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Labour Market Rigidities, Trade and Unemployment

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We study a two-country, two-sector model of international trade in which one sector produces homogeneous products and the other produces differentiated products. Both sectors are subjected to search and matching frictions in the labour market and wage bargaining. As a result, some of the workers searching for jobs end up being unemployed. Countries are similar except for frictions in their labour markets, such as efficiency of matching and costs of posting vacancies, which can vary across the sectors. The differentiated-product industry has firm heterogeneity and monopolistic competition. We study the interaction of labour market rigidities and trade impediments in shaping welfare, trade flows, productivity, and unemployment. We show that both countries gain from trade. A country with relatively lower frictions in the differentiated-product industry exports differentiated products on net. A country benefits from lowering frictions in its differentiated sector's labour market, but this harms the country's trade partner. Alternatively, a simultaneous, proportional lowering of labour market frictions in the differentiated sectors of both countries benefits both of them. The opening to trade raises a country's rate of unemployment if its relative labour market frictions in the differentiated sector are low, and it reduces the rate of unemployment if its relative labour market frictions in the differentiated sector are high. Cross-country differences in rates of unemployment exhibit rich patterns. In particular, lower labour market frictions do not ensure lower unemployment, and unemployment and welfare can both rise in response to falling labour market frictions and falling trade costs.

1. INTRODUCTION

International trade and international capital flows link national economies. Although such links are considered to be beneficial for the most part, they produce an interdependence that occasionally has harmful effects. In particular, shocks that emanate in one country may negatively impact trade partners. On the trade side, links through terms-of-trade movements have been studied extensively, and it is now well understood that, say, capital accumulation or technological change can worsen a trade partner's terms of trade and reduce its welfare. On the macro side, the transmission of real business cycles has been widely studied, such as the impact of technology shocks in one country on income fluctuations in its trade partners.

Although a large literature addresses the relationship between trade and unemployment, we fall short of understanding how these links depend on labour market rigidities. Indeed, measures of labour market flexibility developed by Botero *et al.* (2004) differ greatly across countries.[1] The rigidity of employment index, which is an average of three other indexes—difficulty of hiring, difficulty of firing, and rigidity of hours—shows wide variation in its range between zero and 100 (where higher values represent larger rigidities). Importantly, countries with very different development levels may have similar labour market rigidities. For example, Chad, Morocco, and Spain have indexes of 60, 63, and 63, respectively, which are about twice the average for the OECD countries of 33.3 and higher than the average for sub-Saharan Africa. The United States has the lowest index, equal to zero, while Australia has an index of 3 and New Zealand has an index of 7, all significantly below the OECD average. Yet some of the much poorer countries also have very flexible labour markets, e.g. both Uganda and Togo have an index of 7.[2]

We develop in this paper a two-country model of international trade in order to study the effects of labour market frictions on trade flows, productivity, welfare, and unemployment. We are particularly interested in the impact of a country's labour market rigidities on its trade partner, and the differential impact of lower trade impediments on countries with different labour market rigidities. Blanchard and Wolfers (2000) emphasize the need to allow for interactions between shocks and differences in labour market characteristics in order to explain the evolution of unemployment in European economies. They show that these interactions are empirically important. On the other side, Nickell *et al.* (2003) emphasize changes over time in labour market characteristics as important determinants of the evolution of unemployment in OECD countries. We focus the analysis on search and matching frictions in Sections 2–5, and discuss in Section 6 how the results generalize to economies with firing costs and unemployment benefits.[3]

The literature on trade and unemployment is large and varied. One strand of this literature considers economies with minimum wages, of which Brecher (1974) represents an early contribution.[4] Another approach, due to Matusz (1986), uses implicit contracts. A third approach, exemplified by Copeland (1989), incorporates efficiency wages into trade models.[5] Yet another line of research uses fair wages. Agell and Lundborg (1995) and Kreickemeier and Nelson (2006) illustrate this approach. The final approach uses search and matching in labour markets. While two early studies extended the two-sector model of Jones (1965) to economies with this type of labour market friction,[6] Davidson, Martin, and Matusz (1999) provide a particularly valuable analysis of international trade with labour markets that are characterized by Diamond–Mortensen–Pissarides-type search and matching frictions.[7] In their model, differences in labour

1. Their original data has been updated by the World Bank and is now available at http://www.doingbusiness.org/ExploreTopics/EmployingWorkers. The numbers reported in the text come from this site, downloaded on 20 May 2007. Other measures of labour market characteristics are available for Organisation for Economic Co-operation and Development (OECD) countries; see Nickell (1997) and Blanchard and Wolfers (2000).

