FDI, Skill-Specific Unemployment and Institutional Spillover Effects*

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Abstract

This paper studies interaction and cross-country-spillover effects between FDI and labor markets in a Feenstra and Hanson type of trade model with imperfect labor markets due to search friction a là Pissarides (2000). I can show that FDI outflows increase aggregate equilibrium unemployment in the FDI sending country whereas the receiving country benefits from FDI-inflows and expands production to industries formerly associated to the sending country. The analysis of unemployment in a continuum of industries framework fascilitates the distinction between adjustments at the intensive and extensive margin of labor demand resulting in an ex-ante ambiguous effect of FDI on unemployment. Changes in labor market institutions also affect FDI-flows and lead to spillover effects between the integrated countries' labor markets. A numerical simulation illustrates and quantifies the results.

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1. Introduction

A massive reduction in transportation costs, as well as barriers to trade and capital have fueled a debate about potential risks of job destruction triggered by a reallocation of production to low cost countries. The widespread belief that globalization is responsible for job destruction also rationalizes the recent surge in protectionism described by Scheve and Slaughter (2007) amongst others and therefore motivated a large and emerging literature on trade and unemployment. Our contribution to this debate is to shed light on the interaction between product and labor markets by studying how footloose capital flows between two countries affect equilibrium unemployment. Moreover, the second major contribution is to analyze institutional spillover effects that stem from labor market institutional changes in favor of the workers. Institutional changes that benefit the workers lead to massive capital outflows and open a channel through which changes in one economy's labor market affect labor markets in the rest of the world. Such a change in institutions is also a potential explanation for the recently observed reversing trend in FDI to China. After two decades of attracting an astonishing amount of capital inflows and strengthening of Chinese firms in the 80s and 90s, China more recently started to transform into an FDI sending country.[1] The comparative static implications drawn from the model presented in this paper imply a two-way relationship with wages being jointly determined by labor market institutions and international trade. Based on this outcome of the model, recent improvements in the Chinese security system and workers' labor rights are a potential explanation for such a reversing trend.

Secondly, it will be shown that *FDI* affects labor demand on both the intensive and extensive margin. At the extensive industry margin the widening of the *FDI* receiving country's range of active industries is due to increased competitiveness in industries located close to the former cutoff, which boosts labor demand and thus decreases equilibrium unemployment. The impact of such an industry-reallocation from one to the other country is expected to be much stronger in magnitude than the effects caused by pure substitution between labor and capital. The effect is ambiguous and thus addressed in a numerical simulation. Conversely, adjustments in the standard Pissarides (2000) framework with capital but without a continuum of industries occur at the in-

[1] See Braunstein and Epstein (2002) for instance.

tensive margin only. *FDI-inflows* in such a simple model reduce capital costs and thus lead to substitution of labor by capital.

To the best of my knowledge, this paper is the first focusing on the unemployment effects of global sourcing in a model with a continuum of industries. Although the literature on global sourcing and unemployment is sparse and incomplete, the number of studies focusing on the effects of trade liberalization on labor market outcomes is numerous. Starting with Brecher (1974), researchers began to investigate the link between trade liberalization and international labor markets. Davidson and Matusz (1988, 2004) and Davidson et al. (1999) analyze those effects by merging the Pissarides search and matching framework with international trade models such as the Heckscher Ohlin model. Building on their work, Moore and Ranjan (2005) came forward with a model that allows to study how globalization affects skill-specific unemployment in a Heckscher Ohlin framework. More recently the spotlight has been turned towards the popular Melitz (2003) international trade model. Egger and Kreickemaier (2009) were the first to relax the full employment condition in the Melitz model by use of a fair wage constraint. However, their main interest lies in wage inequality rather than unemployment. Further approaches later started to study the implications of search frictions in the Melitz model (2003). In Felbermayr, Prat, and Schmerer (2010) we highlight a channel through which trade liberalization reduces equilibrium unemployment through the firm-selection and the cleansing of unproductive firms in an economy. The paper is closely related to Helpman and Itshkoki (2007), or Helpman, Itshkoki and Redding (2008, 2009), who focus on wage inequality, search unemployment, and the role of labor market institutions when firms are heterogeneous with respect to productivity.

Besides job destruction, the magnification of wage and employment inequality over the last few decades is also frequently associated with globalization. Feenstra (2010), for instance, emphasizes the widening of the gap between white and blue collar workers' wages in the period 1984 to 2001. Intuitively, one would expect that such an increase in the relative wage of high skilled workers is accompanied by a substitution between both kind of workers resulting in a decline of relative high-to-low skill employment. However, by comparing relative wages and relative employment data, Feenstra (2010) shows that both time series evolve equally over time. Implementing search frictions à la Pissarides (2000) into the Feenstra and Hanson (1996, 1997) trade model with a continuum of industries opens a new channel through which globalization likely affects unemployment and wages consistent with Feenstra (2010).

In Felbermayr, Prat, and Schmerer (2009), who show that trade openness is negatively associated with equilibrium unemployment using panel and cross-sectional data. Moreover, in line with theory we are able to identify TFP as potential channel variable through which globalization affects unemployment. Dutt, Mitra, and Ranjan (2010) employ cross-sectional data and find the same negative relationship.

2. The benchmark model

Product market equilibrium is determined in a two-stage production process: In stage 1, final goods are assembled using intermediate goods produced by two different types of firms in stage 2, and capital. Firms producing high skill intermediates do this by solely using high skill labor, whereas low skill intermediate good producers employ low skill labor only. Stage 2 firms and workers take expected prices charged by stage 1 firms into consideration and bargain about wages. Search frictions drive a wedge between labor costs and prices charged for intermediate goods. The production and consumption side is interacted over all stages since labor and capital costs together pin down national income, world income, and (international) goods' prices.

Consumer demand. Aggregate demand for intermediate goods Y over all industries reads as

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

where $x(z)$ denotes the amount of intermediate goods demanded from industry z and $\varphi(z)$ is industry z's Cobb Douglas consumption share.[2] The aggregate consumption good is produced without costs and sold for an aggregate price level $P = \int_0^1 p(z)$. Since prices and wages are jointly determined at stage 1 and 2, aggregate demand for the final output good equals total expenditure $YP = E$. The aggregate demand function (1) implies that a fraction $\varphi(z)$ of world expenditure is spent on the consumption of good z. Thus, consumer demand for output generated in industry z

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

[2] Summing up the shares over the whole continuum of industries must equal unity.

is such that the share of expenditure spent for that particular industry z is equal to the revenue generated in the respective industry.

Stage 1: Final consumption goods. Goods are produced using the input factors capital, high-, and low-skill intermediates. The input coefficients that determine labor requirements for production in z are given exogenously.[3] 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 for 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. Note, that technology plays a minor role since the results are not driven by differences in endowments or technology. 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.[4] The functional form of both input coefficient curves is

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

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

where i is the country identifier, α is a constant and γ denotes the industry specific component of labor requirement. Similar to Feenstra and Hanson (1996, 1997) the final intermediate good is assembled according to a nested Leontief production function

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

[3] Demand for intermediate goods produced on stage 2 maps into labor requirement due to the small firm assumption and perfect competition. Each stage 2 firm hires exactly one worker.

[4] 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. Lumping high and medium skilled workers to skilled workers we find that all developed counties are skill abundant.

Input over high- and low skill intermediates is assumed to be Leontief nested into a Cobb Douglas production function over intermediates and capital. Let $p(z)$ denote the price of each final intermediate input good, $l(z)$ is low skill labor demand in industry z, and $h(z)$ 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 cutoff is determined by

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

Stage 1 prices equal production costs depending on stage 2 firm's input coefficients, wages earned by workers that produce the intermediates in stage 2, and search cost paid by stage 2 firms in order to recruit workers. Perfect competition implies that the industry price level equals the respective industry unit costs

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

where $B = \zeta^{-\zeta}(1-\zeta)^{1-\zeta}$ and $c(z)$ denotes minimum unit costs in sector z obtained by solving the cost minimization problem to the production function (5) as shown in the Appendix. Goods are ordered according to their relative skill intensity. We know that intermediate good prices are equalized over the whole continuum and set in stage 2 which implies that the unit cost ranking of industries 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 at the final good level and are set in the stage below where firms use high and low skill labor to produce the intermediates. Stage 1 firms adjust their labor demand with respect to prices charged by stage 2 firms.

