Skill-biased labor market reforms and international competitiveness[*]

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Abstract

This paper proposes a multi-industry trade model with integrated capital and goods markets. Labor market imperfections in line with Mortensen and Pissarides (1994) give rise to unemployment and a channel for the government to influence markets through institutional changes. Labor market interventions feedback into the product market through changes in a country's competitiveness. Moreover, the distinction between high- and low-skill workers facilitates the analysis of skill-biased institutional changes that have stronger impact on certain skill groups. The comparative static exercise in this paper shows that high-skilled benefit from low-skill biased labor market reforms through higher wages. Lower labor cost reduce unemployment of the low-skilled and increases the reforming country's competitiveness. One-sided labor market interventions have feedback effects through adjustments at the extensive margin, which affect all workers at home and abroad irrespective of their level of skill. Governments in the non-reforming countries may react to this loss in competitiveness by initiating cooperative labor market reforms instead.
JEL codes: F16, E24, J6

1. Introduction

The establishment of a common currency union fueled a lively debate about labor market reforms and its effects on competitiveness and trade imbalances within the Euro area. Detractors argue that a common currency shuts down one important channel of adjustment, the nominal exchange rate. Countries within a common currency union are unable to restore a loss in international competitiveness - for instance due to labor market reforms in its partner countries - through changes in their monetary policy.

This paper contributes to this discussion by analyzing the effects of labor market reforms on international competitiveness in a model that features a continuum of industries and heterogeneous workers. The latter facilitates to distinguish between labor market reforms that have similar effects on high- and low-skilled workers and labor market reforms that are skill-biased in that they have different effects on different skill-groups. The aim of this second exercise is to evaluate the spillover effects on income and unemployment in groups that are affected indirectly. Our thought-experiment will focus on the effects of a reform that reduce the low-skill workers' outside option through lower unemployment benefits.[1] Wages in the low-income group are directly affected by this reform, which leads to a reduction in unemployment. Competitiveness is affected through production costs. Lower unit labor costs at home are associated with increasing competitiveness and an expansion of the production to industries formerly associated with the foreign country. The direct effect on high-skilled is negligible simply because unemployment benefits are less relevant for the skilled workers. However, labor demand is increasing due to the expansion of production to formerly inactive industries. A surge in demand for both types of workers can only be met by lower unemployment and higher wages. For low-skilled the effect is ambiguous. The unemployment rate decreases through the direct effect which might be already enough to restore the labor market clearing condition. High-skill workers however benefit from the labor market reform due to higher demand for high-skilled labor associated with a surge in wages.

There exists a wide range of stylized facts that motivate this study. Krugman (2012) for instance argues that capital flows from Europe's core to Europe's South (for instance

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[1]Other skill-specific institutional changes could be for instance minimum wages within certain occupational groups or sectors, or employment protection that mainly affect low-skill workers.

in form of foreign direct investments) led to wage increases in the South[2]. This soar in capital flows to the South can be explained by the lower anticipated risk of investments into the South after its entry into the European community. Krugman also points out that - at the same time - wages in Germany grew at a much lower rate, associated with a relative shift in competitiveness from the South to Germany.

Back in the early 2000s, Germany initiated a huge labor market reform program that affected a broad array of labor market institutions and slowed down wage growth in non-manufacturing sectors. It is unlikely that those reforms had a huge impact on high-skill unemployment rates, mainly due to the fact that high-skill unemployment was already extremely low before the government intervention. Furthermore, reemployment in case of job separation is more likely for high- than for low-skilled. Still, those labor market reforms can explain why wages in Germany grew at a much lower rate of 9 percent compared to the 35 percent growth rates found for Southern Europe, mainly through its effect on low-skilled workers. Moreover, under floating exchange rates inequality is a national problem that has little net-effects on other country's demand for trade. The situation is different when nominal exchange rates are fixed as it is (implicitly) the case among countries within the Euro area. Thus, labor market reforms in Germany can have huge effects on other countries through trade and capital flows, and the effects might be relatively strong due to its size.

But is there any evidence on which type of worker was affected mostly? The stylized facts for Germany presented in Dustmann et al. (2009) suggest that wage growth at the bottom of the distribution were stagnant or even negative, whereas wages at the top of the distribution were rising shortly after 2000. A reduced outside option for workers due to a labor market reform is a potential explanation for stagnating or even decreasing wages if workers have to search for employers and if unemployment is high. The less likely reemployment in case of job separation, the more important the outside option gets for a worker. Rising wages at the top of the distribution suggest little impact of those institutional reforms in the high income group. The model in this paper distinguishes between low- and high-skill workers but unemployment benefits for instance

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[2] *"... there were massive flows of capital from Europe's core to its booming periphery. These inflows of capital fed booms that in turn led to rising wages: in the decade after the euros creation, unit labor costs (wages adjusted for productivity) rose about 35 percent in southern Europe, compared with a rise of only 9 percent in Germany. Manufacturing in Europe's south became uncompetitive, which in turn meant that the countries that were attracting huge money inflows began running correspondingly huge trade deficits."* (Krugman, 2012, chapter 10)

are modeled as flow values. Thus, an equal change in unemployment benefits equally affects both skill groups, which is highly unrealistic. We address this issue by assuming that unemployment benefits of the high-skilled remain unaffected by the labor market reform. Workers at the top of the income distribution may have more assets that are generated outside the firm which should be accounted for in the flow value of being unemployed. This is a shortcoming of the standard search and matching framework with more than two skill-groups.

The stylized facts also fit the evolution of skill-specific unemployment. We can observe a massive decrease in low-skill specific unemployment, whereas high-skill specific rates were erratic at a constant low level. This pattern is consistent with labor market reforms that mainly affected low-skilled workers.

The analysis of those effects builds on a multi-industry North-South trade model that goes back to Feenstra and Hanson (1996, 1997), FH model henceforth. All monetary variables, such as wages or prices, are expressed in a common currency and the lack of a financial market rules out any kind of exchange rate policy. Changes in wages thus directly affect production costs and the country's competitiveness, which is close to a common currency union. The original model features trade in goods and capital (FDI) but labor market institutions are beyond the scope of their study. The extension in this paper enables an analysis of the effects of labor market institutions on capital flows, unemployment, and wage inequality due to search frictions à la Mortensen and Pissarides (1994). The government can affect wages and unemployment through the outside option of workers. More stringent labor market institutions are lower unemployment benefits or more employment protection for instance. Less stringent labor market regulations in the extended FH framework increase competitiveness and thus trade and foreign direct investment at home. The aim of this paper is to assess different channels through which labor market institutions affect foreign direct investment, trade, and wage inequality at home and foreign.

The paper therefore sorts into a large and emerging literature on spillover effects of labor market institutional changes on trade and unemployment between the integrated countries. In his seminal paper, Davis (1998) was among the first researchers who stressed that institutions are crucial for the explanation of different labor market patterns in countries that are internationally interdependent. Egger, Greenaway, and Seidel (2011) distinguish between the long- and short-run effects of capital mobil-

ity in their theoretical and empirical analysis of labor market rigidities and its effects on the share of intra-industry trade measured by a bilateral Grubel-Loyd index. Felbermayr, Larch, and Lechthaler (2009) show that institutional changes in one country equally affect their trading partners' labor market outcomes. The model presented herein contributed to the literature by developing a model that allows to assess how unilateral changes in labor market institutions affect labor markets not only in the respective but also the integrated countries. The outcome of the model differs in that it can explain skill-specific effects due to the assumption of heterogeneous workers along the lines proposed by Feenstra and Hanson (1996, 1997) and Moore and Ranjan (2005). Moreover, an expansion of production to industries formerly associated with foreign leads to a reduction in unemployment at home but increases unemployment at foreign. This contrasts with Felbermayr, Larch, and Lechthaler (2009), where all economies are equally affected. This stems from the fact that adjustments in the non-reforming country are mainly due to the effects at the extensive margin in our multi-industry framework.

The model employed in this paper is based on Schmerer (2012), where search frictions are also introduced into a Feenstra and Hanson (1996, 1997) trade model but without distinguishing between skill-specific unemployment rates. The predictions about the foreign direct investment and unemployment nexus derived from the model are tested using OECD data on unemployment, labor market institutions, and foreign direct investment. The model proposed in this paper is tied closer to the original Feenstra and Hanson (1996, 1997) approach due to the distinction between low- and high-skill workers, which facilitates an analysis of skill-specific institutional spillover effects. A government can increase its country's competitiveness by influencing wages and unemployment of the low-skilled through less stringent labor market institutions concerning low-skilled workers only. It will be shown that such a policy improves the position of high-skilled workers, while low-skilled loose in terms of wages but benefit in terms of employment through its feedback effects at the extensive margin, where shifts in competitiveness between countries lead to shifts of production from one country to another. Increases of labor demand at the extensive margin therefore means job creation in industries that were formerly inactive within the respective country.