2. There is growing awareness that institutions affect comparative advantage and trade flows. Levchenko (2007), Nunn (2007) and Costinot (2009) provide evidence on the impact of legal institutions, while Cuñat and Melitz (2007) and Chor (2006) provide evidence on the impact of labour market rigidities.

3. While we use a static specification of labour market frictions, our analysis is consistent with a steady state of a dynamic model as we show in Helpman and Itskhoki (2009*b*).

4. His approach has been extended by Davis (1998) to study how wages are determined when two countries trade with each other, one with and one without a minimum wage.

5. See also Brecher (1992) and Hoon (2001).

6. See Davidson, Martin and Matusz (1988) and Hosios (1990).

7. See Pissarides (2000) for the theory of search and matching in labour markets.

market frictions, both across sectors and across countries, generate Ricardian-type comparative advantage.[8]

Our two-sector model incorporates Diamond–Mortensen–Pissarides-type frictions into both sectors: one producing homogeneous goods, the other producing differentiated products. In both sectors wages are determined by bargaining. There is perfect competition in homogeneous goods and monopolistic competition in differentiated products. In the differentiated-product sector, firms are heterogeneous, as in Melitz (2003). These firms exercise market power in the product market on the one hand and bargain with workers over wages on the other.[9] Moreover, there are fixed and variable trade costs in the differentiated sector. We focus the analysis on the differentiated sector and think about the homogeneous sector as the rest of the economy.[10]

We develop the model in stages. The next section describes demand, product markets, labour markets, and the determinants of wages and profits. In the following section, Section 3, we discuss the structure of equilibrium, focusing on the case in which both countries are incompletely specialized, and—as in Melitz (2003)—only a fraction of firms export in the differentiated-product industry and some entrants exit this industry. This is followed by an analysis of the impact of labour market frictions on trade, welfare, and productivity in Section 4. We allow the labour market frictions to vary across both countries and sectors. There we also study the differential impact of lower trade impediments on countries with different labour market frictions. Importantly, we show that both countries gain from trade in welfare terms and in terms of total factor productivity, independently of trade costs and differences in labour market rigidities. The lowering of labour market frictions in the differentiated sector of one country raises its welfare, but harms the trade partner. Nevertheless, both countries benefit from simultaneous proportional reductions of labour market frictions in the differentiated sector across the world.

By lowering frictions in its differentiated sector's labour market, a country gains a competitive advantage in this sector, which is reminiscent of a productivity improvement (but not identical). As a result, it attracts more firms into this sector while the foreign country attracts fewer firms. The entry and exit of firms overwhelms the terms of trade movement, leading to welfare gains in the country with improved labour market frictions and welfare losses in its trade partner.

In Section 4 we also show that labour market flexibility is a source of comparative advantage. The country with relatively lower labour market frictions in the differentiated sector (i.e. lower relative to the homogeneous sector) has a larger fraction of exporting firms and it exports differentiated products on net. Moreover, the share of intra-industry trade is smaller while the volume of trade is larger the larger is the difference in relative sectoral labour market rigidities across countries.

In Section 5 we take up unemployment. We show that the relationship between unemployment and labour market rigidity in the differentiated sector is hump-shaped when the countries are symmetric. A decline in labour market frictions in the differentiated sector decreases the

8. More work has followed this line of inquiry than the other approaches mentioned in the text. Recent examples include Davidson and Matusz (2006a, b) and Moore and Ranjan (2005).

9. A surge of papers has incorporated labour market frictions into models with heterogeneous firms. Egger and Kreickemeier (2009) examine trade liberalization in an environment with fair wages and Davis and Harrigan (2007) examine trade liberalization in an environment with efficiency wages; both papers focus on the wage dispersion of identical workers across heterogeneous firms in symmetric countries. Mitra and Ranjan (2007) examine offshoring in an environment with search and matching and Felbermayr, Prat and Schmerer (2008) study trade in a one-sector model with search and matching and symmetric countries.

10. The analysis can be generalized in a straightforward way to multiple differentiated sectors.

sectoral rate of unemployment and induces more workers to search for jobs in the differentiated-product sector. When the differentiated sector has the lower sectoral rate of unemployment, which happens when labour market frictions are relatively low in this sector, the reallocation of workers across sectors (i.e. the composition effect) reduces the aggregate rate of unemployment. Under these circumstances, the aggregate rate of unemployment declines, because both the shift in the sectoral rate of unemployment and the reallocation of workers across sectors reduce the aggregate rate of unemployment. On the other hand, when labour market frictions are higher in the differentiated sector, these two effects impact unemployment in opposite directions, with the composition effect dominating in a highly rigid labour market and the sectoral unemployment effect dominating in a mildly rigid labour market. As a result, unemployment initially increases and then decreases as labour market frictions decline, starting from high levels of rigidity.