Stage 2: Intermediate input producers. Firms in this final stage use labor to produce intermediate input goods. There are two different type of firms, one producing high skill intermediates by input of high skill labor, and one producing low skill 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 L_i and H_i since each firm in stage 2 employs one worker, and since demand for high and low skill intermediates is dictated by the Leontief production function (5) in stage 1. However, search frictions reduce the number of firms since some of the workers are unemployed.

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 stage 2 firms take stage 1 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 generated is zero if bargaining with one 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 for production. Due to this complementarity in production firms cannot substitute the less efficient factor with more efficient ones which affects the bargaining process. Given that the price for the intermediate good in stage 1 depends on wages paid by stage 2 firms, labor market clearing hinges on a certain equilibrium market tightness to secure that revenue generated by firms in stage 2 is exactly equal to $p_i(z)x_i(z)$.

Wage bargaining and job creation in stage 2. In stage 2 one high (low) skill intermediate firm produces for the assembling process of good $x_i(z)$ in stage 2 and each firm employs one worker. Firms have to post vacancies in order to recruit new workers, which incurs vacancy posting costs. In the following we assume that firms pay 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 (2008) where vacancy costs are paid in terms of the aggregate price level. The common vacancy price index p is measured either in units of numeraire, intermediate good prices, the aggregate price level or wage.[5] In line with Pissarides (2000), I assume that vacancy posting costs are paid in terms of stage 1 prices when solving the general equilibrium of the model. The matching process itself is modeled according to a stan-

[5] 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.

dard Cobb-Douglas matching function $m(\theta)$, which is concave and has constant returns to scale properties.

Job Creation J_k in (8) denotes the present discounted value of expected profits from an occupied job in skill group k and V_k in (9) denotes the value of a vacant job in skill group k.[6] 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.[7] Job separation due to an exogenous shock hits the firm with poisson arrival rate λ and destroys the value associated with that firm.

$$\begin{aligned} rV_k &= -cp + m(\theta_k)(J_k - V_k) \quad (8) \\ rJ_k &= \varrho_k(z) - w_k - \lambda J_k \quad (9) \end{aligned}$$

In equilibrium the value of unoccupied jobs is zero since firms continue to post vacancies until all profits are exploited

$$J_k = \frac{cp}{m(\theta_k)} \quad (10)$$

We can combine (9) and (10) in order to obtain the Job Creation condition under perfect competition with search frictions as

$$\varrho_k(z) - w_k - \frac{cp}{m(\theta_k)}(r + \lambda) = 0 \ , \quad (11)$$

which states that the firm's revenue must equal variable production and recruitment costs. Wages are equalized across firms. This proposition is proved below and due to the definition of equilibrium market tightness which is the ratio between the number of vacancies posted and the number of unemployed workers. It is sufficient to compute the optimal wage/equilibrium market tightness for the cutoff firm. However, unit costs/prices differ across firms since per worker costs for the intermediate good are equal but the input requirement of workers (intermediate good from stage 3) in z is

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

[7] 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.

lower if $z < z'$.

Wage Curve To the worker the value of a job is worth the wage minus the opportunity cost of being employed. However, the firm might be destroyed with a certain probability. In that particular case the value of the job becomes zero and the worker receives her outside option worth rU_k. Unemployed workers receive some unemployment benefits b and with a certain probability they successfully find a new job in another firm.

$$\begin{aligned} rW_k &= w_k - \lambda(W_k - U_k) && (12) \\ rU_k &= b_k + m(\theta_h)(W_k^e - U_k) && (13) \end{aligned}$$

W_k^e in (13)is expected value of a job. By introducing W_k^e we 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

$$W_k - U_k = \beta(J_k + W_k - V_k - U_k) \tag{14}$$

Thus the distribution of total gains depends on both actors bargaining power and implies

$$w_k = rU_k + \beta(\varrho_k(z) - rU_k) \tag{15}$$

and

$$rU_k = b_k + \frac{\beta}{1-\beta} cp\theta_k \tag{16}$$

we obtain a wage condition by combining the equilibrium conditions (16) and (15) as shown in the Appendix to solve for

$$w_k = (1-\beta)b_k + \beta cp\theta_k + \beta\varrho_k(z) \ , \tag{17}$$

which is the pendant to the labor supply curve in the standard Feenstra and Hanson model.

Equilibrium in stage 2's high skill intermediate sector. In equilibrium, the wage and the equilibrium market tightness θ are determined by interacting the wage curve and the job creation curve such that

$$(1-\beta)b_h + \beta cp\theta_h + \beta \varrho_h(z) = \varrho_h(z) - \frac{cp}{m(\theta_h)}(r+\lambda) \ . \tag{18}$$

Simplifying then yields

$$\varrho_h(z) = \left(b_h + \frac{cp}{1-\beta}\left(\beta\theta_h + \frac{r+\lambda}{m(\theta_h)}\right)\right) \ . \tag{19}$$

Therefore, equation (7) states that all stage 1 firms 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.

Equilibrium in stage 2's low skill intermediate good sector. Following the same line of reasoning we can derive the equilibrium condition for low skill intermediate input prices as

$$\varrho_l(z) = \left(b_l + \frac{cp}{1-\beta}\left(\beta\theta_l + \frac{r+\lambda}{m(\theta_l)}\right)\right) \ . \tag{20}$$

We denote the price paid by stage 1 producers for the purchase of stage 2 low skill intermediate inputs $q_l(z) = \varrho_l(z)$.

Properties of the labor market equilibrium condition. Since the latter 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. In the following chapters I stick to the Pissarides (2000) scenario where vacancy posting costs are paid in terms of goods' prices.

Proposition 1. *a) The intermediate input price is pinned down by*

$$q_{ld} = \frac{(1-\beta)b_{ld}}{(1-\beta) - c(\beta\theta_{ld} + \frac{r+\lambda}{m(\theta_{ld})})} \tag{21}$$

$$q_{hd} = \frac{(1-\beta)b_{hd}}{(1-\beta) - c(\beta\theta_{hd} + \frac{r+\lambda}{m(\theta_{hd})})} \tag{22}$$

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

Proof. Part b) of proposition (1) is easily proven by deriving the first derivative of the stage 2 labor market equilibrium condition with respect to θ, which is increasing since the vacancy filling rate is decreasing in the equilibrium market tightness $\frac{\partial m(\theta)}{\partial \theta} < 0$. Thus the first derivative of (21) and (22) with respect to θ is positive. □

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

$$u(\theta_{ki}) = \frac{\delta}{\delta + \theta m(\theta_{ki})} \quad . \tag{23}$$

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 and u is stronger for relatively low values of unemployment. The convexity of the Beveridge curve is also a potential explanation for the increase in the high to low skill employment ratio described by Feenstra (2010). High skill employment and thus equilibrium market tightness is usually higher than low skill unemployment. Shocks that hit both skill groups therefore translate into stronger changes in low skill employment and raise the employment ratio between both skill groups.[8]

[8] Search frictions give rise to unemployment. Both sides of the labor market clearing condition depend on θ and thus adjust simultaneously. The required change in wages is thus mitigated by the change in unemployment, which is stronger in the low skill sector.

2.1. 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 cost. 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.