Two closely related papers also investigate the link between trade, capital flows and labor market institutions. Beissinger (2001) studies spillover effects of unilateral labor

market reforms on capital flows between two countries. Boulhol (2009) focuses on the pressure of trade liberalization on labor market deregulations. Lin and Wang (2008) empirically investigate the FDI to unemployment nexus based on panel data taken from the UNCDAT.

Moreover, globalization itself may also affect a country's institutions directly. Egger and Etzel (2009) for instance find that more competition at foreign export markets can have negative feedback effects on the bargaining position of a union. Egger and Eckel (2009) find comparable results if firms are able to outsource parts of the production to foreign countries. Felbermayr, Hauptmann, and Schmerer (2012) find supporting evidence for this relationship using matched employer-employee data for Germany.

Mitra and Ranjan (2010) and Davidson, Matusz, and Shevchenko (2008) study the effects of outsourcing on labor market outcomes in trade models with search frictions. Mitra and Ranjan (2010) have a two sector model with labor being the only input factor. In their model, outsourcing decreases equilibrium unemployment. Conversely, Davidson et al. (2008) propose a model where outsourcing forces some of the high-skill workers in the North to search for jobs in the low-skill intermediate sector. This stirs up job competition in that sector and thus triggers a rise in unemployment.

Kohler and Wrona (2010) stress the non-monotonic relationship between offshoring and labor demand/unemployment within industries by showing that the sign of the effect in their model may depend on the level of offshoring.[3] Although the theoretical literature on global sourcing and unemployment is sparse, the number of studies focusing on the effects of trade liberalization on unemployment is numerous. Brecher (1974) introduced minimum wages in the classical Heckscher Ohlin model and analyzed how equilibrium unemployment changes when moving from autarky to free trade. Davidson, Martin, and Matusz (1988, 1999) were among the first to extend canonical trade models by implementing search frictions. Building on their work, Moore and Ranjan (2005) propose a model that permits studying how globalization affects skill specific unemployment in a Heckscher Ohlin world.

More recently, researchers started to focus on labor market effects in the popular Melitz (2003) international trade model with heterogeneous firms. Egger and Kreicke-meier (2009) incorporate fair wages into the Melitz (2003) model in order to explain the

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[3]Non-monotonic means that outsourcing decreases labor demand when the level of outsourcing is low, but increases labor demand beyond a certain threshold level.

trade and inequality nexus. Helpman and Itshkoki (2010), Helpman, Itskhoki, and Redding (2010 a,b), Felbermayr and Prat (2011) and Felbermayr, Prat and Schmerer (2011 a) introduce search frictions in the Melitz model. Exit of less productive firms boosts firms' recruiting efforts and thus reduces unemployment in the long run in the latter approach. Helpman, Itshkoki and Redding (2010 a,b) address worker heterogeneity. Larch and Lechthaler (2011) distinguish between high- and low-skill workers and analyze the effects of trade liberalization on skill-specific unemployment in a model with heterogeneous firms and search frictions.

Two empirical papers that shed light on the interaction of globalization and labor market outcomes are Felbermayr, Prat and Schmerer (2011 b) and Dutt, Mitra, and Ranjan (2009). Using macroeconomic data, both papers successfully test some of the major predictions derived from theory. Felbermayr, Prat, and Schmerer (2011 b) show that trade openness is negatively associated with equilibrium unemployment using panel and cross-sectional data. Moreover, in line with theory they identify TFP as potential channel variable through which globalization affects unemployment. Dutt, Mitra, and Ranjan (2009) employ cross-sectional data and find the same negative relationship.

To summarize the stylized facts discussed in the motivation, standard labor market models predict that a higher capital to labor ratio rises labor productivity and thus wages in the South but decreases wages in capital outflow country. This affects prices and thus competitiveness of the countries iff there are no other channels of price adjustments. Joint labor market interventions within Europe would ease the problem but it remains questionable to what extend such a wage coordination policy can be implemented in the future. Moreover, one-sided labor market policy interventions also affect a country's competitiveness and the pattern of trade between the integrated countries.

Section 2 lays out the benchmark model and discusses the existence of an unique equilibrium. Different scenarios of labor market reforms and their impact on wages, unemployment and competitiveness are discussed in Section 3. Section 4 concludes.

2. The benchmark model

The model is general equilibrium and features two countries that are integrated into a common currency union. Thus, all nominal variables are expressed in terms of a com-

mon currency and the total GDP generated within the union is normalized to unity. Effects arising through trade with non-members are not studied in the underlying paper.

Both countries can produce the same continuum of goods but we will show that countries can also specialize on a certain range of goods and trade them internationally. Final good assemblers or downstream producers use high- and low-skill specific intermediates and capital as input for the final good production. High-skill specific intermediates are produced by input of high-skill labor, whereas low-skill specific intermediates are produced by firms that employ low-skill labor only. Intermediate good producers are henceforth called upstream producers. Workers and upstream producers take expected prices charged by downstream producers into consideration and bargain about wages. The existence of search frictions drives a wedge between labor costs and prices charged by skill-specific upstream producers. The production and consumption side is interacted over all stages since labor and capital costs together pin down national income, union income, and (international) goods' prices.

Consumer preferences. Following Feenstra and Hanson (1996, 1997) preferences for $x(z)$ are modeled by

$$\ln Y = \int_0^1 \varphi(z) \, \ln x(z) dz \ , \tag{1}$$

where $x(z)$ denotes the amount of goods demanded from industry z and $\varphi(z)$ is industry z's Cobb Douglas consumption share.[4] The aggregate consumption good is produced without costs and sold for an aggregate price level P. Prices and wages are jointly determined by upstream producers, workers, and downstream producers. Aggregate demand for the final output good equals total expenditure $YP = E$. The aggregate demand function (1) implies that a constant fraction $\varphi(z)$ of world expenditure is spent on the consumption of good z. Thus, consumer demand for output generated in industry z reads as

$$x(z) = \frac{\varphi(z)E}{\kappa(z)} \ . \tag{2}$$

The share of expenditure spent for that particular industry z is equal to the revenue generated in the respective industry. Perfect competition implies that total revenue in industry z is equal to the quantity produced, $x(z)$, times unit costs, $\kappa(z)$. One can solve the

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[4]Integrating the shares over the whole continuum of industries must equal unity.

standard utility maximization problem of the representative consumer who maximizes utility (1) subject to the budget constraint, which depends upon prices, consumption, and income available for consumption. The first order condition of the utility maximization problem implies equation (2).

2.1. Final consumption goods producers.

We borrow the heterogeneous worker concept from Feenstra and Hanson (1996, 1997) by assuming that goods are produced in a continuum of industries using the input factors capital, high-, and low-skill workers. However, the model setup is different in that workers are not directly used by the final output good producers, instead those final goods are produced using intermediates obtained from small firms hiring either low- or high-skill workers. The input coefficients that determine input of intermediates in the production in z are given exogenously.[5] Goods in the continuum are ranked according to their skill intensities $a_h(z)$ and $a_l(z)$, both described by linear functions increasing in z. The assumption that the input coefficient curves that pin down low- and high-skill labor requirement are both steeper in the foreign country than in the home country give rise to gains from trade and determine the free trade pattern that stems from cross-country differences in production costs. Countries produce goods where they have a comparative advantage by means of lower unit costs compared to the unit costs in the competing country. However, it is sensible to link the input requirement curves to relative factor endowments so that, on average, low-skill abundant countries have a relatively higher low-skill labor demand in all industries. In the following, all countries are assumed to be low-skill abundant and all industries therefore have higher low-skill requirement on average.[6] The functional form of both input coefficient curves is

$$a_{li}(z) = \alpha_{li} + \gamma_{li}(z) \ , \tag{3}$$

$$a_{hi}(z) = \alpha_{hi} + \gamma_{hi}(z) \ , \tag{4}$$

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[5]Demand for intermediate goods produced maps into labor requirement due to the small firm assumption and perfect competition. Each upstream producer hires exactly one worker to produce one intermediate good.

