Unemployment in an Interdependent World* PRELIMINARY

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Abstract

We introduce search unemployment in a model of trade in differentiated goods and heterogeneous firms. Countries differ with respect to size, geographical location, and labor market institutions such as hiring costs, unemployment benefits, and the efficiency of the matching process. Contrary to the literature, we show that bad institutions in one country worsen labor market outcomes not only in that country but also in those that are related through trade in goods. This spill-over effect is conditioned by trade costs and country sizes: smaller and/or more central nations suffer less from inefficient policies at home than large and/or peripheral ones, whereas the spill-over effects is stronger for smaller/more central nations. The reason is that bad labor market institutions in one place reduce the global market potential which harms other countries as well. Our econometric analysis suggests that, controlling for business cycle effects, the conditional spatial correlation of unemployment rates is positive. Moreover, we show that trade-weighted inefficient foreign labor market institutions increase unemployment domestically by a non-trivial amount. Finally, labor market outcomes of more open economies are more strongly affected by foreign institutions.

Keywords: Unemployment; international trade; search frictions; heterogeneous firms; spill-over effects of labor market institutions

JEL-Codes: F11, F12, F16, J64, L11

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1 Introduction

> *"In the flat world, one person's economic liberation could be another's unemployment." (Thomas Friedman, The World is Flat, 2005, p. 205)*

"Globalization" is one of the key words in the popular press as well as the academic literature in international economics.[1] One reason for this might be the very different things that are captured under the umbrella of "globalization": Increased trade in goods and services, more and larger preferential trading blocs, increased multinational activity, rising migration flows, internationalized capital markets, to name just a few.[2] At the heart of all these facets of globalization is one important common feature: Countries and their actions are no longer independent from each other, rather, the economic, political, and social performance of one country also depends on the policies taken by other countries. Hence, countries and their actions are *interdependent*.

The focus on the interdependence of countries is one of the important distinguishing features of international economics. For example, concerning the increased trade in goods and services, the results can be cumulated in the "gains from trade hypothesis": Going from autarky to free trade leads to a welfare increase in every country (see Feenstra, 2004, chapter 6, for a discussion of the gains from trade). As early as 1950, Viner introduced the terms "trade creation" and "trade diversion" when analyzing the effects of custom unions.[3] "Trade creation" refers to a situation where two countries within the customs union begin to trade with each other, whereas they consumed locally produced goods before entering the customs union. "Trade diversion" captures the interdependence effect of customs unions: Here, one country begins to trade with a country that is in the union, whereas it formerly imported the good from another country outside the union. We could continue this list of interdependencies between countries and talk about off-shoring, outsourcing, splitting up the production chain, technological spill-overs, migration flows, and so forth.

Most if not all of these interdependencies are also affected by actions taken by *one* country. Consider again the trade in goods and services. Countries can unilaterally set import tariffs or subsidize exports, which directly affects the trading partner. By entering a preferential trading bloc, (former) trading partners not member of the trading bloc may

[1] A key word search in google lead to 25,5 million hits, whereas a search in google scholar gave 859,000 hits. To compare it with other key words, we did a similar search for the key words "unemployment" and "inflation", two widely used economic terms in the popular as well as academic press. For the former we received 31,1 million hits in google and nearly 1,5 million hits in google scholar, and for the latter 49,9 million and about 1,8 million hits. The search was conducted on October 6th, 2008.

[2] We therefore also tried several other key words in our google search: "outsourcing" leads to 55 million hits in google and to 144,000 hits in google scholar, "migration" to 65,7 million (nearly 4 million) hits in google (google scholar), and "multinational" to 16 million (789,000) hits, respectively.

[3] A custom union is a preferential trading bloc where member countries abolish tariffs on goods traded between them, and set a common external tariff for goods traded with non-member countries.

be hurt ("trade diversion"). Tax competition for multinational firms, subsidization for innovations, and migration policies are other examples where interdependencies between countries are obvious.

Recently, there is new interest in the relationship between trade and unemployment when labor markets are imperfect. Specifically, the distributional consequences of trade liberalization for income, wages and the trade patterns in models with unemployment are investigated (see Davidson, Martin, and Matusz (1999), Davidson and Matusz (2004), Davis (1998), Egger, Greenaway, and Seidel (2008), Dutt, Mitra and Ranjan (2007), Egger and Kreickemeier (2008a,b), Felbermayr, Prat and Schmerer (2008), henceforth FPS, Helpman and Itskhoki (2008), Helpman, Itskhoki, and Redding (2008a,b)). Even though the papers differ in their assumptions about labor market imperfections, ranging from "fair trade preferences" to "search and matching" generated unemployment, all of these models have at least one dimension of labor market rigidities in which countries may differ. Only few papers are explicit about the possible channels through which labor market institutions in one country affect structural unemployment in other countries. There is an emerging consensus in the macroeonomic labor literature that institutions matter for unemployment rates; in particular, product market regulation is important.[4] Since trade liberalization is just one aspect of product market deregulation, one expects that more open economies indeed have lower structural unemployment rates. The data strongly supports this view, see Felbermayr, Prat and Schmerer (2008b). Moreover, to the extent that labor market institutions affect the volume and pattern of trade between countries, it is likely that trade acts as a vehicle through which institutional feature of one country also affect labor market outcomes in the other.

Beissinger and Buesse (2002) use a frictionless two-country model with a fixed number of monopolistically competitive firms in the goods markets and wage bargaining in labor markets and investigate how different unemployment compensation systems affect the consequences of international shock spill-overs on real wages and unemployment. In their Proposition 10 they summarize the results on the interdependencies of labor market institutions: "*If an adverse (favorable) labor market shock occurs in country A, country B experiences the greatest rise (decline) in unemployment in a flat-rate benefit system, a less pronounced rise (decline) in unemployment in a two-tier system and no change in unemployment in an earnings-related system.*"

Helpman, Itskhoki, and Redding (2008a) use a multi-sector, multi-country model and assume workers to be differentiated according to an exogenously given ability. Further, there are two sectors, one homogenous goods sector and one differentiated goods sector. In the former sector they assume a Walrasian labor market, whereas the later sector is subject to search-and-matching frictions on the labor market. Besides a lot of other interesting results concerning the gains from trade and the wage and income inequality, they also study the effects on unemployment. Their result concerning the effect of bad home labor market institutions on home unemployment is ambiguous, with a slight favorable prediction for a *negative* relationship. Higher home screening costs lead unambiguously

[4]See for example Layard, Nickell, and Jackman (1991), Nickell (1997), Ljungquist and Sargent (1998), Nickell and Layard (1999) and Blanchard and Wolfers (2000)

to a lower unemployment rate, whereas higher search costs have an ambiguous effect on unemployment. Higher search costs lead to a decrease in labor market tightness which raises unemployment, but also induce a decrease of the fraction of exporting firms, which lowers unemployment. The result about the international consequences of labor market institutions is summarized in their Proposition 6, part (iii): "*... a rise in the foreign country's labor market frictions raises unemployment in the home country while a rise in the home country's labor market frictions raises unemployment in the foreign country*". The key to understand this result is to recognize that foreign labor market institutions affect unemployment in the domestic market only through trade openness and the fraction of firms that export. Lower variable trade cost and higher foreign labor market frictions increase unemployment in the domestic country by raising the fraction of home firms that export. The increase of firms that export in the domestic market leads to a shift of the industry composition of low- to high-productivity firms. As in their model more productive firms are more selective, this change in industry composition raises unemployment. To sum up, bad labor market institutions tend to lead to a decrease of home unemployment (specifically if screening costs raise), whereas unemployment in the foreign country goes up.

A similar relationship between labor market institutions and unemployment at home and abroad in a very different model was obtained by Egger, Greenaway, and Seidel (2008). They use a multi-country, new economic geography model of trade with mobile capital in general equilibrium, where labor markets are constrained due to fair wage preferences of workers. Besides their main focus on the value of bilateral trade as well as the share of intra- industry trade, they also obtain predictions regarding the interdependence of labor market institutions. They are summarized in their Proposition 1 : "*A marginal increase in the fair wage parameter unambiguously compresses relative factor returns in all countries. This goes along with an increase in the unemployment rate of [the home] country while more employment is generated in all other countries. A marginal variation in the replacement rate has similar effects.*"

Hence, theoretical predictions so far seem mostly to suggest a negative relationship between the effects of labor market institutions at home and abroad, with an exception given by Beissinger and Buesse (2002).[5] However, as we will show in the empirical section of this paper, the conditional spatial correlation of structural unemployment rates across rich OECD countries is positive. By the same token, the correlation between foreign labor market distortions and domestic structural unemployment is positive, too. Therefore, we want to suggest a model that copes with the empirical stylized fact of a positive correlation of bad labor market institutions and raising unemployment rates, both, at home and abroad. Further, we assume firms that differ with respect to their productivity, leading to a distribution of firm sizes and a selection of only the most productive firms into the export

[5]Note that the model from Helpman, Itskhoki, Redding (2008a) would suggest that the correlation between bad labor market institutions at home and home unemployment would be negative, whereas the correlation with foreign unemployment would be positive. The predictions form the model of Egger, Greenaway, and Seidel (2008) would exactly be the opposite: The correlation of bad labor market institutions with home unemployment would be positive, whereas it would be negative with foreign unemployment.

markets. These facts are in line with recent empirically findings (see Dunne, Roberts and Samuelson (1989); Davis and Haltiwanger (1992); Bernard and Jensen (1995, 1999, 2004); Roberts and Tybout (1997); Clerides, Lach and Tybout (1998); and Bartelsman and Doms (2000)). Further, our model is general enough to investigate the impact of the economic size of countries, the geographical location, and the labor market institutions such as hiring costs, unemployment benefits, and the efficiency of the matching process.

We build on the work of FPS , and extend the model to allow for asymmetric endowments, asymmetric geographical locations, and asymmetric labor market institutions. Hence, we assume economies with one final good which is produced with a variety of intermediate inputs. Each intermediate input is provided by a single monopolistically competitive firm, which are heterogeneous according to an exogenously drawn productivity as in Melitz (2003). The labor market is imperfectly competitive due to the existence of search frictions following Mortensen and Pissarides (1999), summarized in Pissarides (2000), leading to equilibrium unemployment.

The main results of our model can be summarized as follows. Contrary to most of the previous literature, we show that bad institutions in one country worsen labor market outcomes not only in that country but also in those that are related through trade in goods. This spill-over effect is conditioned by trade costs and country sizes: smaller and/or more central nations suffer less from inefficient policies at home than large and/or peripheral ones, whereas the spill-over effect is stronger for smaller/More central nations. Using spatial econometric methods, we empirically confirm the negative spill-over effect of bad labor market institutions.

The remainder of the paper is structured as follows. Section 2 outlines the theoretical model. In section 3 we give some analytical results, showing that... Section 4 derives numerical results from a calibration of our theoretical model, leading to prediction of the effect of trade liberalization for all variables. In section 6 we do some sensitivity analysis. The last section concludes.

2 A Heterogeneous Firms Model with Search and Matching Frictions and Asymmetric Countries

Our world consists of N potentially asymmetric countries with firms that differ by an exogenously drawn productivity à la Melitz (2003). The labor market is considered to be imperfect due to search and matching frictions as suggested by Mortensen and Pissarides (1999). Hence, we extend the model from FPS to allow for asymmetries regarding the country size, the geographical locations of countries, and various labor market institutions.

We will describe the various model features in the following sequence: First we explain the production process in the economy, then we state our assumptions about the labor market and finally the entry- and export decision of firms is depicted.

2.1 The Production Process in the Economy

We assume N countries, indexed by subscript i, with $i = 1, ..., N$. Similar to Egger and Kreickemeier (2008b) and FPS , we assume a single final output good in every country, Q_i, which is produced under perfect competition. The final output good can either be consumed or used as an input in the production process. Good Q_i is assembled from a continuum of intermediate inputs, which are partly provided from domestic firms and partly imported from abroad. Denoting the quantity of an intermediate input with $q_i(\omega)$, we can write the production function as follows:

$$Q_i = \left\{ (\bar{M}_i)^{\frac{\nu-1}{\sigma}} \int_{\omega_i \in \Omega_i} q[\omega_i]^{\frac{\sigma-1}{\sigma}} d\omega_i \right\}^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where σ denotes the elasticity of substitution between any two varieties of inputs with $\sigma > 1$, and the measure of the set Ω is the mass $\bar{M}_i$ of available intermediate inputs in country i. Each intermediate input is produced by a distinct monopolistically competitive firm. ν parameterizes the external scale effect through which input diversity affects aggregate productivity, with $\nu \in (0, 1)$. If $\nu = 0$ the number of available varieties is irrelevant for total output. If $\nu = 1$ we are back to the "traditional" case discussed by Krugman (1980) or Melitz (2003).

The price index dual to (1) is given by:

$$P_i = \left(\frac{1}{\bar{M}_i^{1-\nu}} \int_{\omega_i \in \Omega_i} p[\omega_i]^{1-\sigma} d\omega_i \right)^{\frac{1}{1-\sigma}}, \tag{2}$$

where $p[\omega_i]$ is the price of a variety ω_i. We choose the final output good in country 1 as the numéraire, hence $P_1 = 1$.

