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and Wolfgang Lechthaler**

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ISSN 1867-934X (Printausgabe)  
ISSN 1868-0720 (Internetausgabe)

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# Unemployment in an Interdependent World\*

Gabriel Felbermayr, Mario Larch and Wolfgang Lechthaler

Abstract:

We introduce search and matching unemployment into a model of trade with differentiated goods and heterogeneous firms. Countries may differ with respect to size, geographical location, and labor market institutions. Contrary to the literature, our single-sector perspective pays special attention to the role of income effects and shows that bad institutions in one country worsen labor market outcomes not only in that country but also in its trading partners. This spill-over effect is conditioned by trade costs and country size: smaller and/or more centrally located nations suffer less from inefficient policies at home and are more heavily affected from spill-overs abroad than larger and/or peripheral ones. We offer empirical evidence for a panel of 20 rich OECD countries. Carefully controlling for institutional features and for business cycle comovements between countries, we confirm our qualitative theoretical predictions. However, the magnitude of spill-over effects is larger in the data than in the theoretical model. We show that introducing real wage rigidity can remedy this problem.

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

JEL classification: F11, F12, F16, J64, L11

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*\*Acknowledgements:* We are grateful to Alan Auerbach, Kerem Cosar, Peter Egger, Christian Haefke, Oleg Itskhoki, Eckhard Janeba, Philip Jung, Wilhelm Kohler, Peter Neary, Jan van Ours, Julien Prat, Priay Ranjan, Stephen Redding, Hans-Joerg Schmerer, Hans-Werner Sinn, Cristina Terra, Lars Vilhuber, and Christoph Weiss as well as to seminar participants at the GEP-IFN Workshop in Stockholm 2008, the SED Annual Meeting in Istanbul 2009, the NOeG conference 2009 in Linz, the CEA Meetings 2009 in Toronto, the CESifo Institute Munich, the Kiel Institute for the World Economy, the University of Cergy-Pontoise, the University of Erfurt, the University of Innsbruck, the University of Mannheim, and the University of Tuebingen for comments and remarks. All remaining errors are ours.

# 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 current economic debate. It vaguely refers to the fact that 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. The study of these *interdependencias* is the epitome of international economics, whether countries are linked via trade in final goods or inputs or through international mobility of capital or labor. These interdependencies also seem to be at the core of widespread popular fears related to the globalization phenomenon. Those worries are typically strongly related to labor market issues and feature prominently in discussions of the current global economic crisis.

This paper offers a theoretical and empirical perspective on how changes in labor market institutions in one country affect labor market outcomes in the countries with which it trades. The theoretical framework combines the model of trade in differentiated goods (Krugman, 1979, 1980; Melitz, 2003) with the canonical search and matching approach (Pissarides, 2000). To capture interdependencies, countries may differ with respect to labor endowments, geographical position, and labor market institutions. We account for firms’ monopoly power on the goods markets by modeling strategic wage bargaining. Besides these generalizations of the standard frameworks, we do not add any other structural elements, shortcuts or simplifications and focus on *structural* (long-run) equilibrium unemployment.

This no-frills model of the trade-unemployment relation predicts 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 depends on trade costs and country size: smaller and/or more centrally located nations suffer less from inefficient policies at home and are more heavily affected from spill-overs abroad than larger and/or peripheral ones. We confirm this spill-over effect of bad labor market institutions in our econometric analysis. However, we also find that the spill-over effects present in the data are substantially bigger than the ones predicted by our theoretical exercise. To remedy this shortcoming, the model requires more real wage rigidity than the one implied by wage-setting à la Mortensen and Pissarides (1994). We interpret this finding as another indication that the standard matching model has difficulties reproducing the variability of unemployment rates found in the data. Whereas Shimer (2004, 2005) refers to unemployment fluctuations over time, we find a similar phenomenon across countries..

There is an emerging consensus in the macroeconomic labor literature that institutions matter for structural unemployment; in particular, pervasive *product market regulation* increases unemployment.<sup>1</sup> One may therefore conjecture that trade barriers also foster

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<sup>1</sup> See for example Layard, Nickell, and Jackman (1991); Nickell (1997); Ljungquist and Sargent (1998);

unemployment. Recent econometric evidence supports this view, see Dutt, Mitra, and Ranjan (2009) or Felbermayr, Prat, and Schmerer (2009). 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 features of one country also affect labor market outcomes in the other.

Conceptually, one may distinguish between four potential channels through which trade in goods leads to interdependence of countries' labor market outcomes. The first and best understood link is the effect of labor market institutions on the pattern of *comparative advantages*. If labor market institutions in one country deteriorate, unemployment in that country increases. This increases the relative capital-labor abundance of the country. Hence, a relatively capital-rich economy will specialize more strongly on the capital-intensive good while the trading partner produces more of the labor-intensive good. Labor demand in the partner country goes up and the marginal value product of labor increases. Firms find it optimal to create more vacancies, which leads to a fall of unemployment. However, if the country with the deteriorating institutions is labor-rich, the opposite logic applies and unemployment in the partner country will rise. Hence, the sign of the correlation of unemployment rates between countries is *ambiguous*. It depends crucially on the comparison of capital-labor ratios across countries.

The second channel is an income effect. If labor market institutions in one country worsen, unemployment in that country goes up. This reduces the income of that country, which leads to a decreasing demand for partner countries' exports. The income channel, thus, leads to a *positive correlation* of unemployment rates induced by labor market changes between countries. Effects of this type operate in the new economic geography literature<sup>2</sup> but have hardly been explored in models of trade and unemployment. The effect relies crucially on the use of a full-fledged general equilibrium model. One reason why the literature has so far down-played this channel is that its existence gives rise to complications that frustrate closed-form analytical solutions and require to simulate the model.

A third potential link operates through a *competitiveness effect*. It is most visible in partial equilibrium models of strategic interaction where income effects are typically absent. Bad labor market institutions in one country drive up labor costs, thereby decreasing the degree of international competitiveness for all firms from that country. Hence, consumers switch to foreign suppliers, reducing derived labor demand at home and increasing it abroad. This channel tends to decrease unemployment in the trading partners and therefore generates a *negative correlation* of unemployment rates across countries.

A fourth link, strongly related to the existence of firm *selection*, lies in the composition of active firms in the trading partners and is an indirect effect of the second and the third links discussed above. The second channel (the income effect) reduces the export demand of the trading partners. This lowers the weight of exporting firms, which

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Nickell and Layard (1999); Blanchard and Wolfers (2000); Ebell and Haefke (2009) and Felbermayr and Prat (2009).

<sup>2</sup>See for an overview Fujita, Krugman, and Venables (1999) or Baldwin, Forslid, Martin, Ottaviano, and Robert-Nicoud (2003).

are the most productive ones, and thus reduces average productivity. The third channel reduces the competitiveness of the country whose labor market institutions worsen. This alleviates competitive pressures on domestic producers in the other countries, which implies that firms with low productivity, that could not enter the market before, are now profitable. This again reduces average productivity abroad and thus demand for labor, thereby generating a *positive correlation* between unemployment rates.

Our paper features the last three channels; the well-understood comparative advantage link being absent due to the one-sector structure of the model. We show that the most straightforward combination of the Krugman/Melitz-framework with the search-unemployment mechanism à la Pissarides implies a *positive conditional correlation* of unemployment rates across countries. Firm heterogeneity is not crucial for this result if market size is important but it turns out to magnify the strength of the spill-overs and is therefore quantitatively important. We document these findings in simulations of the calibrated model and confirm their empirical validity in an econometric exercise.

**Related literature.** A large number of papers studies the effect of cross-country differences in labor market institutions on the *pattern of trade*, and subsequently, on welfare, the factor income distribution, and unemployment. Early contributions built on frameworks of comparative advantage, in particular on the two-country, two-factor, two-good ( $2 \times 2 \times 2$ ) Heckscher-Ohlin model. Brecher (1974) was the first to study minimum wages in such a framework. Davis (1998) has generalized the Brecher model. In this framework, minimum wages in a capital-abundant country can lead to higher wages in the labor-abundant country and trade exacerbates the adverse effects of minimum wages. Davidson, Martin, and Matusz (1988, 1999) introduce search frictions and wage bargaining into multi-sector models of international trade governed by comparative advantage.<sup>3</sup> These more general models yield very similar conclusions as the Davis (1998) setup. Hence, within the Heckscher-Ohlin trade model, predictions are robust to different wage setting assumptions.

The recent literature focuses on firm-level increasing returns to scale and product differentiation featured by the Krugman (1979, 1980) model and its generalization to heterogeneous firms by Melitz (2003). Two labor market paradigms have been most extensively used: fair wage preferences (and the closely related efficiency wage approach) and the search and matching approach. A central limitation of Krugman-type models with *asymmetric* trade costs consists in the absence of closed form solutions due to the fact that labor market clearing conditions are transcendental. Hence, Egger and Kreickemeier (2008, 2009), Eckel and Egger (2009) and Felbermayr, Prat, and Schmerer (2008) focus on perfectly symmetric cases so that equilibrium outcomes can be completely characterized analytically. This practice makes it impossible to address the effect of asymmetries in labor market institutions and their cross-country implications, which lies at the heart of our

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<sup>3</sup>More recently, Cuñat and Melitz (2007) study the effect of cross-country differences in firing restrictions on patterns of comparative advantage in a Ricardian setting, but they do not address the issue of unemployment. Cuñat and Melitz (2007) contains an excellent discussion of papers that address the effect of labor market institutions on trade patterns.

analysis. Other authors have maintained analytical tractability by fixing expected wages in a numéraire sector that remains unaffected by labor market frictions and trade costs, and which may additionally absorb all income effects due to quasilinear preferences.<sup>4</sup> This strategy blends the comparative advantage channel with Krugman/Melitz mechanisms. Our paper does not follow this path: it allows for income effects to be fully operative and focuses entirely on intra-sector reallocation (with intersectoral reallocation absent). In order to see how our approach differs, it is useful to consider recent papers that use a multi-sector structure.

Helpman and Itskhoki (2008) use a two-sector, two-country model, where one sector produces varieties of differentiated goods under conditions of firm-level economies of scale, monopolistic competition, iceberg trade costs and heterogeneous firms à la Melitz (2003). This sector also features search unemployment. The other (numéraire) sector features a linear production function, perfect competition, no trade costs, and no search frictions. Families allocate members to sectors such that, in equilibrium, expected wage rates are equalized. In most of the paper, Helpman and Itskhoki focus on a situation where consumers' preferences are quasi-linear in the numéraire good. Countries are identical except for labor market frictions, which are parameterized so that both economies are diversified.

In this setup, the less sclerotic country specializes on the differentiated good. Trade liberalization triggers a reallocation of workers into the differentiated sector, thereby pushing up aggregate unemployment. However, there are additional effects due to increased exit and entry of firms and changes in terms of trade, so that the net effect is ambiguous. Helpman and Itskhoki show numerically that a reduction of search frictions in one country leads to a hump-shaped response in this country's unemployment rate but unambiguously decreases the unemployment rate in the other country. It is unclear whether unemployment rates move in the same or in opposite directions; moreover, it is perfectly possible that the more rigid country has the lower rate of unemployment.<sup>5</sup> Helpman and Itskhoki acknowledge that “*the unemployment results depend on certain structural features of the model*” (p. 4).

Helpman, Itskhoki, and Redding (2008a,b) build on the paper by Helpman and Itskhoki (2008), but assume that workers differ according to an exogenously given ability. Firms engage into costly screening of their potential workers' abilities before the wage bargain. In that setup, a deterioration of home labor market institutions has an ambiguous effect on home unemployment, with a slightly favorable prediction for a *negative* relationship. Higher search costs lead to a decrease in labor market tightness which raises unemployment, but also induces a decrease of the fraction of exporting firms, which lowers unemployment. Concerning spill-overs, their model predicts that “... *a rise in the foreign country's labor market frictions raises unemployment in the home country while a rise in*

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<sup>4</sup>To our knowledge, in all papers that integrate search unemployment into general equilibrium trade models authors assume that the destruction rates of matches (or firms) along the steady state are exogenous. Relaxing this assumption is an important direction for future research. One way to do this is to depart from the standard Melitz (2003) model and to allow firm-level productivity to vary over time.

<sup>5</sup>However, whenever the labor market rigidities are low and the differences in labor market institutions are not large, a reduction in one country's search frictions lowers unemployment in both.

*the home country's labor market frictions raises unemployment in the foreign country* ".<sup>6</sup> Since, the effect of institutions on home unemployment is ambiguous, a negative correlation between the home and the foreign unemployment rate is possible (and likely). 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 costs 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 more productive firms are more selective, unemployment goes up.

Egger, Greenaway, and Seidel (2008) obtain a similar relationship between labor market institutions and unemployment at home and abroad. They use a multi-country, new economic geography model of trade with mobile capital, where unemployment exists due to fair wage preferences of workers. They find that: "*A marginal increase in the fair wage parameter*" increases "*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.*" (Proposition 1)

Hence, recent theoretical papers mostly suggest a negative relationship between the effects of labor market institutions at home and abroad.<sup>7</sup> In contrast, our theoretical model predicts a positive correlation between bad labor market institutions at home and unemployment abroad, which is strongly supported by our empirical analysis. Also in line with our theoretical predictions, the data suggests an important role for country size and geography to condition institutional spill-overs.

The remainder of the paper is structured as follows. Section 2 outlines the theoretical model. Section 3 explores the interdependence of labor market outcomes and unemployment of our theoretical model. In section 4 we provide empirical evidence for the key predictions of our model. The last section concludes. The paper focuses on unemployment. Results pertaining to wage effects are relegated to the appendix.

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<sup>6</sup>Proposition 6, part (iii) in Helpman, Itskhoki, and Redding (2008b).

<sup>7</sup>Note that the model from Helpman, Itskhoki, and Redding (2008) 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 from 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. The papers by Beissinger and Büsse (2001, 2002) are the only contributions where the correlation between domestic and foreign unemployment is unambiguously positive and driven by a general equilibrium income effect. In contrast to these papers, we allow for entry and exit of heterogeneous firms, do not assume a frictionless economy, and focus on the dependence between trade costs and labor market spill-overs.



## 2 Model Setup

Our world consists of  $N$  potentially asymmetric countries, indexed by subscript  $i$ , with  $i = 1, \dots, N$ . Countries have work forces denoted by  $L_i$  and labor is the only factor of production. Firms differ with respect to their productivity level  $\varphi$  as in Melitz (2003). The labor market features search and matching frictions as in Mortensen and Pissarides (1994). Our framework generalizes Felbermayr, Prat, and Schmerer (2008) to asymmetries regarding country size, geographical location, and labor market institutions.

### 2.1 Demand for intermediate inputs

Similar to Egger and Kreickemeier (2009) and Felbermayr, Prat, and Schmerer (2008), in each country firms produce a final output good  $Q$  under perfect competition. That good is assembled from a continuum of intermediate inputs, indexed by  $\omega$ , and supplied by domestic and foreign firms who operate under conditions of monopolistic competition. The final output good can be consumed or used by input producers. The aggregate production function in country  $i$  is

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

where  $q[\omega]$  denotes the quantity of intermediate input  $\omega$ , and  $\sigma > 1$  is the elasticity of substitution between any two varieties. The set of available intermediate inputs in country  $i$ ,  $\Omega_i$ , has measure  $\bar{M}_i$ . The parameter  $\nu \in (0, 1)$  governs the extent of *external economies of scale*:<sup>8</sup> If  $\nu = 0$  the number of available varieties is irrelevant for total output. If  $\nu = 1$  we obtain the case discussed by Krugman (1980) or Melitz (2003). The price index corresponding to (1) is given by:

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

where  $p[\omega]$  is the price of a variety  $\omega$ . We choose the price index of country one as the numéraire, i.e.,  $P_1 = 1$ .

Similar to Melitz (2003), intermediate input firms are uniquely described by different productivity levels  $\varphi$  and place of origin, so that we can substitute the firm index  $\omega$  with  $\varphi$  and index prices and quantities with country subscripts denoting place of origin and destination. Due to flow fixed costs, not all firms find it optimal to serve all markets. Serving foreign customers in country  $j$  from country  $i$  entails iceberg trade costs  $\tau_{ij} \geq 1$  (with  $\tau_{ii} = 1$  and  $\tau_{ij} = \tau_{ji}$ ) for all  $i$  and  $j$ . Hence, an intermediate goods producer in

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<sup>8</sup>See, e.g., Blanchard and Giavazzi (2003) or Egger and Kreickemeier (2008b), where  $\nu = 0$ ; and Felbermayr, Prat, and Schmerer (2008) where  $\nu \in [0, 1]$ .

country  $i$  faces the following inverse demand schedule in country  $j$ :<sup>9</sup>

$$p_{ij}[\varphi] = \left( \frac{q_{ij}[\varphi]}{\tau_{ij}} \right)^{-\frac{1}{\sigma}} (P_j)^{\frac{\sigma-1}{\sigma}} \left( \frac{Y_j}{M_j^{1-\nu}} \right)^{\frac{1}{\sigma}}. \quad (3)$$

Profit maximizing firms allocate sales across markets such that marginal revenues are equalized. This implies  $p_{ij}[\varphi] = \tau_{ij}p_{ii}[\varphi]$  for all markets  $j$  on which a firm  $\varphi$  based in country  $i$  is active. Operating revenues of firms based in country  $i$  from sales to market  $j$  are therefore equal to  $R_{ij}[\varphi] = p_{ij}[\varphi]q_{ij}[\varphi]/\tau_{ij}$ . Total revenue of an intermediate input producer based in country  $i$  with productivity  $\varphi$ , is then given by:

$$R_i[\varphi] = \sum_{j=1}^N I_{ij}[\varphi] q_{ij}[\varphi]^{\frac{\sigma-1}{\sigma}} (P_j)^{\frac{\sigma-1}{\sigma}} \left( \frac{\tau_{ij}^{1-\sigma} Y_j}{M_j^{1-\nu}} \right)^{\frac{1}{\sigma}}, \quad (4)$$

where  $I_{ij}[\varphi]$  is an indicator function that takes value one if a firm in country  $i$  with productivity  $\varphi$  is active on market  $j$  and zero otherwise.

## 2.2 The Labor Market

Firms operate with linear production functions  $q_{ij}[\varphi] = \varphi L_{ij}[\varphi]$ , where  $L_{ij}[\varphi]$  is the level of employment at firm  $\varphi$  in country  $i$  for production of goods destined for country  $j$ . 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 types of shocks: With probability  $\chi$  a job is destroyed due to a match-specific shock and with probability  $\delta$  firms are forced to leave the market. Assuming independence of these shocks, the actual rate of job separation is given by  $\eta = \delta + \chi - \delta\chi$ .

The flow costs of posting a single vacancy in country  $i$  are proportional to the parameter  $c_i$  and measured in units of the final good. This implies that hiring costs are linear in the number of workers to be recruited. As usual, the number of matches formed in each period is given by a constant-returns-to-scale matching function. We denote by  $m_i[\theta_i] = \bar{m}_i(\theta_i)^{-\alpha_i}$  the share of posted vacancies  $v$  filled each period, where  $\theta_i$  is the vacancy-unemployment ratio in country  $i$  and  $\bar{m}_i$  measures the efficiency of the labor market in country  $i$ , while  $\alpha_i$  is the elasticity of the matching function. The rate at which unemployed workers find employment is  $\theta_i m_i[\theta_i]$ , an increasing function of  $\theta_i$ .

Each period, an intermediate input producer  $\varphi$  in country  $i$  decides (i) about the optimal number of vacancies to post  $v_i[\varphi]$ , anticipating the wage which will be bargained with the workers, and (ii) how to allocate total production over the domestic and the  $N-1$  foreign markets. Problem (ii) features a decision on the extensive margin (which markets to serve, i.e., on  $I_{ij}[\varphi]$ ) and on the intensive margin (how much to sell on each market, i.e.,  $q_{ij}[\varphi]$ ). We relegate the market entry problem to section 2.3. Here it suffices to note that across every market where the firm is active, it will equalize marginal revenues, i.e.,

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<sup>9</sup>Note that  $p_{ij}[\cdot]$  is the cif price in market  $j$  and  $q_{ij}[\cdot]$  is the quantity produced for that market, including the iceberg transport costs.

$\partial R_{ij}[\varphi]/\partial L_{ij}[\varphi] = \partial R_i[\varphi]/\partial L_i[\varphi]$  for all  $j$ , where  $L_i[\varphi]$  is firm  $\varphi$ 's total employment. This rule determines the distribution of sales across markets given the total output of the firm (which is, in turn, determined through the choice of  $\nu_i$ ).

**Vacancy posting.** The optimal value of an intermediate input producer is given by:

$$\begin{aligned}
J_i[\varphi] &= \max_{\nu_i[\varphi]} \frac{1}{1+r} \left( R_i[\varphi] - w_i[\varphi] L_i[\varphi] - P_i \nu_i[\varphi] c_i \right. \\
&\quad \left. - P_i \sum_{j=1}^N I_{ij}[\varphi] f_{ij} + (1-\delta) J'_i[\varphi] \right), \\
s.t. \quad (i) \quad &R_i[\varphi] \quad \text{given in equation (4)}, \\
(ii) \quad &L'_i[\varphi] = (1-\chi) L_i[\varphi] + m_i[\theta_i] \nu_i[\varphi],
\end{aligned} \tag{5}$$

where  $r$  denotes the interest rate,  $w_i[\varphi]$  is the wage rate in country  $i$  paid by firm  $\varphi$ ,  $J'_i[\varphi]$  is the value of an intermediate input producer next period, and  $L'_i$  is firm  $\varphi$ 's 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:

$$\frac{c_i P_i}{m_i[\theta_i]} = (1-\delta) \frac{\partial J'_i[\varphi]}{\partial L'_i[\varphi]}. \tag{6}$$

It 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). Note that firms with different  $\varphi$  face identical expected recruitment costs; hence, the shadow value of labor is the same across firms, too.