[6]Whether a country is high- or low-skill abundant highly depends on how both categories are classified. On average the world is medium-skill abundant. Using WDI data in order to decompose the total labor force into low-, medium and high-skill components we find that on average 33 percent of the labor force has a low-skill education and only 16 percent of the work force hold a high-skill qualification.

where i is the country identifier, l denotes low-, and h denotes high-skill. Index k is an index for skill, which can take the values l or h. For the input coefficients we assume that α is a country-specific constant and γ denotes the industry specific component of labor requirement depending on z. Moreover, industries are ranked according to unit costs, which implies that $\gamma_{ki} > 0$. Similar to Feenstra and Hanson (1996, 1997) the final intermediate good is assembled according to the nested Leontief production function

$$x_i(z) = \left[\min \left\{ \frac{l_{li}(z)}{a_{li}(z)}, \frac{l_{hi}(z)}{a_{hi}(z)} \right\} \right]^\zeta [k_i(z)]^{1-\zeta} \ . \tag{5}$$

Input over high- and low-skill intermediates is assumed to be Leontief, which implies that the relation between high- and low-skill intermediates is fixed. The aggregated intermediate-good is nested into a Cobb Douglas production function that combines intermediates with capital to produce the final consumption good. Iranzo et al. (2008) use matched employer-employee data in order to estimate the between- and within-group elasticity of substitution among heterogeneous workers. Their results suggest complementarity between different skill groups but substitutability within a certain skill group, which supports the choice of a Leontief production technology.

Let $p(z)$ denote the price of each final intermediate input good, $l_l(z)$ is low-skill labor demand in industry z, and $l_h(z)$ is high-skill labor demand in industry z. Under autarky the whole continuum of goods is produced domestically. Under free trade however, both countries specialize and the range of active industries within each country is determined by the cutoff condition

$$p_d(z^*) = p_f(z^*) \ . \tag{6}$$

Downstream producer prices equal production costs depending on the firm's input coefficients, wages earned by workers producing intermediates for the upstream producers, and search cost paid by upstream producers in order to recruit workers. Goods are ordered according to their relative skill intensity. We know that intermediate good prices are equalized over the whole continuum. This implies that the ranking of industries according to production costs solely depends on the input coefficients, which are exogenously given and increasing in z. Wages in both countries are equalized across sectors z but not across skill groups. Each firm has to pay q_h for high-skill intermediate goods and q_L for low-skill intermediates. Intermediate goods' prices are taken as

given in the final production stage and set in the stage below where firms use high- and low-skill labor to produce the intermediates. Downstream producers adjust their labor demand with respect to prices charged by upstream producers. Perfect competition implies that the industry price level equals the respective industry unit costs

$$p_i(z) = \kappa_i(z) = D(q_{hi}a_{hi}(z) + q_{li}a_{li}(z))^\zeta r_i^{1-\zeta} \ , \tag{7}$$

where $D = \zeta^{-\zeta}(1 - \zeta)^{-(1-\zeta)}$ and $\kappa(z)$ denotes minimum unit costs in sector z obtained by solving the standard cost minimization problem for firms producing according to the production function (5).

2.2. Search and matching between workers and intermediate producers

Firms in this stage use labor to produce intermediate input goods. There are two different type of firms, one producing high-skill specific intermediates by input of high-skill labor, and one producing low-skill specific intermediates by input of low-skill labor. This assumption is consistent with the notion of firms producing different parts with different skill requirements in separated plants. The number of potential firms is given by low-skill labor endowment, L_i, and high-skill labor endowments, H_i. Each intermediate good producer employs one worker, and since demand for high- and low-skill intermediates is dictated by the Leontief production function (5) in the downstream production process, the maximum number of intermediate goods that can be produced in the economy equaly endowments. However, search frictions reduce the number of firms since some of the workers are unemployed.[7] Labor markets are not perfect. Employers and employees have to be matched to each other and firms have to post vacancies before hiring workers. Bargaining between firms and workers is separated according to the workers' skills without intra firm bargaining across skills. However, there is an interaction between high- and low-skill workers since upstream producers take downstream retail prices into consideration when negotiating wages. Equation (5) implies that there is no substitution between high- and low-skill workers since both inputs are used in a certain relation. Thus, firms' revenue is zero if bargaining with one

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[7]See Ebell and Haefke (2004) on a further discussion why the small firm assumption is harmless under the assumption of perfect competition. Under monopolistic competition the number of firms is crucial for determining the equilibrium. The Feenstra and Hanson (1996, 1997) model assumes perfect competition. The small firm assumption used in this extension is thus feasible.

or the other type of worker fails. Even if the relation in the production process is different, their importance for the revenue generated is equal since the real amount of both input factors is equal in production. Factors with higher input coefficients are more productive and therefore less units are used. Given that the price for the intermediate good depends on wages paid by upstream producers, labor market clearing hinges on a certain pair of equilibrium market tightness to secure that revenue generated by the downstream producers is exactly equal to $\kappa_i(z)x_i(z)$.

Intermediate input prices. Since the product market equilibrium depends on the labor market equilibrium more clarification is needed to shed light on the implications from vacancy posting costs for intermediate input prices. Firms can pay vacancy posting costs in terms of income, in terms of the good produced by the respective firm, aggregate price or in terms of the wage rate. The Pissarides (2000) assumption that vacancy posting costs are paid in terms of goods' prices is used in the following sections in order to solve for a unique equilibrium.

Proposition 1. *a) The intermediate input prices are governed by*

$$q_{li} = \frac{(1 - \beta_{li})b_{li}}{(1 - \beta_{li}) - c_{li}(\beta_{li}\theta_{li} + \frac{\eta_i + \lambda}{m(\theta_{li})})} \tag{8}$$

$$q_{hi} = \frac{(1 - \beta_{hi})b_{hi}}{(1 - \beta_{hi}) - c_{hi}(\beta_{hi}\theta_{hi} + \frac{\eta_i + \lambda}{m(\theta_{hi})})} \tag{9}$$

b) An increase in the equilibrium market tightness θ_k leads to an increase in wages and thus intermediate input goods prices since $\frac{\partial q_k}{\partial \theta_k} > 0$. This proposition holds irrespective of whether vacancy posting costs are paid in terms of numéraire or in terms of intermediate input prices.

Proof. Part a) follows from solving the standard Bellman equations as in Pissarides (2000) or Dutt et al. (2009). The small firm assumption implies that each high-skill (low-skill) specific intermediate good is produced by a firm that employs exactly one high-skilled (low-skilled) worker. Firms have to post vacancies in order to recruit new workers, which incurs vacancy posting costs c. In the following we assume that firms pay those recruitment cost c in some common units p. This is a more general formulation as in Pissarides (2000) where vacancy costs are paid in terms of the individual price

or Felbermayr, Prat, Schmerer (2011 a) where vacancy costs are paid in terms of the aggregate price level. The common vacancy price index p is measured either in units of numéraire, intermediate good prices, the aggregate price level, or the wage rate.[8] To solve for the general equilibrium of the model we follow Pissarides (2000) in that we assume that vacancy posting costs are paid in terms of intermediate goods prices. As an alternative, firms' recruitment costs could be paid in terms of the numeraire good. The conclusions drawn from the comparative static exercise in section 3 would not change. Apparently, to let firms pay recruitment costs as share of revenue generated within the firm instead of world income, which is the numéraire in our setup, is a more reasonable assumption.

The matching process itself is modeled according to a standard Cobb-Douglas matching function $m(\theta_k)$, which is concave and has constant returns to scale properties. The labor market tightness θ_k is skill-specific. The higher the number of posted job vacancies v relative to the number of job seekers u within a certain skill-group, the more potential matches will be created but the lower the success rate of a match. The equilibrium market tightness governs wages and unemployment through the Beveridge-curve, the Wage-curve, and the Job-creation condition. The Wage- and the Job Creation-curves are derived as in Pissarides (2000).

Job Creation. J_k in (10) denotes the present discounted value of expected profits from an occupied job in skill group k, V_k in (11) denotes the value of a vacant job in skill group k, and η denotes the exogenously given discount rate.[9] The value of a vacant job negatively depends on unit recruitment costs, but increases in the difference between the value of the filled job and the opportunity costs given by the value of the vacant job. The matching function itself pins down the probability of a successful match due to the assumption of constant returns to scale. The flow value of the filled job is revenue generated by the worker minus the wage rate paid to the worker.[10] Job separation due to an exogenous shock hits the firm with poisson arrival rate λ and destroys the value

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[8]One important feature of p is that it is measured in the common unit. Income, wages, and prices have the same units and are therefore valid.

[9]k is either l for low or h for high-skill.