Proposition 2. *Firms in stage 1 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 on stage 2 between intermediate goods producers and workers, and given that those wages are optimal. Wages therefore map into intermediate goods' prices.*

Using Shepard's lemma we know that demand for intermediates produced in stage 2 is equal to

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

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

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

and

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

holds. The right hand side is aggregate labor demand aggregating industry level labor demand over all industries depending on input prices following (24). The specialization pattern under free trade is ex-ante unknown and depends on the unit cost schedule over all industries, where $\bar{\mathrm{z}}_i$ denotes the upper and $\underline{\mathrm{z}}_i$ the lower bound of the continuum of active industries in the respective country. Prices of high and low skill intermediates determined in stage 2 depend on the endogenous equilibrium market tightness, and some exogenous parameters only. We can substitute q in the labor market clearing condition so that this condition only depends on θ. Following Feenstra and Hanson (1996, 1997) we exploit

$$x(z) = \varphi(z)E/p(z) \tag{27}$$

and equation (7) in order to link the aggregate demand, labor-, and product-market equilibrium via

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

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

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. In the continuous scenario the mass of one single industry is close to zero. We therefore compute the mass of a certain range of industries within the whole continuum. To understand the implications of the assumption made above we compare the continuous scenario with the discrete scenario. Suppose n, the number of goods produced, is large and each industry has the same constant Cobb Douglas expenditure share φ. This would allow us to approximate $\varphi(z) = 1/n$.[9] The approximation in the continuous case is similar but here we need the notion of a mass of industries over the range $\underline{z}$ and $\bar{z}$. The solution to the integral is determined by substitution and integration by parts. We define $f_k(z) = a_k(z)$ and $g'(z) = (q_l(\theta_l)a_l(z) + q_h(\theta_h)a_h(z))^{-1}$ and obtain a solution for (28) and (29) as

$$\begin{aligned}
L_d(1-u_{ld}(\theta_{ld})) &= (\bar{z}_d-\underline{z}_d)\zeta E\left([a_{ld}(z)g(z)]_{\underline{z}}^{\bar{z}} - \int_{\underline{z}_d}^{\bar{z}_d} a'_{hd}(z)g(z)dz\right)\\
&= \frac{(\bar{z}_d-\underline{z}_d)\zeta E\theta}{\varpi'_d}\left([a_{ld}(z)ln\,\varpi(z)]_{\underline{z}_d}^{\bar{z}_d} - \frac{\gamma_{ld}}{\varpi'_d}\left[(\varpi(ln\varpi-1))\right]_{\underline{z}_d}^{\bar{z}_d}\right)\\
H_d(1-u_{hd}(\theta_{hd})) &= (\bar{z}_d-\underline{z}_d)\zeta E\left([a_{hd}(z)g(z)]_{\underline{z}_d}^{\bar{z}_d} - \int_{\underline{z}_d}^{\bar{z}_d} a'_{hd}(z)g(z)dz\right)\\
&= \frac{(\bar{z}_d-\underline{z}_d)\zeta E}{\varpi'_d}\left([a_{hd}(z)ln\,\varpi(z)]_{\underline{z}_d}^{\bar{z}_d} - \frac{\gamma_{hd}}{\varpi'_d}\left[(\varpi(ln\varpi-1))\right]_{\underline{z}_d}^{\bar{z}_d}\right)
\end{aligned}$$

where we use $\varpi = q_{ld}(\theta_l)a_{ld}(z) + q_{hd}(\theta_h)a_{hd}(z)$ and $\varpi'(z) = q_l(\theta_l)\gamma_l + q_h(\theta_h)\gamma_h$. For the

[9] As in the continuous case, the consumption share of one particular industry goes to zero if n is large.

foreign country we get

$$L_f(1-u_{lf}(\theta_{lf})) = (\bar{z}_f - \underline{z}_f)E\zeta\left([a_{lf}(z)g_f(z)]_{\underline{z}_f}^{\bar{z}_f} - \int_{\underline{z}_f}^{\bar{z}_f} a'_{hf}(z)g_f(z)dz\right) \quad (30)$$

$$= \frac{(\bar{z}_f - \underline{z}_f)E\zeta}{\varpi'_f}\left([a_{lf}(z)ln\,\varpi_f(z)]_{\underline{z}_f}^{\bar{z}_f} - \frac{\gamma_{lf}}{\varpi'_f}[(\varpi_f(ln\varpi_f - 1))]_{\underline{z}_f}^{\bar{z}_f}\right) \quad (31)$$

$$H_f(1-u_{hf}(\theta_{hf})) = (\bar{z}_f - \underline{z}_f)E\zeta\left([a_{hf}(z)g_f(z)]_{\underline{z}_f}^{\bar{z}_f} - \int_{\underline{z}_f}^{\bar{z}_f} a'_{hf}(z)g_f(z)dz\right) \quad (32)$$

$$= \frac{(\bar{z}_f - \underline{z}_f)E\zeta}{\varpi'_f}\left([a_{hf}(z)ln\,\varpi_f(z)]_{\underline{z}_f}^{\bar{z}_f} - \frac{\gamma_{hf}}{\varpi'_f}[(\varpi_f(ln\varpi_f - 1))]_{\underline{z}_f}^{\bar{z}_f}\right) \quad (33)$$

as a solution for the LMC curves.

Proposition 3. *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 θs, and each θ 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^*.*

Proof. 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 at zero and converges to an upper bound. The right hand side is also well behaved. Labor demand is decreasing in θ. An increase in θ 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 the bounds of the integral being constant yields

$$\frac{\partial \Gamma_R}{\partial q_k} = \int_{\underline{z}}^{\bar{z}} \frac{\partial f(z, q_l, q_h)}{\partial q_k} dz < 0 \quad (34)$$

due to the normalization $E = 1$.[10] 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 in crease in the wage

[10]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.

rate that enters both group's labor market clearing condition. Figure (1) draws low skill labor supply Γ_L and low skill labor demand Γ_R for a given high skill equilibrium market tightness. The difference between Γ_{R1} and Γ_{R2} is that the given high skill intermediate input price is higher in Γ_{R2} than in Γ_{R1}. Therefore, an increase in the respectively other skill group's intermediate input price shifts down the labor demand schedule in the regarded skill group.

$\square$

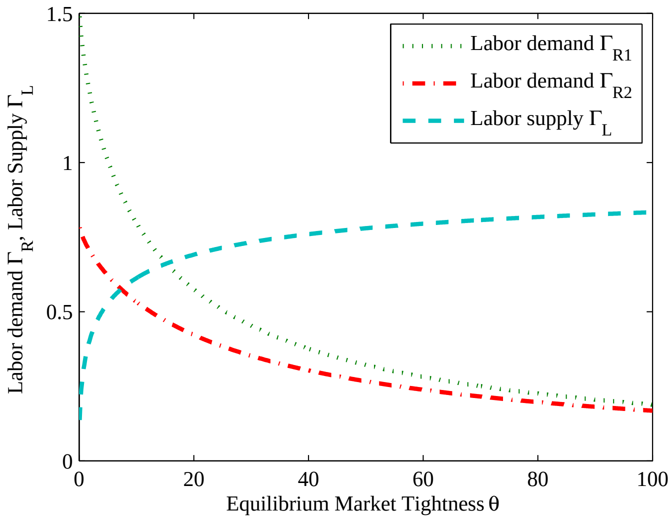


Figure 1: Labor market clearing condition

Figure (1) depicts the left and right hand side of the labor market clearing condition for one skill sector. The focus lies on the interaction between equilibrium market tightness θ and labor demand / supply in the regarded sector. We assume that the other sector's market tightness is in equilibrium. An increase in that sector's θ shifts the respective Γ_R downwards and leaves Γ_L unchanged. The equilibrium is unique since Γ_L has its origin at zero and converges to the upper bound whereas Γ_L converges to zero when θ goes to infinity.