From the equalization of marginal revenues across markets, it follows that the shadow value of labor does not depend on the market where the additional output is actually sold. Hence,  $\partial J_i[\varphi]/\partial L_i[\varphi] = \partial J_i[\varphi]/\partial L_{ij}[\varphi]$ . Differentiating the objective function of the firm (5) with respect to  $L_{ij}$  yields:

$$\frac{\partial J_i[\varphi]}{\partial L_{ij}[\varphi]} = \frac{1}{1+r} \left( \frac{\partial R_i[\varphi]}{\partial L_{ij}[\varphi]} - w_i[\varphi] - \frac{\partial w_i[\varphi]}{\partial L_{ij}[\varphi]} L_{ij}[\varphi] + (1-\delta)(1-\chi) \frac{\partial J'_i[\varphi]}{\partial L'_{ij}[\varphi]} \right). \tag{7}$$

Employing the steady-state condition  $\partial J_i[\varphi]/\partial L_{ij}[\varphi] = \partial J'_i[\varphi]/\partial L'_{ij}[\varphi]$  we obtain:

$$\frac{\partial J_i[\varphi]}{\partial L_{ij}[\varphi]} = \frac{1}{r+\eta} \left( \frac{\partial R_i[\varphi]}{\partial L_{ij}[\varphi]} - w_i[\varphi] - \frac{\partial w_i[\varphi]}{\partial L_{ij}[\varphi]} L_{ij}[\varphi] \right). \tag{8}$$

Using (6) and  $\partial J_i[\varphi]/\partial L_i[\varphi] = \partial J_i[\varphi]/\partial L_{ij}[\varphi]$ , we can solve for  $\partial R_i[\varphi]/\partial L_{ij}[\varphi]$  and obtain an expression that implicitly determines the optimal pricing behavior of the intermediate input producer:

$$\frac{\partial R_i[\varphi]}{\partial L_{ij}[\varphi]} = w_i[\varphi] + \frac{\partial w_i[\varphi]}{\partial L_{ij}[\varphi]} L_{ij}[\varphi] + \frac{c_i P_i}{m_i[\theta_i]} \left( \frac{r+\eta}{1-\delta} \right). \tag{9}$$

**Wage bargaining.** The search-and-matching setup developed above is compatible with a number of different assumptions concerning the wage-setting process. In the largest part of this paper, we follow Felbermayr, Prat, and Schmerer (2008). We assume that wages are bargained before production takes place and that every worker is treated as the marginal worker. This approach is fairly standard now in the literature (see Cosar et al. (2009); Helpman and Itskhoki (2008)); its axiomatic foundation is laid out in Stole and Zwiebel (1996). In a later section of this paper, we will argue that this formulation implies too much wage flexibility so that foreign unemployment reacts too little to domestic institutional changes compared to the empirical evidence. Hence, we also experiment with the opposite extreme case of a perfectly rigid real wage as proposed by Shimer (2004).

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 at firm  $\varphi$ , i.e.,  $E_i[\varphi] = (w_i[\varphi] + (1 - \eta)E_i[\varphi] + \eta U_i) / (1 + r)$  and the value of being unemployed  $U_i = (b_i \Phi_i + \theta_i m[\theta_i] \bar{E}_i + (1 - \theta_i m[\theta_i]) U_i) / (1 + r)$ , where  $\theta_i m[\theta_i]$  is an unemployed worker's probability to find a new job and  $\bar{E}_i$  is the value of employment at the average firm. The flow value of unemployment is given by  $b_i \Phi_i$  with  $b_i \in [0, 1]$  and is proportional to the marginal value product of labor at the average domestic firm deflated by the price index.<sup>10</sup>

$$\Phi_i \equiv \tilde{\varphi}_{ii} p_{ii}[\tilde{\varphi}_{ii}] / P_i. \quad (10)$$

The variable  $\Phi_i$  will turn out to be a sufficient statistic for determining the role of changing productivity distributions on labor market outcomes. In the sequel (with some abuse of wording) we refer to  $\Phi_i$  as a measure of *aggregate productivity*.

Reformulating the expression for  $E_i[\varphi]$ , the advantage of holding a job at firm  $\varphi$  over searching one can be expressed as:

$$E_i[\varphi] - U_i = (w_i[\varphi] - r U_i) / (r + \eta). \quad (11)$$

The firm's surplus is equal to the marginal increase in the firm's value  $\partial J_i[\varphi] / \partial L_{ij}[\varphi]$ , 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 "surplus-splitting" rule:

$$(1 - \beta_i)(E_i[\varphi] - U_i) = \beta_i \frac{\partial J_i[\varphi]}{\partial L_{ij}[\varphi]}, \quad (12)$$

where the parameter  $\beta_i$  measures the bargaining power of the workers and belongs to  $(0, 1)$ . From (6) and (12) it is already apparent that the value of employment  $E_i$  cannot vary across firms so that heterogeneous firms will pay identical wages.

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<sup>10</sup>The productivity of the average *domestic* firm is defined as  $\tilde{\varphi}_{ii}$  and further explained in subsection 2.3. As in Melitz (2003), the upper-tier CES aggregate implies  $p_{ii}[\varphi] = p_{ii}[\varphi'] \varphi'$  for all values of  $\varphi$  and  $\varphi'$ . Hence, specifically for  $\tilde{\varphi}_{ii}$ .

**Labor market equilibrium.** We can use the shadow value of labor as given in equation (8) and the expression for the advantage of holding a job over searching as given in equation (11) in the bargaining solution (12) to obtain:

$$w_i[\varphi] = \beta_i \frac{\partial R_i[\varphi]}{\partial L_{ij}[\varphi]} - \beta_i \frac{\partial w_i[\varphi]}{\partial L_{ij}[\varphi]} L_{ij}[\varphi] + (1 - \beta_i) r U_i. \quad (13)$$

Using  $q_{ij}[\varphi] = \varphi L_{ij}[\varphi]$  in equation (4) and differentiating with respect to labor input  $L_{ij}[\varphi]$  (assuming that  $I_{ij}[\varphi] > 0$ ), leads to

$$\frac{\partial R_i[\varphi]}{\partial L_{ij}[\varphi]} = \frac{\sigma - 1}{\sigma} q_{ij}[\varphi]^{-\frac{1}{\sigma}} \varphi (P_j)^{\frac{\sigma-1}{\sigma}} \left( \frac{\tau_{ij}^{1-\sigma} Y_j}{\bar{M}_j^{1-\nu}} \right)^{\frac{1}{\sigma}}, \quad (14)$$

which allows to solve the wage differential equation (13):<sup>11</sup>

$$w_i[\varphi] = \beta_i \left( \frac{\sigma}{\sigma - \beta_i} \right) \frac{\partial R_i[\varphi]}{\partial L_{ij}[\varphi]} + (1 - \beta_i) r U_i. \quad (15)$$

Using equation (3) in equation (14) and noting that  $\frac{\partial R_i[\varphi]}{\partial L_{ij}} = \left( \frac{\sigma-1}{\sigma} \right) \varphi \tau_{ij}^{-1} p_{ij} = \left( \frac{\sigma-1}{\sigma} \right) \varphi p_{ii}$ , where the last equality follows from equalization of marginal costs between markets, leads to the job creation curve

$$\mathbf{JC}_i: \quad \frac{w_i}{P_i} = \frac{\sigma - 1}{\sigma - \beta_i} \Phi_i - \frac{c_i}{m_i[\theta_i]} \frac{r + \eta}{1 - \delta}. \quad (16)$$

The job creation curve slopes downward in  $\theta$  since a higher degree of labor market tightness makes it more costly to fill vacancies so that a smaller share of the surplus  $\Phi$  can accrue to the worker. Hence, the real wage falls in  $\theta$ . Importantly, the wage rate depends only on aggregate variables such as  $P_i$ ,  $\Phi_i$  or  $\theta$  and does, therefore, not vary across firms. The intuition is that firms with high productivity are larger and move their marginal revenue functions further down by exactly the amount that equalizes the value of a filled vacancy.

Combining equations (3), (9), and (15) shows that the wage rate is given by the sum of the value of non-employment ( $rU_i$ ) and the rent that the worker can extract from the firm:

$$w_i[\varphi] = rU_i + \frac{\beta_i}{1 - \beta_i} \frac{r + \eta}{1 - \delta} \frac{c_i P_i}{m_i[\theta]}. \quad (17)$$

Using the expression for  $U_i$ , we can write  $rU_i = b_i \Phi_i + \theta_i m[\theta_i] (\bar{E}_i - U_i)$ . Using equation (11) and noting that  $w_i[\varphi] - rU_i$  is equal for all firms (see equation (17)), one can derive the following wage curve:

$$\mathbf{W}_i: \quad \frac{w_i}{P_i} = b_i \Phi_i + \frac{\beta_i}{1 - \beta_i} \frac{c_i}{1 - \delta} \left( \frac{r + \eta}{m_i[\theta_i]} + \theta_i \right). \quad (18)$$

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<sup>11</sup>The solution can be checked by reinserting

$$\frac{\partial w_i}{\partial L_{ij}} = \beta_i \left( \frac{\sigma}{\sigma - \beta_i} \right) \frac{\partial \left( \frac{\partial R_i[\varphi]}{\partial L_{ij}} \right)}{\partial L_{ij}} = \beta_i \left( \frac{\sigma}{\sigma - \beta_i} \right) \left( \frac{\partial R_i[\varphi]}{\partial L_{ij}} \right) \left( \frac{-1}{\sigma} \right) \left( \frac{1}{L_{ij}} \right)$$

into equation (13).

The wage curve is an increasing function of  $\theta$  since workers have more power to hold-up the firm when the labor market is tight and the costs of a break-down of negotiations are high for firms.

The equilibrium real wage  $w_i/P_i$  and labor market tightness  $\theta_i$  are found by interacting the wage curve with the job creation curve. A central feature of both the wage and the job creation curves is that their intercept in  $(w_i/P_i, \theta_i)$  –space is proportional to  $\Phi_i$ . In the wage curve, this simply reflects the fact that unemployment benefits are by assumption a share of the marginal value product of labor. More interestingly, the job creation curve depends on  $\Phi_i$  because more productive firms spend a smaller fraction of their revenue on flow fixed costs  $f_{ij}$ , which are denominated in units of the final output good, and a larger fraction on labor. Hence, the reallocation of workers towards more productive firms increases the demand for labor.

We can now state a first Lemma.

**Lemma 1 [Labor market equilibrium]**

- (a) For given aggregate productivity  $\Phi_i$ , there is a unique labor market equilibrium  $\{w_i/P_i, \theta_i\}$  if  $\frac{\sigma-1}{\sigma-\beta_i} > b_i$ .
- (b) Wages are constant over firms.
- (c) A decrease of  $\Phi_i$  lowers the real wage  $w_i/P_i$  and the degree of labor market tightness  $\theta_i$ .
- (d) For given  $\Phi_i$ , 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  $\theta_i$ .

The Lemma shows that labor market outcomes can be entirely characterized once aggregate productivity  $\Phi_i$  is known. That variable summarizes the stance of the entire productivity distribution and the number of available varieties. Trade liberalization can only affect labor markets through this variable. Also, institutional changes in other countries will affect domestic labor markets through  $\Phi_i$ .

Part (a) in Lemma 1 follows from the fact that the job-creation curve is strictly downward sloping in  $\theta_i$ , 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) implies that workers are paid similarly across firms with different productivity levels. As in Stole and Zwiebel (1996) firms exploit their monopsony power until employees are paid their outside option. This property of the model is a fairly general feature of Krugman/Melitz-type models.<sup>12</sup>

Part (c) holds true under the condition established in part (a). Figure 1 illustrates this effect. The intuition is that any change in  $\Phi_i$  must have a smaller effect on the flow value of non-employment ( $b_i\Phi_i$ ) than on the flow value of employment  $\frac{\sigma-1}{\sigma-\beta_i}\Phi_i$ ; otherwise, no worker would be willing to seek employment. Hence, a reduction in  $\Phi_i$  shifts the wage

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<sup>12</sup>See, e.g., Eckel and Egger (2009) for an analysis of unionized labor markets framework without search frictions, and Felbermayr, Prat, and Schmerer (2008) for the case of firm-level collective bargaining in the presence of search frictions.

curve ( $W_i$ ) down by less than the job creation curve ( $JC_i$ ). It follows that both the real wage and the degree of labor market tightness fall.

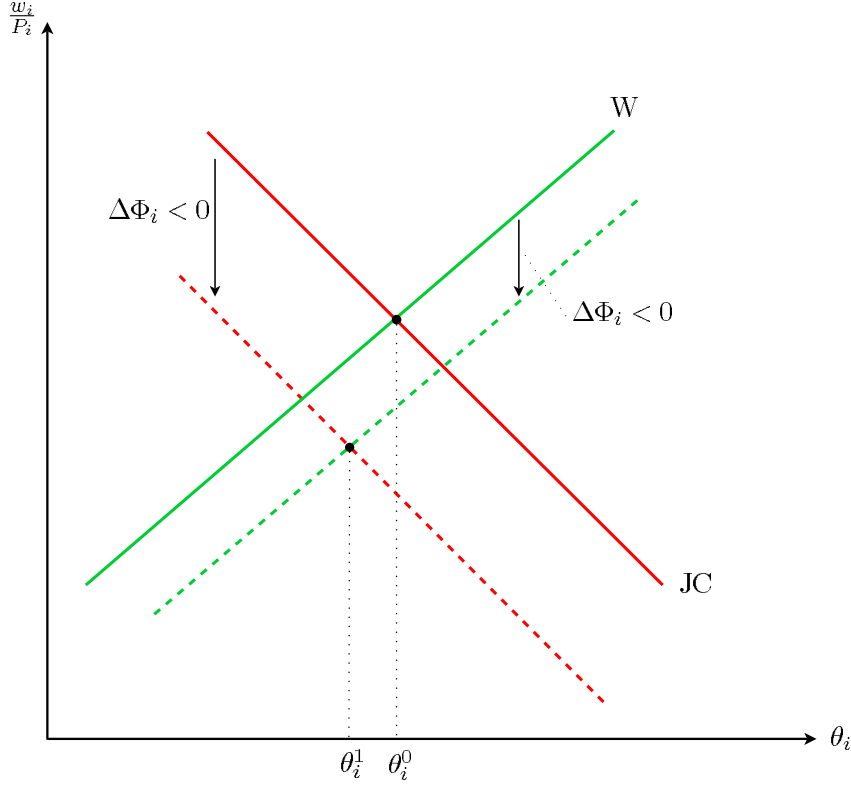


Figure 1: The effect of a fall in  $\Phi_i$  on labor market tightness.

Part (d) establishes that, whatever the equilibrium value of  $\Phi_i$  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 qualitative effects on labor market tightness and, hence, on the rate of unemployment.<sup>13</sup> We will see below that the determination of  $\Phi_i$  does not directly depend on labor market *institutions*  $b_i$ ,  $c_i$ , or  $\bar{m}_i$  but only on labor market *outcomes* such as the real wage or the rate of unemployment. It follows that changes in  $b_i$ ,  $c_i$ , or  $\bar{m}_i$  have all qualitatively similar effects on labor market outcomes in all countries. In our comparative statics exercise, it is therefore sensible to focus on  $b_i$  as one important (and empirically relevant) representative institutional variable.

### 2.3 Entry- and Export Decisions of Firms

In this section, we need to set up those conditions that pin down  $\Phi_i$  for all countries. This is done by combining two sets of equations: conditions that describe the selection of firms into different markets (the domestic and foreign ones) according to their productivity

<sup>13</sup>We have  $\partial\theta_i/\partial b_i < 0$ ,  $\partial\theta_i/\partial c_i < 0$ , and  $\partial\theta_i/\partial\bar{m}_i > 0$ .

levels, and conditions that determine the number of firms that enter into existence each period. These equations will, amongst other things, determine the productivity of the average firm  $\tilde{\varphi}_{ii}$  and the price level. However, unlike in the perfectly symmetric setup of Melitz (2003), Felbermayr, Prat, and Schmerer (2008) or Eckel and Egger (2009), we need to know labor market outcomes to pin down these variables. However, conceptually, the section is close to Melitz (2003), and will therefore be deliberately brief.

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  $\varphi$  from a known distribution with p.d.f.  $g[\varphi]$  and c.d.f.  $G[\varphi]$ . The productivity stays the same as long as the firm exists. Only firms which draw a  $\varphi$  favorable enough to make non-negative profits will start production and engage into sales in one or several markets.

**Entry into markets.** A firm with productivity  $\varphi$  located in country  $i$  will engage in market  $j$  if the expected discounted operating profits exceed costs. Hence, the firm recruits workers with the aim to produce output for market  $j$  if and only if

$$\begin{aligned}\Pi_{ij}[\varphi] &= \sum_{t=1}^{\infty} \left( \frac{1-\delta}{1+r} \right)^t \pi_{ij}[\varphi] - \frac{P_i c_i}{m_i[\theta_i]} L_{ij}[\varphi] - P_i f_{ij} \\ &= \frac{1-\delta}{r+\delta} \pi_{ij}[\varphi] - \frac{P_i c_i}{m_i[\theta_i]} L_{ij}[\varphi] - P_i f_{ij} \geq 0.\end{aligned}\quad (19)$$

The first term in expression (19) is the discounted flow of operating profits that a firm in country  $i$  with productivity  $\varphi$  obtains from sales in country  $j$ . Note that this term accounts for the fact that the firm may be hit by an (exogenous) exit shock during their first period of existence in which no profits are forthcoming yet as recruitment of workers takes one period. The second term describes the costs of recruiting, which arise before production can start.

The flow of profits from sales to market  $j$  is given by

$$\pi_{ij}[\varphi] = R_{ij}[\varphi] - \left( w_i + P_i c_i \frac{\chi}{m_i[\theta_i]} \right) L_{ij}[\varphi] - P_i f_{ij}, \quad (20)$$

which are revenues in country  $j$  of a firm based in country  $i$  with productivity  $\varphi$ ,  $R_{ij}[\varphi]$ , minus total costs of employing the necessary amount of workers  $L_{ij}$  to achieve those revenues including the costs to replace the workers who quit (at exogenous rate  $\chi$ ) and the fixed costs (in units of the final good) to maintain the presence in market  $j$ . Note that we assume that the domestic final output good is used for foreign market fixed costs.<sup>14</sup>

We may characterize the productivity level which makes a firm indifferent between operating in a market or not by solving  $\Pi_{ij}[\varphi_{ij}^*] = 0$ . This gives the *zero cutoff-profit*

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<sup>14</sup>One could alternatively posit that the foreign final output good is used for foreign fixed costs. Another option would be to assume free trade in the final output good so that  $P_i = 1$  in all countries. This choice has no major qualitative implications for our findings.



condition

$$\frac{1 - \delta}{r + \delta} \pi_{ij} [\varphi_{ij}^*] = \frac{P_i c_i}{m_i [\theta_i]} L_{ij} [\varphi_{ij}^*] + P_i f_{ij}. \quad (21)$$

For the marginal firm  $\varphi_{ij}^*$  the discounted value of future operating profits has to be large enough to cover the upfront costs of ramping up production (the hiring costs). Empirical evidence strongly supports the view that only the most productive firms select into foreign markets.<sup>15</sup> Hence, we focus on parameter values where  $\varphi_{ij}^* > \varphi_{ii}^*$  for all  $i, j$ . The ex ante probability of successful entry into the home market  $i$  is  $(1 - G[\varphi_{ii}^*])$ , whereas the ex ante probability of exporting to country  $j$  conditional on successful entry is  $\varrho_{ij} = (1 - G[\varphi_{ij}^*]) / (1 - G[\varphi_{ii}^*])$ . Note that  $\varrho_{ij}$  can also be understood as the share of active firms that sell both to the domestic and to the foreign market  $j$ . Appendix A1 shows how  $\varphi_{ii}^*$  and  $\varphi_{ij}^*$  are related.

**Entry into existence.** 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:

$$\tilde{\varphi}_{ij} = \left( \frac{1}{1 - G[\varphi_{ij}^*]} \int_{\varphi_{ij}^*}^{\infty} (\varphi_i)^{\sigma-1} g[\varphi_i] d\varphi_i \right)^{1/(\sigma-1)}. \quad (22)$$

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

$$f^e P_i = \sum_{j=1}^N (1 - G[\varphi_{ij}^*]) \left( \frac{1 - \delta}{r + \delta} \pi_{ij} [\tilde{\varphi}_{ij}] - \frac{P_i c_i}{m_i [\theta_i]} L_{ij} [\tilde{\varphi}_{ij}] - P_i f_{ij} \right), \quad (23)$$

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 indicates how much a firm will earn in these cases.

Equality in equation (23) 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 mass of available varieties in country  $i$  is given by  $\bar{M}_i = \sum_h \varrho_{hi} M_h$ , where  $M_h$  is the mass of active producers in country  $h$ .

## 2.4 Stationarity conditions

**Employment dynamics.** As usual, we focus on a situation where flows into unemployment and out of it are of equal size, hence  $\eta(1 - u_i) = \theta_i m_i [\theta_i] u_i$ . This provides

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<sup>15</sup>For empirical evidence on selection into the export markets, see Bernard and Jensen (1995, 1999, 2004); Roberts and Tybout (1997); and Clerides, Lach, and Tybout (1998).

us with a one-to-one mapping between labor market tightness and the stationary rate of unemployment

$$u_i = \frac{\eta}{\eta + \theta_i m[\theta_i]}. \quad (24)$$

**Firm dynamics.** Similarly, we require that the flow into the pool of operating firms is equal to the flow out of this pool; hence,  $(1 - \delta)(1 - G[\varphi_{ii}^*])M_i^e = \delta\bar{M}_i$ , where  $M_i^e$  is the total mass of firms that attempt entry (and therefore pay the entry fee  $f^e$ ).