Based on the production function given in (1) and the price index given in (2), the demand function for each variety of intermediate good is given by:

$$q[\omega_i] = p[\omega_i]^{-\sigma} (P_i)^{\sigma-1} \left(\frac{Y_i}{\bar{M}_i^{1-\nu}} \right), \tag{3}$$

where Y_i is total income of country i. Note that aggregate production needs not only cover final consumption but also the fixed costs of production and vacancy posting costs.

Similar to Melitz (2003), intermediate input firms have different productivity levels $\varphi[\omega_i]$. There is a continuum of monopolistically competitive firms which produce each a unique variety. Hence, we also index firms by φ_i. Labor, L, is the unique factor of production. Hence, a firm with productivity level φ_i has output $q(\varphi_i) = \varphi_i L[\varphi_i]$, where $L[\varphi_i]$ is the level of employment at firm φ_i. In addition to the marginal costs of production, input producers have to pay a sunk set-up cost of f in order to start production at home. Besides the domestic market, intermediate input producers can serve each of the N foreign markets via exports. Entry into each of the export markets leads to additional fixed costs of f^x. In addition to these fixed export costs, serving customers in country j from country i entails variable iceberg trade costs $\tau_{ij} \geq 1$.

Hence, we may write the domestic and foreign inverse demand for the intermediate goods producer φ_i as follows:[6]

$$\begin{aligned} p_d[\varphi_i] &= q_d[\varphi_i]^{-\frac{1}{\sigma}} (P_i)^{\frac{\sigma-1}{\sigma}} \left(\frac{Y_i}{\bar{M}_i^{1-\nu}}\right)^{\frac{1}{\sigma}}, \\ p_x[\varphi_i] &= q_x[\varphi_i]^{-\frac{1}{\sigma}} (P_j)^{\frac{\sigma-1}{\sigma}} \left(\frac{\tau_{ij} Y_j}{\bar{M}_j^{1-\nu}}\right)^{\frac{1}{\sigma}}. \end{aligned} \tag{4}$$

If a firm decides to serve domestic and foreign markets, it allocates its output so as to maximize its total revenues. Equating marginal revenues across markets therefore yields $p_x[\varphi_i] = \tau_{ij} p_d[\varphi_i]$ (see Appendix A1).

Operating revenues of a firm in country i with productivity φ_i from sales on the domestic (foreign) market are therefore equal to $R_d[\varphi_i] = p_d[\varphi_i] q_d[\varphi_i]$ ($R_x[\varphi_i] = p_x[\varphi_i] q_x[\varphi_i]/\tau_{ij}$). Total revenue of an intermediate input producer with productivity φ_i, $R[\varphi_i]$, is then given by:

$$\begin{aligned} R[\varphi_i] &= q_d[\varphi_i]^{\frac{\sigma-1}{\sigma}} (P_i)^{\frac{\sigma-1}{\sigma}} \left(\frac{Y_i}{\bar{M}_i^{1-\nu}}\right)^{\frac{1}{\sigma}} \\ &+ I[\varphi_i] q_x[\varphi_i]^{\frac{\sigma-1}{\sigma}} (P_j)^{\frac{\sigma-1}{\sigma}} \left(\frac{\tau_{ij}^{1-\sigma} Y_j}{\bar{M}_j^{1-\nu}}\right)^{\frac{1}{\sigma}}, \end{aligned} \tag{5}$$

where $I[\varphi_i]$ is an indicator function that takes value one when a firm in country i with productivity φ_i exports and zero otherwise.

2.2 The Labor Market

In order to allow for unemployment in our model, we follow the approach of Mortensen and Pissarides (1994) and assume search frictions on the labor market. Our model is in discrete time and all payments are made at the end of each period. At the end of each period, firms and workers are hit by two different type of shocks: Firms in country i are forced to leave the market with a probability of δ_i and with probability χ_i each job is destroyed because of a match-specific shock. Assuming independence of these shocks, the actual rate of job separation is given by $s_i = \delta_i + \chi_i - \delta_i \chi_i$.

Each period any intermediate input producer in country i decides about the optimal number of vacancies v_i, taking the wage rate as given. The costs of posting a vacancy in country i are proportional to the parameter c_i and measured in units of the final good. However, from the posted vacancies v only a certain share $m_i[\theta_i]$ is filled, where θ_i is the vacancy-unemployment ratio in country i and $m_i'[\theta_i] < 0$.[7] We can solve the game by

[6]Note that $p_x[.]$ is the cif price in the foreign market and $q_x[.]$ is the quantity produced for the foreign market, including the iceberg transport costs.

[7]We assume the following standard properties $\lim_{\theta_i \to \infty} m_i(\theta_i) = 0$ and $\lim_{\theta_i \to 0} m_i(\theta_i) = \infty$. In some applications, we write $m_i(\theta_i) = \bar{m}_i \mu(\theta_i)$ where $\bar{m}_i$ parameterizes the overall efficiency of the search technology.

backward induction, hence we first describe the firm's optimal vacancy setting behavior, and then discuss the bargaining problem.

The value of an intermediate input producer solves:

$$\begin{aligned} J[L_i,\varphi_i] \quad &= \quad \max_{v} \frac{1}{1+r}\Big(R[\varphi_i] - w_i L[\varphi_i] - fP_i - v_i c_i P_i \\ &\qquad -I[\varphi_i] f^x P_i + (1-\delta) J_i^{'}\Big), \qquad (6) \\ s.t. \quad (i) \quad & R[\varphi_i] \quad \text{given in equation (5)}, \\ (ii) \quad & L_i' = (1-\chi_i)L_i + m_i(\theta_i)v_i, \end{aligned}$$

where r denotes the interest rate, w_i is the wage rate in country i, and L_i' is the level of employment in the next period. Constraint (i) is the revenue function and constraint (ii) gives the law of motion of employment at the firm level. The first order condition for vacancy posting can be stated as follows:

$$\frac{c_i P_i}{m_i[\theta_i]} = (1-\delta)\frac{\partial J[L,\varphi_i,t+1]}{\partial L_{i,t+1}}. \qquad (7)$$

This first order condition shows that the firm equalizes marginal recruitment costs (given on the left hand side) and the shadow value of labor (given on the right hand side). Substituting the constraints into to objective function of the firm (6), differentiating with respect to L_i and employing the optimality condition (7) yields:

$$\frac{\partial J[L_i,\varphi_i,t]}{\partial L_i} = \frac{1}{1+r}\Big(\frac{\partial R[\varphi_i]}{\partial L_i} - w_i - \frac{\partial w_i}{\partial L_i}L[\varphi_i] + \frac{c_i}{m_i[\theta_i]}(1-\chi)\Big). \qquad (8)$$

Replacing the first order condition (7) into the left-hand side of equation (8), we obtain an expression that implicitly determines the optimal pricing behavior of the intermediate input producer:

$$\frac{\partial R[\varphi_i]}{\partial L_i} = w_i + \frac{\partial w_i}{\partial L_i}L[\varphi_i] + \frac{c_i}{m_i[\theta_i]}\left(\frac{r+s}{1-\delta}\right).$$

Before production takes place, wages are individually bargained. As in Stole and Zwiebel (1996) every worker is treated as the marginal worker, i.e. as the last worker employed by the firm. The total surplus from a successful match is split between the employee and the intermediate input producer. The worker's surplus is equal to the difference between the value of being employed $E[L_i,\varphi_i]$ by a firm with productivity φ_i in country i and workforce L_i and the value of being unemployed U_i. The firms's surplus is equal to the marginal increase in the firm's value $\partial J[L_i,\varphi_i,t]$, which results from the assumption that every worker is treated as the marginal worker. The outcome of the bargaining process over the division of the surplus follows the following "surplus-splitting" rule:

$$(1-\beta_i)\left(E[L_i,\varphi_i] - U_i\right) = \beta_i \frac{\partial J[L_i,\varphi_i,t]}{\partial L_i}, \qquad (9)$$

where the parameter β_i measures the bargaining power of the workers and belongs to $(0,1)$.

We now can use the shadow value of labor as given in equation (8) in the bargaining solution (9). This leaves us with a differential equation in the wage rate, which ban be solved and leads to a *wage curve* (see FPS for a similar procedure):

$$\frac{w_i}{P_i} = b_i\Phi_i + \frac{\beta}{1-\beta}\frac{c_i}{1-\delta}\left(\frac{r+s_i}{m_i[\theta_i]} + \theta_i\right),$$

where b_i are unemployment benefits and

$$\Phi_i \equiv \tilde{\varphi}^*_{ii} p_i\left(\tilde{\varphi}^*_{ii}\right)/P_i \tag{10}$$

relates the marginal value product of labor at the average domestic firm $\tilde{\varphi}^*_{ii} p_i\left(\tilde{\varphi}^*_{ii}\right)$ to the cost of vacancy posting P_i.[8] Hence, Φ_i measures the relative attractiveness of creating an additional vacancy.

The equilibrium real wage w_i/P_i and labor market tightness θ_i are found by interacting the wage curve with the *job creation curve*, which is given by:

$$\frac{w_i}{P_i} = \frac{\sigma-1}{\sigma-\beta_i}\Phi_i - \frac{c_i}{m_i[\theta_i]}\frac{r+s_i}{1-\delta}. \tag{11}$$

The job creation curve implies that workers are paid similarly across firms with different productivity levels. Hence, as in Stole and Zwiebel (1996) firms exploit their monopsony power until employees are paid their outside option.

We can now state a first Lemma.

Lemma 1 [Labor market equilibrium]
(a) For given Φ_i, there is a unique labor market equilibrium $\{w_i/P_i, \theta_i\}$ if $\frac{\sigma-1}{\sigma-\beta_i} > b_i$.
(b) An increase in Φ_i increases the real wage w_i/P_i and the degree of labor market tightness θ_i.
(c) For given Φ_i, variation in institutional parameters b_i, c_i or $\bar{m}_i$ leads to qualitatively equivalent results as regards the degree of labor market tightness θ_i.

Part (a) in Lemma 1 follows from the fact that the job-creation curve is strictly downward sloping in θ, while the wage curve is upward-sloping. An equilibrium exists only if the flow-value of non-employment b_i is smaller than the share of the value of the match that will accrue to the worker.

Part (b) holds true under the condition established in part (a). The intuition is that any increase in the relative profitability of job-creation will lead to more vacancy-posting, to a stronger degree of market tightness, and, eventually, to less unemployment and higher real wage.

Part (c) establishes that, whatever the equilibrium value of Φ_i turns out to be, changes in the most relevant labor market institutions – the replacement rate b_i, hiring costs c_i, and the efficiency of the matching process $\bar{m}_i$ – have similar quantitative effects on labor

[8]The productivity of the average *domestic* firm is $\tilde{\varphi}^d_{ii}$. As in Melitz (2003), the upper-tier CES aggregate implies $p[\varphi_i]\varphi_i = p[\varphi'_i]\varphi'_i$ for all values of φ_i and φ'_i. Hence, specifically for $\tilde{\varphi}^*_{ii}$.

market tightness and,hence, on the rate of unemployment.[9] We will see below that the determination of Φ_i does not directly depend on b_i, c_i, or $\bar{m}_i$ but only on labor market outcomes such as the real wage or the rate of unemployment. It follows that variation in b_i, c_i, or $\bar{m}_i$ affects equilibrium outcomes in qualitatively similar ways. In our comparative statics exercises, we will therefore focus on b_i as a representative institutional variable.

2.3 Entry- and Export Decision of Firms

There is an infinite number of potential firms which can enter the market after paying a fixed and sunk entry cost f^e, measured in terms of the final consumption good. Only after entering they are able to draw their productivity φ_i from a known distribution with c.d.f. $G[\varphi_i]$ and p.d.f. $g[\varphi_i]$. The productivity stays the same as long as the firm exists. Only firms which draw a φ_i favorable enough to make non-negative profits, will start production.

In order to describe the entry-decision, we first define the discounted firm level profits

$$\begin{aligned} \Pi\left[\varphi_i\right] &= (1-\delta)\sum_{t=0}^{\infty}\left(1-r-\delta\right)^t \pi\left[\varphi_i\right] - \frac{c_i P_i}{m_i\left[\theta_i\right]} L\left[\varphi_i\right] - f P_i \qquad (12) \\ &= (1-\delta)\frac{\pi\left[\varphi_i\right]}{r+\delta} - \frac{P_i c_i}{m_i\left[\theta_i\right]} L\left[\varphi_i\right] - f P_i. \end{aligned}$$

$\pi[\varphi_i]$ are the per-period profits of a firm in country i with productivity φ_i, given by:

$$\pi[\varphi_i] = p_i[\varphi_i] q_i[\varphi_i] - w_i L[\varphi_i] - f P_i - \frac{c_i P_i}{m_i[\theta_i]} \chi_i L[\varphi_i],$$

which is revenue minus wage payments, fixed costs and search costs for a firm in country i with productivity φ_i. A firm will decide to start up production whenever its productivity exceeds a certain threshold-value φ_{ii}^*. The marginal operative firm φ_{ii}^* is found by solving $\Pi\left[\varphi_{ii}^*\right] = 0$. Hence, the cut-off level productivity of firms entering the market is defined by:

$$(1-\delta)\frac{\pi[\varphi_{ii}^*]}{r+\delta} = \frac{c_i P_i L[\varphi_{ii}^*]}{m_i[\theta_i]} + f P_i, \qquad (13)$$

where $L[\varphi_{ii}^*]$ are the workers needed for domestic production in country i of the firm with productivity φ_{ii}^*. At the beginning of its existence the firm has to "invest" in its stock of workers, i.e. all the workers have to be newly hired.[10] The discounted value of future profits has to be large enough so that a firm wants to undertake this up-front investment. Otherwise, the firm immediately exits. Equivalently to equation (13), we can determine the export threshold as:

$$(1-\delta)\frac{\pi[\varphi_{ij}^*]}{r+\delta} = \frac{c_i P_i L[\varphi_{ij}^*]}{m[\theta_i]} + f^x P_i, \qquad (14)$$

[9] We have $\partial\theta_i/\partial b_i < 0, \partial\theta_i/\partial c_i < 0$, and $\partial\theta_i/\partial\bar{m}_i > 0$.