[10]A firm's revenue $\varrho(z)$ equals the price charged for each intermediate good due to the small firm assumption. Prices still depend on z but it is possible to proof that prices do not hinge on industry specific parameters.

associated with that firm, which reads as

$$\eta V_k = -c_k p + m(\theta_k)(J_k - V_k) \; ; \tag{10}$$

$$\eta J_k = \varrho_k(z) - w_k - \lambda J_k \; . \tag{11}$$

At this stage we don't know whether per-worker revenue, $\varrho(z)$, is equal across industries. In equilibrium the value of unoccupied jobs is zero since firms continue to post vacancies until all profits are exploited

$$J_k = \frac{c_k p}{m(\theta_k)} \; . \tag{12}$$

It is sufficient to compute the optimal wage/equilibrium market tightness for the cutoff firm. However, unit costs/prices differ across firms in different industries. The Job Creation curve therefore reads

$$w_k = \varrho_k(z) - (\eta + \lambda)\frac{c_k p}{m(\theta_k)} \tag{13}$$

Wage Curve. The worker evaluates a job based on the offered wage and the opportunity cost of accepting the wage offer. The value of the job becomes zero if the job is destroyed. The worker receives the value of her outside option worth ηU_k in case of job separation, depending on the flow value of being unemployed $b_k = \tau_k + \iota_k B$. Following Pissarides (2000) we assume that unemployment benefits, B, enter the flow value of being unemployed additively. Moreover, we assume that high- and low-skilled workers evaluate unemployment benefits differently by introduction of the preference parameter ι_k. The intuition behind that is the assumption that unemployment benefits are low relative to their permanent income and thus relatively unimportant. Moreover, we assume that all other values of being unemployed, τ_k, are skill-specific as well and such that $\tau_h > \tau_l$. Workers find new jobs with a certain probability that depends on the market tightness, which translates into

$$\eta W_k = w_k - \lambda(W_k - U_k) \; ; \tag{14}$$

$$\eta U_k = b_k + m(\theta_k)(W_k^e - U_k) \; . \tag{15}$$

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We follow Dutt et al. (2009) and introduce W_k^e in order to take into account that workers are randomly matched to firms and therefore have to build expectations about W. This also implies that all firms pay the same wage rate and therefore only differ with respect to production. Wages itself are bargained and satisfy the bargaining condition

$$W_k - U_k = \beta_k(J_k + W_k - V_k - U_k) \ . \tag{16}$$

Thus the distribution of total gains depends on both actors' bargaining power, β, so that the equilibrium bargaining outcome must satisfy

$$w_k = \eta U_k + \beta_k(\varrho_k(z) - \eta U_k) \ . \tag{17}$$

It can be shown that the existence of recruitment costs increase wages through the outside option. An unsuccessful match incurs additional recruitment costs which is anticipated by the workers.

$$\eta U_k = b_k + \frac{\beta_k}{1 - \beta_k} c_k p \theta_k \ . \tag{18}$$

We obtain a wage condition by combining the equilibrium conditions (18) and (17) as shown in the Appendix to solve for

$$w_k = (1 - \beta_k)b_k + \beta_k c_k p \theta_k + \beta_k \varrho_k(z) \ , \tag{19}$$

which is the pendant to the labor supply curve in the standard Feenstra and Hanson (1996, 1997) model.

Equilibrium in the high-skill intermediate sector.   In equilibrium, the wage and the equilibrium market tightness θ_k are determined by interacting the wage curve and the job creation curve such that

$$(1 - \beta_h)b_h + \beta_h c_h p \theta_h + \beta_h \varrho_h(z) = \varrho_h(z) - \frac{c_h p}{m(\theta_h)}(\eta + \lambda) \ . \tag{20}$$

Simplifying then yields

$$\varrho_h(z) = \left(b_h + \frac{c_h p}{1 - \beta_h} \left(\beta_h \theta_h + \frac{\eta + \lambda}{m(\theta_h)} \right) \right) \ . \tag{21}$$

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Therefore, equation (21) implies that all downstream producers pay the same price for intermediate goods denoted $q_h(z) = \varrho_h(z)$ so that $q_h(z') = q_h(z'')$ for $z' \neq z''$. Intermediate good prices only depend on exogenous parameters and the equilibrium market tightness, which is common to all firms in all industries. Moreover, we assume that the discount rate η and the capital rental r are tied to the capital rental and we assume that the discount rate is predetermined by the capital rental.

Equilibrium in the low-skill intermediate good sector. Following the same line of reasoning we can derive the equilibrium condition for low-skill intermediate input prices as

$$\varrho_l(z) = \left(b_l + \frac{c_l p}{1 - \beta_l} \left(\beta_l \theta_l + \frac{\eta + \lambda}{m(\theta_l)} \right) \right) . \tag{22}$$

We denote the price paid by downstream producers for the purchase of low-skill intermediate inputs $q_l(z) = \varrho_l(z)$, which is possible due to the small firm assumption. Each firm employs one worker and produces exactly one unit of the intermediate good. The firm's revenue is thus equal the intermediate good price paid by the final output good producers. Moreover, the assumption that search costs are paid in terms of intermediate goods prices gives rise to the solution presented in Proposition 1.

Part b) of Proposition 1 is easily proved by deriving the first derivative of the labor market equilibrium condition with respect to θ_k, which is increasing since the vacancy filling rate is decreasing in the equilibrium market tightness $\frac{\partial m(\theta_k)}{\partial \theta_k} < 0$. Thus the first derivative of (8) and (9) with respect to θ_k is positive. $\qquad\square$

Skill-specific unemployment. Solving the product and labor market equilibrium pins down the low- and high-skill equilibrium market tightness and unemployment in both countries via the skill-specific Beveridge curves

$$u(\theta_{ki}) = \frac{\lambda}{\lambda + \theta_k m(\theta_{ki})} . \tag{23}$$

The Beveridge curve relates the unemployment-to-vacancy ratio such that the flow into unemployment equals the flow out of unemployment and therefore pins down long-run equilibrium unemployment rates in the economy. The Beveridge curve is convex due to the concave matching technology. Thus, the magnitude of the relationship between θ_k and u is stronger for relatively low values of unemployment.

Labor market clearing. The labor market clears when labor supply equals labor demand. However, due to search frictions labor supply is the fraction of matched workers outside the pool of unemployed workers. On the other hand, firms adjust their labor demand to the intermediate input prices that now do depend on wages and search costs. Thus, search costs drive a wedge between intermediate input prices and the wage earned by the firms' workers, but perfect competition still implies that prices are equal to production cost.

Final good producers are price takers and base their labor demand decision on the (already optimal) high- and low-skill intermediate goods' prices, given that wages are bargained between intermediate goods producers and workers, and given that those wages are optimal. Wages therefore map into intermediate goods' prices.

Applying Shephard's Lemma the demand for intermediates produced is equal to

$$
l_k(z) = \frac{\partial \kappa_k(q_h, q_l, r; z)}{\partial q_k(z)} = D\zeta a_k(z)(q_l a_l(z) + q_h a_h(z))^{\zeta-1} r^{1-\zeta} \ . \tag{24}
$$

Domestic labor market equilibrium requires that labor demand at the aggregate level is equal to total labor supply which is satisfied if

$$
L_d(1 - u_{ld}) = \int_{\underline{\mathbf{Z}}_d}^{\bar{\mathbf{Z}}_d} D\zeta \left[\frac{r_d}{q_{ld}a_{ld}(z) + q_{ld}a_{ld}(z)} \right]^{1-\zeta} a_{ld}(z)x(z)dz \ , \tag{25}
$$

and

$$
H_d(1 - u_{hd}) = \int_{\underline{\mathbf{Z}}_d}^{\bar{\mathbf{Z}}_d} D\zeta \left[\frac{r_d}{q_{hd}a_{hd}(z) + q_{hd}a_h(z)} \right]^{1-\zeta} a_{hd}(z)x(z)dz \ , \tag{26}
$$

hold. The right hand side is aggregate labor demand obtained by aggregating industry level labor demand over all industries. The specialization pattern under free trade is ex-ante unknown and depends on the unit cost schedule over all industries, where $\bar{z}_i$ denotes the upper and $\underline{z}_i$ the lower bound of the continuum of active industries in the respective country.

If we allow for free trade both countries are better off by specializing on production in sectors where they have an comparative advantage. A free trade equilibrium requires one unique cutoff $z^* \in (0, 1)$ for which each of the four labor markets is in equilibrium

and for which the cutoff condition

$$p_d(z^*) = p_f(z^*) \iff \kappa_d(\theta_{ld}, \theta_{hd}; z^*) = \kappa_f(\theta_{lf}, \theta_{hf}; z^*) \tag{27}$$

is fulfilled.

However, each cutoff $z^* \in [0, \infty]$ is associated with one unique combination of θ_l and θ_h. Thus, a necessary requirement for the free trade equilibrium is a cutoff associated with a combination of equilibrium market tightness parameters for which all labor markets clear and for which domestic equals foreign unit costs. Obviously, there is no upper bound for z which means that - given the exogenous parameters - such a cutoff might be outside the feasible space of industries, which is restricted to lie within the continuum $z \in [0, 1]$. If the cutoff condition is fulfilled for $z^* > 1$ only, we would obtain a corner solution where one country could produce all goods cheaper. In that case there are no incentives for one of the countries to participate in international trade so that both economies remain under autarky and produce the whole continuum domestically. Both cost schedules are increasing in z. Thus, an increase in the capital rental or the intermediate goods shift the unit cost schedules up. This shift in unit costs over the whole continuum will result in a loss of the comparative advantage in some industries located close to the former cutoff, resulting in a shift of z^*.