Proposition 4. *a) The right hand side of the labor market clearing condition is increasing in z^* in the country where z^* determines the lower 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. b) The low skill sector's Γ_R increases faster in z^* than the low skill sectors Γ_R. c) Income proportionally shifts all labor market clearing conditions.*

Proof. Part one of this proposition 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. Part b) is due to the assumption that $a_h(z) > a_l(z)$, the slope of Γ_R in the low skill sector is always greater than in the high skill sector. For part c) it is enough to see that income proportionally shifts all labor market clearing conditions proportionally. Without loss of generality, we can sterilize the effects on the aggregate level by setting income as nummeraire so that the equilibrium is not affected by changes in world income. □

Proposition 5. *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*

$$p_d(z^*) = p_f(z^*) \quad \Leftrightarrow \quad c_d(\theta_{ld}, \theta_{hd}; z^*) = c_f(\theta_{ld}, \theta_{hd}; z^*) \tag{35}$$

is fulfilled.

However, proposition 4 states that 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 a $z^* > 1$ we get a corner solution where one country produces all goods cheaper at home than abroad. There are no incentives for that country to participate in international trade. In such a scenario, both economies would thus remain under autarky and produce the whole continuum domestically.

3. General Equilibrium

To close the model we still have to determine world income and capital returns. Income is not normalized to unity and equals world factor payments

$$E = L_d(1-u_{ld})w_{ld}+H_d(1-u_{hd})w_{hd}+r_dK_d+L_f(1-u_{lf})w_{lf}+H_f(1-u_{hf})w_{hd}+r_fK_f+UB \ , \tag{36}$$

where $UB = u_{ld}L_db_{ld} + u_{hd}H_db_{hd} + u_{lf}L_fb_{lf} + u_{hf}H_fb_{hf}$ denotes aggregate unemployment benefits paid by the government. The capital rental is determined on stage 1 where capital is used as input factor by exploiting the Cobb Douglas shares so that the share spent on intermediates equals the share spent on capital

$$r_dK_d = \frac{1-\zeta}{\zeta}\left(L_d(1-u_{ld})q_{ld} + H_d(1-u_{hd})q_{hd}\right) \tag{37}$$

$$r_fK_f = \frac{1-\zeta}{\zeta}\left(L_f(1-u_{lf})q_{lf} + H_f(1-u_{hf})q_{hf}\right) \ . \tag{38}$$

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. World income is set as nummeraire so that we have to drop one equilibrium condition as suggested by Walra's law.

4. Comparative statics

We now turn to the comparative statics of the model and analyze how FDI-flows affect the 2×2 equilibrium market tightness parameters. Second, the effects of a change in labor market institutions on FDI-flows and unemployment are analyzed. Endogenous interest rate adjustments are assumed in the first scenario, whereas interest rates in the latter scenario are treated as exogenous.[11] An increase in unemployment benefits for instance shifts the unit cost schedule upwards, followed by adjustments at the extensive margin. Capital must flow between the two economies to restore equilibrium since interest rates are fixed and equalized across countries. At the intensive margin firms will have an incentive to substitute labor with capital since capital becomes relatively

[11] One implication from scenario i) is that without capital barriers capital flows until capital costs are equal in both countries.

cheaper when labor market institutions change in favor of the workers.

4.1. The effects of FDI on skill specific unemployment

In a globalized world without frictions in the financial markets, capital will flow between the economies as long as capital returns across countries are different. For the moment we maintain the assumption that the interest rates are endogenously determined in each country and study how capital in- and outflows affect labor markets. Since some of the ambiguities in the model remain unsolved a numerical example is used to illustrate the results.

FDI in the form of capital flows between countries induces a readjustment in the interest rate. FDI inflows for instance reduce the scarcity of capital and thus also reduce the respective interest rate, thereby affecting unit costs. Given that all other factor prices remain constant, the unit cost schedule shifts down associated with lower industry price level over the whole continuum. The opposite happens in the country that looses capital due to an interest rate that is lower than the interest rate in the foreign country. The FDI-out country's unit cost curve shifts up, accompanied by higher goods' prices in all active industries.

Thus, the former trade pattern is no longer optimal due to a shift of industries located around the initial cutoff. The new intersection of the domestic and the foreign unit cost schedule is pinned down by $z^{*'} > z^*$. The FDI-out economy contracts whereas the FDI-in economy expands production. This also implies that the former labor market equilibrium is not optimal any more: unemployment, wages and the equilibrium market tightness have to adjust in order to restore equilibrium.

At the extensive margin whole industries get lost, which reduces labor demand on the aggregate level by destroying all jobs associated with those industries. At the same time the adjustments of capital costs and wages will also directly affect the equilibrium labor demand in stage 2, which results in a substitution between capital and labor.[12]

Proposition 6. *FDI outflows have an increasing effect upon domestic interest rates resulting in a substitution between capital and labor. Labor demand at the intensive margin increases in both skill sectors. At the extensive margin the increase in the cutoff industry*

[12] Substitution between high and low skill workers is excluded by assuming a Leontieff production function.

destroys all jobs associated with those particular industries. The opposite effects can be found in the FDI-inflow country.

Proof. To see this one has to compute the first derivative of labor demand with respect to the cutoff z^*, which is positive for the receiving country and negative for the sending country. This translates into job creation (FDI-inflow country) and job destruction (FDI-outflow country) at the extensive margin. At the intensive margin it is enough to see that industry labor demand for both types of workers goes up when the interest rate increases.

In order to restore equilibrium labor supply must adjust, too. Since labor demand in the FDI-outflow country decreases at the extensive margin, a higher rate of unemployment is needed to restore equilibrium. Thus, the equilibrium market tightness must fall, wages go down and unemployment increases. This in turn boosts labor demand at the individual industry level and strengthens the increase in labor demand at the intensive margin. A third effect arises due to income adjustments. However, this effect is negligible since i) the magnitude of the effect is small and ii) income proportionally shifts all labor market clearing conditions in the domestic and foreign country. Notice that i) follows from the fact that domestic and foreign equilibrium market tightness evolve in opposite directions. An increase in foreign income is thus mitigated through a decrease in the domestic income, resulting in negligible changes in world income as shown in the simulation. □

4.2. Changes in labor market institutions

Extending the Feenstra and Hanson (1996) framework by implementing a micro based wage setting mechanism in combination with search frictions allows us to study the implications of labor market institutional variables. Without loss of generality, interest rates are set exogenously and remain fixed in the comparative static exercise conducted below. Policies that intend to improve the workers' rights have an increasing effect on wages. 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 stage 1 firms upwards. Although such changes in labor market institutions are unilateral, spillover effects might influence domestic labor markets in countries integrated via trade and FDI. It shall be shown that such spillover effects occur in the model presented above.

Adjustments with exogenous interest rates take place at the extensive margin only. An increase in b or β will increase the respective country's wages in all industries, inducing an upwards shift of the unit cost schedule in country i. Such an increase in labor costs will also induce substitution of labor with capital, which boosts the rate of unemployment at the intensive margin. Adjustment at the extensive margin further reduces labor demand since all jobs connected to those industries get lost in the home country. The destruction of industries also lead to excess capital supply in country i, which will be shifted to countries suffering from excess capital demand due to the enhanced production.