[10] Note that due to the linearity of adjustment costs the work-force immediately jumps to the optimal value.

where $L[\varphi_{ij}^*]$ are the additional workers needed to produce for foreign market j for a firm in country i with productivity φ_{ij}^*. $\pi[\varphi_{ij}^*]$ is the additional profit from serving the export market j, defined similarly as the profit from serving the local market i (see equation (**??**)). Using the revenue functions and the zero-profit conditions, we can derive a relationship between the zero-profit productivity cut-off and the exporting productivity cut-off:

$$\varphi_{ij}^* = \Lambda_{ij}\varphi_{ii}^* \quad \text{with} \tag{15}$$

$$\Lambda_{ij} = \tau_{ij}\frac{P_i}{P_j}\left(\frac{Y_i f^x}{Y_j f}\right)^{\frac{1}{\sigma-1}}\left(\frac{\bar{M}_j}{\bar{M}_i}\right)^{\frac{1-\nu}{\sigma-1}}. \tag{16}$$

The profits from serving the foreign market have to be large enough to justify the extra fixed costs f^x. Empirical evidence strongly supports selection into export markets.[11] Hence, we focus on parameter values where only the most productive firms export and therefore $\varphi_{ij}^* > \varphi_{ii}^*$.

Following Melitz (2003), we define the average productivity of a domestic firm serving the domestic market i and any of the foreign markets j as:

$$\tilde{\varphi}[\varphi_{ij}^*] = \left(\frac{1}{1-G[\varphi_{ij}^*]}\int_{\varphi_{ij}^*}^{\infty}(\varphi_i)^{\sigma-1}\,g[\varphi_i]d\varphi_i\right)^{1/(\sigma-1)} \quad \text{for all} \quad i,j. \tag{17}$$

Based on this definition we can write down the free entry condition as:

$$\begin{aligned} f^E P_i = {} & (1-G[\varphi_{ii}^*])\left((1-\delta)\frac{\pi[\tilde{\varphi}_{ii}]}{r+\delta} - \frac{c_i P_i L[\tilde{\varphi}_{ii}]}{m_i[\theta_i]} - f P_i\right) \\ & + \left(1-G[\varphi_{ij}^*]\right)\left((1-\delta)\frac{\pi[\tilde{\varphi}_{ij}]}{r+\delta} - \frac{c_i P_i L[\tilde{\varphi}_{ij}]}{m_i[\theta_i]} - f^x P_i\right), \end{aligned} \tag{18}$$

where we have the costs of entering a market on the left-hand side and the expected profits on the right-hand side. The profits of the firm are not yet known at the time of the entry-decision because the productivity level is unknown. With probability $1-G[\varphi_{ii}^*]$ the productivity will be high enough to make production profitable in the home country i. With probability $1-G[\varphi_{ij}^*]$ the productivity will be high enough so that even exporting to country j is profitable. The term in brackets indicate how much a firm will earn in these cases.

Equality in equation (18) is assured by the entry of new firms. As long as average profits exceed the entry cost, new firms will enter the market, increasing competition, thereby driving down profits until they have reached the entry cost (and vice versa if profits are too low).

The ex ante probability of successful entry into country i is $(1-G[\varphi_{ii}^*])$, whereas the ex ante probability of exporting conditional on successful entry is $\varrho_{ij} = (1-G\left[\varphi_{ij}^*\right])/(1-$

[11] For empirical evidence on selection into the export markets, see Bernard and Jensen (1995, 1999, 2004), Roberts and Tybout (1997), and Clerides et al. (1998).

$G[\varphi_{ii}^*]$). The mass of available varieties in country i is given by $\bar{M}_i = M_i + \sum_{h \neq i} \varrho_{hi} M_h$, and M_h is the mass of active producers in country h.

With these definitions, the price index can be written as:

$$P_i = \left(\frac{M_i p_i^{1-\sigma} + \sum_{j \neq i} \varrho_{ij} M_j \left(\tau_{ji} \frac{\tilde{\varphi}_{jj}}{\tilde{\varphi}_{ji}} p_j \right)^{1-\sigma}}{\bar{M}_i^{1-\nu}} \right)^{1/(1-\sigma)}, \tag{19}$$

which collapses to the standard form when $\nu = 1$.

Using the condition that profits of φ_{ii}^*-firms are zero, the log-linear relationship between firm sizes, i.e. $L[\tilde{\varphi}_{ij}] = (\tilde{\varphi}_{ij}/\varphi_{ij}^*) L[\varphi_{ij}^*]$ for all i, j, and the job creation curve given in equation (11), we can derive an expression for the labor demand:

$$L[\tilde{\varphi}_{ij}] = \left(\frac{\tilde{\varphi}_{ij}}{\varphi_{ij}^*} \right)^{\sigma-1} \left(\frac{1+r}{1-\delta} \right) \left(\frac{\sigma - \beta}{1 - \beta} \right) \frac{f P_i}{\Phi_i}. \tag{20}$$

2.4 Unemployment

The labor market in all countries is described by a Cobb-Douglas matching function:

$$m[\theta_i] \;=\; \bar{m} (\theta_i)^{-\alpha_i}, \tag{21}$$

where the parameter $\bar{m}$ measures the efficiency of the labor market, while α_i is the elasticity of the matching function in country i. The matching function gives the probability that a vacancy is filled in dependence of θ_i, the tightness of the labor market. In turn, the probability that a worker finds a job in country i can be written as $\theta_i m[\theta_i]$. Noting that the exogenous rate of job-destruction is given by s_i, the equilibrium unemployment rate is given by the Beveridge curve:

$$u_i = \frac{s_i}{s_i + \theta_i m[\theta_i]}. \tag{22}$$

The labor market clearing condition is given by:

$$L_i^e = (1 - u_i) L_i, \tag{23}$$

where L_i^e is aggregate employment and L_i is labor supply in country i.

Finally, the mass of active domestic firms adjusts so that the labor market clears:

$$M_i = \frac{L_i^e}{L[\tilde{\varphi}_{ii}] + \sum_{j \neq i} \varrho_{ij} L[\tilde{\varphi}_{ij}]}. \tag{24}$$

2.5 Income and Multilateral Trade Balance

Total spending on the aggregate output good, i.e. total nominal income, is defined as the sum of payments to employed workers (aggregate consumption expenditure), on flow

fixed costs f and f^x, on appropriately discounted up-front investments f^e, and on search costs:

$$\begin{aligned} Y_i &= w_i L_i^e + P_i M_i \left(\frac{1+r}{1-\delta} \left(f + f^x \sum_{j \neq i} \varrho_{ij} \right) + \frac{r+\delta}{1-G\left[\varphi_{ii}^*\right]} \frac{1}{1-\delta} f^e \right. \\ &+ \left. \frac{s_i + r}{1-\delta} \frac{L_i^e}{M_i P_i} \frac{c_i P_i}{m_i\left[\theta_i\right]} \right). \end{aligned} \tag{25}$$

We assume that, in equilibrium, every country maintains multilateral (though not bilateral) trade balance. The formal multilateral trade balance constraint for country i (or, balance of payments, BOP_i) is given by:

$$\begin{aligned} BOP_i &= \sum_{j \neq i} P_i^{\sigma-1} \tau_{ji}^{1-\sigma} \left(\frac{\tilde{\varphi}_{jj}}{\tilde{\varphi}_{ji}} p_j \right)^{1-\sigma} \left(\frac{Y_i}{\bar{M}_i} \right)^{1-\nu} \varrho_{ji} M_j \\ &- \sum_{j \neq i} P_j^{\sigma-1} \tau_{ij}^{1-\sigma} \left(\frac{\tilde{\varphi}_{ii}}{\tilde{\varphi}_{ij}} p_i \right)^{1-\sigma} \left(\frac{Y_j}{\bar{M}_j} \right)^{1-\nu} \varrho_{ij} M_i. \end{aligned} \tag{26}$$

2.6 General equilibrium

To obtain analytical results, the literature usually assumes quasi-linear preferences of the existence of a freely-traded numéraire good which is produced in every country under conditions of perfect competition and where there are no labor market frictions. We are not opting for such a short-cut, since this would relegate the effect of changes in market sizes into the numéraire sector. Another way towards a full-fledged analytical solution of the model is to assume perfect symmetry in all respects which yields a recursive model structure. Under these latter circumstances, the model perfectly coincides with FPS. The existence and uniqueness results, as well as all the comparative statics presented in FPS carry over. One key insight in that model is that lower variable trade costs increase the relative reward to vacancy posting, Φ_i, in every country. Under symmetry Φ_i does not depend on labor market outcomes so that one can directly infer

When country are asymmetric, the model is much more complicated. The reason is that Φ_i will, inter alia, depend on all the countries' disposable incomes and those are in part determined by their respective rates of unemployment, hence $\Phi_i = f\left(u_1, u_2, \ldots, u_N, \ldots\right)$. The Wage and Job Creation curves imply that $u_i = g\left(b_i, c_i, \bar{m}_i; \Phi_i\right)$. Through Φ_i,country' $i's$ rate of unemployment depends on all the other countries' unemployment rates as well. This, in turn, implies a structural dependence of u_i on the whole world's collection of institutional labor market variables.

The model is a generalized version of Krugman (1979), in which the labor market clearing conditions give rise to transcendental equations which do not possess any solution. Note that the underlying problem in this type of model does not stem from the existence of external economies of scale; it also does not vanish when the price of the final output good P_i is equalized by frictionless international trade. Hence, in order to assess the properties of the model, we need to resort to calibration and simulation of the model at its steady state.

3 Interdependence of Labor Market Outcomes

3.1 Model Calibration

We calibrate the model such that each country's initial steady state reproduces a number of key empirical moments of the United States: for example, we parameterize the economies such that the average firm size, firm turnover rates, or job separation rates are matched. In order to avoid the obvious counterfactual negative correlation between country size and unemployment, we disallow for external economies of scale.

Productivity Distribution. Following the literature on heterogeneous firms (see for example Axtell (2001) and Helpman, Melitz, and Yeaple (2004)), we assume that firms sample their productivity from a Pareto distribution, so that

$$g(\varphi) = \frac{\gamma}{\varphi}\left(\frac{\bar{\varphi}}{\varphi}\right)^{\gamma}. \tag{27}$$

The shape parameter γ measures the rate of decay of the sampling distribution and $\bar{\varphi} > 0$ is the minimum possible value of φ. The assumption of Pareto distributed productivities is justified by the observation that the log-density of firms's log-sizes is well approximated by an affine function.

Using the Pareto distribution, average productivities (17) can be written as:

$$\tilde{\varphi}_{ij} = \left(\frac{\gamma}{\gamma - \sigma + 1}\right)^{1/(\sigma-1)} \varphi^*_{ij}. \tag{28}$$

Note that the average productivity is an increasing function of the cut-off productivity φ^*_{ij}.

Given the distributional assumption, the cut-off level productivity can now be explicitly stated:

$$\varphi^*_{ii} = \left(f + \sum_{j \neq i} f^x \Lambda_{ij}^{-\gamma}\right)^{1/\gamma} (1/f^e)^{1/\gamma} \left[\frac{1+r}{r+\delta}\left(\frac{\gamma}{\gamma - \sigma + 1} - 1\right)\bar{\varphi}^{\gamma}\right]^{1/\gamma}. \tag{29}$$

In order to parameterize the Pareto distribution, we have to set two values: (i) the minimum possible value of φ, $\bar{\varphi}$, and (ii) the shape parameter γ. In order to pin down $\bar{\varphi}$, note that the absolute value of φ is not informative. Hence, we can chose $\bar{\varphi}$ arbitrarily an set it to 0.5. Concerning the shape parameter we follow Bernard, Redding, and Schott (2007) and set it equal to 3.4.

Matching Function. Given that wages are paid at the end of each period, we set the time interval to one month. The matching function is assumed to be Cobb-Douglas as given in Equation (21). We follow the standard practice in the search-matching literature

and set the elasticity parameter α to 0.5. In the absence of well-established estimates, we set the bargaining power $\beta = \alpha$.[12]

To calibrate the scale parameter $\bar{m}$, we use empirical estimates of the job finding rate and labor market tightness. Given the constant returns to scale property of the matching function, the equilibrium tightness must be equal to the ratio of these two rates. Shimer (2005) estimates the monthly rate at which workers find a job to be equal to 0.45. Hall (2005) finds an average ratio of vacancies to unemployed workers of 0.539 over the period going from 2000 to 2002. Accordingly, we match an equilibrium tightness of 0.5 by setting the monthly job filling rate to 0.9. Reinserting these values into Equation (21), we find that $\bar{m} = 0.636$.