Prices of high- and low-skill intermediates depend on the endogenous equilibrium market tightness, and some exogenous parameters only. q can be substituted in the labor market clearing condition so that this condition only depends on θ_k. Following Feenstra and Hanson (1996, 1997) we exploit equation (2) and (7) in order to link the labor-, and product-market equilibrium via

$$L_d(1 - u_{ld}(\theta_{ld})) = \int_{\underline{\mathbf{Z}}_d}^{\bar{\mathbf{Z}}_d} \zeta \left[\frac{a_{ld}(z)\varphi(z)E}{q_{ld}(\theta_{ld})a_{ld}(z) + q_{hd}(\theta_{hd})a_{hd}(z)} \right] dz , \tag{28}$$

$$H_d(1 - u_{hd}(\theta_{hd})) = \int_{\underline{\mathbf{Z}}_d}^{\bar{\mathbf{Z}}_d} \zeta \left[\frac{a_{hd}(z)\varphi(z)E}{q_{ld}(\theta_{ld})a_{ld}(z) + q_{hd}(\theta_{hd})a_{hd}(z)} \right] dz . \tag{29}$$

Thus, the number of matches equals the number of intermediate goods available. The consumption share for each industry z is constant and by assumption equalized over the whole continuum.

Existence of an unique equilibrium. Labor market clearing requires that labor demand equals labor supply in each country and skill group. The labor market clearing conditions therefore pin down four θ_{ik}'s, and each θ_{ik} in turn pins down the respective wage and skill-specific unemployment rate. The equilibrium is unique since there exists exactly one pair of equilibrium market tightness satisfying all 2×2 labor market clearing conditions for a given cutoff z^*.

To see that an unique equilibrium exists we let Γ_L denote the left-, and Γ_R the right hand side of the labor market clearing condition. We further define $f_k(z) = \frac{\varphi(z)Ea_k(z)}{q_l(\theta_l)a_l(z)+q_h(\theta_h)a_h(z)}$. The left hand side of both labor market clearing conditions has its origin in zero and converges to an upper bound. The right hand side is also well behaved. Labor demand is decreasing in θ_k. An increase in θ_k triggers an increase in intermediate input good prices, which in turn reduces demand for intermediates. Applying the Leibniz rule to the right hand side of the labor market clearing condition and assuming that the bounds of the integral being constant yields

$$\frac{\partial \Gamma_R}{\partial q_k} = \int_{\underline{Z}}^{\bar{Z}} \frac{\partial f(z, q_l, q_h)}{\partial q_k} dz < 0 \ , \tag{30}$$

where world income is set as numéraire so that $E = 1$.[11] The first derivative approaches 0 when q_k goes to infinity and $\frac{\partial^2 \Gamma_R}{\partial q_k^2} > 0$. Therefore, firms' labor demand is decreasing in θ_k and converges to zero. Figure 1 illustrates the equilibrium. Notice, that there is an interaction between the low- and high-skill labor market clearing condition. The high-skill labor market tightness shifts low-skill labor demand Γ_R through the increase in the wage rate that enters both groups' labor market clearing condition.

Figure 1 depicts the left and right hand side of the labor market clearing condition in both skill groups. The focus lies on the interaction between equilibrium market tightness θ_k and labor demand / supply. For the sake of clarity we assume that the labor supply function Γ_L are equal in both sectors.[12] A change in one skill group's equilibrium market tightness also affects the respectively other skill-groups Γ_R. The equilibrium is unique since Γ_L has its origin at zero and converges to the upper bound whereas Γ_L

---

[11]Note that this normalization helps to solve some ambiguities. However, as shown later on world income does not change by much due to some countervailing effects of FDI on both countries' wages.

[12]That would be the case if matching functions and labor endowments are equal for both high- and low-skilled. Differences in endowments would shift Γ_L without affecting the shape of the curves. Our institutional variables as unemployment benefits, search costs, or the bargaining power of the workers do not affect the labor supply curves directly.
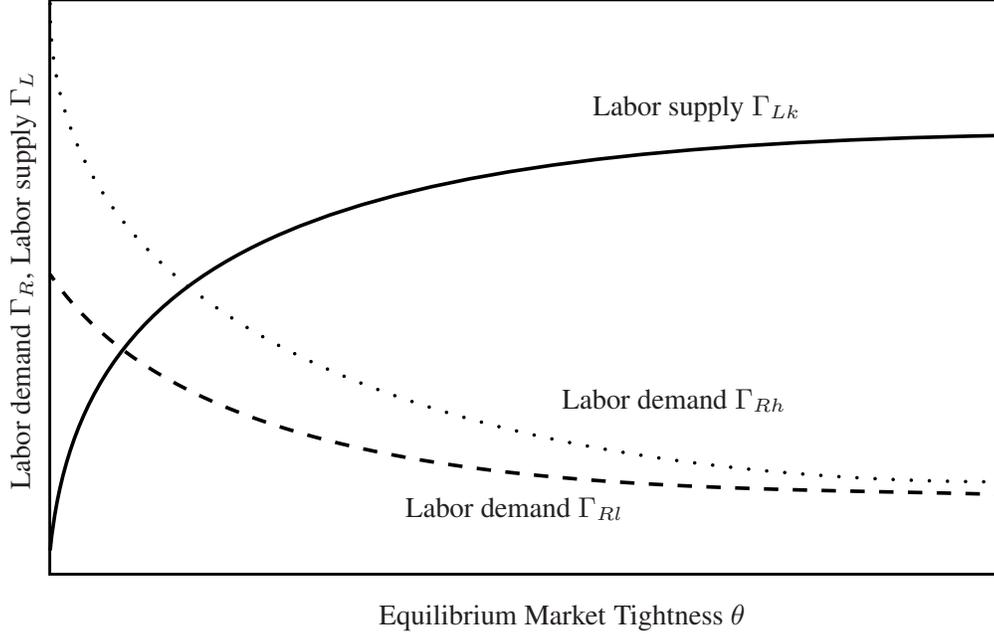
Figure 1: Labor market clearing condition

converges to zero when θ_k goes to infinity. However, equation (20) is asymptotic in θ so that the necessary restriction for θ_k is

$$\beta\theta_k + \frac{\eta + \lambda}{m(\theta_k)} < \frac{(1-\beta)}{c}$$

to secure that $q_k(\theta) > 0$. The market tightness θ is unique if this restriction is fulfilled and such that the wage and the job creation curve intersect.

Lemma 1. *The right hand side of the labor market clearing condition is increasing in z^* in the country where z^* determines the upper bound of active industries. Conversely, countries where z^* pins down the lower bound of industries suffer from a decrease in labor demand if z^* increases.*

Proof. The proof of Lemma 1 follows directly from the first derivative of the right hand side of the labor market clearing condition with respect of z^*, which is positive or negative depending on whether z^* is the upper or lower bound of the integral.Also see the

Appendix for a formal proof. □

2.3. General equilibrium

To close the model we still have to determine world income and capital returns. Income is normalized to unity and equals world factor payments in country d (domestic) and f (foreign)

$$E = L_d(1-u_{ld})q_{ld} + H_d(1-u_{hd})q_{hd} + r_d K_d + L_f(1-u_{lf})q_{lf} + H_f(1-u_{hf})q_{hd} + r_f K_f \ . \quad (31)$$

The capital rental is determined exploiting the Cobb Douglas shares and Shephard's Lemma again

$$r_d K_d = (1-\zeta)(\bar{z}_d - \underline{z}_d)E \ , \quad (32)$$

$$r_f K_f = (1-\zeta)(\bar{z}_f - \underline{z}_f)E \ . \quad (33)$$

Thus, the fraction ζ is spent for intermediates which gives us

$$L_d(1 - u_{ld})q_{ld} + H_d(1 - u_{hd})q_{hd} = \zeta(\bar{z}_d - \underline{z}_d)E \ , \quad (34)$$

$$L_f(1 - u_{lf})q_{lf} + H_f(1 - u_{hf})q_{hd} = \zeta(\bar{z}_f - \underline{z}_f)E \ . \quad (35)$$

Both equilibrium conditions can be solved for E in order to derive

$$r_d K_d = \frac{(1-\zeta)}{\zeta}(L_d(1 - u_{ld})q_{ld} + H_d(1 - u_{hd})q_{hd}) \ , \quad (36)$$

$$r_f K_f = \frac{(1-\zeta)}{\zeta}(L_f(1 - u_{lf})q_{lf} + H_f(1 - u_{hf})q_{hd}) \ . \quad (37)$$

The equilibrium thus depends on 8 endogenous variables: 4 equilibrium market tightness, capital return in the foreign and home country, one cutoff, as well as world income. We follow Feenstra and Hanson (1996, 1997) setting world income as numéraire so that we can drop one equilibrium condition as suggested by Walras' law.

