E$, while L_i^E and $L_{j(i)}^E$ move in opposite directions from the old to the new equilibrium if that strict inequality is reversed.

Proof: This follows from straightforward algebra using the solution for aggregate employment from (III.33). ∎

PROPOSITION III.3 thus provides a necessary and sufficient condition for the levels of aggregate employment in both countries to move in the same direction in response to a unilateral labor market reform in one of the two countries. Whenever the levels of aggregate employment in both countries move in the same direction, I will speak

of a "positive (international) spill-over", while I will use the term "negative (international) spill-over" otherwise.

Except for being interesting in itself, the question whether or not such spill-overs are positive or negative is obviously important for the question whether or not there might be international conflicts over unilateral labor market reforms: If international spill-overs are negative, then unilateral labor market reforms would boost employment at home at the expense of employment abroad so that international coordination, which I will study further below, might be a better means of reducing unemployment. The condition in (III.35) also reveals very clearly what makes it more or less likely that the spill-overs of unilateral labor market reform are positive: Sufficiently strong pecuniary externalities in labor markets as captured by the value of the parameter ξ and hence a high degree of wage-flexibility make sure that that condition is satisfied, so if one knew the value of ξ with certainty but only had some prior beliefs about the values of α and σ, one would clearly be able to conclude from PROPOSITION III.3 that stronger pecuniary externalities in labor markets and hence greater wage-flexibility make it *more likely* that international spill-overs are positive. Similarly, a sufficiently low value of α ensures that the condition in (III.35) holds, so a sufficiently high degree of openness and, consequently, a sufficiently high importance of terms-of-trade-related considerations make sure that international spill-overs of unilateral labor market reforms are positive and in the same spirit as for ξ, one may thus conclude that a sufficiently low value of α and hence sufficient openness and sufficient importance of terms-of-trade-related considerations make it *more likely* that international spill-overs are positive.[202] In particular, if $\alpha < \frac{\sigma-1}{\sigma}$, then the right-hand side in the condition in (III.35) is negative so that that condition necessarily holds in light of $\xi \geq 0$, which means that in sufficiently open economies where terms-of-trade-effects are sufficiently important – recall that for $\alpha < \frac{\sigma-1}{\sigma}$ EE-curves are downwards-sloping as the terms-of-trade-effects dominate the product-variety-effects – international spill-overs from unilateral labor market reforms are necessarily positive.

The sign of the international spill-overs of unilateral labor market reform can be understood graphically, too. This is due to the fact that the condition in (III.35) in PROPOSITION III.3 has the following interpretation: Note that ξ is the elasticity of real wages with respect to aggregate employment coming out of the WD-curves in (III.29), while $\alpha \frac{\sigma}{\sigma-1} - 1$ is the elasticity of real wages with respect to aggregate employment (in the same country) coming out of

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[202] A similar conclusion would apply to the elasticity of substitution σ: The higher the value of σ and hence the less market-power firms have, the more likely is it that international spill-overs are positive.

the EE-curves in (III.28) and these are the four curves whose unique intersections for each country characterize the unique equilibrium of the model as established in PROPOSITION III.1. As those elasticities indicate which of the respective curves has the steeper slope in their unique intersection in a given country in diagrams with the real wage on the vertical axis and the level of aggregate employment in the same country on the horizontal axis, the condition for international spill-overs to be positive from (III.35) has the following geometric interpretation: If and only if in the initial equilibrium the WD-curves are steeper than the EE-curves of both countries, international spill-overs of unilateral labor market reform in one country are positive, while they are negative otherwise. This insight is illustrated in Figure III.1 and Figure III.2:[203]
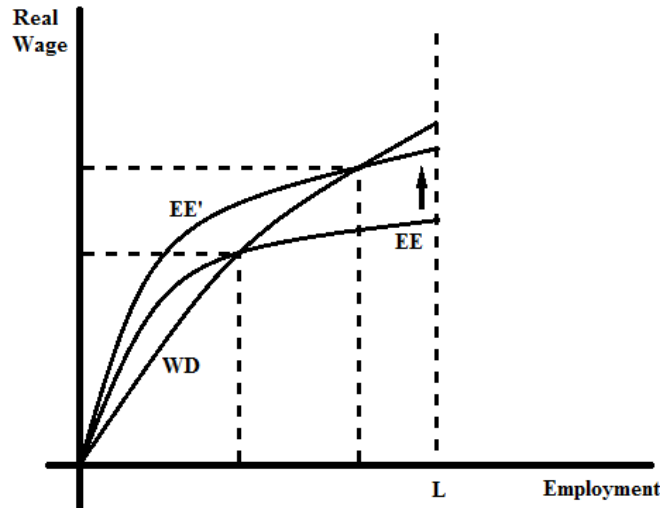

Figure III.1: Positive international spill-overs of unilateral employment-enhancing labor market reform.