## 2.5 Market clearing conditions

**Labor market.** The labor market clearing condition is given by  $L_i^e = (1 - u_i)L_i$ , where  $L_i^e$  is aggregate employment and  $L_i$  is labor supply in country  $i$ . The mass of active domestic firms adjusts so that the labor market clears, hence

$$M_i = \frac{L_i^e}{\sum_{j=1}^N \varrho_{ij} L_{ij} [\tilde{\varphi}_{ij}]}. \quad (25)$$

**The market for the final output good.** Total spending on the aggregate output good, i.e., total nominal income, is defined as the sum of revenues generated by intermediate goods producing firms from sales on the domestic and export markets. Using the free entry condition given in equation (23), the expression for  $\pi_{ij}[\varphi]$  given in equation (20), the definition for the ex ante probability of exporting to country  $j$  conditional on successful entry  $\varrho_{ij} = (1 - G[\varphi_{ij}^*]) / (1 - G[\varphi_{ii}^*])$ , the distribution of workers across markets  $L_i^e = M_i \sum_{j=1}^N \varrho_{ij} L_{ij} [\tilde{\varphi}_{ij}]$ , and summing over all firms  $M_i$ , we may solve for  $\sum_{j=1}^N M_i \varrho_{ij} R_{ij}[\varphi]$ :

$$\sum_{j=1}^N M_i \varrho_{ij} R_{ij}[\tilde{\varphi}] = w_i L_i^e + \frac{P_i M_i}{1 - \delta} \left( (1 + r) \sum_j \varrho_{ij} f_{ij} + \frac{r + \delta}{1 - G[\tilde{\varphi}_{ii}^*]} f^e \right) + \frac{\eta + r}{1 - \delta} L_i^e \frac{P_i c_i}{m_i[\theta_i]}, \quad (26)$$

which is the sum of payments to employed workers (aggregate consumption expenditure), on flow fixed costs  $f_{ij}$ , on appropriately discounted up-front investments  $f^e$ , and on search costs. Note that  $\sum_{j=1}^N \varrho_{ij} R_{ij}[\tilde{\varphi}]$  is equal to aggregate income in country  $i$ , denoted by  $Y_i$ , and also is equal to the value of final goods production.<sup>16</sup>

**Input markets.** Intermediate inputs are traded across countries. In equilibrium every country maintains multilateral (though not bilateral) trade balance so that the total

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<sup>16</sup>Note that we assume that the final output good is non-traded. Alternatively, one could assume that  $Y$  is freely tradable across countries. This choice would neither be more realistic, nor would it give rise to major analytical simplifications. Additionally, the results are hardly affected by assuming a freely tradable final good.

aggregate value of imports is equal to the total aggregate value of exports. The multilateral trade balance constraint for country  $i$  (or, balance of payments,  $BOP_i$ ) is given by:

$$\begin{aligned}
 BOP_i &= \sum_{\substack{j=1 \\ j \neq i}}^N P_i^{\sigma-1} \tau_{ji}^{1-\sigma} \left( \frac{\tilde{\varphi}_{jj} p_j}{\tilde{\varphi}_{ji}} \right)^{1-\sigma} \left( \frac{Y_i}{M_i} \right)^{1-\nu} \varrho_{ji} M_j \\
 &- \sum_{\substack{j=1 \\ j \neq i}}^N P_j^{\sigma-1} \tau_{ij}^{1-\sigma} \left( \frac{\tilde{\varphi}_{ii} p_i}{\tilde{\varphi}_{ij}} \right)^{1-\sigma} \left( \frac{Y_j}{M_j} \right)^{1-\nu} \varrho_{ij} M_i = 0.
 \end{aligned} \tag{27}$$

## 2.6 General equilibrium

To obtain analytical results, the literature usually assumes quasi-linear preferences or 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 present model perfectly coincides with Felbermayr, Prat, and Schmerer (2008) where the effects of trade liberalization on labor market outcomes can be fully described analytically in closed-form and for a general distribution function  $G(\varphi)$ .

When countries are asymmetric, the  $\Phi$ 's depend, amongst other things, on all the countries' disposable incomes. The disposable incomes are in part determined by the respective rates of unemployment, hence  $\Phi_i = f(u_1, u_2, \dots, u_N, \dots)$ . The wage and job creation curves imply that  $u_i = g(b_i, c_i, \bar{m}_i; \Phi_i)$ . Through  $\Phi_i$ , country  $i$ 's rate of unemployment depends on all the other countries' unemployment rates as well. This implies a structural dependence of  $u_i$  on the whole world's collection of institutional labor market variables.

The proposed model is a generalized version of Krugman (1980). That model does not lend itself to analytical solutions in the presence of asymmetries and trade costs, even in the absence of firm heterogeneity or search frictions.<sup>17</sup> 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.<sup>18</sup>

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<sup>17</sup>See Anderson and van Wincoop (2003) for a recent example. Technically, in the generalized Krugman (1980) model, labor market clearing conditions give rise to transcendental equations which do not possess any analytical solution. Hence, wages cannot be solved for analytically.

<sup>18</sup>This is what many authors in the economic geography literature do; see, e.g., the surveys by Fujita, Krugman, and Venables (1999) or Baldwin, Forslid, Martin, Ottaviano, and Robert-Nicoud (2003).

## 3 Interdependence of labor market outcomes

### 3.1 Model calibration

We calibrate the model for three countries (hence,  $i = 1, 2, 3$ ,  $j = 1, 2, 3$  and  $N = 3$ ), which is the minimum number of countries in order to discuss the role of geography. We choose parameter values such that all three countries are completely symmetric in the initial steady-state and their equilibrium allocations replicate key empirical moments of the United States for which both the search-and-matching and the Melitz (2003) model have been calibrated by several authors. We set  $\nu = 0$  in our benchmark analysis (thereby ruling out external economies of scale). Existence and uniqueness of this symmetric case is shown in Felbermayr, Prat, and Schmerer (2008). Time is discrete and the time interval is set to one month.

**Productivity distribution.** Following the literature,<sup>19</sup> we assume that firms sample their productivity from a Pareto distribution, so that the p.d.f. is  $g(\varphi) = \gamma\bar{\varphi}^\gamma\varphi^{-(1+\gamma)}$ . The shape parameter  $\gamma$  measures the rate of decay of the sampling distribution and  $\bar{\varphi} > 0$  is the minimum possible value of  $\varphi$ . We follow Bernard, Redding, and Schott (2007) and set  $\gamma$  equal to 3.4. Without loss of generality, we may normalize  $\bar{\varphi} = 0.5$ .

**Matching function.** The matching function is Cobb-Douglas  $\bar{m}(\theta_i)^{-\alpha_i}$ . We follow the standard practice and set  $\alpha_i = 0.5$ . In the absence of well-established estimates, we set the bargaining power  $\beta_i = \alpha_i$ .<sup>20</sup> To calibrate the scale parameter  $\bar{m}$ , we use empirical estimates of the job finding rate and labor market tightness. Constant returns to scale of the matching function implies that 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 the matching function, 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%<sup>21</sup>, as suggested by the estimates in Bartelsman, Haltiwanger, and Scarpetta (2004). The match-specific shocks account for the job separations which are left

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<sup>19</sup>See for example Axtell (2001); Helpman, Melitz, and Yeaple (2004); or Bernard, Redding, and Schott (2007). 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.

<sup>20</sup>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.

<sup>21</sup>Along the steady state, the gross rate is  $2 \times 12 \times 0.916 = 21.98$ .

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  $\chi$  should be equal to 0.025 per month.

**Cost parameters.** 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  $b_i = 0.4$  for all  $i$  in the benchmark 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 for all three countries. 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  $\tau_{ij}$  equal to 1.3 for all country-pairs  $ij$  in the benchmark equilibrium, following Ghironi and Melitz (2005). Given the Pareto distribution for firm productivities, the share of firms that export is

$$q_{ij} = \tau_{ij}^{-\gamma} \left( \frac{P_j}{P_i} \right)^\gamma \left( \frac{R_j f_{ii}}{R_i f_{ij}} \right)^{\frac{\gamma}{1-\sigma}}. \quad (28)$$

That number is put at about 21% by Bernard, Eaton, Jensen, and Kortum (2003). Together with  $\tau_{ij} = 1.3$  for all country-pairs  $ij$  and assuming a symmetric benchmark equilibrium, this pins down the ratio  $f_{ij}/f_{ii}$  at about 1.7. We use the values of entry costs,  $f^e$ , and the flow fixed costs,  $f_{ij}$ , to match the following two moments. First, we ensure that the equilibrium tightness  $\theta_i = 0.5$  for all countries in the benchmark equilibrium. Second, we target an average firm size equal to 21.8 employees, as estimated by Axtell (2001). The 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 (2009) 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. The Appendix contains a summary table of all chosen parameter values.

### 3.2 How domestic institutions impact outcomes world-wide

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 they are easily observable in the data, exhibit substantial variation across countries, and are shown to consistently explain unemployment rates in empirical research.<sup>22</sup> Moreover, we know that the model reacts similarly to changes in search costs  $c_i$  or the search technology  $\bar{m}_i$  (see Lemma 1). Specifically, we study what effects an increase in unemployment benefits of country 1 (the “bad” country) has on unemployment in that country and, more importantly, in its trading partners (countries 2 and 3). We vary  $b_1$  in the interval  $[0.4, 0.8]$  and hold unemployment benefits for countries 2 and 3 constant at the benchmark value of 0.4.

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<sup>22</sup>See, e.g., Bassanini and Duval, 2006.

Similarly, we consider trade costs in  $[1, 1.6]$ , i.e., ad valorem tariff equivalents from 0 to 60%. Remember that the benchmark value of  $\tau$  is 1.3 for all country-pairs  $ij$  (or: 30%). For our first investigation we assume  $L_i = L$ , hence countries are symmetric with respect to all things except the unemployment benefits. The main insights from these experiments are summarized in Results 1a to 1c and visualized in Figure 2. The left-hand diagram in Figure 2 shows the unemployment rate in country 1 for various values of trade costs on the x-axis (equal between all countries) and unemployment benefits in country 1 on the y-axis. Trade costs are in percent, i.e.,  $\tau(\%) = (\tau - 1) \times 100$ . The right-hand diagram shows the unemployment rate in country 2 for various values of trade costs on the x-axis and unemployment benefits in country 1 on the y-axis (country three is not shown, as the effects there are equal to the ones in country two).

**Result 1a [Globalization and labor markets]**

*Trade liberalization leads to lower unemployment in all countries.*

Result 1a extends the theoretical findings in Felbermayr, Prat, and Schmerer (2008) to asymmetric countries. As shown in Figure 2, in all countries, unemployment is lowest for minimum values of trade costs and unemployment benefits of country 1. If trade costs decrease from 60% to 0%, unemployment in all countries falls from about 8% to 6.5%. So, trade liberalization can have a very substantial impact on the long-run structural rate of unemployment.

The intuition for Result 1a is as follows. Trade liberalization affects the equilibrium productivity distribution through the selection effect introduced in Melitz (2003): on the one hand, inefficient firms in all countries suffer from increased import competition by more efficient foreign firms, their residual demands and revenue levels fall, and they are no longer able to cover operating fixed costs; on the other hand, the most efficient domestic firms can expand due to increased foreign sales. Hence, there is a *cleansing effect* of trade, and the average domestic firm  $\tilde{\varphi}_{ii}$  is now more efficient than before trade liberalization. It has larger sales and a lower price,  $p_{ii}[\tilde{\varphi}_{ii}]$ , but – due to the standard assumption  $\sigma > 1$ , the price falls by less than productivity increases. It follows that  $\tilde{\varphi}_{ii}p_{ii}[\tilde{\varphi}_{ii}]$ , the flow value of an additional filled vacancy, increases due to trade liberalization. On top of this, the aggregate price level goes down as prices of available varieties are on average lower. Hence, the term  $\Phi_i \equiv \tilde{\varphi}_{ii}p_{ii}[\tilde{\varphi}_{ii}]$  goes up in all countries. To sum up, trade liberalization strengthens the average firm’s incentives to post vacancies in all countries, leading to lower unemployment in all countries.

This result is in line with aggregate empirical evidence presented by Dutt, Mitra, and Ranjan (2009), or Felbermayr, Prat, and Schmerer (2009). However, it is in contrast to a number of other theoretical contributions, such as Egger and Kreickemeier (2009) or an array of recent contributions by Helpman, Itskhoki, and Redding. The first authors focus on a different labor market paradigm – fair wages. Trade liberalization would lead to trade dispersion, which is deemed unfair and needs to be compensated by a higher average wage level. This mechanism drives up the unemployment rate. The latter papers use the search-matching model as we do. However, in addition they make various other structural assumptions that condition the effect of trade liberalization on unemployment. Helpman and Itskhoki (2008), and Helpman, Itskhoki, and Redding (2008a, 2008b), assume the existence of a numéraire sector with costless international trade, perfect competition,

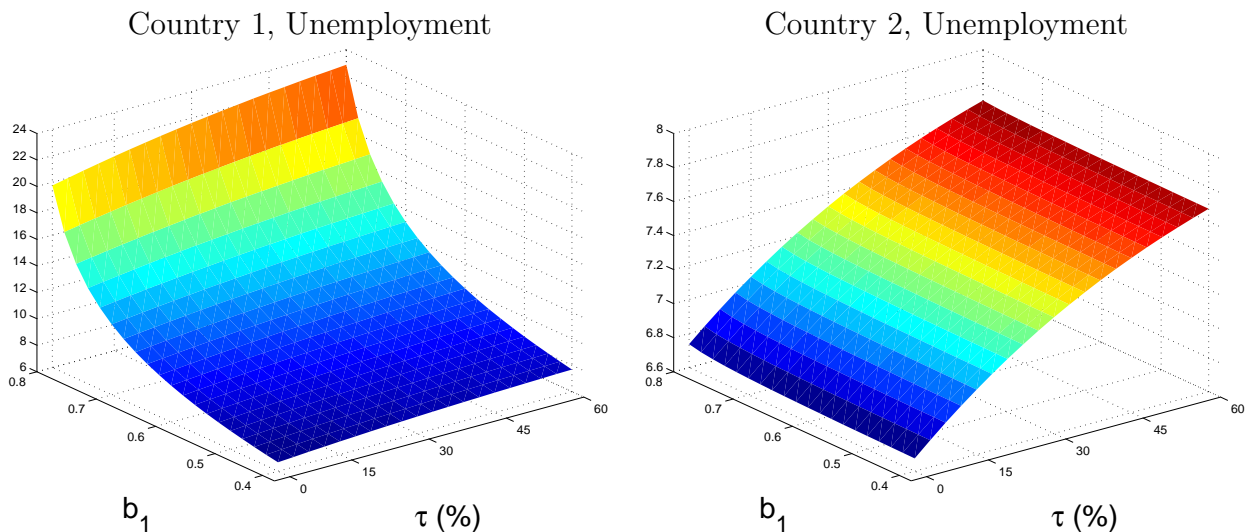


Figure 2: Country 1 labor market regulation and unemployment in countries 1 and 2 (=3). [Rate of unemployment on the vertical axis.]

constant returns to scale, and, most importantly, frictionless labor markets. The second sector has heterogeneous firms, monopolistic competition, search frictions, and trade costs. When trade costs fall, the second sector becomes more competitive, and workers leave the no-unemployment numéraire sector to fuel the expansion of the other sector. This tends to result in higher aggregate unemployment. This result crucially depends on the existence of the numéraire sector. There is a second important difference relative to our model: In most of their analysis, Helpman, Itshhoki, and Redding assume that preferences are quasilinear such that all changes in income are absorbed by the homogeneous good. This means that additional income due to gains from trade does not create additional demand in the unemployment-ridden second sector and can, therefore, not compensate the increase in unemployment.

#### **Result 1b [Labor market reform]**

*If one country increases its unemployment benefits, then unemployment increases in that country.*

An increase of  $b_1$  from 0.4 to 0.8 (at the benchmark value of  $\tau = 30\%$ ) drives up the rate of unemployment from about 7% to about 20%. This result is in line with closed economy search-and-matching models and with empirical evidence.<sup>23</sup> We will study in detail below how the geographical location of the country with the deteriorating institutions conditions the unemployment effect. Figure 2, however, already clearly suggests that the gradient of  $u_1$  with respect to  $b_1$  is smaller if country 1 is more open to international trade.

#### **Result 1c [Institutional spill-overs]**

*If one country increases its unemployment benefits, then, in all other countries, unemployment rises. While this qualitative pattern is very robust, the size of the spill-over*

<sup>23</sup>See Bassanini and Duval (2006).

*effect is about two orders of magnitude smaller than the own effect.*

Result 1c is our central result about the interaction of labor market institutions. If labor market institutions in country 1 deteriorate, unemployment in that country goes up, real wages increase, but income falls (due to lower production). These effects also reduce firms' incentives to create jobs in countries 2 and 3. There are three channels through which a change in  $b_1$  has an impact on  $\Phi_2$  and  $\Phi_3$  and therefore on unemployment: An income effect, a competitiveness effect and a selection effect.

The income effect results from the reduced income in country 1. Country 1 spends part of its income on foreign varieties. Hence, increased unemployment in that country reduces demand for goods from countries 2 and 3, thereby lowering those countries' exports and export prices, which tends to increase unemployment. The second effect is a competitiveness effect. As the increase in the workers' outside option pushes up the real wage in country 1, the prices of country 1's varieties go up relative to varieties from countries 2 or 3. Moreover, as employment contracts, the number of firms in country 1 and hence the number of varieties produced falls. This endows firms in countries 2 and 3 with a better competitive stance: Residual demand for each firm is higher, which tends to decrease unemployment in countries 2 and 3. The income and the competitiveness effect give rise to an additional effect that relies on the selection of firms. The reduced demand for exports of firms from countries 2 and 3 (the income effect) harms the most productive firms, as those are the only ones that export. As those firms lose weight, average productivity goes down and thus  $\Phi_2$  and  $\Phi_3$  fall. Similarly, decreased competitiveness of firms in country 1 implies that domestic firms in countries 2 and 3 earn higher profits. It follows that the entry-threshold falls: Some firms that were too unproductive to survive before the reform, can now stay in the market and drive down average productivity. This again drives down  $\Phi_2$  and  $\Phi_3$  and thus lowers incentives to post vacancies.

Overall, we have three channels through which a worsening of labor market institutions in one country affects unemployment in its trading partners. The competitiveness effect tends to decrease unemployment, while the income and the selection effects tend to increase it. It turns out that the latter are dominating. This finding is very robust to alternative calibrations. However, spill-over effects are fairly small quantitatively. The own effect of inefficient labor market institutions in country 1 is by about two magnitudes stronger than the effect on the unemployment rates in countries 2 and 3. This finding is independent from varying other labor market parameters such as  $c_i$  or  $\bar{m}_i$ . We will show in section 3.6 that the magnitude of spill-overs is much higher when real wages are rigid.

### 3.3 How geography and country size shape the spill-over

The only channel of transmission of institutional changes in country 1 to labor market outcomes in countries 2 and 3 is trade in intermediary goods. Since our model implies a straight-forward gravity-type link between trade costs, country sizes, and bilateral trade volumes, it is natural to study the implications of these variables on the strength of institutional spill-overs.

Starting with the role of geography, we change the *centrality* of the “bad” country,



country 1 (i.e., we vary its multilateral, or overall, degree of openness). Assuming symmetric bilateral trade costs between all countries ( $\tau_{jk} = \tau_{kj}$  for all  $j, k$ ) and treating countries 2 and 3 as identical ( $\tau_{j1} = \tau_{1j} = \tau_1$  for all  $j \neq 1$ ), we solve the model for different degrees of centrality of country 1 (i.e., we vary  $\tau_1$ ) while keeping trade costs between countries 2 and 3 ( $\tau_{jk}$  for all  $j \neq 1, k \neq 1$ ) constant. The outcome is summarized in the following result and visualized in Figure 3.

**Result 2a [Geography and spill-overs]**

*As the degree of centrality of country 1 goes up, a given rise in country 1’s unemployment benefits yields a smaller unemployment increase in country 1 and a larger increase in countries 2 and 3.*

For illustration see the variation of  $\tau_1$  on the  $x$ -axis in Figure 3. The variation of country size on the  $y$ -axis is discussed in Result 2b. The figure shows the absolute change of the unemployment rates,  $\Delta u_1$  (left-hand diagram) and  $\Delta u_2 = \Delta u_3$  (right-hand diagram) generated by a given change of  $b_1$  (from 0.4 to 0.8; hence  $\Delta b_1 = 0.4$ ) for different values of  $\tau_1$ , where lower values of  $\tau_1$  indicate higher centrality of country 1. For  $\tau_1 = 30\%$  and  $s_i = 0.33$ , an increase of  $b_1$  from 0.4 to 0.8 moves  $u_1$  up by about 15 percentage points in country 1 and by about 0.03 percentage points in countries 2 and 3. This effect can also be read off Figure 2 by comparing unemployment rates at  $\tau = 30\%$  for  $b_1 = 0.4$  and  $b_1 = 0.8$ .

In line with Results 1b and 1c, the change in unemployment is positive for all countries. The new insight from Figure 3 is that a higher degree of centrality of the “bad” country (i.e., a lower  $\tau_1$ ) weakens the increase in the unemployment rate in country 1 but strengthens the increase in countries 2 and 3. We see that the increase in  $b_1$  increases unemployment in country 1 by about 13 percent when  $\tau_1 = 0$  and by about 16 percentage points when  $\tau_1 = 0.6$ . Hence, the more central a country is, the lower are the unemployment costs of its own bad institutions. Trade partners, however, suffer more as a decrease in  $\tau_1$  drives up the change in the unemployment rate. However, quantitatively, the effect is fairly small.

The intuition for Result 2a is straightforward. If country 1 is more central, it trades more with countries 2 and 3. If country 1 has no access to international markets ( $\tau_1 \rightarrow \infty$ ), lower *domestic* demand for country 1’s products due to higher unemployment in that country would be tantamount to lower *total* demand, so that the adverse labor market implications are most severe. In the other extreme where  $\tau_1 = 0$ , domestic demand only accounts for a fraction of total demand faced by country 1’s firms. Since foreign institutions remain unchanged, there is no first-order effect on foreign unemployment and hence income, so that the relative downfall of total demand faced by country 1’s firms is less than proportional to the fall in domestic demand. Therefore, the resulting increase in the unemployment rate is smaller. That logic holds in reverse for countries 2 and 3 which rely more on country 1’s demand when  $\tau_1$  is lower.