3. Comparative statics

This section analyzes unilateral changes in labor market institutions on trade, foreign direct investment, and inequality. Labor market institutional changes in the extended FH framework improve a countries competitiveness through lower production costs. This change in competitiveness not only has an effect on domestic labor market, foreign labor markets are affected through capital inflows and a shift of the pattern of trade. Interest rates are treated as exogenous. A reduction in unemployment benefits for instance shifts the unit cost schedule down, followed by adjustments at the extensive margin through an expansion of production at home. Capital must flow between the two economies in order to restore equilibrium since interest rates are fixed and equalized across countries.

The explicit distinction between high- and low-skill workers allows us to disentangle the aggregate effects into its skill-specific effects. Institutional reforms always affect skill-specific unemployment in both the low- and the high-skill group directly through the wage setting mechanism and/or indirectly through the adjustments at the extensive margin. Put differently, improvements in the bargaining power of the low-skilled workers at home directly affect their wages and thus unemployment of the low-skilled only. Beyond that, wages and unemployment of all workers at home and abroad are affected through trade and FDI. We relax the assumption that high- and low-skilled workers evaluate labor market institutions with equal weights by changes in the preference parameter for unemployment benefits. The workers bargaining power or recruitment costs can be skill-specific. One could think about unions that have more power in low-skill labor intensive industries due to the higher union density. Search costs can be directly affected through the creation of job centers and special reemployment programs for less skilled workers. For instance by financing vocational retraining programs that help workers to switch occupations. Skill-biased effects of changes in the replacement rate are less obvious. Here we assume that high-skilled workers evaluate unemployment benefits with a very low preference when building expectations about their future income.

3.1. Non skill-biased effects of institutional reforms

Without loss of generality, interest rates are set exogenously and remain fixed in the comparative static exercise conducted below. All policies that intend to improve the workers' labor standards have an increasing effect on wages and unemployment. Less stringent institutions as lower unemployment benefits or lower employment protection legislation for instance reduce wages and unemployment in the search and matching framework. As shown in the Appendix, increases in unemployment benefits or bargaining power boost equilibrium wages in all industries and thus shift the unit cost schedule for downstream producers upwards. Although such changes in labor market institutions are unilateral, spillover effects might influence labor markets in countries integrated via trade and FDI. Adjustments with exogenous interest rates take place at the extensive margin only. An decrease in B or β will decrease the respective country's wages in all industries, inducing a downward shift of the unit cost schedule in country i. Adjustments at the extensive margin further increases labor demand since all jobs connected to those industries are newly created in the home country. The creation of industries also leads to excess capital supply in country i, which will be shifted to countries suffering from excess capital supply at the shrinking foreign economy. Due to the same reasons adjustments in country $i \neq j$ also take place at the extensive margin only. The capital inflow country's unit cost schedule therefore remains constant in the first step. However, since production expands in the inflow country, labor demand goes up, accompanied by an increased labor supply. A higher wage rate is needed to trigger an increase in labor supply. Therefore, the new equilibrium requires a higher market tightness in both skill sectors to satisfy the increase in labor demand.

Proposition 2. *a) An unilateral decrease in unemployment benefits B_i, bargaining power β_i, or search costs c leads to an decrease in country i's unemployment and wages and triggers capital inflows. b) Country $j \neq i$'s capital outflows and loss in competitiveness will increase its unemployment and employees' wages.*

Proof. a) follows directly by $\frac{\partial w_{ki}}{\partial B_i} > 0$ or $\frac{\partial w_{ki}}{\partial \beta_i} > 0$ if labor market institutions for high- and low-skill are equally affected by the reform. The intuition is straightforward. From equation (19) we get that that the wage curve shifts down if for instance unemployment benefits decrease. Suppose that the equilibrium market tightness remains fixed in a first step. The only way to restore equilibrium would be a proportional decrease in the

23

associated intermediate good price q. This would lead to more demand for intermediates and changes in the equilibrium market tightness so that labor market equilibrium is fulfilled again. A formal proof can be found in the Appendix.

Therefore, unit costs in all industries are lower due to lower labor costs. Labor supply Γ_{li} must go up in both skill sectors, since labor demand $\frac{\partial \Gamma_{ri}}{\partial q_{hi}} < 0$ and $\frac{\partial \Gamma_{ri}}{\partial q_{li}} < 0$. Again we first assume that the cutoff remains constant. At the extensive margin, we know that the unit cost schedule shifts down in country i followed by adjustments of the cutoff in favor of i. The adjustments at the extensive margin are already derived for the proof of the existence of an equilibrium. For country i the capital inflow and the expansion of its production to additional industries boosts labor demand and thus reduces unemployment, even if labor market institutions in that country remain unchanged. Again, a formal proof is already provided in the last chapter. To analyze how capital changes in the aftermath of institutional reforms we have to introduce capital market clearing conditions by aggregating individual industry demand for capital as

$$\frac{\partial \kappa_i(z)}{\partial r_i} = D(1 - \zeta)(q_{hi}a_{hi}(z) + q_{li}a_{li}(z))^\zeta r_i^{-\zeta} \ . \tag{38}$$

On the aggregate level capital demand is pinned down by

$$K_i = \int_{\underline{\mathbf{Z}}_d}^{\bar{\mathbf{Z}}_d} \frac{(1 - \zeta)\varphi(z)E}{r_i} dz \ , \tag{39}$$

which is found by aggregating individual industry capital demand (38) over the whole continuum of active industries. The cutoff is therefore directly linked to capital demand since interest rates and world capital stock is fixed per assumption and $\frac{\partial K_i}{\partial \bar{\mathbf{Z}}} > 0$ and $\frac{\partial K_i}{\partial \underline{\mathbf{Z}}} < 0$. This follows from the two country scenario where z^* is always one country's upper and the other country's lower bound of active industries. Unemployment decreases due to $\frac{\partial u_k}{\partial \theta_k} < 0$, which follows from equation(23). Part b) follows directly from part a) but the effects go into the opposite direction due to the fact that z^* is the lower bound of active industries at foreign. □

3.2. Skill-biased effects of institutional changes

Suppose that unemployment benefits enter the high-skilled workers outside option with a very low preference parameter ι_h. For sake of simplicity we focus on the sce-

nario where $\iota_h = 0$ so that the reduction of the replacement rate has zero effects on high-skilled wages.

Proposition 3. *a) With $\iota_h = 0$ the decrease in unemployment benefits B_i decreases unemployment and wages of the low skilled in country i but leaves wages of the high-skilled unchanged. This reduction in wages and thus intermediate good prices is associated with an expansion of industries through a higher competitiveness. b) High-skilled workers benefit from increased competitiveness due to an increase in their wage and an decrease in high-skill specific unemployment. c) Unemployment in country $j \neq i$ is increasing in both skill groups through the adjustments at the extensive margin.*

Proof. a) Suppose that the domestic country has a comparative advantage in industries closer to the lower bound of the mass of industries so that z^* is the domestic upper variable bound of active industries. Without a change in the equilibrium market tightness θ_{ld}, the reduction in B_d reduces wages of the low-skilled through b_{ld} but leaves b_{hd} unchanged. Nevertheless, production costs, $\kappa(z)$, are lower over the whole continuum. This reduction in unit costs shifts the unit costs schedule downwards associated with a higher cutoff $z^{*\prime} > z^*$. Domestic competitiveness increased through the labor market reform that lowered production costs at home. This scenario is illustrated in Figure 2.

Substitution between different skill-specific intermediates is not allowed by assumption, which translates into proportional changes of high- and low-skill specific intermediates. Higher demand for low-skill specific intermediates automatically increases demand for high-skill specific intermediates. The situation is different from the situation of the low-skilled workers. Increased demand for high-skilled can be met only by increases in the high-skilled wages so that wage inequality is rising due to the skill-biased labor market reforms.