We also discuss the transmission of shocks across asymmetric countries, using numerical examples to illustrate various patterns. In particular, we show that in the absence of unemployment in the homogeneous sector, if a single country reduces its labour market frictions in the differentiated sector, this reduces unemployment in the country's trading partner by inducing a labour reallocation from the differentiated-product sector to the homogeneous-product sector. We also show that lowering trade impediments can increase unemployment in one or both countries, despite its positive welfare effect, and that the interaction between trade impediments and labour market rigidities produces rich patterns of unemployment. Specifically, differences in rates of unemployment across countries do not necessarily reflect differences in labour market frictions; the more flexible country can have higher or lower unemployment, depending on the height of trade impediments and the levels of labour market frictions. In Section 6 we discuss the impacts of firing costs and unemployment benefits as additional sources of labour market frictions. In particular, we describe conditions under which the previous results remain valid, as well as how they change when these conditions are not satisfied. The last section summarizes some of the main insights from this analysis.

2. THE MODEL

We develop in this section the building blocks of our analytical model. They consist of a demand structure, technologies, product and labour market structures, and determinants of wages and profits. After describing these ingredients in some detail, we discuss in the next three sections equilibrium interactions in a two-country world. In order to focus on labour market rigidities, we assume that the two countries are identical except for labour market frictions. This means that the demand structure and the technologies are the same in both countries. They can differ in the size of their labour endowment, but this difference is not consequential for the type of equilibrium we discuss in the main text.

2.1. *Preferences and demand*

Every country has a representative agent who consumes a homogeneous product q_0 and a continuum of brands of a differentiated product whose real consumption index is Q. The real consumption index of the differentiated product is a constant elasticity of substitution aggregator:

$$Q = \left[\int_{\omega \in \Omega} q(\omega)^{\beta} d\omega \right]^{\frac{1}{\beta}}, \quad 0 < \beta < 1, \tag{1}$$

where $q(\omega)$ represents the consumption of variety ω, Ω represents the set of varieties available for consumption, and β is a parameter that controls the elasticity of substitution between brands.

Consumer preferences between the homogeneous product, q_0, and the real consumption index of the differentiated product, Q, are represented by the quasi-linear utility function[11]

$$\mathbb{U} = q_0 + \frac{1}{\zeta} Q^{\zeta}, \quad 0 < \zeta < \beta.$$

The restriction $\zeta < \beta$ ensures that varieties are better substitutes for each other than for the outside good q_0. We also assume that the consumer has a large enough income level to always consume positive quantities of the outside good, in which case it is convenient to choose the outside good as numeraire, so that its price equals 1, i.e. $p_0 = 1$. Under the circumstances $p(\omega)$, the price of brand ω, and P, the price index of the brands, are measured relative to the price of the homogeneous product.

The utility function $\mathbb{U}$ implies that a consumer with spending E who faces the price index P for the differentiated product chooses $Q = P^{-1/(1-\zeta)}$ and $q_0 = E - P^{-\zeta/(1-\zeta)}$.[12] As a result, the demand function for brand ω can be expressed as

$$q(\omega) = Q^{-\frac{\beta-\zeta}{1-\beta}} p(\omega)^{-\frac{1}{1-\beta}} \tag{2}$$

and the *indirect* utility function as

$$\mathbb{V} = E + \frac{1-\zeta}{\zeta} P^{-\frac{\zeta}{1-\zeta}} = E + \frac{1-\zeta}{\zeta} Q^{\zeta}. \tag{3}$$

As usual, the indirect utility function is increasing in spending and declining in price. A higher price index P reduces the demand for Q, and—holding expenditure E constant—reduces welfare. This decline in welfare results from the fact that consumer surplus, $(1-\zeta) P^{-\zeta/(1-\zeta)}/\zeta = (1-\zeta) Q^{\zeta}/\zeta$, declines as P rises and Q falls. In what follows, we characterize equilibrium values of Q, from which we infer welfare levels.

2.2. *Technologies and market structure*

All goods are produced with labour, which is the only factor of production. The market for the homogeneous product is competitive, and this good serves as numeraire. When a firm is matched with a worker, they produce one unit of the homogeneous good.

The market for brands of the differentiated product is monopolistically competitive. A firm that seeks to supply a brand ω bears an entry cost f_e in terms of the homogeneous good, which covers the technology cost and the cost of setting up shop in the industry. After bearing this cost, the firm learns how productive its technology is, as measured by θ; a θ-firm requires $1/\theta$ workers per unit output. In other words, if a θ-firm employs h workers, it produces θh units of output. Before entry, the firm expects θ to be drawn from a known cumulative distribution $G_\theta(\theta)$.