In country $i \neq j$ adjustments take place at the extensive margin only since interest rates do not change. The receiving country's unit cost schedule therefore remains constant. However, since production expands in the receiving 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 7. *a) An unilateral increase in unemployment benefits b_i or bargaining power β_i leads to an increase in country i's unemployment and wages and triggers capital outflows. b) Country $j \neq i$'s capital inflows will reduce its equilibrium unemployment but increase its employees wages.*

Proof. a) follows directly by $\frac{\partial w_{ki}}{\partial b_i} > 0$ or $\frac{\partial w_{ki}}{\partial \beta_i} > 0$ where we assume that the labor market institutions across high and low skill sectors are equal. Therefore, unit costs in all industries rise and labor is substituted with capital. Labor supply Γ_{li} must go down 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 to derive the effects at the intensive margin. At the extensive margin, we know that the unit cost schedule shifts upwards in country i followed by adjustments in the cutoff. The adjustments at the extensive margin are already derived for the prove of proposition (3). For country $i \neq j$ 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 for proposition (3). 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

$$\frac{\partial c_i(z)}{\partial r_i} = B(1-\zeta)(q_{hi}a_{hi}(z) + q_{li}a_{li}(z))^{\zeta} r_i^{-\zeta} \ . \tag{39}$$

On the aggregate level capital demand is pinned down by

$$K_i = \int_{\underline{\mathrm{Z}}_d}^{\bar{\mathrm{Z}}_d} \frac{(1-\zeta)\varphi(z)E}{r_i} dz \ , \tag{40}$$

which is found by aggregating individual industry capital demand (39)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 $\frac{\partial K_i}{\partial \bar{\mathrm{Z}}} > 0$ and $\frac{\partial K_i}{\partial \underline{\mathrm{Z}}} < 0$. 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.

□

4.3. The effects of FDI on wage and employment inequality

Wages and unemployment are determined by the respective equilibrium market tightness. Generally, wages and employment equally evolve in θ and thus move along. However, inequality measures hinge on the magnitude and the direction of the effect. In the model presented above wages in both skill groups increase if the respective country is the FDI-in country and decrease if FDI flows out. However, the magnitude of the effect is different which has important implications for the inequality measures depending on the properties of the matching function and the input requirements. The convexity of the Beveridge curve implies that the unemployment rate is less elastic for relatively higher values of the equilibrium market tightness. High skill unemployment is usually lower than low skill unemployment which implies $\theta_{hi} > \theta_{li}$. Search frictions and the convexity of the Beveridge curve thus give rise to an additional channel that influences the magnitude of the effects on wages and unemployment. This new channel is easily seen by comparing the LMC curves of the original Feenstra and Hanson (1996, 1997) framework with equation (33). Without search frictions the left hand side of equation (33) remains constant and wages must adjust so that the full employment condition is fulfilled. In my approach both sides of equation (33) adjust. Suppose that FDI-outflows decrease the range of active industries in the domestic country. To restore equilibrium in (33) wages have to decrease and the rate of unemployment goes up.[13] This reduction in employment also reduces the pressure on wages due to a reduction in the active labor force since both Γ_L and Γ_R are changing. The convexity of the Beveridge curve and the fact that $\theta_{hi} > \theta_{li}$ implies that the magnitude of the change in unemployment is relatively stronger for low than for high skill unemployment. The change in the equilibrium market tightness needed to restore equilibrium is therefore stronger for the high skilled than for low skilled. Second, as in Feenstra and Hanson differences in technology also magnify the inequality.

Proposition 8. *Wage and employment inequality move along and are increasing in the sending but decreasing in the receiving country.*

Proof. The convexity of the Beveridge curve and $\theta_h > \theta_l$ imply $\frac{\partial u(\theta_h)}{\partial \theta_h}\frac{1}{u(\theta_h)} < \frac{\partial u(\theta_l)}{\partial \theta_l}\frac{1}{u(\theta_l)}$. From Proposition (3) we know that a change in z^* affects labor demand Γ_R in both skill groups. To restore equilibrium wages have to adjust through adjustments in the equilibrium market tightness which also affects the left hand side of the LMC curve. Suppose for instance z^* changes in a way that the range of domestic industries contracts. A lower wage rate is needed to restore equilibrium and Γ_R in both skill groups decrease. However, lower wages also decrease the number of workers searching for a job, inducing a surge in unemployment and a decline in Γ_l. Thus the magnitude of the change in wages needed to restore the LMC equilibrium is lower with search frictions. This mitigation effect is stronger for the low skill sector then for the high skill sector due to the fact that $\theta_h > \theta_l$, which gives rise to $\frac{\partial u(\theta_h)}{\partial \theta_h}\frac{1}{u(\theta_h)} < \frac{\partial u(\theta_l)}{\partial \theta_l}\frac{1}{u(\theta_l)}$. □

5. Numerical Example

The following numerical example illustrates the model's predictions and allows us to solve some of the remaining ambiguities in the comparative static exercises. The parameters are set as required to match certain moments found in other empirical labor market studies. However, calibrating the product market parameters remains difficult because of the notion of a continuum of industries. Table 2 provides the necessary details on the benchmark specification of the simulation.

[13] A lower equilibrium market tightness reduces the wage rate and the rate of employment.

Figure 2: Parameterizations of the model

Parameters used for the simulation		
Labor market parameters		
λ	Job destruction rate	0.04
α	Elasticity of the matching function	0.50
b	Unemployment benefits	0.1
m	Scale parameter of the matching function	0.7
c	Vacancy posting costs	0.4
Industry Input Coefficients		
α_{ld}	Constant of the input coefficient curve (domestic low skill)	2.3
α_{hd}	Constant of the input coefficient curve (domestic high skill)	2.9
α_{lf}	Constant of the input coefficient curve (foreign low skill)	1.6
α_{hf}	Constant of the input coefficient curve (foreign high skill)	1.9
γ_{ld}	Slope of the input coefficient curve (domestic low skill)	0.2
γ_{hd}	Slope of the input coefficient curve (domestic high skill)	0.3
γ_{lf}	Slope of the input coefficient curve (foreign low skill)	1.8
γ_{hf}	Slope of the input coefficient curve (foreign high skill)	1.9
ζ	Cobb Douglas share (stage 1 production)	0.50
Endowment		
L_d	Low skill labor force, domestic	0.22
H_d	High skill labor force, domestic	0.25
L_f	Low skill labor force, foreign	0.22
H_f	High skill labor force, foreign	0.25
K_d	Capital domestic	6.25
K_f	Capital foreign	6.25

Product market related parameters. The high and low skill input coefficient curves are set such that the domestic country has a comparative advantage in industries closer to one, whereas the foreign country has a comparative advantage in industries located closer to zero. Notice, that the outcome of the comparative static exercise is independent of the assumptions about technology, provided that an free trade equilibrium is feasible.[14]

The Leontief production function requires that the relative *low-to-high skill* industry labor requirements reflect the relative labor endowments in the respective country (on average). The respective parameters α and γ are set accordingly. Labor endowments in the domestic and the foreign country are assumed to be equal and set to 0.25 for high and 0.22 for low skill labor endowment. This replicates the stylized fact that countries are slightly high skill abundant on average. The notion of a continuum of industries implies that a single industry has almost zero mass. Thus, the labor requirement for a industry approaches zero, which explains why the input coefficient for a single industry is relatively high compared to the endowment of the whole economy. The interpretation of a particular industry is meaningless and one instead should focus on a range of industries in order to obtain sensible results.

The Cobb-Douglas share in stage 1 is set equal to $\zeta = 0.5$ and equilibrium interest rates are targeted to approach 2 percentage points.

Labor market related parameters. Labor market parameters are set to target skill specific unemployment rates around 4 percentage points in the high skill sector and 10 percentage points in the low skill sector.[15] However, the solution slightly departs from the targeted values since the 2×2 equilibrium market tightness, 2×1 interest rates, and the cutoff are simultaneously determined in equilibrium. Reasonable estimates from Hall (2005) are $\theta = 0.5$ corresponding to a 7 percentage point rate of unemployment for the U.S. economy. We target the equilibrium market tightness to lie slightly above (high skill) and below (low skill) that value and set the scale of the matching function so that equilibrium unemployment is 4 percent for high skill and 8 percent for low skill workers. The replacement rate and the vacancy posting cost parameter is a black box with no sensible data existing. In line with Petrongolo and Pissarides (2001) we set the

[14] Which is the case if the equilibrium $z^* \in [0, 1]$ is feasible before and after the change in the variable of interest.

[15] See Shimer (2005) for a full-fledged calibration of the search and matching mechanism.

elasticity of the matching function equal 0.5.