Separation shocks. Job separations occur either because the firm leaves the market or because the match itself is destroyed. We consider that the first type of shock arrives at a Poisson rate of 0.916% per month. This implies that the annual gross rate of firm turnover is equal to 22%, as suggested by the estimates in Bartelsman, Haltiwanger, and Scarpetta (2004). The match-specific shocks account for the job separations which are left unexplained by the firm-specific shock. Given that Shimer (2005) estimates the monthly rate of job separation to be 0.034, it follows that the rate of arrival of match-specific shocks χ should be equal to 0.025 per month.

Cost parameters. As it is common in the real business cycle literature, we set the interest rate to 4% per year. In order to calibrate the value of non-market activity, we follow Shimer (2005) and set $b_i = 0.4$ to match an earnings replacement ratio close to 40%. The cost of posting a vacancy, c_i, is set 50% above the vacancy filing rate. Given that the equilibrium wage is around $w_i = 1.137$, this value yields an average recruitment cost of around 5.7 weeks of workers' earnings, as suggested by empirical estimates.

Variable and fixed costs of trade and entry. We choose variable trade costs τ_i equal to 1.3 as Ghironi and Melitz (2005). Given the Pareto distribution, the share of firms that export is given by

$$\varrho_{ij} = \tau_{ij}^{-\gamma} \left(\frac{f}{f^x} \right)^{\frac{\gamma}{1-\sigma}}. \tag{30}$$

That number is put at about 21% by Bernard, Eaton, Jensen, and Kortum (2003). Together with $\tau_i = 1.3$, this pins down the ratio f^x/f at about 1.7.

We use the values of entry costs, f^e, and the flow fixed costs, f, to match the following two moments. Firstly, we ensure that the equilibrium tightness $\theta = 0.5$. Secondly, we target an average firm size equal to 21.8 employees, as estimated by Axtell (2001). These two moments are perfectly matched for the set of parameters reported in Table 1. The

[12]The equality of the bargaining power and matching function elasticity is known as the "Hosios condition' (Hosios, 1990) in the search-matching literature. Note, however, that in our case this condition is not sufficient to ensure an efficient allocation because of the over-hiring externality.

calibrated entry costs are equivalent to 2.82 years of income per capita. This figure can be compared to the assessment by Ebell and Haefke (2006) that regulatory barriers to entry in the US amount to 0.6 month of yearly income. The parametrization therefore suggests that technological innovation costs outweigh entry fees by an order of magnitude.

A summary of all chosen parameter values is given in Table 1.

3.2 The Role of Interdependence in a Symmetric World

We now deviate from the symmetric benchmark equilibrium and allow for differences in unemployment benefits, trade frictions, and country sizes. We pay particular attention to cross-country differences in unemployment benefits as, in contrast to search costs and the parameter of the matching functions, unemployment benefits are readily observable. Moreover, we know that the model reacts similarly to changes in search costs c_i or the search technology $\bar{m}_i$. Specifically, we study the effect where country 1 has higher unemployment benefits than countries 2 and 3. For this we vary b_1 from 0.4 to 0.8 and hold unemployment benefits for country 2 and 3 constant at 0.4. Further, trade costs vary for trade between all countries from no trade costs up to 60%, i.e. $\tau_{ij} = \bar{\tau}$ varies from 1 to 1.6 for all i, j. For our first investigation we assume $L_i = \bar{L}$, hence countries are symmetric with respect to all things except the unemployment benefits. The main insights from these experiments are summarized in Result 1:

Result 1a [Globalization as a trend]
If countries are symmetric in all respects except the unemployment benefits ($b_1 > b_{j\neq 1}$) *(in particular* $\tau_{ij} = \bar{\tau}$ *for all* i, j*), then* $d\bar{\tau} < 0 \Rightarrow du_i < 0$ *and* $d(w_i/P_i) > 0$ *for all* i*.*

Result 1b [Institutional spill-overs in a symmetric world]
If $\tau_{ij} = \bar{\tau} \geq 1$ *for all* i, j*, and countries are symmetric in all respects except the cost of unemployment benefits, then* $db_1 > 0 \Rightarrow du_i \geq 0$*,* $d(w_1/P_1) \geq 0$ *and* $d(w_j/P_j) \leq 0$ *for all* $j \neq i$*.*

We demonstrate Result 1 with the help of Figures 1. The left-hand diagram one shows the unemployment rate in country 1 for various values of trade costs on the x-axis and unemployment benefits on the y-axis. Unemployment is lowest for zero trade costs and an unemployment benefit of 40% (about 6.7% for our chosen calibration). If trade costs increase or unemployment benefits raise, unemployment in country 1 goes up. Hence, two things are worth noting from Figure 1: (i) Opening up to trade lowers unemployment, (ii) labor market institutions that "foster" unemployment (i.e., bad labor market institutions) like an increasing unemployment benefit, rise unemployment in the country with the bad labor market institutions.

The first of these two results is driven by the increased demand of labor in the economy. As economies open up to trade, more demand for every firm, producing a single variety, leads to more employment in every firm. This result aggregates to a lower unemployment rate in the whole economy. This result has to be seen in the light of the recent literature. There are only two recent paper that are very explicit about the trade liberalization effects on unemployment. Helpman, Itskhoki, Redding (2008a) summarize their finding about unemployment in the differentiated sector in Proposition 3: "*In the differentiated sector,*

Table 1: Base-line Calibration of Parameters Values

Parameter	Description	Value	Source
r	Discount rate	0.33%	4% annual discount rate
ν	Parameter of external scale economies	0	Blanchard and Giavazzi (2003)
σ	Elasticity of Substitution	3.8	Bernard, Redding, Schott (2007)
b_i	Unemployment benefits	0.4	Standard
$\bar{m}$	Efficiency of matching function	0.636	Job finding rate=0.45; Shimer (2005) and Hall (2005)
β	Bargaining power	0.5	Hosios (1990)
δ	Rate of firm exit	0.91%	Firm turnover rate=1.8%; Bartelsmann, Haltiwanger and Scarpetta (2004)
χ	Rate of match-specific separation	2.5%	Job separation rate=3.4%
$\bar{\varphi}$	Minimum value of productivity	0.5	Arbitrary.
γ	Shape of Pareto Distribution	3.4	Bernard, Redding, Schott (2007)
c	Cost of posting a vacancy	1	To match $\theta = 0.5$ (Hall, 2005)
f^e	Fixed entry cost	39.57	To match $\theta = 0.5$ (Hall, 2005)
f	Fixed cost of production	0.116	Average firm size = 21.8
f^x	Fixed foreign market access costs	0.193	Bernard, Eaton, Jensen and Kortum (2003)
τ	Iceberg trade costs	1.3	Ghironi & Melitz (2005)
L_i	Size of population	1	Size normalization
P_1^H	Numraire	1	Normalization
N	Number of countries	3	Allows for direct and indirect spill-overs

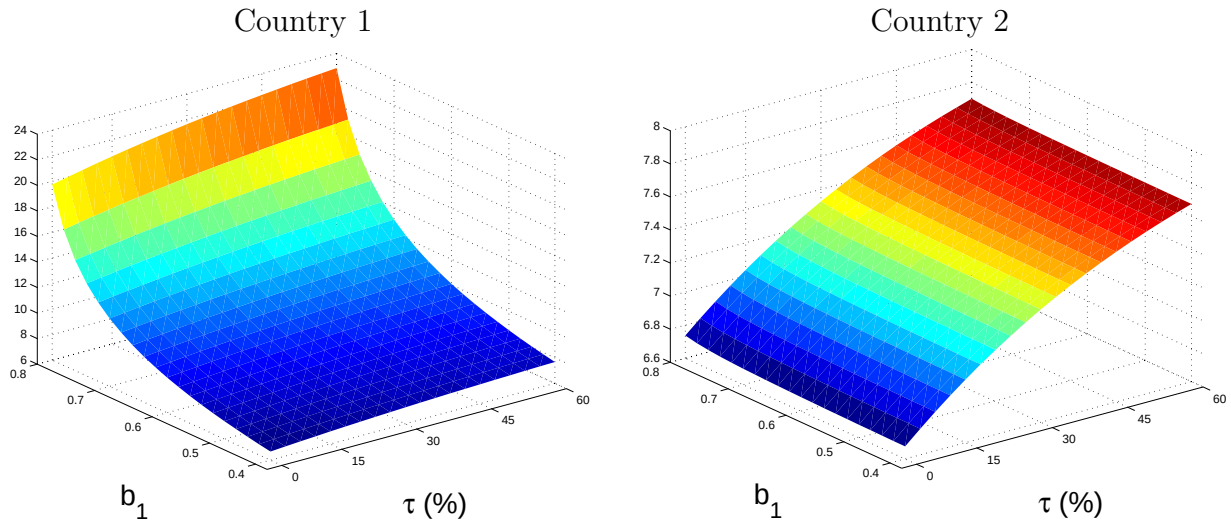

Figure 1: Country 1 labor market regulation and unemployment in countries 1 and 2 (=3). [Rate of unemployment on the vertical axisl.]

the hiring rate is strictly lower and the unemployment rate is strictly higher in a trade equilibrium than in autarky." The main intuition for their result is that after opening up to trade there is a shake out of unproductive firms. As more productive firms are more selective (screen to a higher ability cutoff), this change in industry composition raises sectoral unemployment. In contrast, FPS note, also in Proposition 3, that "... a reduction of variable trade costs τ or an increase in the number of trading partners n lead to a fall in the equilibrium rate of unemployment and a rise in the real wage". Hence, there is a sharp contrast between the theoretical predictions.

Where do differences come from? In Helpman, Itskhoki, Redding (2008a) there are two sectors, one homogenous sector with a perfect labor market, and on differentiated sector. It is assumed via a quasi-linear utility function, that all changes in income only affect the demand for the homogeneous good. In contrast, in the model from FPS as well as in the presented one, there is only one sector, which is also the sector where search and matching frictions on the labor market occur. The main driving force for the negative effect found by Helpman, Itskhoki, Redding (2008a) is also present in FPS (2008) and in the presented model. Even though in the latter there are no screening costs, there is a shift to more productive firms after opening up to trade. This reduces demand for workers. However, there is an additional force at work in the latter models: Opening up to trade leads to an increased demand for differentiated goods, which is due to the (increased) demand of the foreign market as well as to the additional income spend which is generated due to the gains from trade. The increased demand leads to a reduction of aggregate unemployment and explains why the models lead to different predictions. We think that it is important to account for these income and general equilibrium effects, which also has a long tradition in international trade, specifically when it comes to the

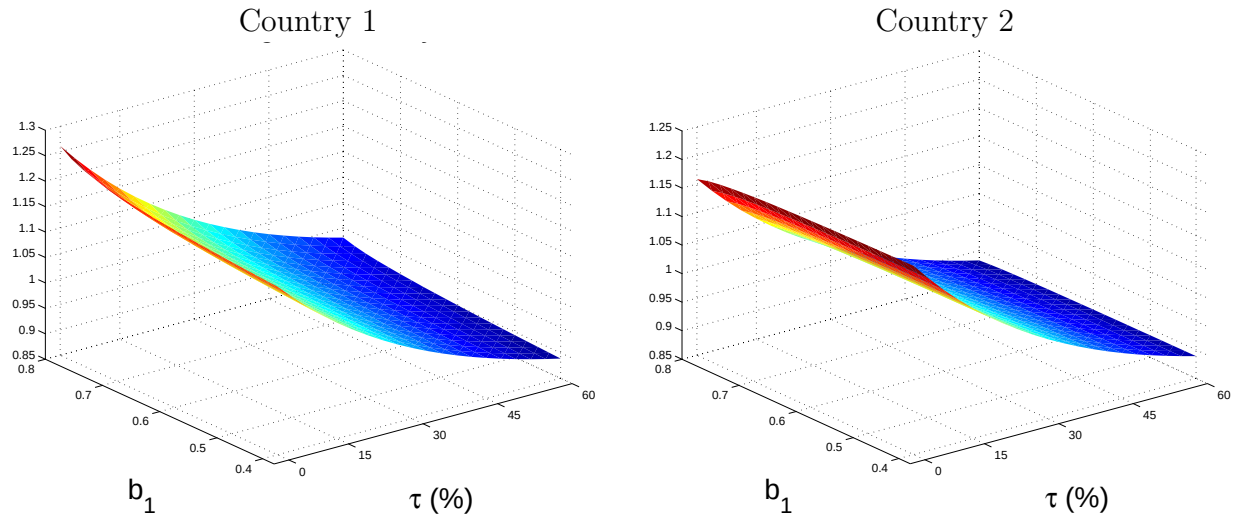

Figure 2: Country 1 labor market regulation, trade costs, and real wages [on vertical axis] in countries 1 and 2 (=3).

evaluation of trade liberalization effects.[13]

The second effect is the direct effect of changing labor market institutions on home unemployment. If labor market institutions at home worsen, home unemployment goes up. The reason is that with higher unemployment benefits (or higher search costs, more inefficient matching at the labor market), the outside option for workers is better, leading to higher wages and, in equilibrium, to a higher aggregate unemployment. More interesting in this regard is the spill-over effect of bad labor market institutions on unemployment abroad. What we find here is an increase of unemployment in the foreign country. If labor market institutions at home worsen, unemployment rises, leading to an overall decrease of income in that country. As part of the income is spend on foreign varieties, this leads to reduced exports from the foreign country to the home country. Hence, bad labor market institutions are propagated abroad via reduced demand for foreign varieties. In the foreign country we can distinguish two effects: (i) The reduced export demand leads to lower demand for workers, (ii) and as labor market institutions in the foreign country stay constant and the bad labor market institutions at home raise prices of differentiated goods relative to the foreign differentiated goods price, there is a shift from foreign do domestic varieties. This leads to an increased demand of workers. As the first effect is a direct effect of the bad labor market institutions and the second effect is an indirect effect of bad labor market institutions, working through changes in prices of differentiated goods, the first effect will outweigh the second. Hence, demand for workers will be lower, leading to an increase in aggregate unemployment.