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[203] The level of aggregate employment on the horizontal axis in these figures is meant to be the level of aggregate employment in the country to which the real wage on the vertical axis of the respective figure refers. Note also that since WD-curves and EE-curves exhibit the same elasticities in both countries, respectively, it cannot be the case that in equilibrium the respective WD-curve is steeper than the corresponding EE-curve in one country but flatter than the corresponding EE-curve in the other country, which is why it is sufficient to display the curves for just one country.
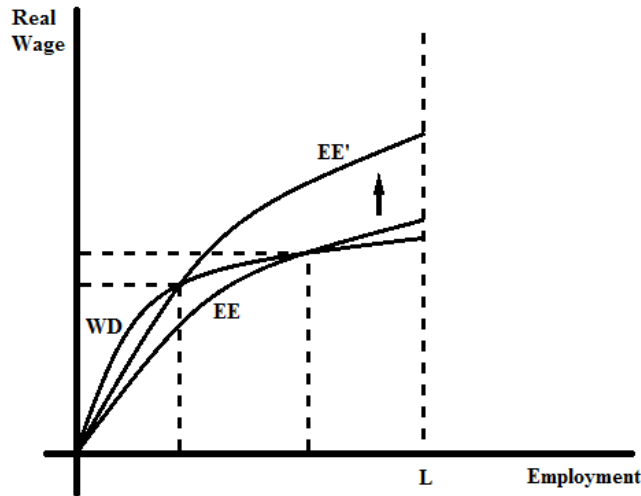
Figure III.2: Negative international spill-overs of unilateral employment-enhancing labor market reform.

If the foreign country $j(i)$ implements a unilateral labor market reform that in light of PROPOSITION III.2 is known to increase its level of employment in equilibrium, the EE-curve in country i necessarily rotates upwards. This follows directly from (III.28) and from the discussion in section III.4.1 and is the result of both the product-variety-effect and the terms-of-trade-effect associated with the increase in aggregate employment in country $j(i)$ which both push into this direction. The figures look at country i and in both figures the resulting new EE-curve of country i is indicated with a prime. The spill-over effect of the labor market reform in country $j(i)$, which induces this shift in the EE-curve of country i, on aggregate employment in country i depends crucially on the slopes of the two curves: Figure III.1 displays a situation in which the condition from (III.35) is satisfied so that the WD-curve is steeper in its unique intersections with any EE-curve. We know that the spill-over effect must be positive in that case and in fact, this is what Figure III.1 displays as the unambiguous outcome of an upwards-rotation of the EE-curve along a stable WD-curve if the WD-curve is steeper in the initial intersection and if both curves are isoelastic. By contrast, Figure III.2 illustrates a case in which the condition from (III.35) is violated so that in the initial equilibrium the EE-curve is steeper than the WD-curve. PROPOSITION III.3 clearly implies that in that situation the spill-over effect must be negative and as one can infer from Figure III.2, this necessarily follows from an upwards-rotation of the EE-curve along a stable WD-curve if the EE-curve is steeper in the initial intersection and

if both curves are isoelastic. I have only drawn the case where EE-curves are increasing, but for a decreasing EE-curve the geometric argument would obviously play out in a very similar way as in Figure III.1 because in such a case the WD-curve is necessarily steeper in the unique intersection, so international spill-overs of unilateral labor market reform on aggregate employment are necessarily positive.

The relationship of the slopes of EE-curve and WD-curve in their (unique) intersection also plays a big role in the closed-economy analysis in part I of this dissertation – albeit in a different context: While in the present context that relationship governs the nature of international spill-overs, in the closed-economy case of part I of this dissertation it governs whether a supply-side policy or a demand-side policy is required to raise aggregate employment. In light of PROPOSITION III.2, however, that geometric principle from the closed-economy case does not apply in an open-economy-setting with asymmetries between countries. But this should not be surprising inasmuch as the EE-curve in the present open-economy-setting is defined in a different way than in a closed economy since aggregate employment abroad and hence international linkages appear in the EE-curve of a given country, which gives a "partial equilibrium character" rather than a "general equilibrium character" to any relationship between real wages and aggregate employment in a given country. Hence, this geometric principle from the closed-economy case needs to be modified in open economies with asymmetries between countries when it comes to figuring out which type of unilateral labor market intervention is required for raising employment, but an interesting new aspect is that a similar principle clearly applies regarding international spill-overs of unilateral labor market reform. The closed-economy formulas and geometric principles will still turn out to be very useful in open economies, too, inasmuch as they will show up again further below in the context of multilateral labor market reform, trade liberalization and proportional technological progress.

Finally, note that in light of PROPOSITIONS III.2 and III.3 both demand-side and supply-side policies when they are capable of raising aggregate employment in the country implementing them may have positive or negative international spill-overs.

III.4.2.2 Multilateral Labor Market Reform

Let me now consider the case where countries coordinate their labor market policies. That case is interesting to study because of the negative spill-overs unilateral labor market reforms might entail as shown above: In the

presence of such negative spill-overs international coordination might be desirable and might lead to superior outcomes. I will restrict my discussion to the case where the values of ψ_H and ψ_F are scaled up or down by a common factor κ where $\kappa > 1$ is the case of a (multilateral) demand-side policy and $\kappa < 1$ constitutes the case of a (multilateral) supply-side policy according to the aforementioned definitions. I will thus restrict attention to the case of a "proportional" multilateral labor market reform that changes labor market parameters in both countries by a common factor. But I still allow for ψ_H and ψ_F to be at different levels prior to (and thus also after) the proportional multilateral labor market reform – and the levels of A_i and f_i^P may of course also differ across countries for any comparative statics I conduct throughout this paper. It is sufficient to study the "proportional" case of multilateral labor market reform since the effects of any non-proportional multilateral reform can easily be inferred from combining the results regarding unilateral reform I have provided above with those regarding proportional multilateral reform I am about to provide.