Next, we study how the size of the “bad” country affects spill-overs. We measure country size in terms of population, as income is endogenous in our model. More precisely, we fix the world population  $L^w = \sum_{i=1}^3 L_i$ , and then change country 1’s share of world population from 10% to 90%. The remaining population is distributed equally between

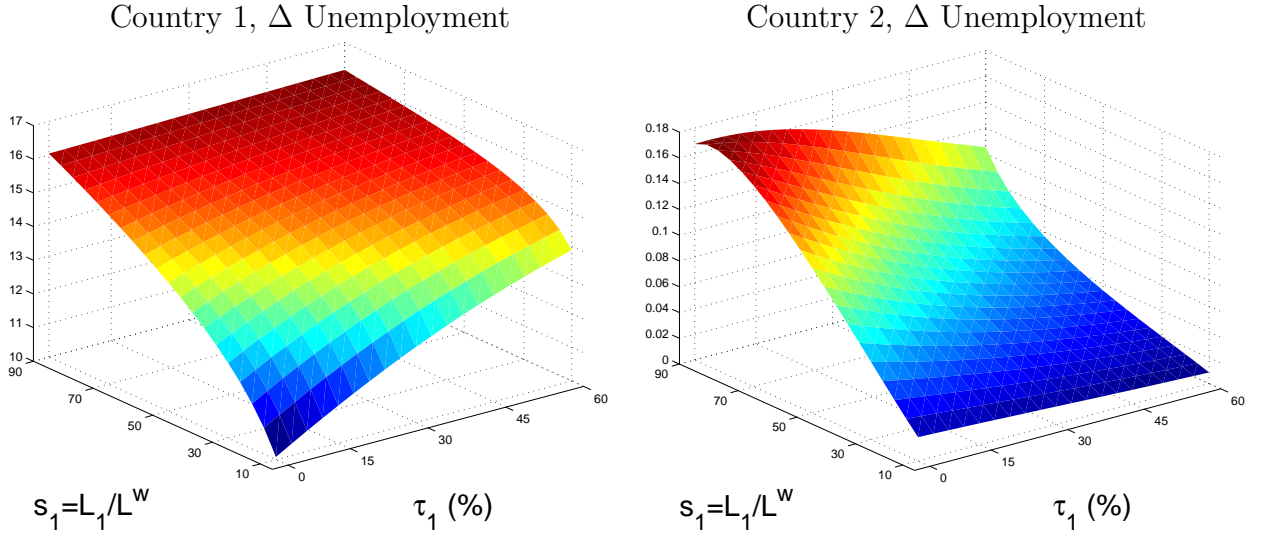


Figure 3: Change in unemployment [on the vertical axis] as a function of centrality and size of the “bad” country 1 for a given change of  $b_1$  from 0.4 to 0.8.

countries 2 and 3.

**Result 2b [Relative size and spill-overs]**

*The higher the relative size of country 1 the stronger is the increase in unemployment rates in all countries due to a rise of country 1’s unemployment benefits.*

Figure 3 shows that, at the benchmark value of  $\tau = 30\%$ , moving  $s_1$  from 0.1 to 0.9 increases the gradient of unemployment with respect to  $b_1$  from about 12 percentage points to 16 in country 1 and from virtually zero to about 0.14 percentage points in countries 2 and 3. The logic for this result is similar to the one about centrality. When  $s_1$  is very large, demand of firms in all countries depends mostly on country 1’s income. Hence, variations in  $b_1$  have strong implications not only for country 1 but for the entire world. If  $s_1$  is very small, the variation in  $b_1$  has implications only for a very small fraction of global demand and therefore has little effect on unemployment rates world-wide.

Firm heterogeneity and the existence of fixed costs for foreign production have important implications for the quantitative impact of institutional changes in the directly affected country 1 and in its trading partners. The reason is that a shortfall of income in country 1 has first-order effects on firms of all productivities in country 1. However, in countries 2 and 3, only firms with high productivity levels directly depend on country 1’s level of income as less inefficient firms do not engage in international trade and are therefore sheltered from variation in country 1’s labor market institutions. This explains why the quantitative impact of  $\Delta b_1$  is much stronger in country 1 than in the rest of the world.

### 3.4 The role of the elasticity of substitution and external economies of scale

This section performs robustness checks with respect to the elasticity of substitution  $\sigma$  between varieties of inputs and with respect to the degree of external economies of scale  $\nu$ . This exercise confirms the overall validity of Results 1 and 2 discussed above and further allows insights into the details of the model mechanisms.

First, we focus on an increase in the elasticity of substitution  $\sigma$ . This parameter has crucial implications for the role of the *competitiveness* and *income* effects discussed in Result 1c.

The implications of changing  $\sigma$  are illustrated in Figure 4 which makes similar assumptions as Figure 3. Instead of relative country size, the y-axis now varies the elasticity of substitution between 3.8 and 10, and the x-axis varies values of trade costs (equal between all countries) as in Figure 2.<sup>24</sup> The following result summarizes.

**Result 3 [The elasticity of substitution and spill-overs]**

*The higher the elasticity of substitution, the smaller is the increase in unemployment rates in all countries following a rise of country 1's unemployment benefits.*

A higher  $\sigma$  more strongly insulates firms from foreign competition as exports are proportional to  $\tau^{1-\sigma}$ .<sup>25</sup> For given levels of trade costs, this term becomes smaller with increases in  $\sigma$  and thus bilateral trade flows become lower. As a consequence, countries depend less on global demand and more on domestic demand. This has two implications. On the one hand, the country where the labor market shock occurs is hit harder as it can not spill-over part of the negative shock to other countries, on the other hand trading partners are less affected due to lower trade volumes. Hence, in country 1, the income effect is stronger with higher  $\sigma$ , while it is weaker in the rest of the world.

Note further that, when  $\nu < 1$ , the monopolistic competition model exhibits a monopoly distortion that leads to excess entry. The strength of this distortion, however, depends on  $\sigma$  (big if  $\sigma$  is small). So, as we increase  $\sigma$ , we reduce the distortion, which has positive effects on the level of aggregate productivity and hence labor market outcomes. This explains why the increase in unemployment is smaller in country 1 for higher  $\sigma$ 's. Overall, the smaller changes in unemployment of country 1 as well as the lower trade volumes for higher values of  $\sigma$  imply that adverse spill-overs from country 1 to the rest of the world should decrease with rising  $\sigma$ . In a world with increased product differentiation ( $\sigma$  falls), cross-country interdependencies become more pronounced.

Up to now we have analyzed our model for the case of  $\nu = 0$ , which implies that absolute size effects do not influence the level of unemployment. Hence, whenever we would increase the population in all countries, the rate of unemployment would not change. However, new trade theory (see for example, Helpman and Krugman, 1985) and the new economic geography (see for example, Fujita, Krugman, and Venables, 1999; or Baldwin,

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<sup>24</sup> Note that  $\sigma$  is bounded from below by the condition  $\frac{\sigma-1}{\sigma-\beta_i} > b_i$  for given  $b_i$  and  $\beta_i$ .

<sup>25</sup>This can be seen from rearranging equation (3).

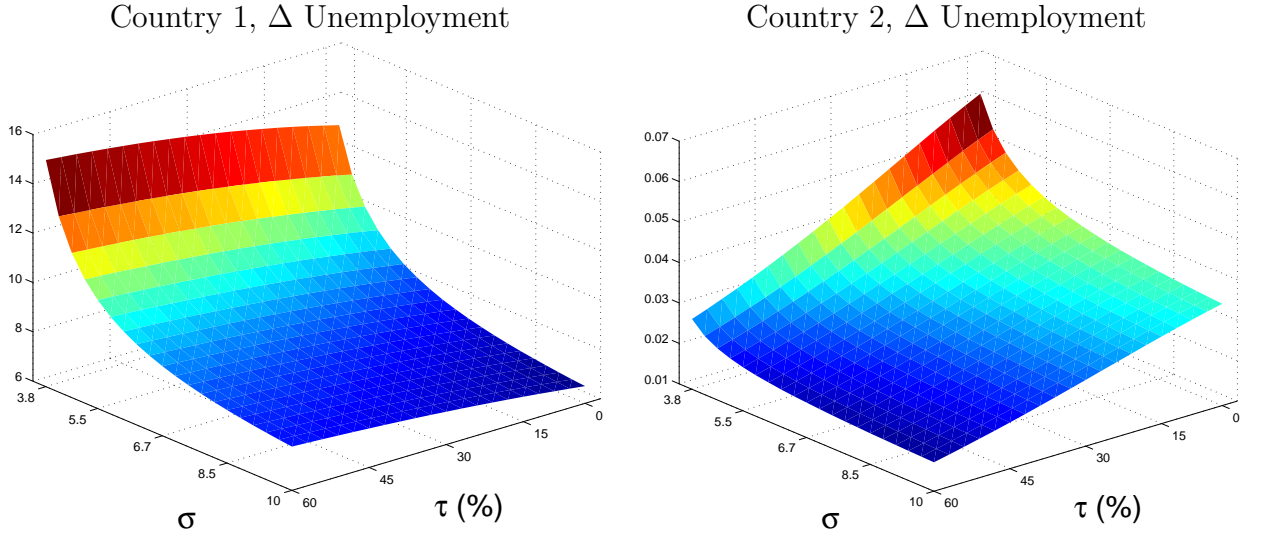


Figure 4: Change in unemployment [on the vertical axis] as a function of trade costs and the elasticity of substitution for a given change of  $b_1$  from 0.4 to 0.8.

Forslid, Martin, Ottaviano, and Robert-Nicoud, 2003) emphasize the role of market size for explaining the pattern of trade as well as the agglomeration of industries and activities. Hence, we next investigate how changes in the degree of external economies of scale,  $\nu$ , affect the spill-over. Result 4 summarizes our findings:

**Result 4 [External economies of scale and spill-overs]**

*Stronger external economies of scale result in more pronounced unemployment effects in all countries.*

Figure 5 reveals that a higher  $\nu$  implies a larger change in unemployment in all countries. The reason is that now the income effect is reinforced because the *absolute size* of the countries matters while this effect is sterilized with  $\nu = 0$ . A larger market implies higher demand, leading to more production and, therefore, lower unemployment.

However, if unemployment benefits rise, the demand shrinks due to lower income (resulting from less efficient institutions). A higher degree of external economies of scale reinforces this process, leading in the end to higher unemployment in the country where the unemployment benefits rise. The spill-overs for the trading partner are also larger with a higher degree of external economies of scale due to the shrinking export market.

### 3.5 How important is firm-level heterogeneity?

Next, we explore the role of firm heterogeneity by changing  $\gamma$ , the shape parameter of the Pareto distribution. We vary  $\gamma$  between 3.8 and 10. A shape parameter of the Pareto distribution of  $\gamma = 3.8$  with a lower bound of  $\bar{\gamma} = 0.5$  implies a variance of 0.067, a standard deviation of 0.260 and a coefficient of variation of 0.382, whereas a  $\gamma = 10$  implies a variance of 0.004 a standard deviation of 0.062 and a coefficient of variation

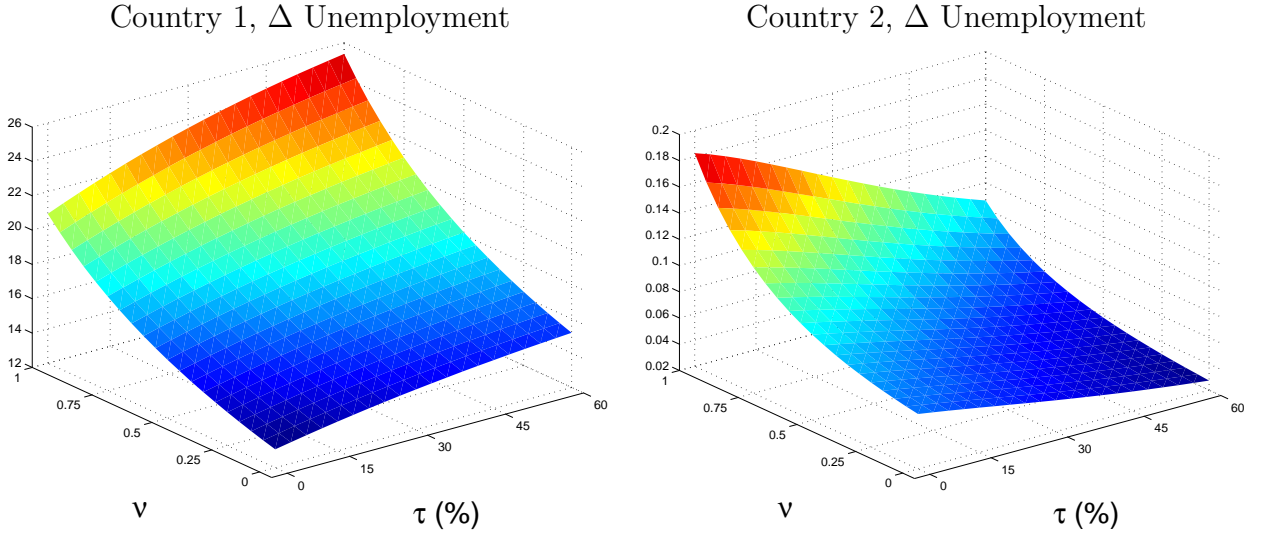


Figure 5: Change in unemployment [on the vertical axis] as a function of trade costs and external economies of scale for a given change of  $b_1$  from 0.4 to 0.8.

of 0.112.<sup>26</sup> Hence, a higher value of  $\gamma$  is associated with less firm heterogeneity; it is, however, also associated with a lower mean of the productivity distribution. Our main findings can be summarized as follows:

**Result 5 [How firm heterogeneity conditions spill-overs]**

*The larger the shape parameter of the Pareto distribution describing the distribution of firm-level productivity, the smaller is the effect on unemployment in all countries triggered by a given increase in unemployment benefits in country 1.*

The more equal firms are concerning their productivity, the less changes in unemployment benefits affect unemployment in both, the country where the change occurs and the trading partner country. The effect of unemployment changes shrinks with more equal firms, as changes in unemployment benefits have only a minor effect on average productivity. Hence, the competitiveness channel due to lower import competition is weakened, leading to a smaller reaction of unemployment. For the trading partner, a second fact is important. If firms are nearly homogeneous, then only few firms are productive enough to incur the fixed costs for both, the home market and the foreign market. Hence, there is less trade when firms are more homogeneous. With a  $\gamma = 10$  and trade costs of  $\tau = 1.6$ , the spill-over nearly vanishes, as hardly any firm from country 1 serves the foreign customers.

Note that a value of  $\gamma = 10$  does not completely shut down heterogeneity. If one wants to eliminate heterogeneity, the zero-profit cutoff conditions become redundant and the system of equilibrium conditions essentially collapses to one where the Krugman

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<sup>26</sup>Note that for a Pareto distribution, the variance is given by  $\frac{\bar{\gamma}^2 \gamma}{(\gamma-2)(\gamma-1)^2}$  for  $\gamma > 2$ , the standard deviation is given by  $\frac{\bar{\gamma}}{\gamma-1} \sqrt{\frac{\gamma}{\gamma-2}}$ , and the coefficient of variance is given by  $\frac{1}{\sqrt{\gamma(\gamma-2)}}$ . Further we assume that  $\gamma > \sigma - 1$  so that the variance of log productivity is finite.

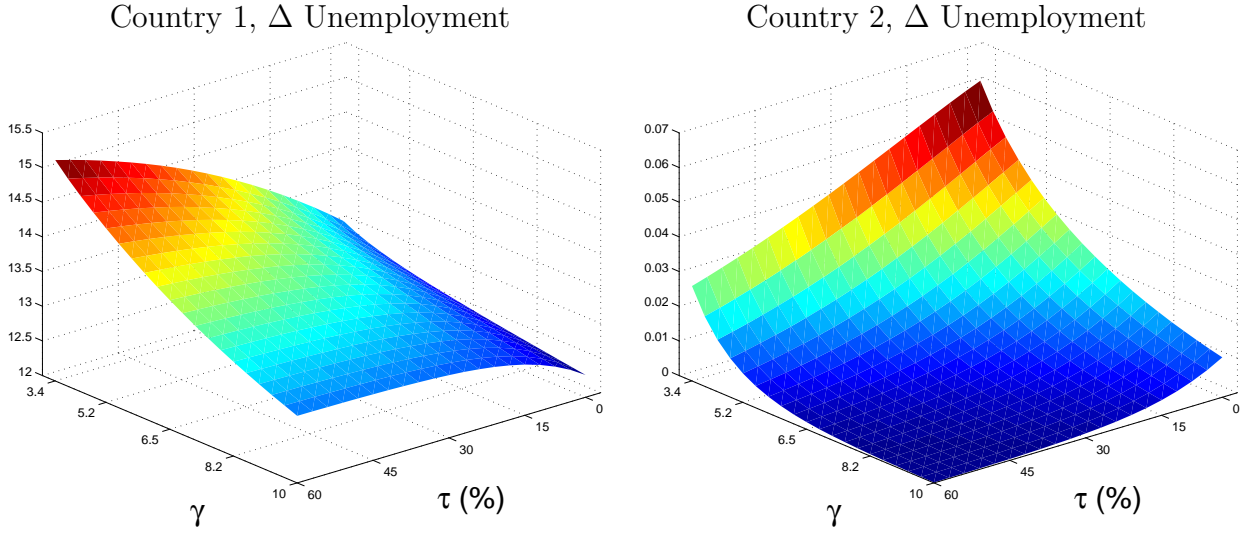


Figure 6: Change in unemployment [on the vertical axis] as a function of trade costs and the shape parameter of the Pareto distribution for a given change of  $b_1$  from 0.4 to 0.8.

(1980) model is combined with search-and-matching unemployment. In the last step of our numerical analysis, we therefore work with homogeneous firms. We assume that all firms export, implying that the free entry condition given in equation (23) holds for all firms.<sup>27</sup> Without selection, there are many more firms left that export, as every firm that enters the market also serves the customers abroad. We find the following result.

**Result 6a [Spill-overs in the Krugman economy]**

*If firms are homogeneous and external economies of scale are important ( $\nu = 1$ ), then an increase of unemployment benefits in country 1 leads to increases of unemployment in all countries.*

Figure 7 shows the effects of changes of unemployment benefits in country 1 on unemployment for countries 1 and 2 when firms are homogeneous and  $\nu = 1$ . We see that the changes in unemployment are positive for both countries. The mechanism underlying the spill-over is the change in the market size which results from higher unemployment in country 1. Hence, the Krugman model highlights the market potential effect in the absence of firm selection.

It is interesting to contrast this result with those obtained when firm heterogeneity persisted but was assumed to gradually vanish. There, firms become more equal as  $\gamma$  becomes larger. The spill-over there becomes smaller with higher  $\gamma$  as only few firms are productive enough to export. If we focus on the Krugman economy, every firm that enters the market also exports. In other words, the home and foreign market in the Krugman model are not separated, rather firms maximize joint profits over these two markets.<sup>28</sup>

<sup>27</sup>In this setup, either all firms export or no firm does so. If no firm exports, there are no spill-overs at all.

<sup>28</sup>Or one may argue that firms indeed maximize profits for the home and foreign market separately,

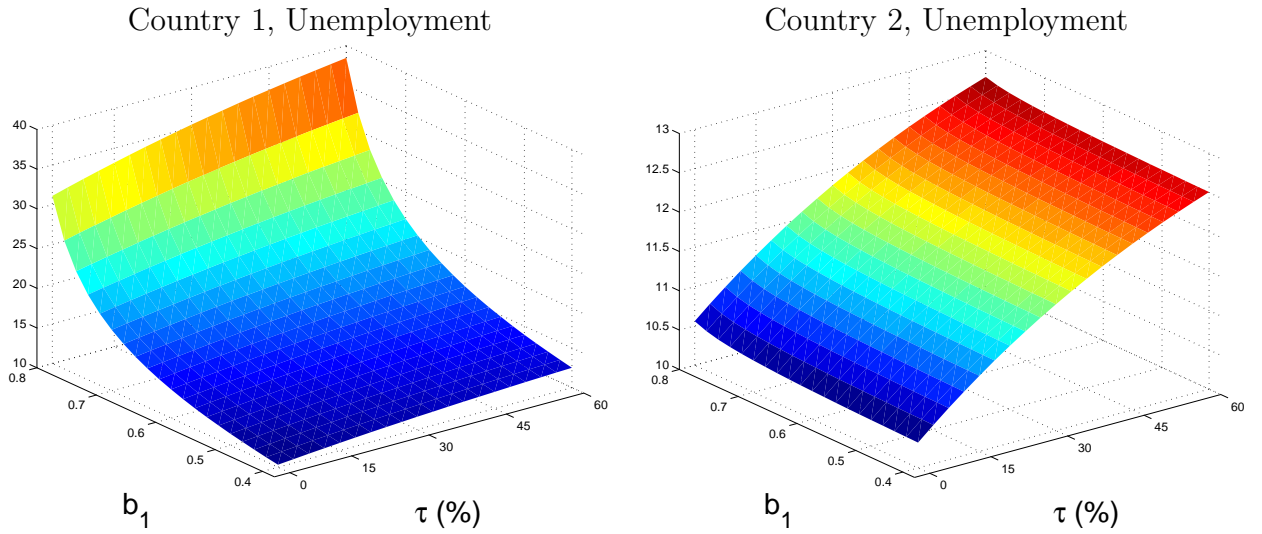


Figure 7: Country 1 labor market regulation and unemployment in countries 1 and 2 ( $=3$ ), when  $\nu = 1$  and firms are homogeneous. This corresponds to a Krugman (1980) economy. [Rate of unemployment on the vertical axis.]

Hence, as it is always profitable for some firms to enter the market, spill-overs do not vanish. Rather, there is another effect at work, namely, the market potential effect.

One may ask the question, what would happen in a world with homogeneous firms, if the market potential effect were not at work? This case is summarized in Result 6b:

**Result 6b [Spill-overs in the Krugman economy without external economies of scale]**

*If firms are homogeneous and there are no external economies of scale ( $\nu = 0$ ), an increase in unemployment benefits in one country will increase unemployment in that country while unemployment in all other countries is (almost) unaffected.*

As you can see in Figure 8, if we shut down the external economies of scale channel when firms are homogeneous, no spill-overs are left on the unemployment rate in country 2 when  $\tau = 1$ , and the effects are very small if  $\tau > 1$ . If  $\tau = 1$ , all varieties in the world enter the price index and utility symmetrically. As absolute size differences do not matter with  $\nu = 0$  and the competitiveness effect is not at work if firms are homogeneous, changes in unemployment benefits in country 1 do not affect the unemployment rate in country 2. However, if  $\tau > 1$ , one channel is still at work, namely changes in the relative composition of the consumption bundle. With changing unemployment benefits in country 1, the price for varieties abroad changes. Hence, when varieties do not enter perfectly symmetric, as is the case with  $\tau > 1$ , there will be a compositional change in the consumption bundle. Varieties produced at home become relatively cheaper, hence, consumers will switch from foreign varieties to home varieties, which will lead to more production at home and less

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but due to the homogeneity of firms, either all firms export or no firm does. There is no co-existence of exporting firms and domestic firms as in the case with heterogeneous firms.