The effects on real wages of trade liberalization is positive in both countries (see Figure

[13]See for a recent example of the importance of income and general equilibrium effects in the evaluation of trade barriers for international trade Anderson and van Wincoop (2003).

2). More trade leads to more specialization and product variety, lowering overall consumer prices. Further, gains from trade leads, overall, to raising nominal wages. Hence, real wages raise in both countries. This is in line with the findings of Melitz (2003) and FPS.

However, focusing on an increase in unemployment benefits, we see that while real wages in country 1 raise, real wages in country 2 fall. Higher unemployment benefits lead to better outside options of workers, strengthening their bargaining power. This leads to higher bargained wages and to a shake out of the most unproductive firms. In the foreign country, the outside option does not change, however, the export demand shrinks, whereas domestic demand grows. This leads less productive firms to enter the market and a greater share of firms only sale their products locally. As shown in FPS in Corollary 1, a fall in aggregate productivity leads to a fall in the vacancy-unemployment ratio, θ_i. This leads to a lower real wage.

3.3 The Role of Geography and Relative Size

So far we assumed symmetric countries in all respects but the labor market institutions. Our results suggest that it is possible for a country with bad labor market institutions to spill-over part of the burden on the labor market to foreign countries (unemployment is lower when trade costs are lower, given the labor market institutions). Hence, foreign countries also suffer from bad labor market institutions abroad in terms of higher unemployment, i.e., there is a positive correlation of the degree of unemployment at home and abroad that stem from bad labor market institutions.

Bringing these predictions to data, we have to take into account that countries are not alike concerning their geographic location and size. Hence, we next want to investigate how geography conditions the spill-over effects of labor market institutions, and how the relative size of the home country, changing the degree of labor market imperfections, effect the interdependence between countries. In Result 2 we summarize our findings for the degree of centrality of country 1 and its country size:

Result 2a [How geography of the "bad institutions" country conditions spill-overs]
If $b_1 > b_{j\neq 1}$, $\tau_{jk} = \bar{\tau}_{jk}$, $\tau_{1j} = \tau_{1k} = \tau_{j1} = \tau_{k1}$ for $j, k \neq 1$, and the RoW is symmetric, and we increase b_1, i.e., $\Delta b_1 > 0$, then an increase of the degree of centrality of country 1, $(d\tau_{1k} = d\tau_{1j} = d\tau_{k1} = d\tau_{j1} < 0)$, leads to a decrease of du_1 and an increase of $d(w_1/P_1)$ for a given change db_1, whereas du_j increases and $d(w_j/P_j)$ decreases.

Result 2b [How relative size of the "bad institutions" country conditions spill-overs]
If $b_1 > b_{j\neq 1}$, $\tau_{jk} = \bar{\tau}_{jk}$, $\tau_{1j} = \tau_{1k} = \tau_{j1} = \tau_{k1}$ for $j, k \neq 1$, and the RoW is symmetric, and we increase b_1, i.e., $\Delta b_1 > 0$, then an increase of the population share of country 1, $s_1 = L_1/\Sigma_i L_i$, leads to an increase of unemployment in all countries, i.e., $du_i > 0$ for all i, and a decrease in the change of real wages in all countries, $d(w_i/P_i) < 0$ for all i.

The results for unemployment are illustrated in Figure 3. Here we assume in the base case a rate of unemployment benefits in all countries of 0.4. In the counterfactual we assume an increase in unemployment benefits in country 1 from 0.4 to 0.8. Then we plot

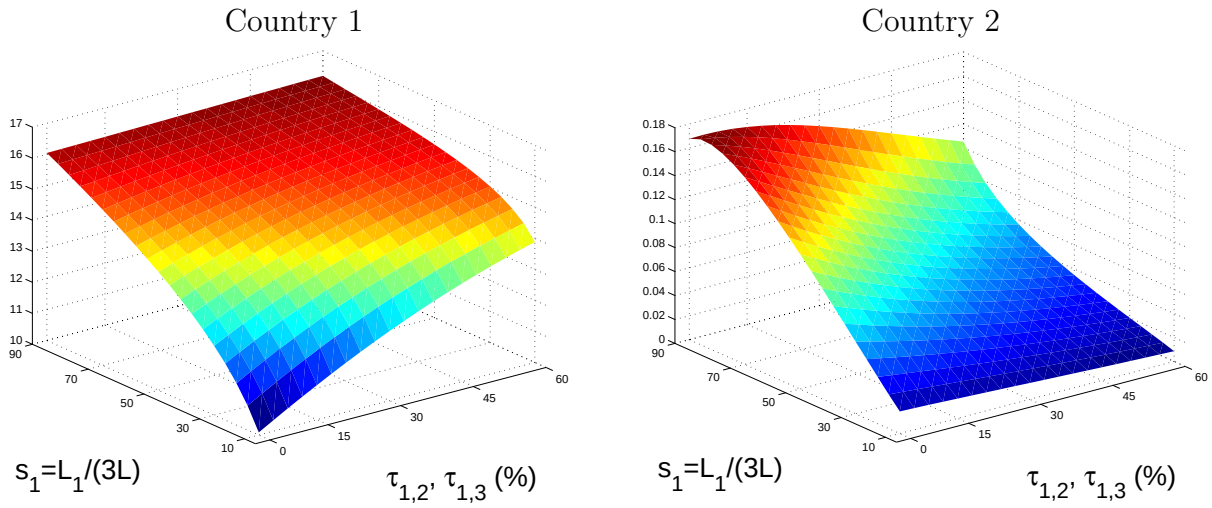

Figure 3: Change in unemployment [depicted by color of shade] as a function of centrality and size of the "bad" country 1.

the percentage change in unemployment resulting from this increase of unemployment benefits in country 1 for different values of trade costs and country sizes of country 1. On the x-axis of the diagrams depicted in Figure 3 we vary trade costs between country 1 and countries 2 and 3, i.e., change $\tau_{1j} = \tau_{1k}$ for $j, k \neq 1$, but hold constant trade costs between countries 2 and 3, i.e., $\tau_{jk} = \bar{\tau}_{jk}$ for $j, k \neq 1$. Decreasing trade costs of country 1 with countries 2 and 3 but holding constant trade costs between 2 and 3 reflects an increased centrality of country 1. On thy y-axis we vary the country size of country 1. We "measure" country size in terms of population, as income, i.e., gross domestic product, is endogenous in our model. Specifically, we assume a constant world population $\bar{L}$, and then change country 1's share of world population from 10% to 90%. The remaining population is distributed equally between countries 2 and 3. This allows us to study the effect of changing absolute country size of country 1 relative to countries 2 and 3, holding the relative size between countries 2 and 3 constant.

First note that the change in unemployment is always positive for all countries. As we have seen for the symmetric world already, bad labor market institutions lead not only to an increase of unemployment at home but also abroad. However, the interesting new information is how strong the spill-overs are for varying degrees of centrality and country sizes. Hence, we study how centrality and country size *condition* the strength of labor market institution spill-overs.

We see that an increase of the centrality of country 1 for a given change in unemployment benefits, $db_1 > 0$, leads to a weaker increase of unemployment in country 1 but a stronger increase of unemployment in countries 2 and 3 when unemployment benefits rise in country 1 (figures for country 3 are suppressed, as countries 2 and 3 are perfectly symmetric). If country 1 is more central, it trades more with both other countries, 2 and 3. Hence, falling domestic demand can be compensated via two channels: (i) If domestic demand falls, firms can export to the rest of the world. This is easier the lower are

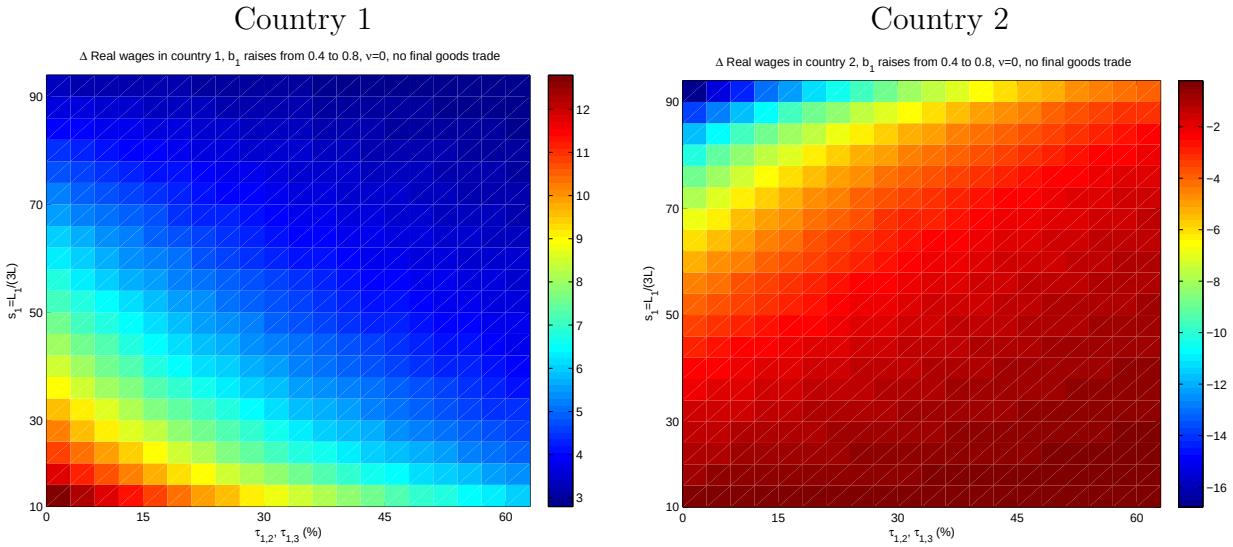

Figure 4: Change in unemployment as a function of centrality and size of the "bad" country 1.

trade costs, i.e., if country 1's centrality is high. (ii) Falling domestic demand hurts the home country most in autarky. If it is well integrated in the world economy, part of the burden of lower domestic demand falls on the foreign countries. This also explains why unemployment rises more if trade costs fall for a given change in labor market institutions.

Increasing the size of country 1 with respect to the rest of the world, we find that the increase in unemployment is stronger in all countries (see Figure 3. The reason for the increase in the home country 1 is that if its country size is large, hence, the rest of the world comparable small, only a small fraction of the burden of bad labor market institutions can be transferred to foreign countries. Hence, the negative effect of the bad institutions fully rests in the home country. For the foreign country, even though they only take a smaller share of the burden if they are small compared to country 1, a larger country 1 means that country 1 is a more important trading partner. Hence, changes in demand in country 1, as the ones that result from changing labor market institutions, are more severe for the countries 2 and 3.

The conditioning effects of centrality and size of country 1 if labor market institutions change on real wages is visualized in Figure 4. Concerning trade costs, we find that the change in real wages increase in all countries. Hence, in country 1 the increase in real wages is larger if it is more central, whereas the decrease in real wages increases in the rest of the world. This finding roots in the fact that with lower trade costs, i.e., higher centrality, of country 1, country 1 more easily can spill-over bad labor market institutions, leading to higher real wages, whereas the countries that take a larger part of the burden, countries 2 and 3, see a higher drop in real wages.

Concerning the country size we find that an increasing size of country 1 leads to a lower increase in real wages in country 1 but a stronger decrease in real wages in country 2. The explanation is similar to the one given for the effects on unemployment: If country 1 is

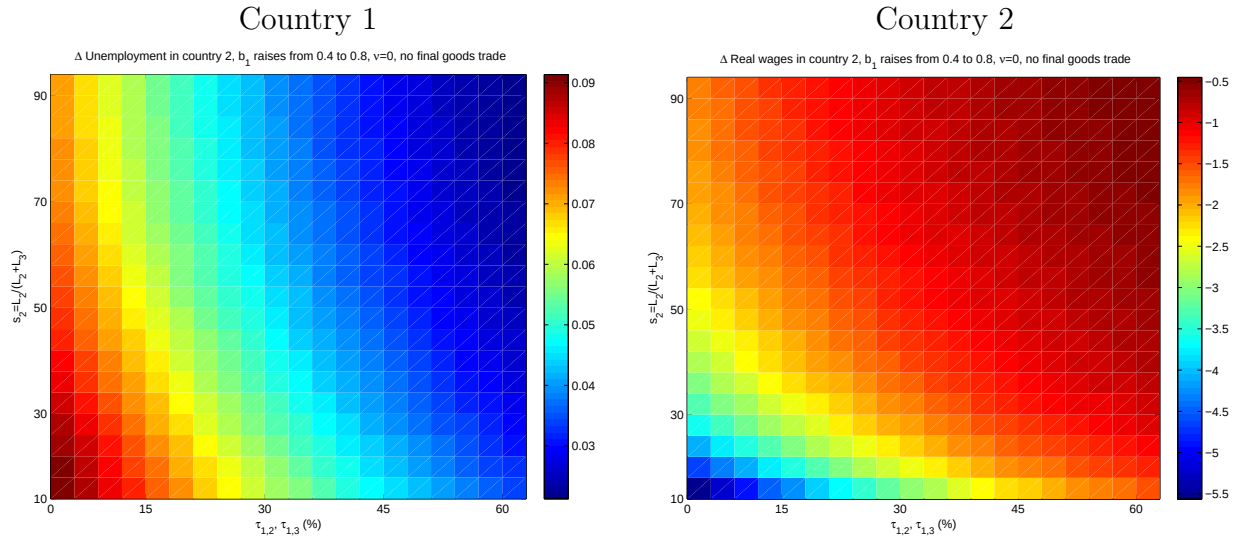

Figure 5: Change in unemployment as a function of centrality and size of the "bad" country 1.

larger, home demand is more important, making it harder to spill-over bad labor market institutions to foreign countries. However, for the foreign countries a larger country 1 means a more important trading partner, leading to a higher sensitivity on the economic performance of this country.