PROPOSITION III.4 (*Effects of Proportional Multilateral Labor Market Reform*): Suppose that the values of ψ_H and ψ_F are both multiplied by the same constant κ that satisfies $\kappa < 1$, which constitutes a supply-side policy (that satisfies $\kappa > 1$, which constitutes a demand-side policy), while the values of all other parameters remain unchanged and suppose that the conditions for equilibrium to exist and to be unique as established in PROPOSITION III.1 are satisfied both before and after that change in the values of ψ_H and ψ_F. If parameter values are such that…

- … $\xi > \frac{1}{\sigma-1}$, then L_H^E and L_F^E are both higher (lower) in the new equilibrium.

- … $\xi < \frac{1}{\sigma-1}$, then L_H^E and L_F^E are both lower (higher) in the new equilibrium.

Proof: This follows from straightforward algebra using the solution for aggregate employment from (III.33). ∎

PROPOSITION III.4 has two major implications: First, it clearly follows that multilateral labor market reform – at least in the proportional case – represents a way to work around negative spill-overs of unilateral labor market reforms and to achieve benefits in terms of higher aggregate employment for both countries. Hence, international coordination is a promising route for regions of the parameter space where the strength of the pecuniary externality in labor markets and hence the degree of wage-flexibility is such that unilateral labor market reform would impose negative effects on one's trade partners (cf. PROPOSITION III.3). Second, PROPOSITION III.4 provides guidance as to what kind of policy is required for raising employment in both countries by means of a proportional

multilateral intervention in labor markets: Whenever $\xi > \frac{1}{\sigma-1}$ is true, it takes proportional supply-side policies to raise aggregate employment in both countries, while proportional demand-side policies are needed if $\xi < \frac{1}{\sigma-1}$. Two aspects of this threshold-rule are remarkable: First, the parameter α which captures the openness of countries and hence the strength of potential terms-of-trade-effects is absent. This has a very natural reason: A proportional multilateral labor market reform leaves the terms-of-trade unchanged as it can be shown to scale aggregate employment in both countries by a common factor, i.e. it changes aggregate employment in both countries proportionally. And given that it has been shown in section III.4.1 that the terms-of-trade are essentially determined by the ratio of the levels of aggregate employment in the two countries, it is clear that there is not any terms-of-trade-effect associated with a proportional multilateral intervention in labor markets. That insight is also central to understanding why a proportional multilateral labor market reform is a way to work around the negative spill-overs a unilateral reform might entail: Recall that product-variety-effects and terms-of-trade-effects are the major driving forces in this model. But while product-variety-effects always affect both countries in a similar way, changes in the terms-of-trade are always beneficial for one country and detrimental for the other country. Hence, it is not surprising that a proportional multilateral policy which does not entail changes in the terms-of-trade affects both countries in a similar way. My result that a "proportional multilateral labor market reform" as analyzed in PROPOSITION III.4 may overcome the problems of negative spill-overs from unilateral reform is very similar to a major result obtained by Helpman and Itskhoki (2010) who find in a "search and matching"-model à la Mortensen and Pissarides (1994) that reducing labor market frictions unilaterally generates negative international spill-overs, while what they call a "simultaneous, proportional" reduction of labor market frictions is beneficial for both countries.

The second remarkable aspect about the threshold-rule $\xi \lessgtr \frac{1}{\sigma-1}$ indicating whether it takes supply-side or demand-side policies to boost employment on a global scale by means of proportional multilateral labor market reform is that this same threshold-rule obtains for the corresponding question in the closed-economy-setting analyzed in part I of this dissertation for the case of standard CES-preferences and an isoelastic WD-curve. While one would expect that a global economy behaves like a closed economy if there is a proportional global policy-intervention, it is still interesting that the same formula applies in spite of the fact that the present model of a global economy allows for differences in the levels of labor market parameters, of quasi-fixed costs and of the technology-shifter across

countries as well as for shipping costs – all those elements of heterogeneity are absent in the closed-economy-setting analyzed in part I of this dissertation.

III.4.2.3 Wage-Effects of Labor Market Reform and Distributional Conflicts

So far I have only analyzed effects of changes in labor market institutions on aggregate employment. But what about the effects on real wages? Those effects are interesting for at least two reasons: First, if aggregate employment and real wages move in opposite directions in response to some change in policy or some shock at home or abroad, there might be conflicts *within* a country as some people lose their jobs while others see their wages increase or some people find jobs while others see their wages decline. Second, to the extent that real wages and aggregate employment move in the same direction, one may infer that welfare – even if agents do not provide perfect consumption insurance for each other – moves in that same direction, too, as labor income is the only source of consumption expenditure in this model.[204] In the closed-economy analysis in part I of this dissertation it turns out that real wages and aggregate employment in fact always move in the same direction in response to changes in labor market institutions, technology or product market institutions. But can one also be sure that such conflicts *within* countries about unilateral labor market reforms do not arise in open-economy-settings? The answer is: Not necessarily. To see why real wages might decline in an open economy that implements a unilateral employment-enhancing labor market reform, first consider a case in which according to PROPOSITION III.2 a unilateral demand-side policy, i.e. an increase in the value of ψ_i, would raise aggregate employment in country i. In that case, real wages in country i necessarily increase, too, as aggregate employment increases: Both an increase in aggregate employment in country i and an increase in the value of ψ_i push towards higher real wages in country i via the WD-curve from (III.29) and inasmuch as equilibrium must necessarily be located on that curve, it clearly follows that real wages increase in response to an increase in aggregate employment brought about by a unilateral demand-