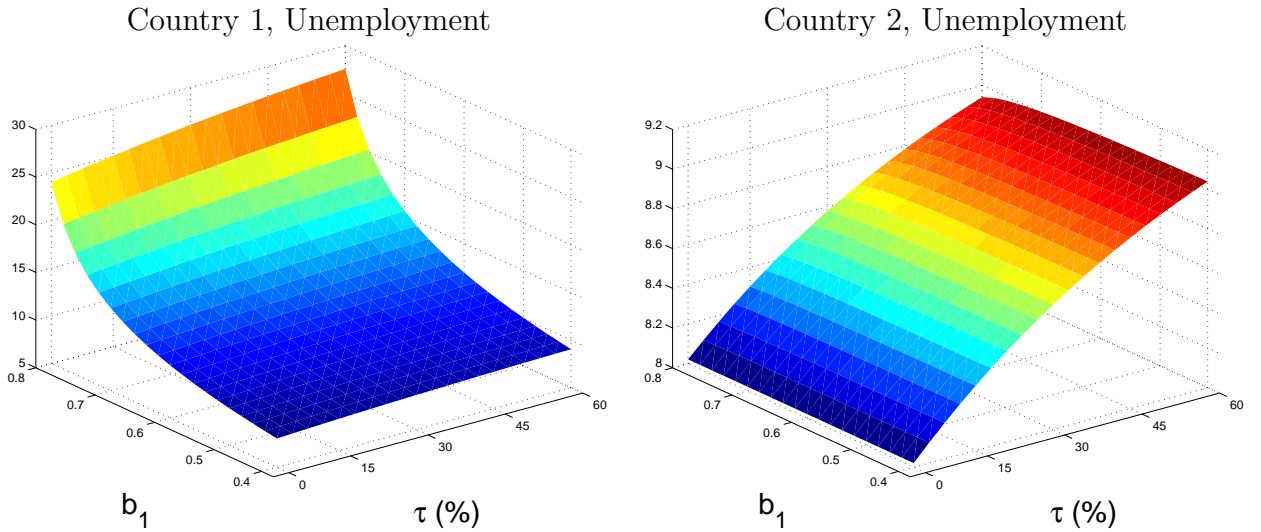


Figure 8: Country 1 labor market regulation and unemployment in countries 1 and 2 ( $=3$ ), when  $\nu = 0$  and firms are homogeneous. [Rate of unemployment on the vertical axis.]

unemployment. Hence, one part of the competitiveness channel survives, even in the homogeneous firms model without external economies of scale.

### 3.6 The role of real wage rigidity

So far, our numerical exercise suggests that the effect of domestic institutional change on the domestic rate of unemployment is by about two orders of magnitudes larger than the effect on the foreign rate of unemployment. The calibration exercise is extremely stylized and allows countries to differ only across a small set of parameters. Yet, the quantitative findings are very robust to different parameterizations of the model. The small magnitude of spill-over effects clearly questions their political relevance. Moreover, in section 4, we will measure the magnitude of spill-over effects in an empirical panel analysis of 20 rich OECD countries. The regressions suggest a larger and more important role for spill-over effects.

To address these concerns, this subsection shows that the lack of strong spill-over effects in our theoretical benchmark model is related to the Shimer-puzzle (Shimer, 2005), which posits that the conventional search-and-matching model of the (closed) US economy cannot reproduce the elasticity of labor market tightness with respect to productivity shocks along the business cycle. Our model concentrates on *spatial dependence* across countries rather than on *time-series* evidence. However, the problem is similar. The change in country 1's labor market institutions affects the other countries' rate of unemployment through aggregate productivity in those countries. If the link between productivity and unemployment is generally weak, then spill-overs have to be small.

Therefore, we follow Shimer (2004) and contrast the analysis of earlier subsections,



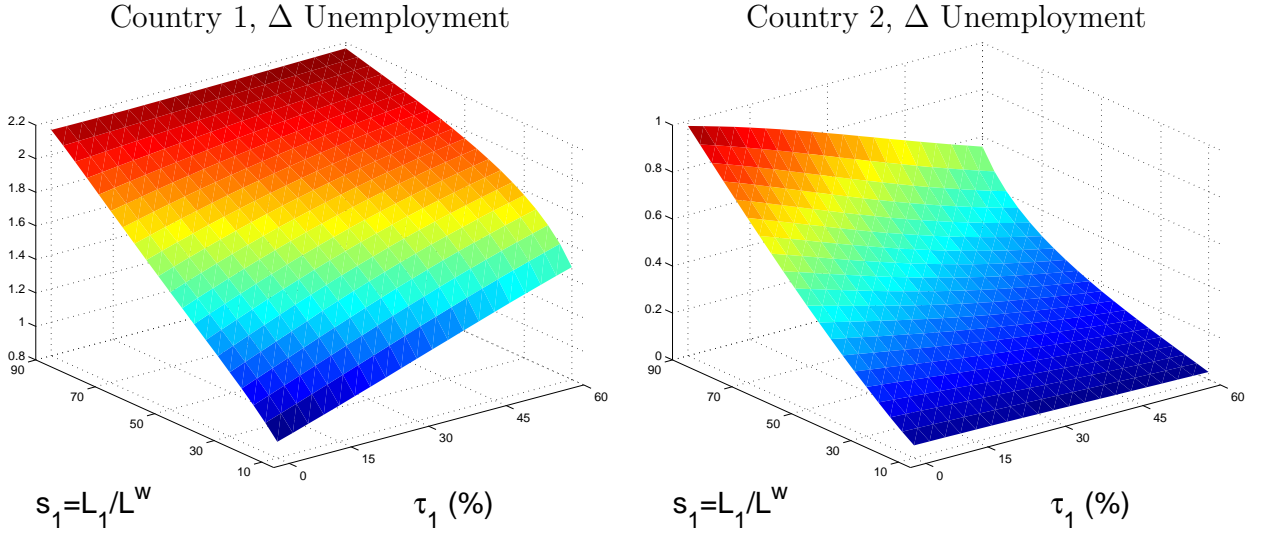


Figure 9: Change in unemployment [on the vertical axis] as a function of centrality and size of the “bad” country 1 for a given increase of country 1’s search costs from 1 to 1.3 under *perfect real wage rigidity*.

where wages are bargained individually, with the opposite extreme assumption of perfect real wages rigidity. The lack of adjustment in prices naturally increases the scope of adjustment in quantities. Hence, real wage rigidity should increase spill-overs in terms of unemployment rates. Comparing the cases of individual bargaining with rigid wages spans the interval in which the ‘true’ size of spill-overs lies.

When real wages are rigid, the wage curve (18) is replaced by the requirement that  $w_i/P_i = \bar{\omega}_i$ . We recalibrate the model such that our choice  $\bar{\omega}_i$  reproduces the unemployment rates, firm and job turnover rates, export penetration rates, and the average firms sizes as shown in Table A1. All external parameters are the same as in the earlier calibration.<sup>29</sup> Since the replacement rate  $b_i$  appears only in the now redundant wage curve, we vary the cost of vacancy creation  $c_i$  over the interval  $[1, 1.3]$ .

Figure 9 reproduces Figure 3 for the new scenario ( $c_1$  rather than  $b_1$  is changed) and under the assumption of rigid real wages. When  $c_1$  grows from 1 to 1.3, the unemployment rate in country 1 moves up by about 0.8 to 2.2 percentage points, depending, as before, on the relative size of country 1 and on its geographical location relative to its trading partners. The spill-overs to countries 2 and 3 (again treated symmetric) are now much more sizeable than before and vary between 0 and 1 percentage points. The model predicts that the strength of spill-overs is up to 45% of the effect in the reforming country. This is in strong contrast to our earlier results for flexible wages (Figure 3). To make sure that this difference does not come from our change in the experiment (changing  $c_1$  instead of  $b_1$ ), we repeat the same exercise with flexible wages. Figure 10 confirms that the change

<sup>29</sup>The structure of the model implies that, in the baseline equilibrium, the value of  $\bar{\omega}_i$  will be identical to the real wage that results under individual bargaining.

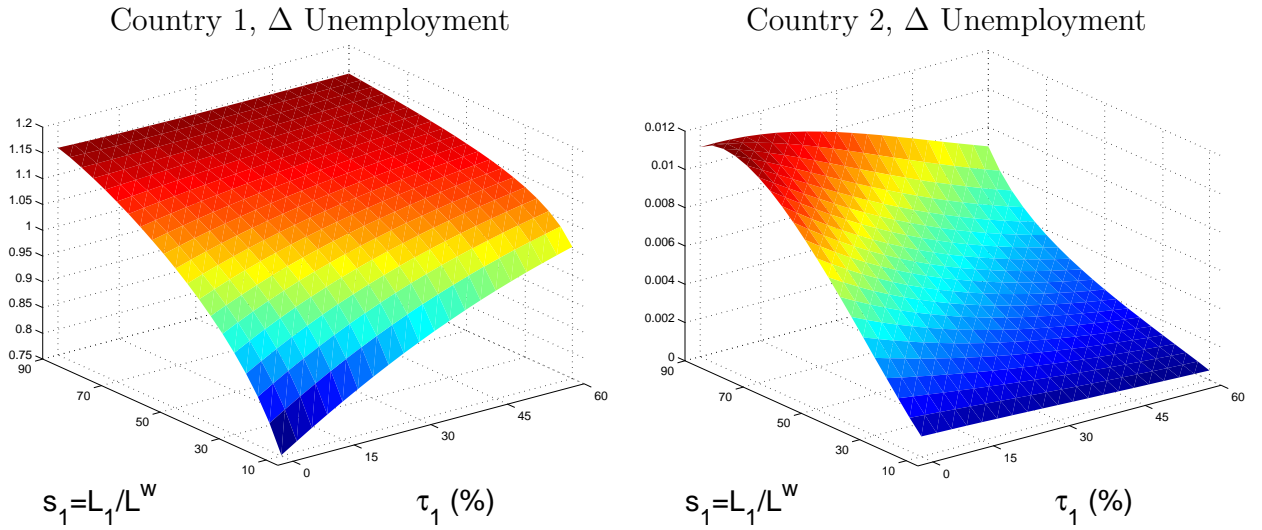


Figure 10: Change in unemployment [on the vertical axis] as a function of centrality and size of the “bad” country 1 for a given increase of country 1’s search costs from 1 to 1.3 *when wages are perfectly flexible*.

in results indeed stems from wage rigidity.

**Result 7 summarizes these findings.**

**Result 7 [The role of real wage rigidity]**

*The size of international spill-over effects depends on the degree of wage rigidity. When wages are perfectly flexible, an increase in country 1’s search costs has small effects on country 2 and 3’s unemployment rates. When real wages are perfectly rigid, the same scenario leads to an increase in unemployment in countries 2 and 3 of up to 45% of the effect in country 1.*

## 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 openness and relative size; (iv) the size of the spill-over effects depends on the degree of real wage rigidity.

## 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.<sup>30</sup> Typically, researchers have estimated equations of the type

$$u_{it} = \boldsymbol{\lambda} \cdot \mathbf{LMR}_{it} + \pi \cdot pmr_{it} + \gamma \cdot gap_{it} + \mathbf{F}_i + \mathbf{T}_t + \mathbf{S}_{it} + \varepsilon_{it}, \quad (29)$$

where  $\mathbf{LMR}_{it}$  is a vector of variables describing the stance of labor market regulations such as union density, the degree of corporatism, employment protection legislation (EPL), and a measure that relates to the flow value of non-employment  $b_{it}$ . It also includes a measure of the intensity of product market regulations,  $pmr_{it}$ , and the output gap,  $gap_{it}$  (calculated as the difference between actual output and the HP-filtered series). The vector  $\mathbf{F}_i$  collects the comprehensive set of country fixed-effects, and  $\mathbf{T}_t$  is a vector of year dummies while  $\mathbf{S}_{it}$  includes a number of variables recording exogenous shocks (TFP, real interest rates, terms of trade, and labor demand shocks). The construction of the latter variables is detailed in Bassanini and Duval (2006) and is in line with common practice in the literature. The error term  $\varepsilon_{it}$  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.<sup>31</sup> 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, Kleven, Kreiner and Saez, 2007). This will be our preferred measure of  $b_{it}$ . Other measures relating to the nature of wage bargaining, employment protection legislation, or the prevalence of minimum wages receive mixed empirical support. This is not necessarily surprising, given the ambiguity of theoretical results (see, e.g., the discussion in Blanchard and Wolfers, 2000).<sup>32</sup> Hence, in our regressions, we mostly focus on a single labor market variable, the *tax wedge* ( $b_{it}$ ), but we also include additional controls as robustness checks. A number of variables in (29) may seem endogenous; the existing literature, however, almost always treats them as exogenous and we largely follow this tradition as we lack natural instruments.<sup>33</sup>

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<sup>30</sup>The condensed and revised version is published as Bassanini and Duval (2009).

<sup>31</sup>A recent empirical literature studies the effects of trade openness on unemployment rates; see Dutt, Mitra, and Ranjan (2009) and Felbermayr, Prat, and Schmerer (2009). These papers find that trade liberalization lowers structural unemployment rates in the long run.

<sup>32</sup>Another variable that typically works well but that is very crude and not directly related to our theoretical model is the degree of corporatism. Typically, highly corporatist countries such as Scandinavian countries or Austria have lower unemployment rates due to centralized bargaining and the implied internalization of economy-wide effects of wage negotiations by the unions.

<sup>33</sup>Costain and Reiter (2008) argue that using the tax wedge rather than unemployment benefits mitigates endogeneity concerns. Also note that our extensive business cycle controls account for cyclical

Our theoretical model gives rise to a gravity-type relation between bilateral trade volumes and explanatory variables related to countries' market sizes and bilateral trade costs.<sup>34</sup> The model also predicts that the effect of labor market regulations of some country  $j$  on country  $i$ 's rate of unemployment is conditioned by the amount of bilateral trade between the two countries. However, when computing trade-weighted averages of foreign variables to gauge the influence, e.g., of foreign labor market institutions, we need to make sure that the weights are strictly exogenous. Hence, we proxy the amount of bilateral trade between  $i$  and  $j$  by

$$\tilde{\omega}_{ijt} = \frac{POP_{it}^{\alpha_1} POP_{jt}^{\alpha_2}}{DIST_{ij}^{\delta}}, \quad (30)$$

where  $POP_{it}$  denotes population of country  $i$ ,  $DIST_{ij}$  is the great circle distance between the two countries' most populated cities;  $\alpha_1$ ,  $\alpha_2$ , and  $\delta$  are parameters.  $\tilde{\omega}_{ijt}$  varies with time as population changes. It mimics the simplest possible gravity formulation, but substitutes population for GDP which is potentially endogenous.<sup>35</sup> Standard gravity predictions suggest that  $\alpha_1 = \alpha_2 = 1$ . Overman, Redding, and Venables (2003) state that  $\delta$ , "the elasticity of trade volumes with respect to distance is usually estimated to be in the interval 0.9 to 1.5." In a 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. Hence, we choose  $\delta = 1$  as our benchmark case, but conduct robustness checks with respect to the assumptions on  $\alpha_1$ ,  $\alpha_2$ , and  $\delta$ .

We calculate  $\tilde{\omega}_{ijt}$  for all 168 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). There are several possible ways to *normalize* the data; the choice of normalization has interpretational consequences but should not affect our qualitative findings. In our preferred setting, we normalize the weights such that  $\sum_{j=1}^{168} \omega_{ijt} = 1$  for all 168 countries. Then, we construct the trade-weighted average of foreign unemployment rates,  $u_{it}^* = \sum_{j=1}^{20} \omega_{ijt} u_{jt}$ , where country  $i$ 's rate of unemployment is excluded by definition ( $\omega_{iit} = 0$ ) and the summation only involves the 20 OECD countries for which high-quality unemployment rates are available. Similarly, we construct the trade-weighted average tax wedge of all countries other than  $i$  as  $b_{it}^* = \sum_{j=1}^{20} \omega_{ijt} b_{jt}$  (and similarly for all other labor market variables  $\mathbf{LMR}_{it}$ , denoted by  $\mathbf{LMR}_{it}^*$ ), and the average foreign output gap as  $gap_{it}^* = \sum_{j=1}^{20} \omega_{ijt} gap_{jt}$ . Note that this strategy implies that the foreign variables have smaller sample means than the domestic ones.

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covariation between  $u_{it}$  and  $b_{it}$ . In a similar empirical study without spill-over effects, Felbermayr, Prat, and Schmerer (2009) treat  $b_{it}$  as endogenous but do not find evidence for endogeneity bias.

<sup>34</sup>See Helpman, Melitz, and Rubinstein (2008) for a derivation of a gravity model in the presence of firm heterogeneity.

<sup>35</sup>We have also worked with predicted bilateral trade volumes obtained by regressing observed bilateral trade on exogenous variables such as population, distance, and other typical covariates such as common language, contiguity, joint membership of countries in currency unions or free trade areas, etc., using Poisson Pseudo maximum likelihood methods following Santos Silva and Tenreyro (2006, 2008). Results are qualitatively and quantitatively comparable. We prefer our specification as bilateral trade volumes may be endogenous to unemployment rates so that weights obtained from this procedure may lead to inconsistent estimates.

A natural alternative normalization would set the weights such that  $\sum_{k \in K} \omega_{ikt} = 1$ , where  $K$  is the set of our 20 OECD countries. One could also normalize weights by  $\max_j \omega_{ijt}$ . In a series of robustness checks, we will show that the choice of normalization has little qualitative effect on our results.

## 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<sup>36</sup> 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 for example Nickell, Nunziata, and Ochel (2005). The key problem with unemployment rates from a wider spectrum of countries is their lack of comparability across time and space. Moreover, detailed data on labor market institutions does not exist, except for a cross-section (Botero, Djankov, La Porta, De Silanes, and Shleifer, 2004). Data on the degree of product market regulation (PMR), the output gap, and the array of exogenous shocks also come from Bassanini and Duval (2006).

Data on geographical distance come from CEPII.<sup>37</sup> Population data is from the Penn World Tables mark 6.2. We compute capital stocks using the perpetual inventory method; see Benhabib and Spiegel (2005). Summary statistics are in the Appendix.

## 4.3 Conditional cross-country correlation of unemployment rates

As a first step, we show that our data replicates the typical results found in the empirical literature. Column (1) in Table 1 shows the results of estimating (29) using OLS. The coefficient on the tax wedge  $b_{it}$ , our key labor market variable of interest, implies that a 20 percentage point increase (approximately equal to one standard deviation of  $b$  in the data) increases the equilibrium rate of unemployment by about 1.8 percentage points. Union density and employment protection legislation (EPL) do not have any measurable influence on equilibrium unemployment. This is a standard finding; see Bassanini and Duval (2006) or Baker, Glyn, Howell, and Schmitt (2004). Countries featuring a high degree of corporatism (such as the Scandinavian countries or Austria) have a rate of unemployment that is by about 1.7 percentage point lower. Finally, the output gap (*gap*) is an important determinant of the unemployment rate. Note that country fixed effects alone explain about 78 percent of the total variation (adjusted  $R^2$ ) of unemployment rates in our sample (not shown). Accounting for the common business cycle by including year fixed effects adds five percentage points of explanatory power; adding country-specific

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<sup>36</sup>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).

<sup>37</sup>[www.cepii.fr/anglaisgraph/bdd/distances.htm](http://www.cepii.fr/anglaisgraph/bdd/distances.htm).

estimates of the output gap adds another five so that these three variables already generate an adjusted  $R^2$  of 0.88. The additional covariates used in (1) of Table 1 increase the adjusted  $R^2$  to 93 percent. Hence, controlling for business cycle effects and fixed country characteristics, labor market institution do not explain a large fraction of variance of the unemployment rate since their entire cross-sectional variance is absorbed by the country fixed effects.

In the next step, we include the trade-weighted average foreign unemployment rate  $u_{it}^*$  and estimate versions of

$$u_{it} = \rho u_{it}^* + \lambda \cdot \mathbf{LMR}_{it} + \pi \cdot pmr_{it} + \gamma_1 \cdot gap_{it} + \gamma_2 \cdot gap_{it}^* + \mathbf{F}_i + \mathbf{T}_t + \mathbf{S}_{it} + \varepsilon_{it}. \quad (31)$$

The domestic unemployment rate is not used in the calculation of  $u_{it}^*$ . However, if shocks to the unemployment rate exhibit correlation between countries, then estimation of (31) via OLS would yield a biased value for  $\rho$ . To avoid this *endogeneity bias*, we instrument  $u_{it}^*$  by lagged foreign regulatory variables,  $\mathbf{LMR}_{i,t-1}^*, pmr_{i,t-1}^*$ .<sup>38</sup> The underlying assumption is that past *foreign* regulation is exogenous to *domestic* contemporaneous labor market outcomes.

Columns (2) and (3) show the most parsimonious specifications, using only  $u_{it}^*$  along with  $gap_{it}$ ,  $\mathbf{F}_i$ ,  $\mathbf{T}_t$ , and  $\mathbf{S}_{it}$ . The OLS estimate and the IV estimate are both positive; the former is  $\rho^{OLS} = 0.072$ ; the latter, being somewhat smaller, is  $\rho^{IV} = 0.067$ . The sign of the bias  $\rho^{OLS} - \rho^{IV}$  is not surprising, since one would have expected that unemployment shocks are correlated positively between countries so that OLS should overestimate. However, the difference between the estimates is very small and will remain so in more complete specifications. Note that adding  $u_{it}^*$  increases the adjusted  $R^2$  relative to a model with  $gap_{it}$ ,  $\mathbf{F}_i$ ,  $\mathbf{T}_t$ , and  $\mathbf{S}_{it}$  as the only controls from 88 to 92 percent. Also note that the IV strategy works well: invalidity of instruments or model specification is rejected with high degrees of statistical significance.

Columns (4) and (5) add an array of labor market controls. They also include  $gap_{it}^*$  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  $\rho$  is somewhat larger now than in the specification without controls. The sign of the endogeneity bias of  $\rho$  changes, but the difference between the OLS and the IV estimate is minor. Interestingly, while the coefficient on  $gap_{it}^*$  is estimated with low precision, its sign is positive.

Columns (6) and (7) drop the insignificant labor market controls. Results do not change much, but the overidentification test (while easily passed) becomes less convincing. Hence, we prefer specification (5) over (7). It implies that an increase of the average foreign unemployment rate by one percentage point increases the domestic unemployment rate by about 0.09 percentage points. The average effect, therefore seems small. In terms of the (different) underlying standard deviations of  $u_{it}$  and  $u_{it}^*$ , the effect is 0.06 ( $0.088 \cdot 3.144 / 4.294$ ). However, this average effect may hide substantial variation across countries.