5.0.1. FDI-flows and skill specific unemployment

FDI-flows with endogenous interest rates. In a first scenario the effects of capital flows from the domestic to the foreign country are studied. The starting point for the analysis is the benchmark situation where $r_f > r_d$ triggers capital flows from Home to Foreign until interest rates are equalized. For the analysis we choose $K_D = 4.25$ $K_F = 8.25$ as starting point and simulate symmetric flows from the foreign to the domestic country up to the point $K_F = 8.25$ $K_D = 4.25$. Capital flows affect equilibrium capital and labor cost and thus equilibrium unemployment exactly as predicted in the theory section of this paper. Although the marginal effects have the expected sign, the magnitude of the effect is weak. High and low skill employment, as well as wages are decreasing in the receiving (home) country and increasing in the sending (foreign) country. The benchmark in Figure (3) represent the point where the foreign and domestic interest rate curves intersect, which is the point where Home and Foreign both have 6.25 units of capital.

The middle right panel in Figure (3) illustrates this result. In the domestic FDI sending economy capital becomes relatively more scarce resulting in an increase in capital costs. Such an increase shifts the cost schedule upwards, accompanied by a higher cutoff.[16] Factor costs in the foreign country adjust, too. Due to the increased supply, the foreign interest rate is decreasing, but the unit cost schedule shifts upward. This stems from the increase in intermediate goods' cost that outweigh the reduction in unit cost induced by the fall in capital cost.

The evolution of equilibrium market tightness enables us to study the effects of FDI on skill specific unemployment. Capital flows shifted the comparative advantage in some industries located around the cutoff from Home to Foreign. To avoid excess supply of both types of workers, the wage and unemployment rate must increase in the FDI-out country .[17]

The foreign country itself expands production in industries formerly hosted by the

[16] This experiment holds provided the unrealistic assumption that factor cost for labor remain constant. Changes in labor cost are analyzed in the next step.

[17] Substitution at the intensive margin countervails the adjustments on the extensive margin but is not enough to compensate for the immense job destruction on the extensive margin.

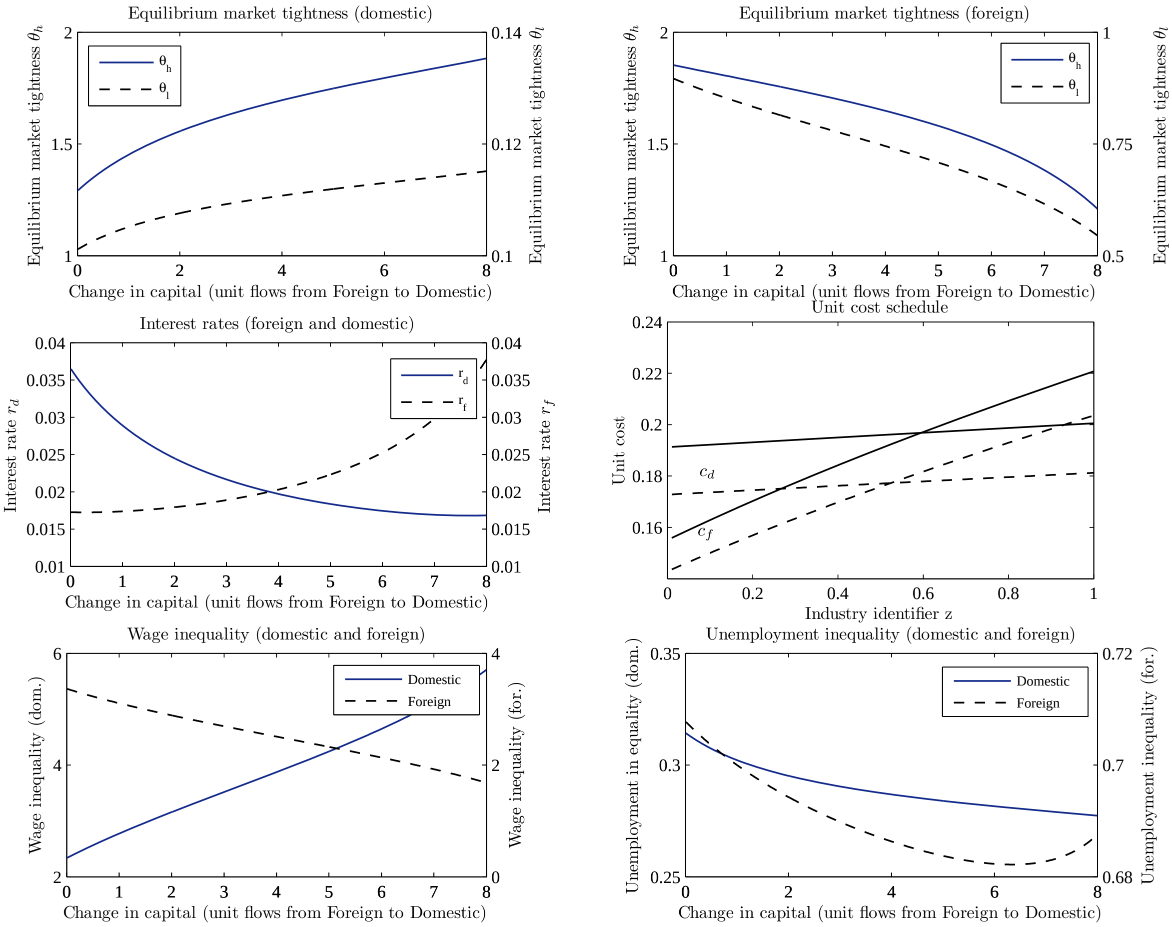


Figure 3: FDI outflow effects on the domestic labor market

domestic country. The active labor force must increase to meet the increase in labor demand, which reduces the rate of unemployment.

Finally we study the effects of FDI on wage and employment inequality. Due to the search and matching mechanism both curves likely evolve equally over time depending on the level of unemployment. As discussed in the comparative static chapter, the effect on the inequality measures are ex ante ambiguous but the concavity of the matching function and $a_h > a_l$ gives rise to stronger effects in the high than the low skill sector. This expected rise in high-to-low skill inequality is partly supported by the numerical example. Wage inequality measures evolve linearly. High and low skill wages increase in the domestic (FDI-in) country, but the magnitude of the increase is stronger for high-than for low-skilled. In the foreign FDI-out country wages decrease but again more for the high-skilled workers which decreases wage inequality.

Unemployment also moves in the same direction in both skill groups, but the magnitude is different in both skill groups depending on the level of unemployment. High-to-low skill unemployment inequality decreases in the domestic country due to stronger decrease in high skill unemployment, but the higher the high skill equilibrium unemployment the less elastic the Beveridge curve so that increase in low skill unemployment becomes relative more important for the evolution of unemployment inequality. In the foreign country the unemployment inequality increases until a certain threshold capital stock in both countries is reached. Again, the high skill unemployment rate is rather low and the reduction in unemployment is thus relatively weak.

5.1. Labor market institutions and global job sourcing

Domestic labor market institutions and exogenous interest rates. In the second scenario, the effects of a change in labor market institutions on $i)$ the equilibrium capital stock and $ii)$ the equilibrium market tightness are studied. Unilateral changes in unemployment benefits (Figure 4) or workers' bargaining power (Figure 5) induce an upward shift of the domestic unit costs schedule. The former cutoff no longer pins down the equilibrium. Some of the domestic industries located near the cutoff shift to the foreign country where new jobs are created in both skill groups. Capital flows between the two countries since interest rates are fixed. Foreign labor market institutions remain unchanged, but wages and unemployment rates in the foreign country must adapt due to spillover effects triggered by a capital reallocation and the change in the cutoff industry. In Figure 4, unemployment benefits increase from the benchmark scenario ($\dot{b} = 0$) up to unemployment benefits equal 0.7 ($\dot{b} = 0.2$). As expected, both domestic skill-specific unemployment rates increase, triggered directly through the effect at the intensive margin, and indirectly through job destruction at the extensive margin. In the foreign country unemployment is affected indirectly only by adjustments on the extensive margin. The sign is negative as expected, but the magnitude of the effect is rather weak. Capital flows from the country that introduces institutional reforms to the integrated economy where capital is needed to satisfy the increased capital demand.