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[204] In principle, there could still be conflicts within countries over labor market reform even if real wages and aggregate employment move in the same direction: That could still be the case if there is both job creation and job destruction in response to labor market reform so that there are movements in and out of employment beyond the net change in aggregate employment. I abstract away from such forces in my analysis and focus on a different source of potential distributional conflicts within countries. But even if one took those other forces into account, one could still conclude that welfare increases (declines) whenever both aggregate employment and the real wage increase (decline) if one either allowed for the possibility of lump-sum transfers between agents (such transfers could eliminate individual welfare-losses associated with turnover in the labor market that goes beyond net changes in aggregate employment) or if one used a utilitarian welfare-criterion in which every member of society is assigned the same weight.

side policy in the labor market of country i. This argument does not work for a unilateral employment-enhancing supply-side policy, though: The reason for that is that such a policy is defined by a decline in the value of ψ_i and that brings about a decline in real wages conditional on aggregate employment, so even if such a unilateral policy-intervention leads to an increase in aggregate employment, one cannot infer from the WD-curve whether real wages in country i increase or decline as the two forces go in opposite directions. In the closed-economy case studied in part I of this dissertation one can still unambiguously conclude that real wages increase in response to an employment-enhancing supply-side policy since the EE-curve is not affected by a change in the value of ψ_i in a closed economy, so any increase in employment brought about by a change in the value of ψ_i leads to higher real wages as equilibrium is relocated along the unchanged and increasing EE-curve. That argument, however, is not available in the open-economy case – for two reasons: First, note that a change in the value of ψ_i, while not *directly* affecting the EE-curve of country i from (III.28), still shifts that curve inasmuch as aggregate employment abroad shows up in it and as PROPOSITION III.3 indicates, employment abroad generally changes with changes in the value of ψ_i. Hence, to make a similar argument about the wage-effects of employment-enhancing supply-side policies as in the closed-economy case, at the very least one needs international spill-overs to be positive such that they rotate EE-curves upwards rather than downwards, i.e. one needs $\xi > \frac{1}{\sigma-1}$ to be true in light of what PROPOSITION III.2 and PROPOSITION III.3 jointly imply for the spill-overs of unilateral employment-enhancing supply-side policies. But even in that case, there is still another issue with EE-curves that shows up in an open economy but not in a closed economy: EE-curves may be decreasing in open economies, so even if aggregate employment increases and international spill-overs are positive so that EE-curves rotate upwards, real wages might still be pushed down as one *moves along a decreasing EE-curve*. To avoid that EE-curves are decreasing, the condition in (III.34), namely $\alpha > \frac{\sigma-1}{\sigma}$, needs to be satisfied, i.e. economies must not be so open that terms-of-trade-effects dominate product-variety-effects. Hence, if pecuniary externalities in labor markets are sufficiently strong so that $\xi > \frac{1}{\sigma-1}$ holds and if economies are not too open so that the terms-of-trade do not play a too important role for price-indices, namely if $\alpha > \frac{\sigma-1}{\sigma}$ is true, then one can be sure that real wages and aggregate employment move in the same direction as aggregate employment is raised by means of a unilateral supply-side policy. Otherwise, it depends on parameter values and employment-enhancing unilateral supply-side policies may reduce real wages so that distributional conflicts *within* countries in response to unilateral supply-side policies which increase aggregate

employment are possible. Inasmuch as that cannot occur in the corresponding closed-economy model studied in part I of this dissertation, it clearly follows that terms-of-trade-effects represent the element that can make unilateral employment-enhancing supply-side policies problematic regarding their wage-effects and distributional consequences within open economies. By contrast, unilateral employment-enhancing demand-side policies do not entail such problems – neither in closed nor in open economies.

The effects of a unilateral labor market reform on real wages abroad are very straightforward: Since WD-curves do not change in countries which do not change their labor market institutions, real wages in a non-reforming country must move in the same direction as aggregate employment in response to a unilateral labor market reform which is implemented abroad. Hence, PROPOSITION III.3 which characterizes international spill-overs of unilateral labor market reform on aggregate employment applies to spill-overs on real wages in foreign countries, too.[205] As a consequence, it follows that stronger pecuniary externalities in labor markets (i.e. a higher value of ξ) and more openness (i.e. a lower value of α) make it more likely that an employment-enhancing unilateral labor market reform raises real wages (in addition to aggregate employment) in countries trading with the country which is implementing the reform.