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<sup>38</sup>This vector of instruments satisfies tests for instrument validity.

Table 1: The role of foreign unemployment

<i>Dep. var.: level of unemployment rate</i>		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	OLS	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	IV
$u^*$		0.072 <sup>a</sup> (0.028)	0.067 <sup>b</sup> (0.030)	0.083 <sup>a</sup> (0.029)	0.088 <sup>a</sup> (0.032)	0.071 <sup>a</sup> (0.025)	0.077 <sup>a</sup> (0.028)	0.139 <sup>a</sup> (0.032)	0.138 <sup>a</sup> (0.039)	0.119 <sup>a</sup> (0.026)	0.133 <sup>a</sup> (0.030)	
$u^* \times k^*/k$								0.049 <sup>b</sup> (0.023)	0.162 <sup>a</sup> (0.094)	0.056 <sup>b</sup> (0.023)	0.145 (0.120)	
$k^*/k$								-1.010 <sup>a</sup> (0.248)	-1.622 <sup>a</sup> (0.484)	-0.986 <sup>a</sup> (0.241)	-1.536 <sup>b</sup> (0.651)	
$b$		0.091 <sup>a</sup> (0.019)		0.085 <sup>a</sup> (0.020)	0.098 <sup>a</sup> (0.019)	0.092 <sup>a</sup> (0.018)	0.104 <sup>a</sup> (0.017)	0.075 <sup>a</sup> (0.020)	0.100 <sup>a</sup> (0.022)	0.085 <sup>a</sup> (0.017)	0.102 <sup>a</sup> (0.019)	
PMR		0.745 <sup>a</sup> (0.198)		0.878 <sup>a</sup> (0.212)	0.948 <sup>a</sup> (0.203)	0.774 <sup>a</sup> (0.187)	0.868 <sup>a</sup> (0.175)	0.917 <sup>a</sup> (0.214)	0.927 <sup>a</sup> (0.214)	0.789 <sup>a</sup> (0.183)	0.880 <sup>a</sup> (0.170)	
High corporatism		-1.739 <sup>a</sup> (0.412)		-1.615 <sup>a</sup> (0.420)	-1.827 <sup>a</sup> (0.394)	-1.581 <sup>a</sup> (0.367)	-1.810 <sup>a</sup> (0.353)	-1.616 <sup>a</sup> (0.407)	-1.712 <sup>a</sup> (0.387)	-1.597 <sup>a</sup> (0.357)	-1.693 <sup>a</sup> (0.379)	
Union density		-0.001 (0.023)		-0.004 (0.023)	-0.005 (0.022)			-0.013 (0.026)	0.004 (0.028)			
EPL		-0.193 (0.340)		-0.419 (0.367)	-0.314 (0.351)			-0.506 (0.375)	-0.180 (0.425)			
$gap$		-0.620 <sup>a</sup> (0.044)		-0.621 <sup>a</sup> (0.044)	-0.611 <sup>a</sup> (0.039)			-0.624 <sup>a</sup> (0.043)	-0.615 <sup>a</sup> (0.039)			
$gap^*$				0.024 (0.075)	0.067 (0.070)	0.020 (0.072)	0.060 (0.067)	0.148 (0.100)	0.423 <sup>a</sup> (0.218)	0.151 (0.100)	0.387 (0.285)	
<b>2nd stage statistics</b>												
RMSE		1.134	1.234	1.139	1.129	1.010	1.061	1.106	0.998	1.145	1.062	
adj. $R^2$		0.930	0.917	0.919	0.931	0.935	0.929	0.934	0.937	0.929	0.929	
F		146.7	125.2		147.4	155.4		134.2		139.1		
<b>1st stage statistics (p-values)</b>												
partial $R^2(u^*)$				0.757		0.752	0.777		0.6801		0.7561	
partial $R^2(u^* \times k^*/k)$				0.889		0.792	0.220		0.0636		0.0239	
$\chi^2$ -overidentification				0.727		0.947	0.833		0.356		0.437	
$\chi^2$ -endogeneity									0.432		0.542	

Robust standard errors in parentheses,  $p < 0.01$ ,  $p < 0.05$ ,  $p < 0.1$ . Number of observations: 397 in OLS and 374 in IV regressions. All regressions contain a full set of country fixed-effects, year dummies, and an array of orthogonal shocks (TFP, terms of trade, real interest rate, and labor demand shocks) as additional controls for business cycle comovements. Trade-weighted averages for foreign variables (denoted by asterisks) are computed using  $\alpha_1 = \alpha_2 = 1$ , and  $\delta = 1$ . In IV regressions, the foreign unemployment rate  $u^*$  is instrumented by  $b_{t-1}^*$ ,  $PMR_{t-1}^*$  and  $gap_{t-1}^*$ . The  $\chi^2$ -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 instruments or model misspecification is rejected in all presented IV models).

Columns (8) to (11) include the ratio of capital intensities  $(K^*/L^*)/(K/L) = k^*/k$  and the interaction term  $u^* \times k^*/k$ .<sup>39</sup> This is motivated by the prediction of the Heckscher-Ohlin-framework, where the spill-over depends on the relative capital-to-labor ratios from the home country  $k$  and the foreign country  $k^*$ . More precisely, suppose that a bad shock on foreign institutions drives up foreign unemployment. If the foreign economy is relatively capital-abundant relative to the domestic economy, after the shock its effective capital to labor ratio is even higher than before and it produces more of the capital-intensive good. The domestic economy, in turn, produces more of the labor-intensive good so that labor demand goes up, and ultimately unemployment falls. This is, however, not what we observe in the data, where an increase in  $u^*$  drives up domestic unemployment by more when the domestic economy appears relatively capital poor. However, the effect is weak, and inference is possibly problematic since  $k$  and hence  $k^*/k$  may be endogenous. Also, results rely on a fairly small country sample. While not offering a conclusive test, our results at least suggest that empirical support for the comparative advantage view is probably weak. Given the well-known poor empirical performance of the Heckscher-Ohlin model, this is not a surprise. Also note that Dutt, Mitra and Ranjan (2009) have not found any effect of comparative advantage motives in the determination of unemployment rates in a large cross-section of countries. The standard deviation of  $k^*/k$  relative to its mean (the coefficient of variation) is 1.91, while that of  $u$  is 0.54. Hence, our results do not hinge on the absence of variance in  $k^*/k$  in our sample.

Interestingly, the direct effect of  $k^*/k$  on the equilibrium unemployment rate is negative and statistically significant. However, that effect is hard to interpret. The overall extent of comparative advantage of the domestic economy could be measured by  $|1 - k^*/k|$  or  $(1 - k^*/k)^2$ . Both variables have no clear empirical effect on the unemployment rate.

#### 4.4 Domestic unemployment and 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:

$$u_{it} = \lambda \cdot \mathbf{LMR}_{it} + \lambda^* \cdot \mathbf{LMR}_{i,t}^* + \pi \cdot pmr_{it} + \gamma_1 \cdot gap_{it} + \gamma_2 \cdot gap_{it}^* + \mathbf{F}_i + \mathbf{T}_t + \mathbf{S}_{it} + \varepsilon_{it}, \quad (32)$$

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

Column (1) in Table 2 shows the most parsimonious specification, where we include only the domestic and the foreign tax wedges  $(b_{it}, b_{it}^*)$  as well as the controls for the domestic and the foreign business cycles and the complete set of fixed effects. We find that the own and the foreign tax wedges help explain the domestic unemployment rate. Both have coefficients with the signs predicted by our theoretical model and are accurately estimated. Column (2) adds PMR as an additional control. PMR reflects different types of entry regulations that limit competition on goods markets. Hence, PMR should be

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<sup>39</sup>Capital intensities are proxied by the stock of capital computed as described above relative to the total population instead of employment in order to mitigate the potential endogeneity of  $k^*/k$ . The variable  $u^* \times k^*/k$  is instrumented by the interactions of  $k_{t-1}^*/k_{t-1}$  with exogenous foreign variables  $\mathbf{LMR}_{i,t-1}^*$  and  $pmr_{i,t-1}^*$ . See Dutt, Mitra, and Ranjan (2009) for a related empirical strategy.



Table 2: The role of foreign labor market distortions

<i>Dep.var.: level of unemployment rate</i>								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$b$	0.081 <sup>a</sup> (0.017)	0.075 <sup>a</sup> (0.017)	0.103 <sup>a</sup> (0.019)	0.086 <sup>a</sup> (0.019)	0.081 <sup>a</sup> (0.020)	0.083 <sup>a</sup> (0.020)	0.072 <sup>a</sup> (0.016)	0.077 <sup>a</sup> (0.019)
$b^*$	0.009 <sup>a</sup> (0.003)	0.012 <sup>a</sup> (0.003)	0.004 (0.003)	0.009 <sup>b</sup> (0.003)	0.027 (0.042)	0.057 (0.037)	0.013 <sup>a</sup> (0.003)	0.013 <sup>a</sup> (0.004)
$b^* \times k^*/k$							0.016 <sup>a</sup> (0.004)	0.011 <sup>a</sup> (0.003)
$k^*/k$							-1.216 <sup>a</sup> (0.274)	-1.219 <sup>a</sup> (0.263)
PMR		0.706 <sup>a</sup> (0.193)		0.856 <sup>a</sup> (0.207)	0.894 <sup>a</sup> (0.219)	0.847 <sup>a</sup> (0.217)	0.743 <sup>a</sup> (0.188)	0.899 <sup>a</sup> (0.209)
Union density			0.008 (0.024)	-0.005 (0.023)	-0.013 (0.023)			-0.009 (0.026)
Union density*					0.062 (0.038)			
High corporatism			-1.545 <sup>a</sup> (0.415)	-1.617 <sup>a</sup> (0.420)	-1.603 <sup>a</sup> (0.445)	-1.655 <sup>a</sup> (0.393)		-1.558 <sup>a</sup> (0.407)
High corporatism*					2.270 (2.001)	1.371 (1.916)		
EPL			0.234 (0.343)	-0.418 (0.371)	-0.574 (0.380)	-0.448 (0.383)		-0.500 (0.382)
EPL*					-2.465 <sup>a</sup> (0.828)	-1.904 <sup>b</sup> (0.837)		
$gap$	-0.613 <sup>a</sup> (0.044)	-0.608 <sup>a</sup> (0.042)	-0.622 <sup>a</sup> (0.045)	-0.622 <sup>a</sup> (0.044)	-0.627 <sup>a</sup> (0.045)	-0.619 <sup>a</sup> (0.040)	-0.635 <sup>a</sup> (0.039)	-0.642 <sup>a</sup> (0.042)
$gap^*$	-0.021 (0.070)	-0.014 (0.073)	-0.034 (0.070)	-0.024 (0.072)	-0.042 (0.077)	-0.107 (0.074)	0.032 (0.073)	0.005 (0.072)
RMSE	1.191	1.169	1.158	1.130	1.123	1.123	1.134	1.098
adj. R <sup>2</sup>	0.923	0.926	0.927	0.931	0.932	0.932	0.930	0.935
F	139.5	154.2	136.8	146.8	147.8	151.1	133.3	129.0

Robust standard errors in parentheses, <sup>a</sup> $p < 0.01$ , <sup>b</sup> $p < 0.05$ , <sup>c</sup> $p < 0.1$ . Number of observations: 397 in all models. All regressions contain a full set of country fixed-effects, year dummies, and an array of orthogonal shocks (TFP, terms of trade, real interest rate, and labor demand shocks) as additional controls for business cycle comovements. Trade-weighted averages for foreign variables (denoted by asterisks) are computed using  $\alpha_1 = \alpha_2 = 1$ , and  $\delta = 1$ .

a good proxy for overall openness to trade, as well. Not surprisingly, it correlates well with conventional openness measures. It should, however, be less prone to endogeneity concerns.

The estimates presented in column (2) imply that a one standard-deviation increase of  $b_{it}$  and of  $b_{it}^*$  leads to an increase in the domestic unemployment rate by 0.318 and 0.065 standard deviations, respectively.<sup>40</sup> Hence, on average, the domestic tax wedge is about 5 times as important quantitatively than the foreign one. This seems like a sensible result which may, however, hide potentially large differences across countries.

Column (3) adds additional labor market institutions but drops PMR. This has an important effect on the coefficients of both  $b$  and  $b^*$ , where the former grows substantially larger and the latter loses statistical significance. However, as shown in column (4), the inclusion of PMR restores the picture that we have already found in column (2). One reason for the importance of PMR may lie in the fact that the construction of the weights  $\omega_{ijt}$  relies on exogenous geographical and demographic data only; it does not reflect trade regulations that may curb the amount of trade between nations. Including PMR mitigates this problem.

Columns (5) and (6) add foreign labor market institutions to the regression. Not surprisingly, adding variables for which the direct effect on home unemployment is already dubious (union density or EPL), does not improve accuracy of estimation. The coefficients on  $b^*$  are insignificant and seem unplausibly large; not to speak of the coefficient on  $EPL^*$ , to name only the most striking case. Hence, the lack of a robust relationship between these variables in standard equations such as (29) also impairs inference when using their spatial lags.

Finally, columns (7) and (8) replicate our preferred specifications (2) and (4) with the exception that they now also include the Heckscher-Ohlin relative capital-abundance  $k^*/k$  and its interaction with the foreign wedge  $b^*$ . Theoretical considerations suggest that a higher foreign wedge should lower the domestic rate of unemployment if the foreign economy is on average more capital-rich than the domestic. Our results suggest that the opposite holds: the more capital-rich the foreign country is, the *stronger* is the adverse effect of foreign distortions on domestic unemployment. As in Table 1, we do not find evidence in favor of the Heckscher-Ohlin view. Instead we find a strong negative direct effect of  $k^*/k$  on domestic unemployment as in Table 1.

## 4.5 The role of real wage rigidity, country size and entry regulation

Table 3 sheds additional light on the channels through which foreign institutions affect domestic unemployment. First, we ask whether foreign labor market institutions have a larger effect on domestic unemployment when domestic labor market institutions imply a high degree of real wage rigidity. There is no clear consensus how to measure real wage rigidity in a single indicator. Rather, the degree of real wage flexibility is a complicated

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<sup>40</sup> $0.075 \times 18.21/4.29 = 0.318$  and  $0.012 \times 23.39/4.29 = 0.065$ .

function of institutional variables. As a consequence, there is no recognized general measure of flexibility with sufficient time and country coverage available. In a very recent paper, Holden and Wulfsberg (2009) provide a very simple measure of *downward real wage rigidity* for 19 OECD countries from 1973-1999. Unfortunately the country coverage differs from our sample and the data is not balanced. However, in their analysis, they conclude that “real wage cuts are less prevalent in countries with strict employment protection legislation and high union density” (p. 605). In the light of this finding, we use an index of union density (adjusted for the degree of corporatism) as a proxy for the rigidity of real wages.<sup>41</sup> Our theoretical model suggests that foreign labor market institutions should affect domestic unemployment more when domestic real wages are rigid. Hence, we interact the rigidity proxy  $rigid_i$  with the foreign wage wedge  $b^*$  and expect a positive sign. Column (1) in Table 3 includes this interaction term into an unemployment regression of the type (32). The rigidity index itself has a positive but statistically insignificant coefficient. Thus, the effect of wage rigidity on unemployment is not significant. However, the interaction with the foreign wage wedge comes with positive sign and high statistical significance, indicating that the spill-over effect of labor market institutions is higher when wages are more rigid. Adding additional labor market institutions to the regression (column (2)) does not change the picture.

Second, we discuss the interaction between country size and the wage distortion. We measure country size by population, just as in our theoretical analysis. This variable has the advantage that it is exogenous. The logic is that the larger the domestic economy is, the more strongly should it be negatively affected by bad domestic labor market institutions and the less by foreign ones. Conversely, the larger the foreign economy is (weighted by bilateral trade potentials), the more strongly should foreign distortions increase the domestic unemployment rate while domestic distortions should be less important. Hence, we expect that the coefficients on  $\ln(pop) \times b$ ,  $\ln(pop) \times b^*$ ,  $\ln(pop^*) \times b$ , and  $\ln(pop^*) \times b^*$  should be positive, negative, negative and positive, respectively. Column (3) in Table 3 is nicely in line with this sign pattern. However, statistical precision is not very high, most likely due to the large degree of correlation between those interaction terms. Including the degree of product market regulation into the regression (column (4)) does not alter the sign of significant coefficients or their magnitudes and only partially improves statistical accuracy. Column (5) focuses on statistically significant effects only. In line with our theory, distortions are more harmful when they have their origins in large countries. Interestingly, the direct effect of the own and the foreign wage distortions is now negative. There is also fairly strong evidence that – everything else equal – large countries have smaller unemployment rates. This is also in line with the theoretical model, where larger home markets are associated with fiercer competition, more varieties, and hence higher productivity of the average firm and, consequently, with lower unemployment.

Third, we discuss the interaction between entry regulation<sup>42</sup> and the wage wedge.

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<sup>41</sup>The proxy is  $rigid_i = union\_density_i \times low\_corporatism_i$ .

<sup>42</sup> The measure of domestic entry regulation ( $pmr$ ) provided by the OECD strongly correlates with other openness measures (e.g., the share of trade over GDP), but has the advantage that it is unrelated to geography and size.

Table 3: Unemployment spillovers: the role of real wage flexibility, country size, and openness

	$z = rigid$		$z = ln(pop)$			$z = pmr$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$b$	0.118 <sup>a</sup> (0.018)	0.124 <sup>a</sup> (0.018)	-0.096 (0.153)	-0.160 (0.153)	-0.240 <sup>c</sup> (0.143)	0.054 <sup>c</sup> (0.030)	0.038 (0.027)	0.098 <sup>a</sup> (0.020)
$b^*$	-0.007 <sup>c</sup> (0.004)	0.002 (0.010)	-0.324 (0.213)	-0.319 (0.205)	-0.382 <sup>c</sup> (0.202)	0.020 (0.019)	0.035 <sup>c</sup> (0.019)	-0.006 (0.016)
<b>Interaction terms</b>								
$z \times b$			0.029 <sup>c</sup> (0.015)	0.031 <sup>b</sup> (0.015)	0.035 <sup>b</sup> (0.014)	0.007 (0.005)	0.011 <sup>a</sup> (0.004)	
$z \times b^*$	0.127 <sup>a</sup> (0.033)	0.104 <sup>a</sup> (0.036)	-0.003 (0.006)	0.001 (0.006)		-0.013 <sup>a</sup> (0.005)	-0.008 <sup>c</sup> (0.004)	
$z^* \times b$			-0.008 (0.005)	-0.006 (0.005)		-0.001 (0.003)		-0.003 (0.003)
$z^* \times b^*$			0.036 <sup>c</sup> (0.021)	0.032 (0.020)	0.038 <sup>c</sup> (0.020)	0.017 <sup>b</sup> (0.007)		0.013 <sup>b</sup> (0.006)
<b>Other controls</b>								
Rigidity index	1.164 (1.186)	2.624 (3.296)						
PMR				0.878 <sup>a</sup> (0.228)	0.889 <sup>a</sup> (0.222)	0.676 <sup>c</sup> (0.375)	0.370 (0.359)	0.804 <sup>a</sup> (0.226)
PMR*				-0.039 (0.250)	0.165 (0.228)	-0.359 (0.427)	0.392 (0.277)	-0.519 (0.413)
$ln(pop)$		-15.514 <sup>a</sup> (4.791)	-16.357 <sup>a</sup> (5.075)	-17.798 <sup>a</sup> (5.206)	-19.642 <sup>a</sup> (4.939)	-17.411 <sup>a</sup> (4.664)	-19.102 <sup>a</sup> (4.546)	-18.352 <sup>a</sup> (4.691)
$ln(pop)^*$		-0.171 (0.149)	0.110 (0.278)	0.048 (0.269)	-0.239 (0.146)	-0.077 (0.182)	-0.315 <sup>c</sup> (0.164)	0.031 (0.179)
Union density		-0.024 (0.032)	0.005 (0.024)	-0.011 (0.023)	-0.017 (0.023)	0.016 (0.026)	0.014 (0.026)	-0.008 (0.024)
High corporatism		-0.102 (1.500)	-1.788 <sup>a</sup> (0.616)	-1.986 <sup>a</sup> (0.656)	-2.002 <sup>a</sup> (0.638)	-2.245 <sup>a</sup> (0.550)	-2.529 <sup>a</sup> (0.529)	-2.080 <sup>a</sup> (0.523)
EPL		0.606 (0.368)	0.569 (0.395)	-0.037 (0.418)	-0.031 (0.407)	-0.061 (0.439)	-0.245 (0.408)	0.035 (0.400)
$gap$	-0.589 <sup>a</sup> (0.040)	-0.611 <sup>a</sup> (0.042)	-0.630 <sup>a</sup> (0.043)	-0.630 <sup>a</sup> (0.042)	-0.633 <sup>a</sup> (0.043)	-0.629 <sup>a</sup> (0.043)	-0.621 <sup>a</sup> (0.043)	-0.631 <sup>a</sup> (0.041)
$gap^*$	-0.002 (0.064)	-0.013 (0.062)	-0.019 (0.062)	-0.020 (0.072)	0.012 (0.070)	0.012 (0.079)	-0.038 (0.073)	0.010 (0.074)
RMSE	1.129	1.115	1.120	1.091	1.091	1.136	1.104	1.104
adj R <sup>2</sup>	0.931	0.933	0.932	0.935	0.935	0.930	0.934	0.934
F	159.4	170.7	149.4	155.7	160.4	133.4	131.6	136.0

Robust standard errors in parentheses, <sup>a</sup> $p < 0.01$ , <sup>b</sup> $p < 0.05$ , <sup>c</sup> $p < 0.1$ . Number of observations: 397 in all regressions. All estimations use OLS and contain a full set of country fixed-effects and year dummies, and an array of orthogonal shocks (TFP, terms of trade, real interest rate, and labor demand shocks) as additional controls for business cycle comovements. Trade-weighted averages for foreign variables (denoted by asterisks) are computed using  $\alpha_1 = \alpha_2 = 1, \delta = 1$ .