The same pattern applies for the adjustment process initiated by an increase in

Figure 4: Unemployment, FDI net-flows, and a change in unemployment benefits

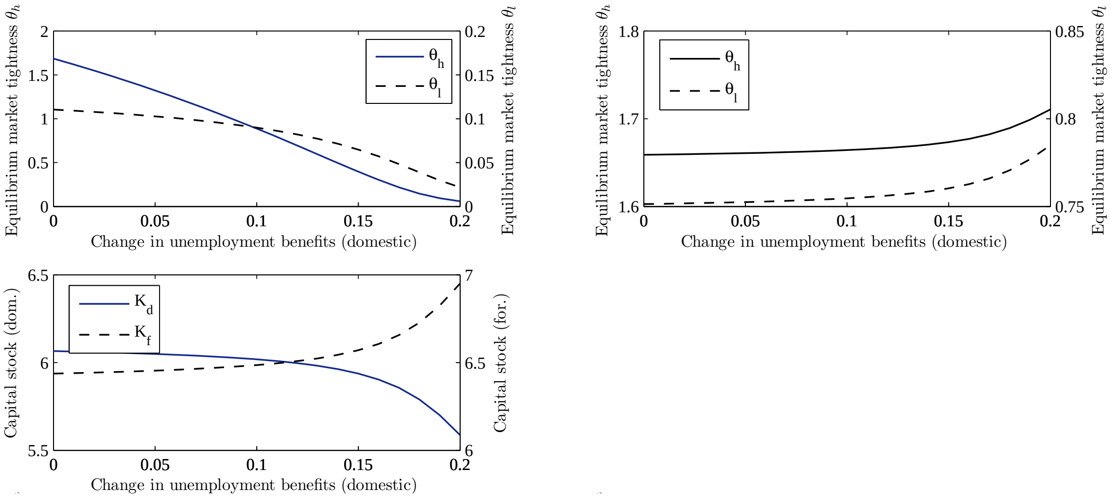
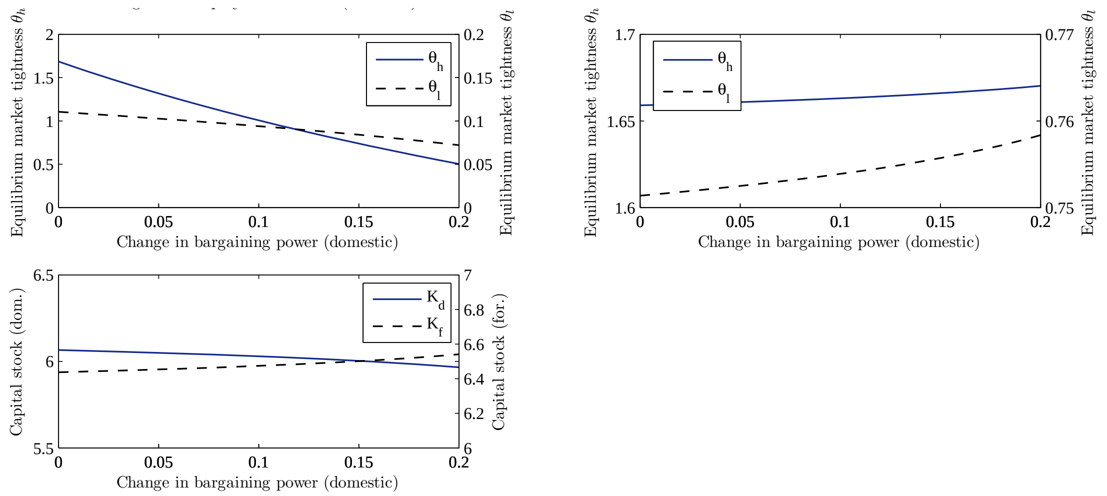


Figure 5: Unemployment, FDI net-flows, and a change in bargaining power



worker's bargaining power. A higher β strengthens the worker's position during the wage bargaining process. The only concern for this comparative static exercise are unbalanced capital flows so that the total capital stock slightly changes during the adjustment process. Addressing this issue in a simulation is difficult since an interest rate adjustment would be necessary to fully restore equilibrium. I skip a further discussion since full adjustment does not add any new insights concerning capital flows and unemployment.[18]

6. Conclusion

In a nutshell, this paper's main contribution is to extend the Feenstra and Hanson (1996, 1997) international trade model in a way that allows for a two-dimensional analysis where wages and the equilibrium market tightness serve as mediator between labor market institutions and product markets. This in turn implies that wages and capital flows are triggered 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. This channel is new regarding the already existing literature on trade and unemployment, which is silent on adjustments at the extensive margin. As a result, I can show that FDI-in countries benefit from foreign capital investments by extending their production to industries formerly associated with other countries. This widening of the production in formerly inactive industries combined with the adjustments at the intensive margin reduce unemployment and increase wages in the new equilibrium. However, the FDI sending country's workers suffer from the loss in competitiveness in some of its formerly active industries located close to the former cutoff. Without the continuum of industries adjustments would take place only at intensive margin. The increased capital supply in the FDI-in countries would reduce capital cost and thus lead to a substitution of capital by labor, thereby unambiguously increasing unemployment. The novel micro-founded wage setting mechanism in the Feenstra and Hanson model also fascilitates the study of changes in labor market institutions and its effects on FDI and labor market outcomes. Wages in the original Feenstra and Hanson (1997,1998) model adjust such that the labor market is in equilibrium. Institutional changes benefiting the workers directly influence FDI through wages. 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.

[18]Suppose that the government first decides to fix interest rates, and thereby trigger capital flows between both countries according to the simulation in Figure (5). However, to fully restore equilibrium a slight adjustment is needed in a second step to adjust further capital flows between both countries such that the capital account is balanced. I neglect this final adjustment since the derivation is negligible small.

Regarding wage and employment inequality I am able to show that the concavity of the matching technology in combination with the search and matching mechanism contributes to the finding that wage and employment inequality might move along depending on the level of unemployment, and as required to match the evolution of both inequality measures in the data.

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A Proofs

Derivation of equation (18). 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 (10) and (9) are combined so that

$$(r+\lambda)\frac{cp}{m(\theta_k)} = \varrho_k(z) - w_k \tag{41}$$

which can be rearranged to equation (11). To solve for the wage curve we start with rearranging equation (14) as

$$W_k - U_k = \frac{\beta}{1-\beta} J_k \ . \tag{42}$$

Equation (9) can be rewritten as

$$(r+\lambda)J_k \quad = \quad \varrho_k(z) - w_k \ . \tag{43}$$

Expanding equation (12) by multiplying both sides with $(r+\lambda)U_k$ gives

$$\begin{aligned} (r+\lambda)(W_k - U_k) &= w_k + \lambda U_k - (r+\lambda)(U_k) && (44)\\ (r+\lambda)(W_k - U_k) &= w_k - rU_k && (45) \end{aligned}$$

A solution for the outside option is obtained by combining equation (13), equation (42), and equation (10) as

$$rU_k = b_k + \theta_k m(\theta_k)\frac{\beta}{1-\beta}\frac{cp}{m(\theta_k)} \tag{46}$$