The cutoff changes iff the direct effect on low-skill specific intermediate prices is not outweighed by the rise in high-skilled workers wages so that unit production costs, $\kappa(z)$ are falling over the whole continuum. This leads to an expansion of industries at home associated with the following adjustment processes. Firstly, labor demand for both type of skills increased due to the higher domestic output. Secondly, there is excess capital demand at home but excess capital supply at Foreign. Capital owners reallocate capital from Foreign to home through foreign direct investment iff capital rentals remain constant. Thirdly, both countries demand goods from the whole continuum of industries.
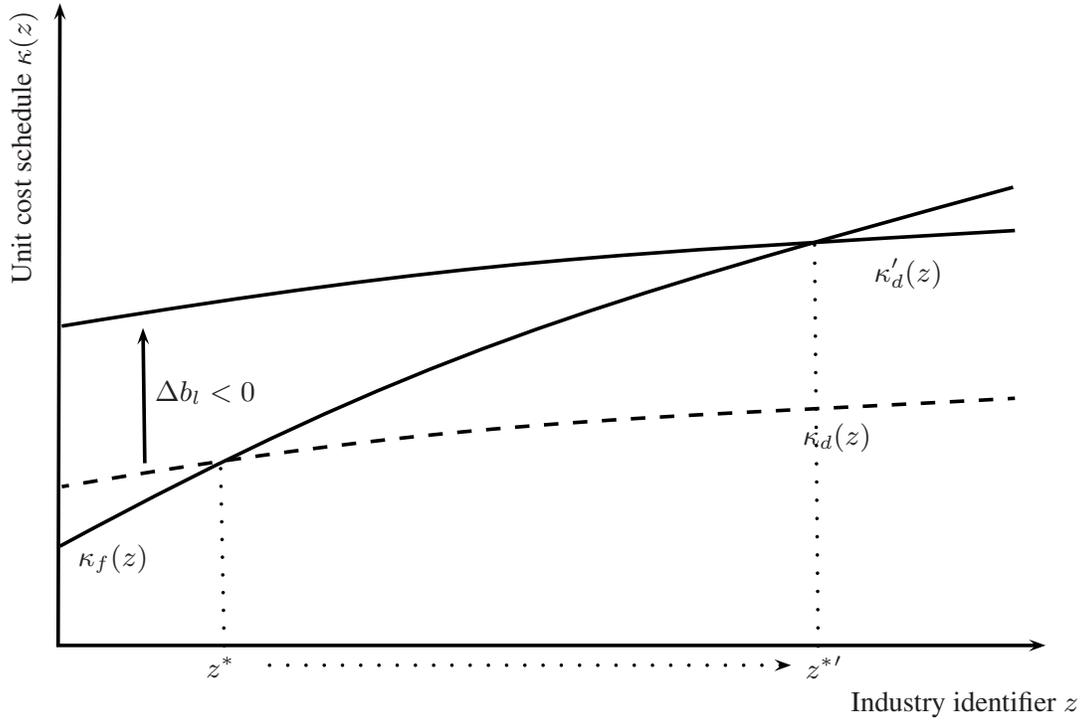
Figure 2: Skill-specific institutional spillover effects

Thus, home will export more but import less. Foreign consumers benefit from lower export prices but home consumers are worse off because of higher import prices. Part b) follows directly from the assumption that low- and high-skilled workers are complements. The expansion of production to industries formerly associated with Foreign also increases demand for high-skill specific intermediates through adjustments at the extensive margin, where the increase in z^* through the shift of the unit cost schedule increases aggregate labor demand. Wages of the high skilled increase and unemployment is decreasing. Wage inequality is increasing as suggested by the stylized facts presented in Dustman et al. (2009). Part c) is also straightforward. Unemployment in the foreign country must rise in both skill groups as the economy contracts and less labor is used to produce low- and high-skill specific intermediates. □

3.3. Cooperative labor market reforms

One-sided labor market reforms of one country's government without interventions in countries that are integrated through trade and foreign direct investment fosters unemployment in the non-reforming country. Reforms that are skill-biased in that mainly the low-skilled are directly affected benefit the high-skilled in the reforming country through the effects at the extensive margin. Those spillover effects can be mitigated by joint labor market reforms implemented by all governments within the community. Suppose that both government reduce unemployment benefits in way that the unit cost schedule in both countries shift such that the cutoff remains unchanged. Wages and unemployment of the low-skilled would be decreasing in both countries but the effects at the extensive margin would be zero without an effect on foreign direct investments or the pattern of trade between both countries.

4. Conclusion

In a nutshell, this paper's main contribution is to extend the Feenstra and Hanson (1996, 1997) international trade model by Pissarides (2000) search frictions in a way that enables the analysis of different type of labor market institutions on skill-specific wages, unemployment and the pattern of trade and foreign direct investment. This in turn implies that wages and capital flows can be affected by both, trade liberalization and changes in labor market institutions. Moreover, the notion of a continuum of industries not only permits the study of spillover effects across countries, it also gives rise to a new channel through which FDI affects labor demand at the extensive margin where whole industries are shifted abroad. As a result, it is possible to show that countries benefit from institutional changes in foreign countries through an expansion of their production to industries formerly associated with the reforming country. Put differently, labor market reforms can be associated with a rise in competitiveness if other channels as exchange rate policies are disregarded as we do in the model studied in this paper. The widening of the production to initially inactive industries, combined with the adjustments at the intensive margin reduce unemployment and increase wages in the new equilibrium. However, the reforming country's workers suffer from the loss in competitiveness in some of its initially active industries located close to the former

cutoff.

Wages in the original Feenstra and Hanson (1996,1997) model adjust independently from labor market institutions. However, the novel micro-founded wage setting mechanism in the Feenstra and Hanson model also facilitates the analysis of skill-biased changes in labor market institutions and its effects on FDI and labor market outcomes. It is possible to show that those institutional changes not only affect workers' wages and unemployment, it also indirectly affect FDI flows across countries. Surging labor costs render FDI more attractive and therefore lead to an increase in FDI outflows accompanied by higher wages and higher rates of unemployment.

One possible policy implication is that high-skilled workers benefit from those skill-biased labor market reforms and that governments should stick to joint labor market intervention in order to avoid negative spill-over effects on its partner countries.

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A Proofs

Derivation of equation (20). To derive the ETC conditions for both high- and low-skill intermediate producers we need to derive and interact the wage and the job creation curves. To solve for the job creation curve equation (12) and (11) are combined so that

$$(\eta + \lambda)\frac{cp}{m(\theta_k)} = \varrho_k(z) - w_k \tag{40}$$

To solve for the wage curve we start with rearranging equation (16) as

$$W_k - U_k = \frac{\beta}{1 - \beta} J_k \ . \tag{41}$$

Equation (11) can be rewritten as

$$(\eta + \lambda) J_k = \varrho_k(z) - w_k \ . \tag{42}$$

Expanding equation (14) by substracting $(\eta + \lambda)U_k$ on both sides gives

$$(\eta + \lambda)(W_k - U_k) = w_k + \lambda U_k - (\eta + \lambda)(U_k) \tag{43}$$

$$(\eta + \lambda)(W_k - U_k) = w_k - \eta U_k \tag{44}$$

A solution for the outside option is obtained by combining equation (15), equation (41), and equation (12) as

$$\eta U_k = b_k + \theta_k m(\theta_k)\frac{\beta}{1 - \beta}\frac{cp}{m(\theta_k)} \tag{45}$$

Combining equation (44), (41), (42), and (45) gives

$$(\eta + \lambda)\frac{\beta}{1 - \beta} J_k = w_k - \eta U_k \tag{46}$$

$$(\eta + \lambda)\frac{\beta}{1 - \beta}\frac{\varrho_k(z) - w_k}{\eta + \lambda} = w_k - \eta U_k \tag{47}$$

$$(\eta + \lambda)\frac{\beta}{1 - \beta}\frac{\varrho_k(z) - w_k}{\eta + \lambda} = w_k - b_k - \theta_k m(\theta_k)\frac{\beta}{1 - \beta}\frac{cp}{m(\theta_k)} \tag{48}$$

$$\beta\varrho_k(z) - \beta w_k = (1 - \beta)w_k - (1 - \beta)b_k - \theta_k\beta cp \tag{49}$$

$$w_k = (1 - \beta)b_k + \beta(\varrho_k(z) + \theta_k cp) \tag{50}$$

To solve for the equilibrium intermediate good price we can interact the wage curve (19) and the job creation curve (40) and solve for $\varrho_k(z)$

$$(1 - \beta)b_k + \beta(\varrho_k(z) + \theta_k cp) = \varrho_k(z) - (\eta + \lambda)\frac{cp}{m(\theta_k)} \tag{51}$$

$$\varrho_k(z) = b_k + \frac{cp}{1 - \beta}\left(\beta\theta_k + \frac{\eta + \lambda}{m(\theta_k)}\right) \tag{52}$$

Substituting p with ϱ, solving for ϱ yields the equilibrium price condition (8) and (9), where ρ is substituted with q due to independence of z. Using the Bellman equations we have shown that wages are independent from industries, which also implies that intermediate goods doe not depend on the industry identifier z.