How about the distributional consequences of proportional multilateral labor market reform as studied in the last subsection? For that case, using (III.28) one can in fact show that real wages move in the same direction as aggregate employment so that neither supply-side nor demand-side policies induce any distributional conflicts *within* countries if they are conducted in a proportional way at a global scale. This should not be surprising in light of the earlier findings according to which proportional multilateral labor market reforms do not entail terms-of-trade-effects which have been shown to be the source of any divergent movement in real wages and aggregate employment within a given country in response to labor market reform. Furthermore, recall that a proportional multilateral labor market reform plays out in a similar way as a labor market reform in the case of a closed economy and that such distributional conflicts do not arise in response to labor market reform in closed economies as pointed out in part I of this dissertation. Hence, through the lens of my model, conducting labor market policy at a global scale and in a "proportional" way seems to be superior to unilateral labor market interventions for two reasons: It can avoid negative spill-overs across countries and thus conflicts *between* countries and it can also avoid

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[205] Formally, L_i^E in that proposition can be replaced by w_i.

conflicts *within* countries. But it is also important to keep in mind that there are regions of the parameter space where both types of conflicts do not arise in response to unilateral labor market reforms, so international coordination is not always required.

III.4.2.4 Minimum Wages as a Special Case

Minimum wage constraints can be viewed as a special case of my model of labor market frictions: For $\xi = 0$, according to the WD-curves real wages are necessarily equal to $\psi_i > 0$ in any given country i whenever there is unemployment in equilibrium in country i and real wages do not change even if aggregate employment changes as long as full-employment is not reached in the respective country. Hence, the case $\xi = 0$ can arguably capture the case of minimum wages (where the minimum wage is specified in welfare-relevant *real* units of consumption). Minimum wages have received considerable attention in the literature on international trade and unemployment. The perhaps most well-known examples include the works by Brecher (1974a, 1974b) and Davis (1998a, 1998b). More recently, Egger, Egger and Markusen (2012) have studied minimum wages in an open-economy framework.[206] Let me briefly discuss what my analysis has to say about minimum wages.

If $\xi = 0$, one is necessarily in one of the last three regions of the parameter space stated in PROPOSITION III.2. But depending on the values of α and σ that still leaves room for both unilateral increases in the minimum wage and unilateral reductions in the minimum wage (i.e. increases or declines in the value of ψ_i) to be capable of raising aggregate employment in the country that unilaterally adjusts its minimum wage.[207] Likewise, for $\xi = 0$ the inequality in PROPOSITION III.3 may or may not be satisfied, so depending on the values of α and σ both positive and negative international spill-overs from unilateral changes of the minimum wage are possible. The only case that in light of PROPOSITION III.2 and PROPOSITION III.3 can be ruled out in the special case of $\xi = 0$ is that a unilateral reduction in the minimum wage raises aggregate employment in both countries, but that conclusion seems to be interesting in itself for it means that unilateral reductions in minimum wages may lead to higher

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[206] Further literature references include Neary (1985), Oslington (2002) and Meckl (2006).

[207] As I assume ξ to take on the same value across countries, my analysis can only speak to cases where both countries exhibit binding minimum wage constraints, which may, however, be set at different levels.

aggregate employment in at most one of the two countries.[208] Further, that conclusion also implies that a unilateral increase in the minimum wage never harms both countries, while Egger, Egger and Markusen (2012) argue that damage to both countries is the unambiguous outcome of a unilateral increase in the level of the real minimum wage in their model.[209]

The fact that (beyond this one clear conclusion according to which unilateral reductions (increases) in minimum wages never entail benefits (losses) for both countries) my analysis does not have very sharp and unambiguous implications for the effects of changes in minimum wages seems to mirror an aspect of the preceding literature on minimum wages, unemployment and international trade, where results tend to be mixed and/or dependent on parameter values, too. However, my results are not directly comparable to large parts of that literature since with the exception of the contribution by Egger, Egger and Markusen (2012) that literature does not consider imperfectly competitive firms and product differentiation. Instead, studies in the spirit of Brecher (1974a, 1974b) and Davis (1998a, 1998b) have mainly used Heckscher-Ohlin-type models and have thus mainly focused on terms-of-trade-related effects. The interaction of terms-of-trade-effects with product-variety-effects resulting from product differentiation and imperfect competition is, however, a central aspect of my analysis. To see why this difference might matter for the discussion of minimum wages in an international context, consider one well-known result from the study by Davis (1998a): This author claims that unemployment in Europe pushes up real wages in the United States. My analysis clearly reveals that the "product-variety-channel" undoubtedly pushes towards

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[208] However, note that it is possible that a unilateral *increase* in the minimum wage raises aggregate employment in both countries.

[209] Egger, Egger and Markusen (2012) also model imperfect competition and product differentiation à la Krugman (1980) and look at country-specific minimum wages in real terms, but their setting differs from mine in several crucial ways: They do not allow for trade costs, they do not introduce the additional layer of product differentiation à la Armington (1969), and, most importantly, allowing for heterogeneous firms but fixing the mass of potential entrants they apply the zero-profit-condition only at the margin so that the free-entry-condition in my model has no analogue in their work. By abstracting away from trade costs and a fully endogenous determination of the mass of producers and by having zero profits only at the margin, Egger, Egger and Markusen (2012) obtain some counterfactual implications when they compare autarky to free trade in their model: They find a decline in the cut-off productivity-level and a decline in average firm-level productivity when moving from autarky to free trade, which is the opposite from what the standard version of the model à la Melitz (2003) predicts and that standard version has found a lot of empirical support (cf. Melitz and Redding (2014)). In light of these counterfactual implications coming out of their alternative modelling choices regarding trade costs and free entry, it is not surprising that their results differ from my results which are based on a more standard trade model that exhibits trade costs and zero profits due to free entry.

positive international spill-overs of higher employment in one country on wages abroad, so taking product differentiation and imperfect competition into account may change this picture dramatically.