The analysis is motivated by the following considerations. If domestic entry regulation is strong, interactions with foreign countries should be weak. In other words, we would expect that the interaction  $pmr \times b$  has a positive sign and the interaction  $pmr \times b^*$  a negative one. If foreign regulation  $pmr^*$  is high, domestic firms can rely very little on foreign demand. Hence, whenever  $b$  goes up, they have to bear most of the induced reduction in demand themselves; we therefore expect that the effect of the interaction  $pmr^* \times b$  on domestic unemployment is positive. However, domestic unemployment would depend less on foreign distortions since the foreign economy plays a smaller role for domestic firms. Therefore, the coefficient on  $pmr^* \times b^*$  should be negative. Column (6) in Table 3 tests these predictions in a model with all four potential interaction terms. Interaction terms with domestic regulation come out with the right sign while those for foreign regulation do not. Column (7) focuses on domestic regulation and the respective interaction terms. They are statistically significant and show up with the right signs: the more closed the domestic economy is, the more important are domestic institutions and the less the foreign ones. This is in line with our theory. Column (8) concentrates on foreign regulation. Interestingly, the more closed the foreign economy is the stronger are the domestic unemployment-creating effects of foreign labor market distortions.

## 4.6 Robustness checks

Tables A3 and A4 in the Appendix contain a number of robustness checks on our preferred specifications. Columns (1) to (6) in Table A3 refer to regressions that include the foreign unemployment rate on the right-hand-side; columns (7) and (8) use foreign exogenous variables. The regressions in columns (1) and (2) use the log of unemployment  $\ln u$  as the dependent variable instead of the level in a regression of domestic unemployment on foreign one, but are otherwise perfectly similar to the regressions (4) and (5) presented in Table 1. Compared to the benchmark case where the level of  $u$  is used, this transformation ensures 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 associated to the regression in column (2). However, qualitatively, our main result holds up in the OLS and the IV model.

Column (3) in Table A3 reverts to the level of the unemployment rate as the dependent variable and uses contemporaneous instruments rather than the lagged ones. This does not change the qualitative findings relative to the benchmark of Table 1. Column (4) presents an OLS model, using  $u_{i,t-1}^*$  as the dependent variable. Results change very little.

Columns (5) and (6) add an EU dummy to the regressions, but otherwise leaves the regressions identical to those in Table 1. Inclusion of the dummy does not change the results of the OLS and the IV model. Comfortingly, the EU dummy is only marginally significant in the OLS model and insignificant in the IV specification, so that the accession to the EU does not have any effects on the unemployment rate other than those already

captured by the institutional variables in the model.<sup>43</sup>

Finally, columns (7) and (8) carry out two robustness checks relative to Table 2. First, instead of using the level of the unemployment rate, its logarithm is used. This has no effect on the signs of the right-hand-side variables nor on their statistical significance. Second, the EU dummy is introduced into column (8), with the level of the unemployment rate again as the dependent variable. Again, results do not change qualitatively. Here, however, we do have some evidence that joining the EU does drive up the equilibrium rate of unemployment.

Table A4 carries out extensive robustness checks with respect to the choice of normalization of the weights. Columns (1) to (6) vary the elasticities of country size  $\alpha_1$  and  $\alpha_2$ , as well as that of distance in the bilateral trade flow proxies shown in equation (30). Odd-numbered columns refer to equation (5) in Table 1, even-numbered columns to equation (5) in Table 2. First, the coefficient of the distance variable in the computation of the weights is set to the lower bound of estimates found in the gravity literature, i.e.,  $\delta = 0.75$  (Disdier and Head, 2008). Then a higher bound, i.e.,  $\delta = 1.50$ , is used. 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 (1) is  $0.096 \times 2.47/4.29 = 0.055$  and in column (3)  $0.065 \times 4.63/4.29 = 0.070$ , which nicely bounds the benchmark results obtained in Table 1 (column (5), 0.06) from above and from below. Using a finer grid on  $\delta$  shows that the obtained standardized beta coefficients systematically fall in  $\delta$ . In the limit, when  $\delta$  is infinite, the effect of  $u^*$  vanishes. A similar effect is observed in columns (2) and (4), where the variable of interest is  $b^*$  instead of  $u^*$ .

Columns (5) and (6) modify the weights in that they close down the direct size effect:  $\alpha_1 = \alpha_2 = 0$ . In both models, the signs of the interesting coefficients remain unchanged. In terms of their economic significance, the standardized beta coefficients are  $0.006 \times 36.07/4.29 = 0.050$  in the case of column (5) and  $0.052 \times 8.07/4.29 = 0.098$  in the case of column (6). Hence, taking out country size from the construction of the bilateral weights reduces the estimated effects, but only in a very limited amount.

The remainder of Table A4 modifies the normalization of bilateral weights. In columns (7) and (8) the weights are normalized by  $\max_i (\omega_{ijt})$ , for each year  $t$  and country  $j$ , while in columns (9) and (10) the weights are normalized such that they add up to one for the 20 OECD countries that our panel regressions draw upon. These different normalizations do not have any bearing on the qualitative results. The standardized beta coefficient of  $u^*$  in column (9) is  $0.006 \times 32.33/4.29 = 0.045$ , which is in line with our previous findings.

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<sup>43</sup>Note that the effect of EU membership is identified using time-variation only since the model features country fixed-effects.

## 5 Conclusions

In this paper, we have introduced search and matching unemployment into a multi-country single-sector trade model with firm-level increasing returns to scale and product differentiation. 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, labor market institutions, and trade costs, we ask how an institutional change in one country affects labor market outcomes in other countries. Countries are linked via trade on the product markets and maintain multilateral trade balance. We find that an increase of the tax wedge (unemployment benefits plus tax rate on wages) unambiguously increases unemployment in the country that enacts the institutional change. In the trading partner countries, unemployment goes up as well. 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.

We emphasize three key mechanisms that drive these results, namely, a market size effect, a competitiveness effect, and a selection effect. A deterioration of labor market institutions, such that domestic unemployment goes up, reduces the domestic market size. The world market shrinks, and this implies lower exports for all countries. This anti-size effect drives down labor demand and leads to higher unemployment in all countries in the world that are at least partially open to international trade. This pure size effect reverses the Krugman-type gains from trade that rely on the existence of larger markets. However, even in absence of external economies of scale a smaller global market leads to higher unemployment. The reason is that market size and selection effects interact: with smaller global markets and less foreign competition, it is easier for inefficient firms to maintain their market presence at home, which makes the average firm less productive. This also drives up aggregate unemployment.

Bad domestic labor market institutions also affect foreign countries via the competitiveness channel. For example, if improved outside options of workers drive up the real wage so that exporters become less competitive internationally, the unemployment rate at home goes up. On the other hand, trading partners become relatively more competitive, which tends to decrease unemployment. However, the gain in competitiveness also has its backside: as import competition is less fierce, inefficient firms find it easier to survive, the average firm is less productive, and hence, the rate of unemployment in foreign countries tends to increase.

We also find that the adverse effects of bad institutions depend 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.

Our calibrated model suggests that international spill-overs across countries are small when wage are flexible. However, when real wages are rigid the effects are by at least one

order of magnitude bigger. These two extreme scenarios open the interval in which the ‘true’ size of spill-overs is likely to lie.

In order to measure the empirical importance of spill-overs, 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 unemployment 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 correlation between unemployment rates of countries. 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. 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. Hence, our empirical results confirm the qualitative predictions of our theoretical model. On average, our results suggest that the effect of foreign institutions on domestic unemployment is about 10% as strong as the effect of domestic institutions. We show that, in order to replicate this finding, the Mortensen-Pissarides search-and-matching model requires a stronger degree of real wage rigidity than the one provided by the usual individual bargaining approach.



# Appendix

## A1 Relationship between $\varphi_{ii}^*$ and $\varphi_{ij}^*$

Using the demand equations (3) and the fact that  $p_{ij}[\varphi] = \tau_{ij}p_{ii}[\varphi]$ , we can express relative revenues at home and in the foreign country  $j$  from a firm with productivity  $\varphi$  based in country  $i$  as:

$$\frac{R_{ij}[\varphi]}{R_{ii}[\varphi]} = \tau_{ij}^{1-\sigma} \left(\frac{P_j}{P_i}\right)^{\sigma-1} \left(\frac{Y_j}{Y_i}\right) \left(\frac{\bar{M}_i}{\bar{M}_j}\right)^{1-\nu}. \quad (\text{A1})$$

The zero-productivity cut-off above which firms produce for the domestic market,  $\varphi_{ii}^*$ , and the exporting productivity cut-off, above which firms produce for both the domestic and the export market  $j$ ,  $\varphi_{ij}^*$ , are determined by  $R_{ii}[\varphi_{ii}^*] = \sigma f_{ii}P_i$  and  $R_{ij}[\varphi_{ij}^*] = \sigma f_{ij}P_i$ , respectively.

Combining these two equations leads to an equation that links the revenues of a firm at the zero-profit productivity cut-off to those of a firm at the exporting productivity cut-off. Further, the relationship between revenues of two firms with different productivities in the same industry and country is given by:  $R_{ii}[\varphi_{ii}'] = \left(\frac{\varphi_{ii}'}{\varphi_{ii}''}\right)^{\sigma-1} R_{ii}[\varphi_{ii}']$ . These two relationships together yield and equilibrium relationship between the two productivity cut-offs:

$$\varphi_{ij}^* = \Lambda_{ij}\varphi_{ii}^* \quad \text{with} \quad (\text{A2})$$

$$\Lambda_{ij} = \tau_{ij} \frac{P_i}{P_j} \left(\frac{Y_i f_{ij}}{Y_j f_{ii}}\right)^{\frac{1}{\sigma-1}} \left(\frac{\bar{M}_j}{\bar{M}_i}\right)^{\frac{1-\nu}{\sigma-1}}. \quad (\text{A3})$$

The profits from serving the foreign market have to be large enough to justify the extra fixed costs  $f_{ij}$ , where  $\Lambda_{ij}$  would collapse to  $\tau_{ij} (f_{ij}/f_{ii})^{1/(\sigma-1)}$  in the case of complete symmetry. For  $\varphi_{ij}^* > \varphi_{ii}^*$ , we need  $\Lambda_{ij} > 1$ . In the symmetric case, this requirement boils down to  $f_{ij}\tau^{\sigma-1} > f_{ii}$ .

Table A1: Base-line calibration of parameter values

Parameter	Description	Value	Source
$r$	Discount rate	0.33%	4% annual discount rate
$\nu$	Parameter of external scale economies	0	Blanchard and Giavazzi (2003)
$\sigma$	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)
$\alpha$	Elasticity of the matching function	0.5	Hosios (1990)
$\beta$	Bargaining power	0.5	Hosios (1990)
$\delta$	Rate of firm exit	0.91%	Firm turnover rate=1.8%; Bartelsmann, Haltiwanger and Scarpetta (2004)
$\chi_i$	Rate of match-specific separation	2.5%	Job separation rate=3.4%
$\bar{\varphi}$	Minimum value of productivity	0.5	Arbitrary.
$\gamma$	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)
$\tau$	Iceberg trade costs	1.3	Ghironi and Melitz (2005)
$L_i$	Size of population	1	Size normalization
$P_1$	Numéraire	1	Normalization
$N$	Number of countries	3	Allows for direct and indirect spill-overs

Table A2: Summary statistics

Variable	Description	Mean	Std. Dev.	Min	Max
$u$	unemployment rate (percent)	7.994	4.294	0.396	24.042
$b$	tax wedge (percent)	58.385	18.212	21.008	96.973
PMR	product market regulation (index, 1-10)	3.864	1.290	1.050	6.000
Union density	(percent)				
High corporatism	(dummy)	0.554	0.498	0.000	1.000
EPL	employment protection legislation (index, 1-10)	2.080	1.082	0.200	4.188
$gap$	output gap (percent)	-1.019	2.538	-12.211	6.297
$u^*$	W x u	2.399	3.144	0.037	13.875
$b^*$	W x b	18.182	23.394	0.269	89.783
PMR*	W x PMR	1.230	1.679	0.011	8.181
Union density*	W x union density	12.426	15.974	0.180	71.088
High corporatism*	W x high corporatism	0.176	0.245	0.001	1.096
EPL*	W x EPL	0.657	0.882	0.009	4.252
$gap^*$	W x gap	-0.303	0.990	-5.803	2.699
$k^*/k$	(W x (K/L)) / (K/L)	0.942	1.798	0.000	9.474
TFP shock		-0.002	0.023	-0.099	0.054
TOT shock		-0.037	0.066	-0.217	0.187
Real interest rate shock		4.759	2.194	-9.282	14.122
Demand shock		0.033	0.062	-0.138	0.236

All data (except weighting matrix W) are from Bassanini and Duval (2006). Number of observations  $N = 397$ . Weights are based on  $\alpha_1 = \alpha_2 = 1$  and  $\delta = 1$ ; standard normalization. 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).

Table A3: Robustness Checks: Semi-log specification and different IV strategy

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. var.	$\ln u$	$\ln u$	$u$	$u$	$u$	$u$	$\ln u$	$u$
Instruments / Proxy	OLS	IV	IV	OLS	OLS	IV	OLS	OLS
$\ln u^*, u^*$		$b_{t-1}^*, pmr_{t-1}^*$	$b_{t-1}^*, pmr_t^*$	$u_{t-1}^*$		$b_{t-1}^*, pmr_{t-1}^*$		
	0.018 (0.013)	0.022 <sup>c</sup> (0.013)	0.080 <sup>a</sup> (0.028)	0.075 <sup>a</sup> (0.027)	0.086 <sup>a</sup> (0.030)	0.087 <sup>a</sup> (0.032)		
$b^*$							0.002 <sup>a</sup> (0.001)	0.009 <sup>a</sup> (0.003)
$b$	0.017 <sup>a</sup> (0.003)	0.018 <sup>a</sup> (0.003)	0.085 <sup>a</sup> (0.018)	0.099 <sup>a</sup> (0.020)	0.078 <sup>a</sup> (0.020)	0.095 <sup>a</sup> (0.019)	0.018 <sup>a</sup> (0.003)	0.079 <sup>a</sup> (0.020)
PMR	0.184 <sup>a</sup> (0.037)	0.198 <sup>a</sup> (0.033)	0.875 <sup>a</sup> (0.196)	0.939 <sup>a</sup> (0.215)	0.843 <sup>a</sup> (0.210)	0.920 <sup>a</sup> (0.203)	0.182 <sup>a</sup> (0.036)	0.821 <sup>a</sup> (0.206)
Union density	-0.003 (0.003)	-0.003 (0.003)	-0.004 (0.022)	-0.003 (0.023)	-0.005 (0.023)	-0.004 (0.022)	-0.003 (0.003)	-0.005 (0.023)
High corporatism	-0.129 <sup>b</sup> (0.057)	-0.150 <sup>a</sup> (0.056)	-1.619 <sup>a</sup> (0.390)	-1.865 <sup>a</sup> (0.427)	-1.527 <sup>a</sup> (0.415)	-1.781 <sup>a</sup> (0.390)	-0.124 <sup>b</sup> (0.057)	-1.525 <sup>a</sup> (0.415)
EPL	-0.012 (0.054)	0.007 (0.049)	-0.413 (0.342)	-0.300 (0.375)	-0.458 (0.366)	-0.326 (0.351)	-0.020 (0.056)	-0.461 (0.371)
EU dummy					0.724 <sup>c</sup> (0.383)	0.438 (0.355)		0.732 <sup>c</sup> (0.383)
$gap$	-0.091 <sup>a</sup> (0.009)	-0.090 <sup>a</sup> (0.008)	-0.621 <sup>a</sup> (0.041)	-0.609 <sup>a</sup> (0.042)	-0.639 <sup>a</sup> (0.043)	-0.617 <sup>a</sup> (0.039)	-0.091 <sup>a</sup> (0.009)	-0.641 <sup>a</sup> (0.043)
$gap^*$	-0.008 (0.015)	-0.002 (0.014)	0.021 (0.070)	0.015 (0.067)	0.034 (0.073)	0.073 (0.070)	-0.008 (0.015)	-0.015 (0.070)
<b>2nd stage statistics</b>								
RMSE	0.210	0.188	1.046	1.095	1.123	1.008	0.210	1.124
adj. R <sup>2</sup>	0.893	0.896	0.931	0.935	0.932	0.936	0.893	0.931
F	72.41		158.7	150.0			73.06	149.7
<b>1st stage statistics (p-values)</b>								
partial R <sup>2</sup>		0.633	0.972			0.753		
$\chi^2$ -overidentification		0.0190	0.680			0.970		
$\chi^2$ -endogeneity		0.695	0.623			0.886		

Robust standard errors in parentheses, <sup>a</sup> $p < 0.01$ , <sup>b</sup> $p < 0.05$ , <sup>c</sup> $p < 0.1$ . Number of observations: 397 in OLS and 374 in IV regressions. All regressions contain a full set of country fixed-effects, year dummies, and an array of orthogonal shocks (TFP, terms of trade, real interest rate, and labor demand shocks) as additional controls for business cycle comovements. 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  $gap_{t-1}^*$ . The  $\chi^2$ -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 instruments or model misspecification is rejected in all presented IV models).

Table A4: Robustness Checks: Alternative construction of weighting matrix

	Normalization over all countries,				Normalization over all,				Normalization over 20	
	$\delta = 0.75, \alpha_i = 1.00$		by $\sum_i \omega_i$		$\delta = 1.00, \alpha_i = 0.00$		by $\max_i \omega_i$		OECD countries, by $\sum_i \omega_i$	
	(1) IV	(2) OLS	(3) IV	(4) OLS	(5) IV	(6) OLS	(7) IV	(8) OLS	(9) IV	(10) OLS
$u^*$	0.096 <sup>b</sup> (0.042)		0.065 <sup>a</sup> (0.021)		0.582 <sup>a</sup> (0.178)		0.011 <sup>b</sup> (0.005)		0.026 <sup>b</sup> (0.011)	
$b^*$		0.011 <sup>b</sup> (0.005)		0.006 <sup>a</sup> (0.002)		0.052 <sup>a</sup> (0.019)		0.001 <sup>b</sup> (0.000)		0.003 <sup>b</sup> (0.001)
$b$	0.098 <sup>a</sup> (0.019)	0.085 <sup>a</sup> (0.020)	0.098 <sup>a</sup> (0.019)	0.087 <sup>a</sup> (0.019)	0.098 <sup>a</sup> (0.018)	0.089 <sup>a</sup> (0.019)	0.101 <sup>a</sup> (0.019)	0.088 <sup>a</sup> (0.019)	0.100 <sup>a</sup> (0.019)	0.087 <sup>a</sup> (0.020)
PMR	0.939 <sup>a</sup> (0.206)	0.864 <sup>a</sup> (0.211)	0.837 <sup>a</sup> (0.204)	0.837 <sup>a</sup> (0.204)	0.799 <sup>a</sup> (0.190)	0.774 <sup>a</sup> (0.199)	0.917 <sup>a</sup> (0.200)	0.839 <sup>a</sup> (0.208)	0.910 <sup>a</sup> (0.201)	0.844 <sup>a</sup> (0.210)
Union density	-0.002 (0.022)	-0.003 (0.023)	-0.007 (0.022)	-0.006 (0.023)	0.001 (0.021)	-0.002 (0.023)	-0.007 (0.022)	-0.007 (0.023)	-0.005 (0.022)	-0.005 (0.023)
High corporatism	-1.860 <sup>a</sup> (0.394)	-1.635 <sup>a</sup> (0.420)	-1.800 <sup>a</sup> (0.395)	-1.608 <sup>a</sup> (0.421)	-1.774 <sup>a</sup> (0.381)	-1.594 <sup>a</sup> (0.411)	-1.833 <sup>a</sup> (0.392)	-1.619 <sup>a</sup> (0.419)	-1.849 <sup>a</sup> (0.393)	-1.638 <sup>a</sup> (0.419)
EPL	-0.271 (0.349)	-0.392 (0.367)	-0.349 (0.350)	-0.431 (0.373)	-0.283 (0.330)	-0.374 (0.355)	-0.282 (0.353)	-0.387 (0.372)	-0.257 (0.352)	-0.369 (0.369)
$gap$	-0.608 <sup>a</sup> (0.039)	-0.620 <sup>a</sup> (0.044)	-0.614 <sup>a</sup> (0.039)	-0.624 <sup>a</sup> (0.044)	-0.610 <sup>a</sup> (0.038)	-0.614 <sup>a</sup> (0.044)	-0.611 <sup>a</sup> (0.039)	-0.622 <sup>a</sup> (0.044)	-0.611 <sup>a</sup> (0.039)	-0.622 <sup>a</sup> (0.044)
$gap^*$	0.028 (0.096)	-0.070 (0.097)	0.063 (0.045)	-0.004 (0.045)	0.924 <sup>a</sup> (0.298)	0.596 <sup>b</sup> (0.269)	0.015 (0.011)	0.004 (0.011)	0.007 (0.008)	0.000 (0.008)
<b>2nd stage statistics</b>										
RMSE	1.011	1.130	1.008	1.130	1.000	1.116	1.012	1.132	1.013	1.132
adj. R <sup>2</sup>	0.935	0.931	0.936	0.931	0.937	0.933	0.935	0.931	0.935	0.930
F		145.7		147.2		161.3		144.1		143.7
<b>1st stage statistics (p-values)</b>										
partial R <sup>2</sup>			0.741		0.714		0.759		0.766	
$\chi^2$ -overidentification			0.667		0.0153		0.825		0.687	
$\chi^2$ -endogeneity			0.927		0.155		0.997		0.965	

Robust standard errors in parentheses, <sup>a</sup> $p < 0.01$ , <sup>b</sup> $p < 0.05$ , <sup>c</sup> $p < 0.1$ . Number of observations: 397 in OLS and 374 in IV regressions. All regressions contain a full set of country fixed-effects, year dummies, and an array of orthogonal shocks (TFP, terms of trade, real interest rate, and labor demand shocks) as additional controls for business cycle comovements. Trade-weighted averages for foreign variables are denoted by asterisks. In IV regressions, the foreign unemployment rate  $u^*$  is instrumented by  $b_{t-1}^*$ ,  $PMR_{t-1}^*$  and  $gap_{t-1}^*$ . The  $\chi^2$ -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 instruments or model misspecification is rejected in all presented IV models).