Result 3 [How relative size of the "affected" countries conditions the effect of spill-overs]
If $b_1 > b_{j\neq 1}$, $\tau_{jk} = \bar{\tau}_{jk}$, $\tau_{1j} = \tau_{1k} = \tau_{j1} = \tau_{k1}$ *for* $j, k \neq 1$, *and the RoW is symmetric besides the country size* $s_j = L_j/L^{RoW} \in (0,1)$, *and we increase* b_1, *i.e.,* $\Delta b_1 > 0$, *then an increase of the the population share* $s_j = L_j/L^{RoW}$, $(ds_j > 0)$, *leads to a decrease of* du_j *and and increase of* $d\left(w_j/P_j\right)$.

Result 3 can be demonstrated with help of Figures 5 and 6. They are similar to Figure 4, but now we vary on the y-axis not the size of country 1, but rather the relative sizes of country 2 and 3 holding constant the size of country 1. We assume that country 1 has a third of the world population, whereas the other two thirds are distributed between countries 2 and 3. Hence, we can study *who* takes the burden of the labor market spill-overs from country 1. For this reason we entirely focus on the effects on countries 2 and 3, as the effects for country 1 are hardly affected by changing relative sizes between the trading partners. Note, that we plot the results for country 2 only. However, the effects for country 3 can be inferred from the same figures, as $s_3 = 1 - s_2$, and trade costs are symmetrically varied.

Concerning unemployment we find that the rise in unemployment is larger if a country is comparable smaller and country 1 is more central. Hence, if country 2 is smaller than country 3, it has a smaller home market and relies more heavily on trade with the other countries. As one of these countries, country 1, spills over unemployment via bad labor market institutions, this has a stronger affect on the small country. And this affect is

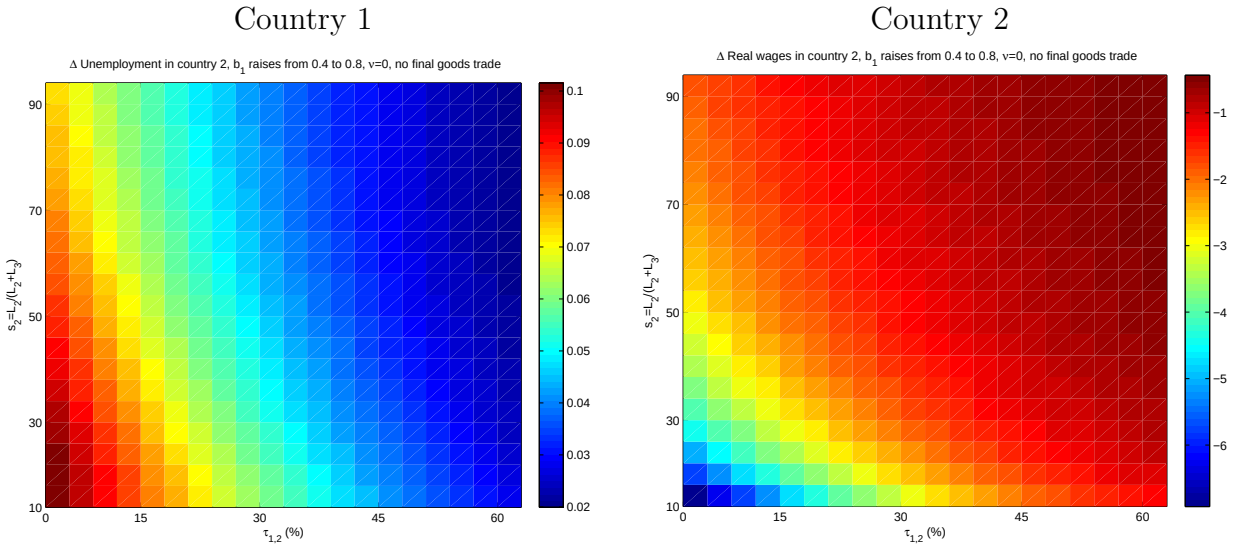

Figure 6: Change in unemployment as a function of centrality and size of the "bad" country 1.

stronger the more central country 1 is. Similarly, the affect on real wages is stronger if a country is relatively small and country 1 is more central for similar reasons.

Result 4 [How geography of the "affected" countries conditions the effect of spill-overs]
If $b_1 > b_{j\neq 1}$, $\tau_{jk} = \bar{\tau}_{jk}$, $\tau_{12} = \tau_{21}$ *for* $j, k \neq 1$, *and the RoW is symmetric besides the country size* $s_j = L_j/L^{RoW} \in (0,1)$, *and we increase* b_1, *i.e.,* $\Delta b_1 > 0$, *then a decrease of trade costs between countries* 1 *and* 2, $d\tau_{12} = d\tau_{21} < 0$, *leads to an increase of* du_2 *and a decrease of* $d\left(w_j/P_j\right)$, *and these changes are stronger as in the case where* $(d\tau_{1k} = d\tau_{1j} = d\tau_{k1} = d\tau_{j1} < 0)$.

So far we assumed that both countries, 2 and 3, are equally distant from country 1. We focussed on the centrality of country 1 by changing trade costs vis-à-vis both other countries symmetrically. Now we want to study how the geography of the "affected" country conditions the spill-over effect of labor market institutions. Therefore, we plot on the x-axis of Figures 5 and Figure 6 changes in $\tau_{12} = \tau_{21}$, whereas the y-axis is the same as in Figure 4.

First, we note that the qualitative results for unemployment and real wages are the same as for the case where trade costs between country 1 and both countries, countries 2 and 3, vary symmetrically (compare Figures 5 and Figure 6). However, the effects for country 2 are stronger if it is more integrated with country 1 than is the other trading partner, country 3. Hence, the spill-over effects are stronger for countries that are closer, i.e., are more integrated and have lower trade costs, to the country with bad labor market institutions.

4 Empirical evidence

In this section, we use panel data on labor market institutions and unemployment rates for 20 rich OECD countries for 1982-2003. Our aim is not to provide a formal test of our theoretical model, but rather to check whether the empirical evidence is in line with three key predictions of our model, namely: (i) controlling for business cycle comovement, unemployment rates are positively correlated across countries; (ii) the unemployment rate of a country is not only determined by its own labor market institutions but also by those of other countries; (iii) the relative importance of foreign countries' institutional features depends crucially on the bilateral volume of trade.

4.1 Econometric specification

Our starting point is a standard cross-country unemployment regression. Bassanini and Duval (2006) provide a comprehensive survey of different empirical models and methods. Typically, researchers have estimated equations of the type

$$u_{i,t} = \lambda \cdot \mathbf{LMR}_{i,t} + \pi \cdot pmr_{i,t} + \gamma \cdot gap_{i,t} + \nu_i + \mathbf{T}_{i,t} + \varepsilon_{i,t}, \tag{31}$$

where $\mathbf{LMR}_{it}$ is a vector of variables describing the stance of labor market regulations, $pmr_{i,t}$ measures the intensity of product market regulations and $gap_{i,t}$ is the output gap (calculated as the difference between actual output and the HP-filtered series). The vector ν_i collects the comprehensive set of country fixed-effects, and the vector $\mathbf{T}_{i,t}$ contains country-specific time trends. The error term ε_{it} is assumed to have the usual properties.

Bassanini and Duval (2006) do not survey a single study which would address the possibility that the foreign rate of unemployment or foreign labor market regulations might matter for domestic labor market outcomes. The existing literature has found robust and quantitatively relevant effects on the rate of unemployment only for a very limited number of labor market institutions. The most important is the participation tax rate (or tax wedge); see Costain and Reiter (2008). It consists of the sum of the average wage tax burden and social benefits foregone when a worker switches from unemployment into a job. It therefore measures the *total* fiscal burden imposed on the worker (Saez (2002); Immervoll et al. (2007)). Other measures relating to the nature of wage bargaining, employment protection legislation, or the prevalence of minimum wages have a more mixed empirical support. Hence, in our regressions, we mostly focus on a single labor market variable, the *tax wedge* $(b_{i,t})$.

Our model predicts that the effect of labor market regulations or the rate of unemployment of some country j on country $i's$ rate of unemployment is conditioned by the amount of bilateral trade between the two countries. It is therefore natural to compute a trade-weighted average of the foreign unemployment rate or foreign labor market institutions. In order to avoid that the trade weights are endogenous to the domestic rate of unemployment, we use a proxy for the amount of bilateral trade between i and j,

$$\tilde{\omega}_{ij,t} = \frac{POP_{i,t}^{\alpha_1} POP_{j,t}^{a_2}}{DIST_{ij}^{\delta}}, \tag{32}$$

where $POP_{i,t}$ denotes population of country i, $DIST_{ij}$ is the great circle distance between the two countries' most populated cities; α_1, α_2,and δ are parameters. This variable varies with time as population changes. It mimics the simplest possible gravity formulation, but substitutes population for GDP which is potentially endogenous.[14] Standard gravity predictions suggest that $\alpha_1 = \alpha_2 = 1$. Overman et al. (2003) state that δ, "the elasticity of trade volumes with respect to distance is usually estimated to be in the interval 0.9 to 1.5." In their meta analysis of 1,467 estimates from 103 papers, Disdier and Head (2008) find that the mean effect is about 0.9, with 90% of estimates lying between 0.28 and 1.55. However, they also show that δ has increased substantially over time. Hence, we choose $\delta = 1$ as our benchmark scenario but conduce robustness checks with respect to the assumptions on α_1, α_2, and δ. Alternatively we also work with the distance between the two countries' capitals and a population-weighted measure computed over several cities.

We calculate $\tilde{\omega}_{ij,t}$ for all countries for which population and distance data is available (i.e., not only the 20 OECD countries for which we have reliable labor market data) and normalize the weights such that $\sum_j \omega_{ij,t} = 1$ for all i. We construct the trade-weighted average of foreign unemployment rates, $u^*_{i,t} = \sum_j \omega_{ij,t} u_{j,t}$, where country $i's$ rate of unemployment is excluded by definition $(\omega_{ii,t} = 0)$. Similarly, we construct the trade-weighted average tax wedge of all countries other than i as $b^*_{i,t} = \sum_j \omega_{ij,t} b_{j,t}$ or the average foreign output gap as $gap^*_{i,t} = \sum_j \omega_{ij,t} gap_{j,t}$.

4.2 Data

Bassanini and Duval (2006) have assembled the most comprehensive data set on labor market variables. It reflects intensive efforts at the OECD to come up with harmonized measures. Unfortunately, it covers only 20 countries[15] for the years 1982 to 2003. However, it should be mentioned that virtually all cross-country unemployment regressions in the literature make use of exactly this data set (or its numerous precursors), see Nickel et al. (2005), (MORE QUOTES). Data on geographical distances comes from CEPII.[16] Population data has been retrieved from the Penn World Tables mark 6.2.

4.3 The role of foreign unemployment rates

As a first step, we show that our data reproduces the typical results found in the empirical literature. Column (1) in Table 2 shows the results of estimating (31) using OLS. The

[14] We have also fitted a more complete gravity equation (i.e., one that includes additional covariates such as common language, contiguity, etc.) to bilateral trade data, using Poisson Pseudo maximum likelihood methods. Results are qualitatively and quantitatively compareable. We prefer our specification as bilateral trade volumes may be endogenous to unemployment rates.

[15] Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), Switzerland (CHE), Germany (DEU), Denmark (DNK), Spain (ESP), Finland (FIN), France (FRA), Great Britain (GBR), Ireland (IRL), Italy (ITA), Japan (JPN), Netherlands (NLD), Norway (NOR), New Zealand (NZL), Portugal (PRT), Sweden (SWE), and the United States of America (USA).

[16] www.cepii.fr/anglaisgraph/bdd/distances.htm

tax wedge $b_{i,t}$, the measure of product market regulation (PMR) and the output gap (gap) have the expected signs. They turn out highly significant statistically and are quantitatively comparable to results found in the literature. The other labor market variables included in the regression – union density, the degree of corporatism, and the strictness of employment protection legislation (EPL) – do not have any measurable effect. This is a standard finding; see Baker et al. (2006).