III.4.3 Trade Liberalization

Let me now turn to an analysis of the effects of trade liberalization in the form of a decline in the iceberg transport costs τ. In part II of this dissertation, where the focus is entirely on the case of completely identical countries, I analyze in great detail the effects of trade liberalization of this type by embedding the same model of the labor market as I use in the present paper into intra-industry models of international trade à la Krugman (1980) and à la Melitz (2003). In that related work it turns out that *qualitatively*, the effects of trade liberalization on aggregate employment are described by the same simple formula regardless whether there is firm heterogeneity à la Melitz (2003) or not, i.e. whether employment rises or declines can be inferred from the same formula in both cases and only by how much aggregate employment changes depends on whether firms are heterogeneous or not. The present setting can obviously be used to ask the question whether that formula from part II of this dissertation also goes through if countries are different rather than perfect mirror images of each other. The answer is: Yes.

PROPOSITION III.5 (*Effects of Trade Liberalization*): Suppose that the value of τ declines while the values of all other parameters remain unchanged and suppose that the conditions for equilibrium to exist and to be unique as established in PROPOSITION III.1 are satisfied both before and after that change in the value of τ. If parameter values are such that…

- … $\xi > \frac{1}{\sigma-1}$, then L_H^E and L_F^E are both higher in the new equilibrium.

- … $\xi < \frac{1}{\sigma-1}$, then L_H^E and L_F^E are both lower in the new equilibrium.

Proof: This follows from straightforward algebra using the solution for aggregate employment from (III.33). ∎

The threshold-rule $\xi \lessgtr \frac{1}{\sigma-1}$ is exactly the one established in part II of this dissertation for the case of perfectly identical economies, so the results in that related paper of mine are robust to allowing for asymmetry in the values of structural parameters across countries. On a conceptual level, PROPOSITION III.5 strengthens a general message from part II of this dissertation: Sufficiently strong pecuniary externalities in labor markets as captured by

the value of ξ represent a necessary and sufficient condition for trade liberalization to have beneficial effects – whenever those externalities are too weak and real wages at the firm-level are thus not sensitive enough to aggregate labor market conditions, trade liberalization reduces aggregate employment. The terms-of-trade-related parameter α does not show up in this discussion of trade liberalization even though countries are asymmetric. This is due to the fact that a reduction in the value of τ leaves the terms-of-trade unchanged.[210] And that is basically also why differences in the structure of the two economies do not have any impact on the effects of trade liberalization on aggregate employment.[211] Real wages necessarily move in the same direction as aggregate employment in response to trade liberalization, which is due to the simple fact that changes in the value of τ leave the WD-curves in both countries unchanged. Hence, as in part II of this dissertation, in the present setting, too, trade liberalization does not entail distributional conflicts neither within nor across countries.

III.4.4 Technological Change and Product Market (De-)Regulation

In this subsection I analyze the implications of unilateral or multilateral changes in the technology-shifter A_i and in the level of quasi-fixed costs (or entry-costs) f_i^P. Increases in the value of A_i and declines in the value of f_i^P can evidently be interpreted as resulting from some type of technological progress, but changes in the value of f_i^P could also capture changes in product market regulation. In particular, declines in the value of f_i^P may be interpreted as a form of product market *de*regulation. Hence, it is natural to focus on the effects of declines in the value of f_i^P and of increases in the value of A_i throughout this subsection, but the results would of course be similar (just with reversed sign) if those parameters moved in the respective opposite directions. Rather than going through a detailed, tedious and not very insightful list of cases to characterize the effects of unilateral changes in the values of f_i^P and A_i for any region of the parameter space, let me focus on some general and easily interpretable insights that can be gained:

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[210] The terms-of-trade do not change as aggregate employment changes proportionally in both economies in response to trade liberalization.

[211] This could obviously be different as soon as one studied asymmetric trade liberalization, which can, for instance, be done by means of introducing tariffs into the model which may be adjusted unilaterally. I do not discuss that case in this paper as some preliminary explorations of the model along that route suggest that the effects of unilateral changes in tariffs seem to depend a lot and in a not particularly straightforward way on the parameters of the model. This should not be surprising inasmuch as tariffs play out in multiple dimensions: They may be used to manipulate the terms-of-trade, but they also raise revenues and distort relative prices and they also affect product variety through their impact on the entry-decisions firms make.

PROPOSITION III.6 (*Effects of Unilateral Technological Progress or Product Market Deregulation*): Suppose there is an increase in the value of A_i (a decline in the value of f_i^P) in a given country i, while the values of all other parameters remain unchanged and suppose that the conditions for equilibrium to exist and to be unique as established in PROPOSITION III.1 are satisfied both before and after that change in the value of A_i (of f_i^P). Then,

(III.36)
$$\xi > \alpha \frac{\sigma}{\sigma-1} - 1$$

is a *sufficient* condition for aggregate employment in both countries, L_H^E and L_F^E, to move in the same direction from the old to the new equilibrium and aggregate employment in both countries…

- … increases if $\xi > \frac{1}{\sigma-1}$ is satisfied.

- … decreases if $\alpha \frac{\sigma}{\sigma-1} - 1 < \xi < \frac{1}{\sigma-1}$ is satisfied.