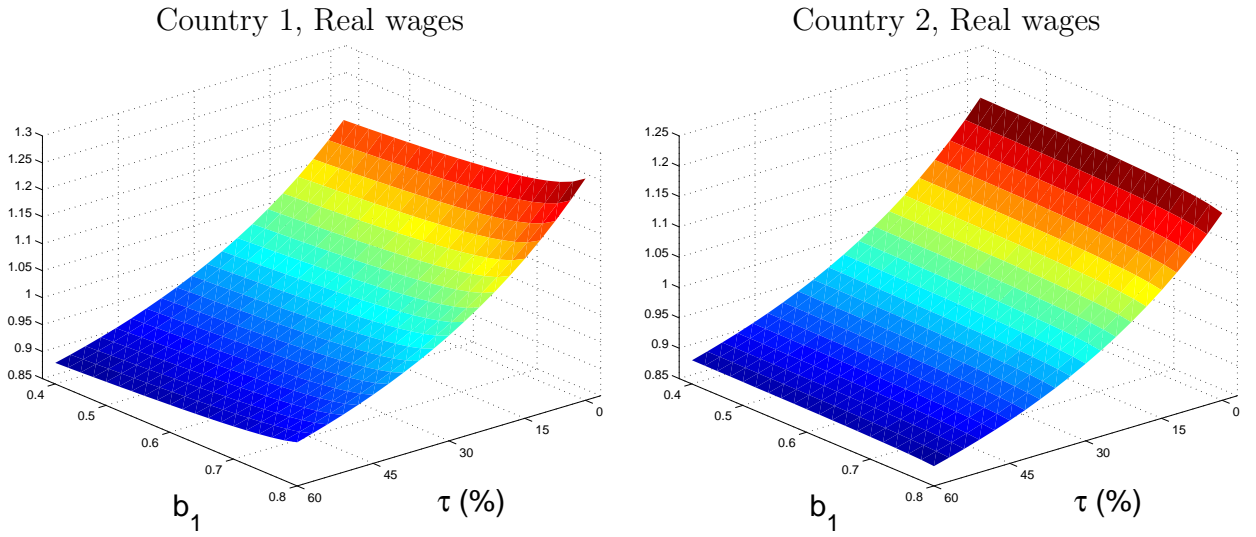


Figure A1: Country 1 labor market regulation, trade costs, and real wages [on vertical axis] in countries 1 and 2 (=3).

## A2 Wage effects

As we have demonstrated in the main text, the magnitude of the spill-over crucially depends on the level of real wage flexibility. Hence, in parallel to the unemployment effects described in the main text for the individual-bargaining model, we illustrate in this Appendix the accompanying results for real wages. Due to the way how unemployment and wages are determined in the individual-bargaining regime, real wage effects are mainly mirror images of the unemployment effects: Whenever a policy change in one country leads to a decrease in average productivity in its trading partners, we will not only see an increase in unemployment in the trading partners but also a decrease in real wages.

### A2.1 How domestic institutions impact outcomes world-wide

#### Result A1a [Globalization and labor markets]

*Trade liberalization leads to higher real wages in all countries.*

#### Result A1b [Labor market reform]

*If one country increases its unemployment benefits, then real wages increase in that country.*

#### Result A1c [Institutional spill-overs]

*If one country increases its unemployment benefits, then, in all other countries, real wages will fall.*

For an illustration see Figure A1. Again Result A1a is a generalization of the results found by Felbermayr, Prat, and Schmerer (2008) for asymmetric countries. Result A1b stems from the fact that higher unemployment benefits increase the bargaining power of

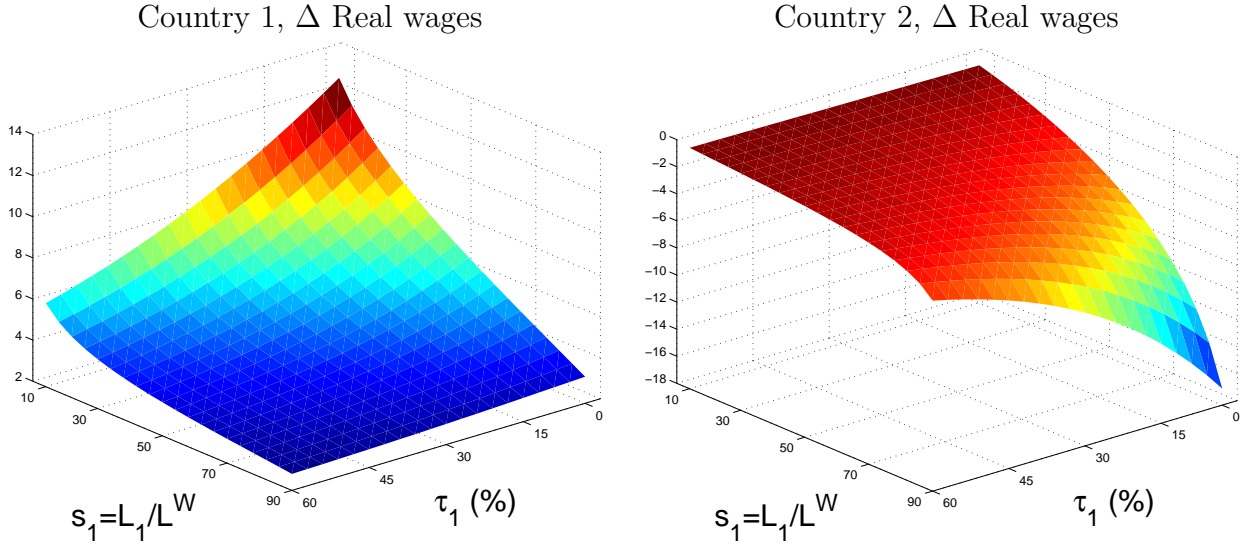


Figure A2: Change in real wages [on the vertical axis] as a function of centrality and size of the “bad” country 1 for a given change of  $b_1$  from 0.4 to 0.8.

workers. A novelty is Result A1c, which is the backside of Result 1c in the main text, stating that an increase in unemployment benefits in one country will lead to an increase in unemployment in all other countries. This is due to the institutional spill-overs described in detail in the main text.

## A2.2 The role of geography and relative size

### Result A2a [Geography and spill-overs]

*As the degree of centrality of country 1 goes up, a given rise in country 1’s unemployment benefits yields a larger real wage increase in country 1 and a larger decrease in countries 2 and 3.*

### Result A2b [Relative size and spill-overs]

*The higher the relative size of country 1 the weaker is the increase in real wages in country 1 and the larger is the decrease in all other countries due to a rise of country 1’s unemployment benefits.*

The conditioning effects of centrality and size of country 1 are visualized in Figure A2. Concerning trade costs, we find that the change in real wages increases 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 higher centrality of country 1, country 1 more easily can spill-over bad labor market institutions.

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 all other countries. The explanation is similar to the one given for the effects on unemployment: If

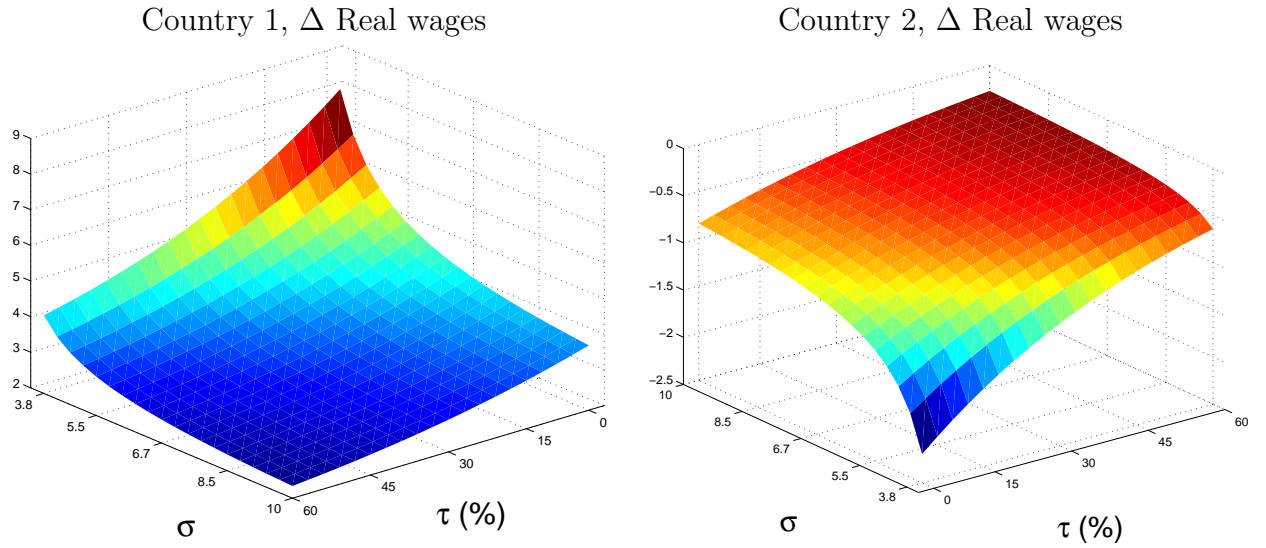


Figure A3: Change in real wages [on the vertical axis] as a function of trade costs and the elasticity of substitution for a given change of  $b_1$  from 0.4 to 0.8.

country 1 is 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.

### A2.3 The role of the elasticity of substitution and external economies of scale

#### Result A3 [The elasticity of substitution and spill-overs]

*The higher the elasticity of substitution, the smaller are the changes in real wages in all countries following a rise of country 1's unemployment benefits.*

As discussed in the main text, an increase in the elasticity of substitution leads to a weakening of the income effect and to a strengthening of the competitiveness effect and thus lowers the spill-over effects of bad labor market institutions. As illustrated in Figure A3 this implies that the wage drops in countries 2 and 3 become smaller.

#### Result A4 [External economies of scale and spill-overs]

*Stronger external economies of scale result in smaller decreases in real wages for all trading partner countries. The results for country 1 are ambiguous.*

The result is illustrated in Figure A4. For real wages, two things are important: the nominal wage, and the price level for the aggregated final output good. Both, the nominal wage and the price level for the aggregated final output good change the sign when  $\nu$  varies. For low  $\nu$ 's the change is positive for both, whereas the change is negative for high  $\nu$ 's.<sup>44</sup>

<sup>44</sup>Note that  $P_1 = 1$  due to our normalization. Hence, a decrease of  $P_2$  implies a higher relative price



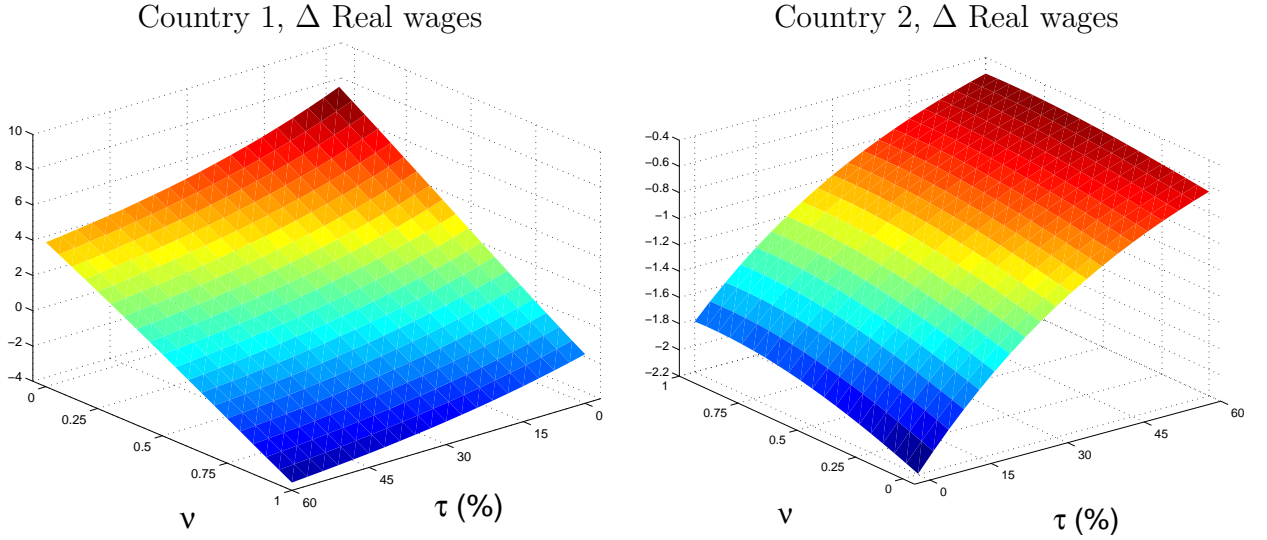


Figure A4: Change in real wages [on the vertical axis] as a function of trade costs and external economies of scale for a given change of  $b_1$  from 0.4 to 0.8.

If  $\nu$  is low, the competitiveness and relative composition of home and foreign varieties drives the results. However, for high  $\nu$ 's the absolute market size is important. We know from Figure A2 that the real wage change should increase in country 1 and decrease in country 2, if country 1 becomes smaller and external economies of scale are not present, i.e.,  $\nu = 0$ . However, if external economies of scale are important, the real wage change in country 1 will be lower and may even turn negative, as the smaller home market implies fewer home varieties, leading in equilibrium to lower relative real wages due to a relative increase in the costs of living. The change in real wages in country 2 becomes smaller, as external economies of scale become more important because country 2 now has more varieties compared to country 1, leading to a relative decrease of the aggregate price level.

## A2.4 How important is firm-level heterogeneity?

### Result A5 [How firm heterogeneity conditions spill-overs]

*The larger the shape parameter of the Pareto distribution describing the distribution of firm-level productivity, the higher is the increase in real wages of country 1 and the lower are the decreases in real wages of the trading partner countries, triggered by a given increase in unemployment benefits in country 1.*

Result A5 is plotted in Figure A5. Similar as for unemployment, the real wage change decreases with increasing similarity of firms. The reason is again that the competitiveness channel is weakened, and that spill-overs are weak if firms are more homogenous as only few firms export.

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for the aggregate good in country 1.

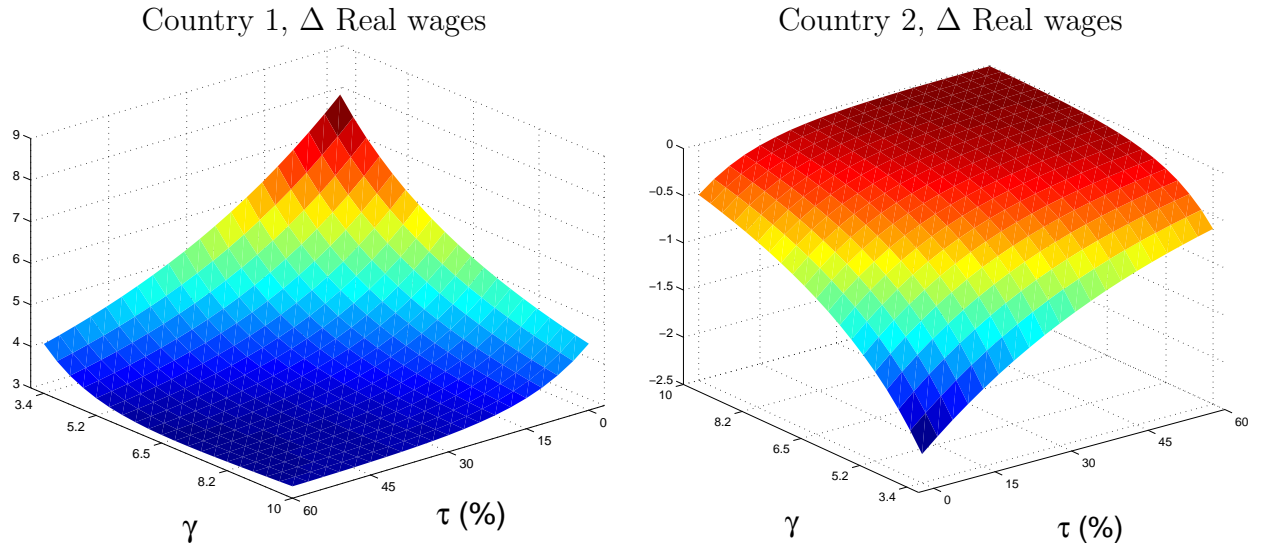


Figure A5: Change in real wages [on the vertical axis] as a function of trade costs and the shape parameter of the Pareto distribution for a given change of  $b_1$  from 0.4 to 0.8.

**Result A6a [Spill-overs in the Krugman economy]**

*If firms are homogenous and external economies of scale are important ( $\nu = 1$ ), then an increase of unemployment benefits in country 1 leads to a decrease of real wages in all countries.*

The increase in unemployment is accompanied by a loss in real wages in all countries, as is shown in Figure A6. The main reason here is that due to less varieties and higher prices, the overall price level rises. This is a result of the external economies of scale. As in the Krugman model with perfect labor markets, larger markets imply lower prices and higher real wages. Hence, if unemployment goes up, the opposite effects occur.

**Result A6b [Spill-overs in the Krugman economy without external economies of scale]**

*If firms are homogenous and there are no external economies of scale ( $\nu = 0$ ), an increase in unemployment benefits in one country will have ambiguous wage effects in that country while in all other countries wages increase.*

Figure A7 plots real wages when firms are homogenous and external economies of scale are not important. In this case, the effects on real wages for country 1 are ambiguous. On the one hand, home varieties become relatively more expansive as foreign varieties, implying higher costs of living, and hence, lower real wages. On the other hand, higher unemployment benefits lead to higher equilibrium bargained nominal wages. The net effect is ambiguous. For the trading partner, the compositional effect implies a gain in attractiveness, leading to relative lower prices for home varieties relative to foreign varieties. This leads to a fall of the costs of living and therefore to higher real wages. Note that this compositional effect again vanishes as for unemployment if all varieties enter the price index symmetrically, which is the case when trade costs are zero. Hence, real wages do not change at all if  $\tau = 1$ .

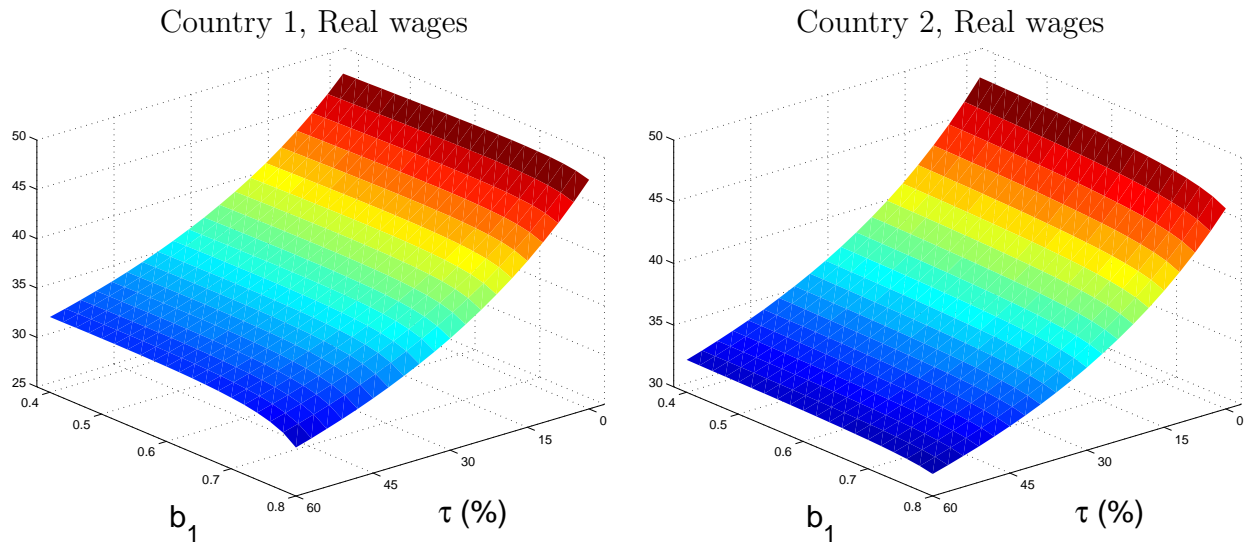


Figure A6: Country 1 labor market regulation and real wages in countries 1 and 2 ( $=3$ ), when  $\nu = 1$  and firms are homogeneous. This corresponds to a Krugman (1980) economy. [Real wages on the vertical axis.]

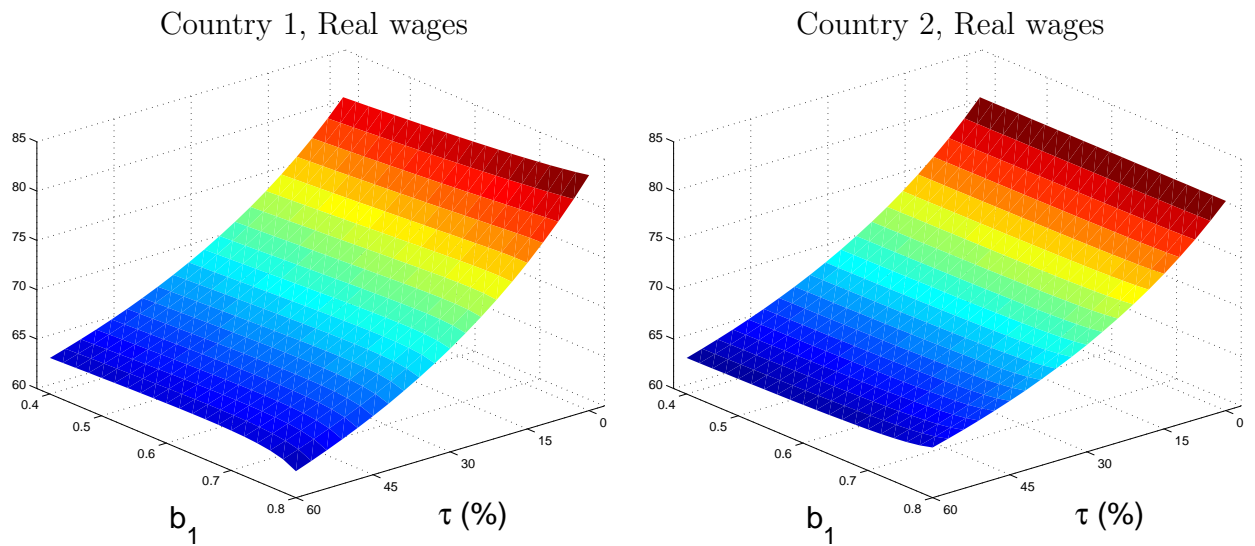


Figure A7: Country 1 labor market regulation and real wages in countries 1 and 2 ( $=3$ ), when  $\nu = 0$  and firms are homogeneous. [Real wages on the vertical axis.]

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