In the next step, we include the trade-weighted average foreign unemployment rate $u^*_{i,t}$ and estimate versions of

$$u_{i,t} = \rho u^*_{i,t} + \lambda \cdot \mathbf{LMR}_{i,t} + \pi \cdot pmr_{i,t} + \gamma_1 \cdot gap_{i,t} + \gamma_2 \cdot gap^*_{i,t} + \nu_i + \mathbf{T}_{i,t} + \varepsilon_{i,t}. \qquad (33)$$

The domestic unemployment rate is not used in the calculation of $u^*_{i,t}$. However, if shocks to the unemployment rate exhibit spatial correlation, then estimation of (33) via OLS would yield a biased value for ρ. To avoid this endogeneity bias, we instrument $u^*_{i,t}$ by lagged foreign regulatory variables, $\mathbf{LMR}^*_{i,t-1}, pmr^*_{i,t-1}$.[17] The underlying assumption is that past regulation is exogenous to contemporaneous labor market outcomes.

Columns (2) and (3) show the most parsimonious specifications. Parameters λ, π, γ are constrained to zero. The OLS estimate and the IV estimate are both positive; the former is $\rho^{OLS} = 0.298$; the latter, being somewhat larger, is $\rho^{IV} = 0.393$. The sign of the bias $\rho^{OLS} - \rho^{IV}$ is surprising, since one would have expected that unemployment shocks are correlated positively over space so that OLS should overestimate. However, to the extent that $u^*_{i,t}$ is a noisy measure for foreign labor market spillovers into the domestic market, we would expect OLS to underestimate due to attenuation bias and the IV strategy to correct this bias.

Columns (4) and (5) add an array of labor market controls. They also add $gap^*_{i,t}$ in order to control for the direct effect of the foreign business cycle on domestic unemployment. Qualitatively and quantitatively, results are comparable to those presented in column (1). However, the measured coefficient ρ is substantially smaller now than in the specification without controls. The sign of the endogeneity bias of ρ remains unchanged. Note that the largest part in the size reduction of ρ is due to the inclusion of the foreign output gap. Interestingly, while the coefficient on $gap^*_{i,t}$ is estimated with moderate precision, its sign is positive.

Columns (6) and (7) drop the insignificant labor market controls. This has virtually no effect on the 2nd stage F statistic or adjusted R^2. Our preferred specification (column (7)) implies that a one-standard-deviation increase in the average foreign rate of unemployment increases domestic unemployment by about *0.21* standard-deviations.[18] We believe that this effect is sizeable. Note that this effect is not driven by comovement of the domestic and the foreign business cycle, since we control for both of them $\left(gap_{i,t}, gap^*_{i,t}\right)$.

[17] This vector of instruments usually satisfies tests for instrument validity.

[18] This is a *standardized beta coefficient,* computed as $\hat{\rho} \times \sigma^2_{u^*}/\sigma^2_u$ where σ^2_u and $\sigma^2_{u^*}$ refer to the sample standard deviations of the domestic and the foreign unemployment rate, respectively.

Table 2: The role of foreign unemployment and foreign labor market institutions

Dep.var.: level of unemployment rate	(1) OLS	(2) OLS	(3) IV	(4) OLS	(5) IV	(6) OLS	(7) IV	(8) OLS	(9) IV
u^*		0.298^a	0.329^a	0.217^a	0.258^a	0.228^a	0.284^a	0.186^a	0.286^a
		(0.058)	(0.065)	(0.049)	(0.081)	(0.049)	(0.080)	(0.051)	(0.068)
$u^* \times k^*/k$								0.071^a	0.033
								(0.026)	(0.047)
k^*/k								-0.182	-0.076
								(0.433)	(0.151)
b	0.056^a			0.066^a	0.068^a	0.071^a	0.076^a	0.073^a	0.078^a
	(0.021)			(0.021)	(0.021)	(0.022)	(0.022)	(0.022)	(0.022)
PMR	0.877^a			0.843^a	0.705^a	0.699^a	0.564^b	0.747^a	0.601^a
	(0.287)			(0.273)	(0.244)	(0.240)	(0.220)	(0.238)	(0.228)
Union density	0.041			0.043	0.042				
	(0.041)			(0.041)	(0.038)				
High corporatism	-0.764			-0.578	-0.802				
	(0.666)			(0.652)	(0.555)				
EPL	-0.776			-0.676	-0.713				
	(0.549)			(0.539)	(0.505)				
gap	-0.441^a			-0.449^a	-0.465^a	-0.469^a	-0.487^a	-0.477^a	-0.492^a
	(0.028)			(0.031)	(0.029)	(0.028)	(0.026)	(0.028)	(0.027)
gap^*				0.181^b	0.239^b	0.215^b	0.292^a	0.299^a	0.359^a
				(0.089)	(0.112)	(0.089)	(0.110)	(0.096)	(0.099)
2nd stage stats									
RMSE	1.079	1.475	1.353	1.060	0.911	1.064	0.922	1.057	0.915
adj. R^2	0.934	0.876	0.881	0.936	0.945	0.935	0.944	0.936	0.945
F	161.1	124.5		153.9		154.2		148.8	
1st stage stats									
partial R^2			0.384		0.385		0.394		o.k.
Chi2 overidentification			0.931		0.678		0.561		0.539
Chi2 endogeneity			0.734		0.711		0.633		0.409

Robust standard errors in parentheses,$^a p < 0.01$,$^b p < 0.05$,$^c p < 0.1$. Number of observations: 420 in OLS and 400 in IV regressions. All regressions contain a full set of country fixed-effects and country-specific time trends. Trade-weighted averages for foreign variables (denoted by asterisks) are computed using $\alpha_1 = alpha_2 = 1, \delta = 1$. In IV regressions, the foreign unemployment rate u* is instrumented by b^*_{t-1}, PMR^*_{t-1} and gap^*_{t-1}. Endogeneity test tests the null that u* is exogenous (and rejects in all presented IV models). Overidentification is tested for using the Wooldridge robust Score test (invalidity of intruments or model misspecification is rejected in all presented IV models).

4.4 The role of foreign institutions

In the next step, we analyze the direct effect of foreign labor market institutions on the domestic rate of unemployment. We estimate an equation of the form

$$u_{i,t} = \lambda \cdot \mathbf{LMR}_{i,t} + \lambda^* \cdot \mathbf{LMR}^*_{i,t} + \pi \cdot pmr_{i,t} + \gamma_1 \cdot gap_{i,t} + \gamma_2 \cdot gap^*_{i,t} + \nu_i + \mathbf{T}_{i,t} + \varepsilon_{i,t}, \quad (34)$$

where $\mathbf{LMR}^*_{i,t}$ collects foreign labor market variables.

Table 3: Foreign labor market institutions and the freeness of trade

Dep.var.: level of unemployment rate.							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
b	0.082^a	0.081^a	0.084^a	0.105^a	0.083^a	0.079^a	0.168^a
	(0.025)	(0.020)	(0.025)	(0.021)	(0.021)	(0.022)	(0.018)
b^*	0.025^a	0.117^a	0.019^a	0.060^a	0.114^a	0.006	-0.004
	(0.006)	(0.028)	(0.007)	(0.016)	(0.029)	(0.009)	(0.170)
$b^* \times k^*/k$			0.007				
			(0.007)				
k^*/k			-0.041				
			(0.507)				
$b^* \times PMR$				-0.016^a	0.002		
				(0.004)	(0.004)		
$b^* \times MOP$						0.044^b	0.049^c
						(0.021)	(0.028)
PMR	0.927^a	0.785^a	0.958^a	0.623^b	0.721^a	0.769^a	0.445
	(0.239)	(0.227)	(0.238)	(0.248)	(0.245)	(0.228)	(1.408)
MOP						-0.077^a	-0.151^c
						(0.022)	(0.079)
gap	-0.455^a	-0.558^a	-0.463^a	-0.590^a	-0.558^a	-0.439^a	-0.486^a
	(0.030)	(0.035)	(0.031)	(0.038)	(0.036)	(0.028)	(0.057)
gap^*	0.106	0.091	0.146^c	-0.001	0.110	0.128^c	0.273^a
	(0.077)	(0.114)	(0.081)	(0.126)	(0.122)	(0.075)	(0.077)
Add'l LMR controls		yes			yes		
RMSE	1.657	1.536	1.151	1.625	1.538	1.060	1.546
adj. R^2	0.843	0.865	0.924	0.849	0.865	0.927	0.844
F	75.124	72.11	72.11	72.35	70.08		

Robust standard errors in parentheses, $^a p < 0.01$, $^b p < 0.05$, $^c p < 0.1$. Number of obsverations 440 in all models. All regressions contain a full set of country fixed-effects and country-specific time trends. Trade-weighted averages for foreign variables (denoted by asterisks) are computed using $\alpha_1 = alpha_2 = 1, \delta = 1$.

Column (1) in Table 3 shows the most parsimonious specification, where we include only the domestic and the foreign tax wedges $\left(b_{i,t}, b^*_{i,t}\right)$ as well as the controls for the domestic and the foreign business cycle as well as the complete set of fixed effects. We find that the own and the foreign tax wedges help explain the domestic unemployment rate. The estimates imply that a one standard-deviation increase of $b_{i,t}$ and of $b^*_{i,t}$ leads to an

increase in domestic unemployment by 0.350 and 0.138 standard deviations, respectively. Hence, the domestic tax wedge is about 2.5 times as important quantitatively than the foreign one. This seems like a sensible result.

Columns (3) and (4) add domestic and foreign labor market controls. The effect of $b_{i,t}$ and $b^*_{i,t}$ still have the predicted sign; their respective standardized beta coefficients are 0.447 and 0.333, respectively. It appears that adding additional labor market covariates strengthens the role of the tax wedges. The sign pattern of the other variables (employment protection legislation (EPL), and union density) is hard to square with intuition; in the case of domestic institutions this is a well-known feature; see Baker et al. (2004). The adjusted R^2 measure improves only slightly; the F-statistic actually deteriorates.

Our theoretical setup predicts that the degree of trade openness should condition the effect of foreign labor market outcomes or institutions on domestic unemployment rates. We account for this fact by the construction of the weighs $\omega_{ij,t}$. However, those weights do not reflect regulation that affects the degree of competition in a market. The data set of Bassanini and Duval (2006) contains a variable that (partly) captures this argument: product market regulation (PMR). Restrictive trade policies – in particular informal ones that have survived the abolishment of formal barriers amongst most OECD countries – often take the form of PMR. Moreover, the PMR index is computed using barriers to competition in industries such as the transport industry, so that it also affects the costs of domestic firms to serve foreign markets. Hence, we interact PMR with the weighted average of foreign labor market institutions. Column (3) shows that the inclusion of this interaction has important effects on the size of the estimated coefficients, but not on their signs. The sign of the interaction term is precisely estimated and negative. This finding is in line with our theoretical model: the more national regulation restricts the entry of foreign firms, the smaller should be the effect of foreign labor market variables on domestic unemployment. The standardized beta coefficients associated to b, b^*, and $b^* \times PMR$ are 0.447,0.333, and 0.386, respectively, which testifies to the economic significance of these variables.

Column (4) adds the other labor market variables. This undoes the significant negative effect of $b^* \times PMR$. However, one should bear in mind that the additional covariates do not improve the empirical fit of the equation. Moreover, when the dependent variable is specified in logs rather than in levels, a significant positive effect of $b^* \times PMR$ appears again.

Columns (5) and (6) carry out a similar exercise. A constant price multilateral openness measure ($MOP_{i,t}$) is interacted with b^*. We expect that the direct effect of $MOP_{i,t}$, should be negative: a stronger exposure to international trade increases domestic productivity and hence lowers the rate of unemployment. Moreover, the coefficient on the interaction should be positive, since a higher degree of trade freeness implies that foreign labor market institutions should be more relevant for domestic labor market outcomes. Since $MOP_{i,t}$ may well be endogenous to the domestic rate of unemployment, we instrument it by the size of the population in country i at time t ($POP_{i,t}$).[19] Similar, we

[19]More populated countries have lower degrees of trade openness since within-country trade is larger.

instrument the interaction term by $POP_{i,t} \times b^*$. The table represents the OLS results in column (5) and the IV findings in column (6). In both cases, the direct effect of openness is negative (more so in the IV case), and the indirect effect is positive (comparable across OLS and IV). This is in line with our theoretical results. The finding that openness has a direct negative effect on the rate of unemployment is a very robust result.[20]

4.5 Robustness checks

Table 4 contains a number of robustness checks on our preferred specifications. Columns (1A) to (1G) refer to column (7) of Table 2; columns (2A) to (2E) conduct robustness checks pertaining to column (3) of Table 3.

The first type of robustness checks varies the calculation of the weights (32). Column (1A) sets the weight of distance in the computation of the weights to the lower bound of estimates found in the gravity literature, i.e., $\delta = 0.75$ (Disdier and Head, 2008). Column (1B) instead uses a higher bound, i.e., $\delta = 1.50$. Qualitatively, these modifications have little effect on the estimates. To achieve a quantitative comparison, we need to take into account that the sample moments of u^* depend on the weights. The standardized beta coefficient of u^* in column (1A) is 0.23 and in column (1B) 0.17 which nicely bounds the benchmark results obtained in Table 2 (column (7), 0.21) from above and from below. Using a finer grid on δ shows that the obtained standardized beta coefficients systematically fall in δ. In the limit, when δ is infinite, the effect of u^* vanishes.