Proof: This follows from straightforward algebra using the solution for aggregate employment from (III.33). ∎

In PROPOSITION III.6 I thus focus on the case where the condition in (III.36) is satisfied, which – in light of my discussion of the slopes of EE- and WD-curves – has the natural interpretation of being the case in which WD-curves are steeper than EE-curves in their unique intersections in the two countries, respectively. As stated in PROPOSITION III.6, this is in fact a sufficient condition for international spill-overs from unilateral technological progress and unilateral product market deregulation to be positive, but that only means that the levels of aggregate employment in the two countries move in the same direction in response to a change in the value of one of the parameters f_i^P and A_i in one country; L_H^E and L_F^E could still both increase or both decline. This sufficient condition for aggregate employment in the two countries to move in the same direction should not be surprising given that (III.36) from PROPOSITION III.6 represents the same condition as (III.35) from PROPOSITION III.3 which characterizes international spill-overs from unilateral labor market reform. But a difference between these two cases is that the condition is necessary and sufficient for positive spill-overs in the context of unilateral labor market reform as discussed in PROPOSITION III.3, while it is only sufficient in the case of technological change or product market deregulation as discussed in PROPOSITION III.6: Even for smaller values of ξ it might be the case that international spill-overs of unilateral changes in the values of A_i or f_i^P are positive, but further discussing spill-overs for that region of the parameter space is not really illuminating. For similar reasons, PROPOSITION III.6

focuses on the same region of the parameter space when it comes to characterizing in which direction aggregate employment in the two countries actually moves in response to a unilateral change in the value of A_i or f_i^P: Interestingly, within that region of the parameter space it turns out that unilateral increases in the value of A_i or unilateral reductions in the value of f_i^P only lead to higher aggregate employment for the economy where this structural change is occurring (as well as for its trading partner since spill-overs have been shown to be positive in that region of the parameter space) if the value of ξ is sufficiently high, namely above $\frac{1}{\sigma-1}$. Otherwise, namely for $\alpha \frac{\sigma}{\sigma-1} - 1 < \xi < \frac{1}{\sigma-1}$, aggregate employment declines everywhere as technology in one country improves or as one country deregulates its product market. Hence, my present open-economy analysis confirms yet another insight from the closed-economy analysis in part I of this dissertation, where for the case of standard CES-preferences and an isoelastic WD-curve the condition $\xi > \frac{1}{\sigma-1}$ is shown to be sufficient (and also necessary!) for increases in the value of A or declines in the value of f^P to bring about higher aggregate employment in a closed economy: Both papers thus suggest that sufficiently strong pecuniary externalities in labor markets imply that technological improvements and product market deregulation raise aggregate employment. The major novel aspect of the present open-economy analysis is that by looking at international spill-overs it reveals that this insight still holds for a given country i even if the technological improvement or the product market deregulation event only affects firms producing in a foreign country $j(i)$ directly: The present analysis implies that sufficiently strong pecuniary externalities in the labor markets of the global economy make it more likely for a given country i to benefit from technological improvements or product market deregulation events which happen entirely abroad and which do not directly affect any firms producing in that given country i. A similar conclusion applies to the degree of openness as can be inferred from the sufficient condition for positive spill-overs in (III.36): The more interconnected the global economy is and the more important international trade is (i.e. the lower the value of α is), the more likely is it that a country benefits from technological improvements or changes in product market regulation which happen entirely abroad and which benefit the foreign economy where they happen.

The presence of terms-of-trade-effects implies that in contrast to the closed-economy case, $\xi > \frac{1}{\sigma-1}$ is no longer a necessary condition for benefits from technological progress or product market deregulation as there might be regions of the parameter space with $\alpha \frac{\sigma}{\sigma-1} - 1 > \xi$ which imply such benefits, too. Thus, as in the case of unilateral

labor market reform, when comparing the closed-economy results from part I of this dissertation to the present open-economy results, it turns out that the comparative statics of the model become richer and less clear-cut as soon as one is in the region where WD-curves are flatter than EE-curves in their unique intersections, i.e. where $\alpha \frac{\sigma}{\sigma-1} - 1 > \xi$. But since $\xi \geq 0$, such a region only exists for $\alpha > \frac{\sigma-1}{\sigma}$, i.e. in "not too open economies". And in sufficiently open economies, i.e. in open economies satisfying the condition $\alpha < \frac{\sigma-1}{\sigma}$, the condition in (III.36) from PROPOSITION III.6 is always satisfied and hence, in that case PROPOSITION III.6 provides a complete characterization of the effects of unilateral changes in the values of A_i or f_i^P for all admissible values of ξ and the same threshold-rule as in the closed-economy case, namely $\xi \lessgtr \frac{1}{\sigma-1}$, indicates whether or not technological progress and product market deregulation are beneficial.

Let me now turn to proportional changes in the values of A_H and A_F or in the values of f_H^P and f_F^P. Again, looking at the proportional multilateral case is sufficient since results for non-proportional multilateral changes can be inferred from combining my results on unilateral and on proportional multilateral changes in the values of A_i or f_i^P with each other.