Combining equation (45), (42), and (43) gives

$$\begin{aligned} (r+\lambda)\frac{\beta}{1-\beta}J_k &= w_k - rU_k && (47)\\ (r+\lambda)\frac{\beta}{1-\beta}\frac{\varrho_k(z)-w_k}{r+\lambda} &= w_k - rU_k && (48)\\ (r+\lambda)\frac{\beta}{1-\beta}\frac{\varrho_k(z)-w_k}{r+\lambda} &= w_k - b_k - \theta_k m(\theta_k)\frac{\beta}{1-\beta}\frac{cp}{m(\theta_k)} && (49)\\ \beta\varrho_k(z) - \beta w_k &= (1-\beta)w_k - (1-\beta)b_k - \theta_k\beta cp && (50)\\ w_k &= (1-\beta)b_k + \beta(\varrho_k(z) + \theta_k cp) && (51) \end{aligned}$$

To solve for the equilibrium intermediate good price we can interact the wage curve (17) and the job creation curve (11) and solve for $\varrho_k(z)$

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

$$\varrho_k(z) = b_k + \frac{cp}{1-\beta}\left(\beta\theta_k + \frac{r+\lambda}{m(\theta_k)}\right) \tag{53}$$

Derivation of the LMC curve. 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

$$L_i(1-u_{li}) = \int_{\underline{Z}_d}^{\bar{Z}_d} l(z)x(z)dz \tag{54}$$

$$L_i(1-u_{li}) = \int_{\underline{Z}_d}^{\bar{Z}_d} B\zeta a_l(z)(q_l a_l(z) + q_h a_h(z))^{\zeta-1} r^{1-\zeta} x(z)dz \tag{55}$$

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 equation (28). The assumption that all industries have equal share in the consumers' expenditure is made to solve the integral. See Feenstra (2010) for an equal treatment. This assumption allows to introduce a constant instead of $\varrho(z)$ 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 $g_k'(z) = (q_l a_l(z) + q_h a_h(z))^{-1}$ in order to solve the integral as $\int f(z)g'(z) = [f(z)g(z)] - \int f'(z)g(z)$ which gives

$$\begin{aligned} L_d(1-u_{ld}(\theta_{ld})) &= (\bar{z}_d - \underline{z}_d)\zeta E\left([a_{ld}(z)g(z)]_{\underline{Z}}^{\bar{Z}} - \int_{\underline{Z}_d}^{\bar{Z}_d} a_{hd}'(z)g(z)dz\right) \\ &= \frac{(\bar{z}_d - \underline{z}_d)\zeta E\theta}{\varpi_d'}\left([a_{ld}(z) ln\, \varpi(z)]_{\underline{Z}_d}^{\bar{Z}_d} - \gamma_{ld}\int_{\underline{Z}}^{\bar{Z}} ln\, \varpi(z)dz\right) \end{aligned}$$

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 the final solution is equation (30).

Proof of Proposition 3. 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 tigthness go to zero and we find that $\lim_{\theta \to 0} \Gamma_L = 0$ since $\lim_{\theta \to 0} u(\theta) = 1$. 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 (18) is asymptotic in θ so that the necessary restriction for θ_k is

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

to secure that $q_k(\theta) > 0$. However, this is not a strong assumption for reasonable values of the exogenous parameters as shown in the calibration section. The first derivative of equation (18) is positive since

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

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

$$\frac{\partial \Gamma_R}{\partial q_k} = \int_{\underline{\mathbf{z}}_d}^{\bar{\mathbf{z}}_d} -\frac{\zeta\varphi(z)E(a_k(z))^2}{[q_l a_l(z) + q_h a_h(z)]^2} dz < 0 \tag{56}$$

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. 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 Proposition (4). Part a) 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. 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

$$\frac{\partial \Gamma_R}{\partial z^*} = -\frac{a_{kd}(z^*)\varphi(z^*)E}{q_{ld}a_{ld}(z^*) + q_{hd}a_{hd}(z^*)} < 0 \tag{57}$$

and respectively

$$\frac{\partial \Gamma_R}{\partial z^*} = \frac{a_{kf}(z^*)\varphi(z^*)E}{q_{lf}a_{lf}(z^*) + q_{hd}a_{hf}(z^*)} > 0 \tag{58}$$

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

Part b) follows from the assumption made about relative skill endowments and technology that $a_h > a_l$ and c) is also straightforward.

Proof of Proposition (6). This Proposition follows from Proposition 4 and 3. The assumption that interest rates are endogenously determined implies that capital flows must be compensated by a change in interest rates. Capital outflows for instance makes capital more scarce. The reduction in supply therefore must be compensated by a readjustment in capital cost. Suppose that everything else remains equal for the moment. Such an increase in capital cost shifts the unit cost curves upward. The reverse applies for the capital inflow country where the increases capital supply will shift the unit cost curves downward. The former cutoff z^* cannot be optimal anymore and must change. The capital outflow country loose its comparative advantage in some industries close to the former cutoff and the capital inflow country will extend its production to industries formerly associated to the outflow country and z^* will readjust. Proposition 4 immediately implies that Γ_R in the outflow country will fall and Γ_L in the inflow country will rise. To restore equilibrium, wages and thus unemployment have to readjust so that $\Gamma_L = \Gamma_R$ again. Wages and thus intermediate good prices in the outflow country must decrease and wages in the inflow country must increase.

Proof of Proposition ??. The first derivative of the ETC curve with respect to b is

$$\frac{\partial q_k}{\partial b_k} = \frac{(1-\beta)}{(1-\beta) - c(\beta\theta_k + \frac{r+\lambda}{m(\theta_k)})} > 0 \tag{59}$$

Thus, the intermediate good's price q_k increases for each θ which shifts the respective unit cost curve upwards. Again the former equilibrium z^* is not optimal anymore and the adjustments are similar to the adjustments in Proposition 6. Take for instance an increase in the bargaining power. Again, the first derivative reads

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

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

$$= \frac{-b_k(1-\beta) + b_k c\beta\frac{r+\lambda}{m(\theta_k)} + b_k c\theta_k + (1-\beta)}{\left[(1-\beta) - c(\beta\theta_k + \frac{r+\lambda}{m(\theta_k)})\right]^2} > 0 \tag{62}$$

$$\tag{63}$$

The inequality sign holds if $b < 1$. The shift of the unit cost schedule and the change in the cutoff industry also affects the other countries through spillover effects according to Proposition 6.

Proof of Proposition 8. The first derivative of the Beveridge curve with respect to θ is

$$\frac{\partial u(\theta)}{\partial \theta} = \frac{-(1-\alpha)m\theta^{-\alpha}s}{[s+\theta m\theta^{\alpha}]^2} < 0 \tag{64}$$

The second derivative of the Beveridge curve is

$$\frac{\partial^2 u(\theta)}{\partial \theta^2} = \frac{\alpha(1-\alpha)m^{-\alpha}s\,[s+m\theta^{-\alpha}]^2 + (1-\alpha)m\theta^{-\alpha}s2(s+m\theta^{1-\alpha})(1-\alpha)m^{-\alpha}}{[s+\theta m\theta^{\alpha}]^4} \tag{65}$$

$$= \frac{\alpha(1-\alpha)m^{-\alpha}s\,[s+m\theta^{-\alpha}] + (1-\alpha)m\theta^{-\alpha}s2(1-\alpha)m^{-\alpha}}{[s+\theta m\theta^{\alpha}]^3} > 0 \tag{66}$$

Thus, the lower θ the stronger the effect of a change in θ on the rate of unemployment. One assumption in the model is that $\theta_h > \theta_l$ since high skill unemployment is usually lower than low skill unemployment. Additionally, changes on the left hand side affect the magnitude of the change in θ needed to readjust the LMCs. Suppose that Γ_R is decreasing. In that particular scenario a lower wage rate is needed to readjust the LMC. Lower wages also have a decreasing effect on labor supply. Unemployment therefore rises and thus mitigates the change in θ needed to readjust the LMC. Since this countervailing effect is stronger for low than for high skill workers, the magnitude of the change in θ needed to restore equilibrium should be lower due to this massive adjustment in unemployment.