Similarly, the effect of u^* disappears when the calculation of weights (32) is modified such that $\alpha_1 = \alpha_2 = 0$. Then, the weights do not factor in differences in country size. Column (1C) illustrates this case. Column (1D) uses a different normalization of the weights (keeping $\delta = 1$). Instead of normalizing $\omega_{ij,t}$ by $\sum \omega_{ij,t}$, weights are normalized by $\min\left[\max_i \omega_{ij,t}, \max_j \omega_{ij,t}\right]$. Qualitatively, this does not change the results; quantitatively, the standardized beta coefficient of u^* is 0.18 which is also very close to the benchmark case.

Column (1E) uses the log of unemployment $\ln u$ as the dependent variable instead of the level. Compared to the the benchmark case where the level of u is used, this transformation ensure that the dependent variable takes values on the entire real line. There is no clear consensus in the empirical cross-country unemployment literature as to whether $\ln u$ or u is to be preferred. In the case of our regressions, the log specification has the drawback that our IV strategy does not work well here; see the overidentification test. However, qualitatively, our main result holds up.

Columns (1F) uses contemporaneous instruments rather than the lagged ones. This does not change the qualitative findings, but, again, the overidentification test signals that instruments are weak. Column (1G) presents an OLS model, using $u^*_{i,t-1}$ as the dependent variable. Results change very little.

The IV equation is just identified. It may suffer from weak instruments problem as the partial R^2 is only slightly above 10 percent.

[20] See Dutt, Mitra, and Ranjan (2007) and Felbermayr, Prat, and Schmerer (2008b).

Table 4: Robustness checks

	ad Table 1							ad Table 2				
	(1A) $\delta = 0.75$	(1B) $\delta = 1.50$	(1C) $\alpha_1 = \alpha_2 = 0$	(1D) norm max	(1E) log u	(1F) IV cont.	(1G) OLS, u^*_{t-1})	(2A) $\delta = 0.75$	(2B) $\delta = 1.50$	(2C) $\alpha_1 = \alpha_2 = 0$	(2D) norm max	(2E) log u
u^*	0.408^a	0.158^a	-0.047	0.041^a	0.056^c	0.210^a	0.140^a					
	(0.107)	(0.054)	(0.358)	(0.011)	(0.031)	(0.047)	(0.041)					
$b*$								0.091^a	0.025^b	-0.099	0.006^b	0.011^a
								(0.018)	(0.012)	(0.060)	(0.002)	(0.003)
$b* \times PMR$								-0.025^a	-0.007^b	0.026^c	-0.002^a	-0.003^a
								(0.005)	(0.003)	(0.014)	(0.001)	(0.001)
PMR	0.533^b	0.590^a	0.567^b	0.585^a	0.092^a	0.889^a	0.875^a	0.751^a	0.407^c	-0.367	0.498^b	0.228^a
	(0.217)	(0.224)	(0.239)	(0.219)	(0.028)	(0.222)	(0.229)	(0.245)	(0.243)	(0.362)	(0.248)	(0.044)
b	0.074^a	0.076^a	0.060^a	0.074^a	0.003	0.081^a	0.075^a	0.102^a	0.110^a	0.135^a	0.108^a	0.015^a
	(0.022)	(0.022)	(0.021)	(0.022)	(0.003)	(0.023)	(0.023)	(0.020)	(0.021)	(0.020)	(0.021)	(0.003)
gap	-0.478^a	-0.494^a	-0.491^a	-0.490^a	-0.070^a	-0.457^a	-0.451^a	-0.587^a	-0.592^a	-0.599^a	-0.589^a	-0.089^a
	(0.025)	(0.027)	(0.029)	(0.026)	(0.004)	(0.028)	(0.028)	(0.038)	(0.038)	(0.038)	(0.038)	(0.006)
gap^*	0.350^b	0.191^a	0.150	0.048^a	0.005	0.199^b	0.069	-0.056	0.037	1.046^b	0.014	-0.022
	(0.145)	(0.074)	(0.250)	(0.016)	(0.011)	(0.080)	(0.072)	(0.158)	(0.086)	(0.404)	(0.022)	(0.018)
Obs.	400	400	400	400	420	440	440	440	440	440	440	440
2nd stage												
RMSE	0.924	0.924	0.949	0.918	0.154	1.078	1.085	1.613	1.642	1.643	1.636	0.262
adj. R^2	0.944	0.944	0.941	0.945	0.928	0.925	0.924	0.851	0.846	0.845	0.847	0.822
F/Chi2	9517	9098	9231	9272	8395	9018	8569	70.42	71.49	79.14	71.09	56.65
1st stage												
partial R^2	0.403	0.385	0.427	0.427	0.280	0.960						
Overid.	0.625	0.463	0.765	0.344	0.003	0.035						
Endog.	0.369	1.000	0.360	0.737	0.925	0.200						

Dependent variable: Level of unemployment rate in all models except (5) and (12) where the log of unemployment is used. Columns (1) to (3) and (8) to (10) modify the construction of the weights; see equation (2). Columns (4) and (11) use a different normalization of the default weights. Column (6) uses contemporaneous variables instead of lags as instruments. Column (7) is OLS, but u* is lagged. Robust standard errors in parentheses, $^a p < 0.01$,$^b p < 0.05$,$^c p < 0.1$. All regressions contain a full set of country fixed-effects and country-specific time trends. If not specified otherwise, trade-weighted averages for foreign variables (denoted by asterisks) are computed using $\alpha_1 = \alpha_2 = 1, \delta = 1$, and the foreign unemployment rate u* is instrumented by b^*_{t-1}, PMR^*_{t-1} and gap^*_{t-1}). Endogeneity test tests the null that u* is exogenous (and rejects in all presented IV models). Overidentification is tested for using the Wooldridge robust Score test (invalidity of intruments or model misspecification is rejected in all presented IV models).

The remainder of Table 4 varies column (2) of Table 3. Different distance weights do not affect results. However, as in the robustness checks to Table 2, size controls are crucial, see column (2C). The remaining robustness checks use a different normalization of the weights (column 2D), and use the log unemployment rate instead of the level (column 2E). Results do not change neither.

5 Conclusions

In this paper, we have introduced search unemployment into a multi-country single-sector trade model with firm-level increasing returns to scale and product differentiation. In order to guarantee existence and uniqueness of the equilibrium, we abstract from the usual assumption of external economies of scale which characterizes models of the Krugman (1979) type. Firms are heterogeneous with respect to their (constant) productivities, and trade liberalization affects economies through selection effects as in Melitz (2003).

Allowing for asymmetric country sizes, asymmetric labor market institutions, and asymmetric trade costs, we ask how an institutional change in one country affects labor market outcomes in other countries. Countries are linked via the product markets and maintain multilateral trade balance. We find that an increase of–say–the tax wedge (unemployment benefits plus tax rate on wages) unambiguously increases unemployment increases the real wage in the country that enacts the institutional change. In the other countries, unemployment goes up as well, but the real wage falls. Other labor market variables such as the efficiency of the search process or search costs have similar effects. Hence, an exogenous shock on labor market institutions triggers a positive correlation between countries' unemployment rates. In contrast, real wages are negatively correlated.

The key mechanism that drives these results is the reduction in market size that a bad institutional reform yields in the country that enacts the reform. Since workers are pushed out of employment, total demand in that market falls, and foreign firms find it harder to recoup their fixed-costs of distribution in that country. Some of them – the least efficient – withdraw, which lowers the degree of competition in that economy so that inefficient domestic firms find it easier to survive. The productivity of the average domestic firm falls as does average revenue. Search costs being fixed in terms of the numèraire, the average firm posts less vacancies and the aggregate rate of unemployment goes up. The other countries are also adversely affected, since they are less strongly exposed to import competition from the domestic economy, which leads to lower productivity there as well.

We also find that the adverse effects of bad institutions depends on the degree of geographical centrality of the "bad" country: the more central it is, the more strongly other countries are exposed to the "bad" country, and the more severe are the adverse spill-overs on their own labor market outcomes. By the same token, the larger the "bad" country is, the more strongly other countries are affected: again, the reason is their relatively larger exposure to that country.

We include trade-weighted foreign variables into otherwise standard cross-country unemployment regressions run on panel data for 20 rich OECD countries. The empirical evidence is in line with our theoretical findings. Instrumenting the average foreign un-

employment rate by foreign exogenous variables and their time lags, and controlling for business cycle effects and own labor market variables, we find a strong positive spatial correlation between the domestic and the foreign unemployment rates. Regressing the domestic unemployment rate directly on foreign institutions confirms this finding. Moreover, we document that the importance of the foreign variables for domestic outcomes is larger, the less domestic product markets are protected and the more open the domestic economy is. The positive correlation between foreign regulation and domestic unemployment disappears when country sizes are omitted from the construction of foreign variables. We conclude that our empirical results are in line with our theoretical treatment. In contrast, we do not find any support for the prediction of multi-sector Heckscher-Ohlin type models, namely, that the correlation between domestic labor market outcomes and foreign labor market regulation depends on the capital-labor ratio.

Appendix

A1 Equalization of Marginal Revenues

To show that $p_x[\varphi_i] = \tau_{ij} p_d[\varphi_i]$, we proceed as follows. First, according to equation (4):

$$p_d[\varphi_i] = q_d[\varphi_i]^{-\frac{1}{\sigma}} (P_i)^{\frac{\sigma-1}{\sigma}} \left(\frac{Y_i}{\bar{M}_i^{1-\nu}} \right)^{\frac{1}{\sigma}}, \quad (A1)$$

$$p_x[\varphi_i] = q_x[\varphi_i]^{-\frac{1}{\sigma}} (P_j)^{\frac{\sigma-1}{\sigma}} \left(\frac{\tau_{ij} Y_j}{\bar{M}_j^{1-\nu}} \right)^{\frac{1}{\sigma}}. \quad (A2)$$

Hence, revenues on the domestic and foreign market are given by:

$$R_d[\varphi_i] = q_d[\varphi_i]^{\frac{\sigma-1}{\sigma}} (P_i)^{\frac{\sigma-1}{\sigma}} \left(\frac{Y_i}{\bar{M}_i^{1-\nu}} \right)^{\frac{1}{\sigma}}, \quad (A3)$$

$$R_x[\varphi_i] = q_x[\varphi_i]^{\frac{\sigma-1}{\sigma}} (P_j)^{\frac{\sigma-1}{\sigma}} \left(\frac{\tau_{ij}^{1-\sigma} Y_j}{\bar{M}_j} \right)^{\frac{1}{\sigma}}. \quad (A4)$$

Now taking partial derivatives with respect to L_i and using equation (**??**) leads to:

$$\frac{\partial R_d[\varphi_i]}{\partial L_{id}} = \frac{\sigma-1}{\sigma} q_d[\varphi_i]^{-\frac{1}{\sigma}} (P_i)^{\frac{\sigma-1}{\sigma}} \left(\frac{Y_i}{\bar{M}^{1-\nu}} \right)^{\frac{1}{\sigma}} \varphi_i,$$

$$\frac{\partial R_x[\varphi_i^H]}{L_{ix}} = \frac{\sigma-1}{\sigma} q_x[\varphi_i]^{-\frac{1}{\sigma}} (P_j)^{\frac{\sigma-1}{\sigma}} \left(\frac{\tau_{ij}^{1-\sigma} Y_j}{\bar{M}_j^{1-\nu}} \right)^{\frac{1}{\sigma}} \varphi_i.$$

Using the demand function, we can reformulate as follows:

$$\frac{\partial R_d[\varphi_i]}{\partial L_{id}^H} = \frac{\sigma-1}{\sigma} p_d[\varphi_i], \quad (A5)$$

$$\frac{\partial R_x[\varphi_i]}{\partial L_{ix}^H} = \frac{\sigma-1}{\sigma} \tau_{ij}^{-1} p_x[\varphi_i]. \quad (A6)$$

This shows that when firms want to equalize marginal revenues across markets, $p_x[\varphi_i] = \tau_{ij} p_d[\varphi_i]$ immediately follows.

A2 Summary statistics

Table 5: Summary statistics

Variable	Description	Mean	Std. Dev.	Min	Max
u	unemployment rate (percent)	7.749	4.178	0.396	24.042
b	tax wedge (percent)	58.460	17.777	21.008	96.973
PMR	PMR (index, 1-10)	3.814	1.282	1.050	6.000
Union density	(percent)	39.887	20.714	8.200	83.863
High corporatism	(dummy)	0.555	0.498	0.000	1.000
EPL	employment protection legislation (index, 1-10)	2.083	1.091	0.200	4.188
gap	Output gap (percent)	-0.922	2.567	-12.211	6.297
EU	(dummy)	0.543	0.499	0.000	1.000
u^*	W x u	2.440	3.078	0.037	13.875
b^*	W x b	18.939	23.264	0.269	89.783
Union density*	W x union denisty	12.761	15.714	0.180	71.088
EPL^*	W x EPL	0.680	0.879	0.009	4.252
gap^*	W x gap	-0.287	0.967	-5.803	2.699

All data (except EU dummy and weighting matrix W) are from Bassanini and Duval (2006). Number of observations $N = 440$. Weights are based on $\alpha\_1 = \alpha\_2 = 1$ and $\delta = 1$. Foreign variables are not to be interpreted as means, since weights do not add up to 1 (due to inclusion of rest of the world in calculation of weights).

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