Derivation of the Labor Market Clearing condition. We know that firms' demand for intermediate goods is given by equation (24). Aggregating low-skill labor demand over all industries and equating aggregate labor demand and supply yields

$$L_i(1 - u_{li}) = \int_{\underline{\mathbf{Z}}_d}^{\bar{\mathbf{Z}}_d} l(z)x(z)dz \tag{53}$$

$$L_i(1 - u_{li}) = \int_{\underline{\mathbf{Z}}_d}^{\bar{\mathbf{Z}}_d} B\zeta a_l(z)(q_l a_l(z) + q_h a_h(z))^{\zeta-1} r^{1-\zeta}x(z)dz \tag{54}$$

where we can use (2) to substitute out $x(z)$ and (7) to solve for (25) or (28) in order to derive a simpler version of the LMC and in order to calibrate the whole model. The assumption that all industries have equal share in the consumers' expenditure is made to solve the integral. This assumption allows us to introduce a constant instead of $\varphi(z)$ which is thus independent of z and instead depends on the bounds of the integral. To solve the integral by integration by parts we define $f_k(z) = a_k(z)$ and $g'_k(z) = (q_l a_l(z) + q_h a_h(z))^{-1}$, which gives us $\int f(z)g'(z) = [f(z)g(z)] - \int f'(z)g(z)$ and solves as

$$L_d(1 - u_{ld}(\theta_{ld})) = (\bar{z}_d - \underline{z}_d)\zeta E\left([a_{ld}(z)g(z)]_{\underline{\mathbf{Z}}}^{\bar{\mathbf{Z}}} - \int_{\underline{\mathbf{Z}}_d}^{\bar{\mathbf{Z}}_d} a'_{hd}(z)g(z)dz\right)$$

$$= \frac{(\bar{z}_d - \underline{z}_d)\zeta E}{\varpi'_d}\left([a_{ld}(z)\ln\varpi(z)]_{\underline{\mathbf{Z}}_d}^{\bar{\mathbf{Z}}_d} - \gamma_{ld}\int_{\underline{\mathbf{Z}}}^{\bar{\mathbf{Z}}}\ln\varpi(z)dz\right)$$

where we use $\varpi = q_{ld}(\theta_l)a_{ld}(z) + q_{hd}(\theta_h)a_{hd}(z)$ and $\varpi'(z) = q_l(\theta_l)\Gamma_l + q_h(\theta_h)\gamma_h$. The second integral is solved by substitution so that we obtain a version of the labor market clearing condition that is idendependent of z.

Existence of an equilibrium. First, notice that the left hand of the LMC curve Γ_L is well behaved due to the convexity of the Beveridge curve. For $\lim_{\theta\to\infty}\Gamma_L = L$ since $\lim_{\theta\to\infty}u(\theta) = 0$. Let the equilibrium market tightness go to zero and we find that $\lim_{\theta\to0}\Gamma_L = 0$ since $\lim_{\theta\to0}u(\theta) = 1$. Thus, for $\theta = 0$ we have full unemployment and no worker is willing to search for a job. The right hand side of the LMC curve is also well behaved. Demand for intermediates hinges on the intermediate goods prices q_k and q_k depends on exogenous parameters and the equilibrium market tightness. However, equation (20) is asymptotic in θ so that the necessary restriction for θ_k is

$$\beta\theta_k + \frac{\eta+\lambda}{m(\theta_k)} < \frac{(1-\beta)}{c}$$

to secure that $q_k(\theta) > 0$. However, this is not a strong assumption for reasonable values of the exogenous parameters. The first derivative of equation (20) is positive since

$$\frac{\partial q(\theta_k)}{\partial\theta_k} = -\frac{-c\left[\beta + \alpha(r+\lambda)m\theta_k^{\alpha-1}\right](1-\beta)b_k}{\left[(1-\beta) - c(\beta\theta_k + \frac{\eta+\lambda}{m(\theta_k)})\right]^2} > 0$$

which is needed to derive $\frac{\partial\Gamma_R}{\partial\theta_k} < 0$. It is enough to apply the Leibniz rule on Γ_R in order to derive

$$\frac{\partial\Gamma_R}{\partial q_k} = \int_{\underline{\mathbf{Z}}_d}^{\bar{\mathbf{Z}}_d} -\frac{\zeta\varphi(z)E(a_k(z))^2}{[q_la_l(z) + q_ha_h(z)]^2}dz < 0 \tag{55}$$

which implies that $\frac{\partial\Gamma_R}{\partial\theta_k} < 0$. To derive this proof the assumption that the upper and the lower bound remain constant was made. The intermediate good price for the other skill group is also implicitly assumed constant and optimal. However, there is an interaction between both skill groups. A change in the price of the other intermediate good shifts the regarded labor demand curve Γ_R. Therefore, given the upper and lower bounds of z there exists exactly one combination for both market tightness for which both skill group's LMC curves are jointly satisfied.

Proof of Lemma (1). This follows immediately by deriving the first derivative of Γ_R with respect to z^*. Notice, that for each country we ex-ante know whether z^* is the upper or lower bound from the assumptions about the countrys's technology parameters which are exogenous. In the two country scenario both countries have one constant bound (either 0 or 1) and one variable bound z^*. So it is important to determine whether z^* is the upper or lower bound for each country, which depends on the regarded country's comparative advantage. For the moment we assume that home has a comparative advantage in the production of goods closer to 1 and foreign has a comparative advantage in the production of goods closer to 0. For the home country z^* is therefore the lower bound of active industries. Changing the bounds and deriving the first derivative with respect to z^* therefore yields

$$\frac{\partial \Gamma_R}{\partial z^*} = -\frac{a_{kd}(z^*)\varphi(z^*)E}{q_{ld}a_{ld}(z^*) + q_{hd}a_{hd}(z^*)} < 0 \tag{56}$$

for home and respectively

$$\frac{\partial \Gamma_R}{\partial z^*} = \frac{a_{kf}(z^*)\varphi(z^*)E}{q_{lf}a_{lf}(z^*) + q_{hd}a_{hf}(z^*)} > 0 \tag{57}$$

for Foreign. An increase in the cutoff industry thus reduces labor demand at the extensive margin due to a reduction in active industries.

Proof of Proposition (2) and (3). The first derivative of the Equilibrium tightness curve with respect to b is

$$\frac{\partial q_k}{\partial b_k} = \frac{(1 - \beta)}{(1 - \beta) - c(\beta\theta_k + \frac{\eta+\lambda}{m(\theta_k)})} > 0 \tag{58}$$

Thus, the intermediate good's price q_k increases for each θ_k which shifts the respective unit cost curve upwards. Again the former equilibrium z^* is not optimal anymore and has to adjust. Take for instance an increase in the bargaining power. Again, the first

derivative reads

$$
\frac{\partial q_k}{\partial \beta} = \frac{-b_k \left[(1-\beta) - c(\beta \theta_k + \frac{\eta+\lambda}{m(\theta_k)}) \right] + (1-\beta)b_k c\theta_k + (1-\beta)b_k}{\left[(1-\beta) - c(\beta \theta_k + \frac{\eta+\lambda}{m(\theta_k)}) \right]^2} \tag{59}
$$

$$
= \frac{-b_k(1-\beta) + b_k c\beta \theta_k + b_k c\beta \frac{\eta+\lambda}{m(\theta_k)} + (1-\beta)b_k c\theta_k + (1-\beta)b_k}{\left[(1-\beta) - c(\beta \theta_k + \frac{\eta+\lambda}{m(\theta_k)}) \right]^2} \tag{60}
$$

$$
= \frac{+b_k c\beta \frac{\eta+\lambda}{m(\theta_k)} + b_k c\theta_k}{\left[(1-\beta) - c(\beta \theta_k + \frac{\eta+\lambda}{m(\theta_k)}) \right]^2} > 0 \tag{61}
$$

$$
\tag{62}
$$

Institutions that reduce search frictions due to lower search costs have the same effects as

$$
\frac{\partial q_k}{\partial c_k} = \frac{(1-\beta)b_{hd}\beta_k\theta_k + \frac{\eta+\lambda}{m(\theta_k)}}{\left((1-\beta) - c_k \left(\beta_k\theta_k + \frac{\eta+\lambda}{m(\theta_k)} \right) \right)^2} > 0 \tag{63}
$$

The shift of the unit cost schedule and the change in the cutoff industry also affects the other countries through spillover effects according to Lemma 1. Firstly, the unit cost schedule in the country where labor market institutions change in favor of the workers shift up. The unit cost schedule in the other country remains unchanged. The cutoff changes exactly as already described for the increase in the capital rental, so that Γ_R and Γ_L have to adjust accordingly. See the proof of Lemma 1 and the proof for uniqueness of the equilibrium to see that increased demand for intermediates can be met by a higher equilibrium market tightness only. A higher tightness lowers unemployment and rises wages or intermediate goods prices. The same logic applies if the reforms are skill biased. However, high-skilled workers benefit from skill-biased reforms due to higher wages and lower unemployment through increased competitiveness of home. Lower wages of high-skilled will boost demand for both high-and low-skill specific intermediates, reduce production costs iff the falling production costs of low-skill specific intermediates is not outwheigted by the rise in high-skill specific intermediate good prices, which further increases high-skilled wages and thus increases inequality.