<u>PROPOSITION III.7</u> (*Effects of Proportional Multilateral Technological Progress or Product Market Deregulation*): Suppose that the values of A_H and A_F (of f_H^P and f_F^P) are both multiplied by a constant κ that satisfies $\kappa > 1$ (that satisfies $\kappa < 1$), which implies technological progress (which implies product market deregulation), while the values of all other parameters remain unchanged and suppose that the conditions for equilibrium to exist and to be unique as established in PROPOSITION III.1 are satisfied both before and after that change in the values of A_H and A_F (of f_H^P and f_F^P). If parameter values are such that…

- … $\xi > \frac{1}{\sigma-1}$, then L_H^E and L_F^E are both higher in the new equilibrium.
- … $\xi < \frac{1}{\sigma-1}$, then L_H^E and L_F^E are both lower in the new equilibrium.

<u>Proof:</u> This follows from straightforward algebra using the solution for aggregate employment from (III.33). ∎

PROPOSITION III.7 implies that either both countries will benefit or both countries will lose in terms of aggregate employment if there is a proportional improvement in technology or a proportional decline in entry-costs/quasi-

fixed costs, so there is no room for international conflicts in response to such structural changes. This should not be surprising inasmuch as these proportional changes again leave the terms-of-trade unchanged as they increase/decrease employment in both countries proportionally. As negative international spill-over effects have been shown to be due to terms-of-trade-effects, a positive co-movement of aggregate employment across borders in response to proportional changes in the values of A_H and A_F (of f_H^P and f_F^P) can thus be expected. And this also explains why the parameter α, which captures the degree of openness of the two economies and hence the importance of terms-of-trade-related issues, does not show up in the simple threshold-rule which according to PROPOSITION III.7 governs whether or not proportional global technological progress and proportional multilateral product market deregulation lead to higher aggregate employment. Further, this threshold-rule $\xi \lessgtr \frac{1}{\sigma-1}$, which is both necessary and sufficient in the case of proportional multilateral changes in the values of A_H and A_F or of f_H^P and f_F^P, is the same as the one established in my related closed-economy work for technological progress and product market deregulation under standard CES-preferences and an isoelastic WD-curve (cf. part I of this dissertation) and again, this is not totally surprising given that a global economy is not too different from a closed economy as soon as there are not any terms-of-trade-effects. It is still worthwhile to point out this similarity since the present setting allows for heterogeneity in technology, quasi-fixed costs, and labor market institutions across countries. Hence, the present paper strengthens the case for the view that sufficiently strong pecuniary externalities in labor markets are required for (global proportional) improvements in technology or (multilateral proportional) declines in quasi-fixed costs/entry-costs to increase aggregate employment.

Finally, let me turn to the question how real wages are affected by changes in the values of A_H, A_F, f_H^P or f_F^P. The answer is unambiguous and does not depend on whether those changes are multilateral and proportional ones or unilateral ones: In both countries, real wages always move in the same direction as aggregate employment in the respective country in response to any possible change in the values of A_H, A_F, f_H^P or f_F^P, i.e. regardless whether the change happens at home or abroad and regardless whether it is unilateral or multilateral. This is simply due to the fact that WD-curves are not affected by any change in the values of A_H, A_F, f_H^P or f_F^P one can think of. Hence, in my model product market deregulation never entails distributional conflicts within countries and the same is true for technological progress, so only employment-enhancing supply-side policies in labor markets may (but need not) lead to distributional issues *within* countries.

III.5 Concluding Remarks

Let me conclude by means of highlighting some of the most interesting results as well as some connections of the results in the present paper to those in my related works in parts I and II of this dissertation: First, the concept of EE-curves which plays a central role in those two papers can be extended to a setting with asymmetric countries in a global economy. But openness and asymmetries between countries introduce terms-of-trade-effects into the picture and those imply that the modified EE-curves for such a setting can be downwards-sloping, which cannot be the case in closed economies (as studied in part I of this dissertation) or if open economies are restricted to remain perfect mirror images of each other (as in part II of this dissertation). And downwards-sloping EE-curves can lead to distributional conflicts if WD-curves are shifted by unilateral employment-enhancing supply-side policies in the labor market. Conducting such policies in international environments might thus be difficult from a political economy perspective. International coordination of labor market interventions has been shown to be a means to overcome these issues as well as the potentially negative spill-over effects unilateral interventions in the labor market may have on trading partners. The key to successful international coordination of structural change is changing the structure of economies in a proportional way on a global scale such that the terms-of-trade do not change. Not surprisingly, as far as proportional structural changes at a global scale are concerned, the results in the present paper – in spite of all potential asymmetries across countries – are similar to the ones in parts I and II of this dissertation dealing with the cases of a closed economy and with a perfectly symmetric global economy, respectively. Another highly interesting aspect is that the same geometric principle that governs many of the results in parts I and II of this dissertation turns out to be applicable to a question which is specific to the present setting: the question regarding the direction of international spill-overs of unilateral structural changes in labor markets. And accordingly, I find that the strength of pecuniary externalities in the labor markets of the global economy is absolutely central for shaping the international spill-overs of such structural changes.

The big lesson which thus emerges from the present analysis in conjunction with my two related works is that pecuniary externalities in labor markets do matter a lot for many different questions. In most cases, it seems beneficial if they are sufficiently strong so that real wages are sufficiently sensitive to aggregate labor market conditions, but in open-economy environments, even strong pecuniary externalities in labor markets might still

leave room for distributional issues associated with unilateral employment-enhancing supply-side interventions in the labor market so that international coordination of labor market policy might be desirable and preferable.

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