After entry, the firm has to bear a fixed production cost f_d in terms of the homogeneous good; without it no manufacturing is possible. Following Melitz (2003), we assume that the differentiated-product sector bears a fixed cost of exporting f_x in terms of the homogeneous

11. Alternatively, we could use a homothetic utility function in q_0 and Q; see Appendix for a discussion of this case.

12. The assumption that consumer spending on the outside good is positive is equivalent to assuming $E > P^{-\zeta/(1-\zeta)}$. Since $\zeta > 0$, the demand for Q is elastic and total spending PQ rises when P falls.

product. In addition, it bears a variable cost of exporting of the melting-iceberg type: $\tau > 1$ units have to be exported for one unit to arrive in the foreign country.[13]

We label the two countries A and B. If a country-j firm, $j = A, B$, with productivity θ hires h_j workers and chooses to serve only the domestic market, then (2) implies that its revenue equals

$$R_j = Q_j^{-(\beta-\zeta)}\Theta^{1-\beta}h_j^{\beta},$$

where $\Theta \equiv \theta^{\beta/(1-\beta)}$ is a transformed measure of productivity which is more convenient for our analysis. Higher Q_j implies tighter competition in the differentiated-product market of country j and proportionately reduces revenues for all firms serving this market.

If, instead, this firm chooses also to export, then it has to allocate output θh_j across the domestic and foreign markets, i.e. $\theta h_j = q_{dj} + q_{xj}$, where q_{dj} represents the quantity allocated to the domestic market and q_{xj} represents the quantity allocated to the export market.[14] With an optimal allocation of output across markets, the resulting total revenue is

$$R_j = \left[Q_j^{-\frac{\beta-\zeta}{1-\beta}} + \tau^{-\frac{\beta}{1-\beta}}Q_{(-j)}^{-\frac{\beta-\zeta}{1-\beta}}\right]^{1-\beta}\Theta^{1-\beta}h_j^{\beta},$$

where $(-j)$ is the index of the country other than j. In general, the revenue function of country-j firm with productivity θ can therefore be represented by

$$R_j\left(\Theta, h_j\right) = \left[Q_j^{-\frac{\beta-\zeta}{1-\beta}} + I_{xj}\left(\Theta\right)\tau^{-\frac{\beta}{1-\beta}}Q_{(-j)}^{-\frac{\beta-\zeta}{1-\beta}}\right]^{1-\beta}\Theta^{1-\beta}h_j^{\beta}, \tag{4}$$

where $I_{xj}\left(\Theta\right)$ is an indicator variable which equals 1 if the firm exports and zero otherwise.

2.3. *Wages and profits*

There are search-and-matching frictions in every sector and firms post vacancies in order to attract workers. The cost of posting vacancies and the matching process generate hiring costs. Moreover, search-and-matching frictions generate bilateral monopoly power between a worker and his firm, as a result of which they engage in wage bargaining.[15]

13. As is common in models with home market effects, we assume that there are no trade frictions in the homogeneous-product sector. We show in our working paper (Helpman and Itskhoki, 2009*a*) that adding trade costs to the homogeneous sector does not affect the results when these costs are not too large. In that paper there are no labour market frictions in the homogeneous sector, but the same arguments can be adapted to our framework.

14. From (2) these quantities have to satisfy

$$q_{dj} = Q_j^{-\frac{\beta-\zeta}{1-\beta}}p_{dj}^{-\frac{1}{1-\beta}} \qquad \text{and} \qquad q_{xj} = \tau Q_{(-j)}^{-\frac{\beta-\zeta}{1-\beta}}\left(\tau p_{xj}\right)^{-\frac{1}{1-\beta}}.$$

In this specification, p_{dj} and p_{xj} are producer prices of home and foreign sales, respectively. Note that when exports are priced at p_{xj}, consumers in the foreign country pay an effective price of τp_{xj} due to the variable export costs. Under the circumstances, they demand $Q_{(-j)}^{-(\beta-\zeta)/(1-\beta)}\left(\tau p_{xj}\right)^{-1/(1-\beta)}$ consumption units. To deliver these consumption units, the supplier has to manufacture q_{xj} units, as shown above. Such a producer maximizes total revenue when marginal revenues are equalized across markets. In the case of constant elasticity of demand functions, this requires equalization of producer prices, which implies that the optimal allocation of output satisfies

$$q_{xj}/q_{dj} = \tau^{-\frac{\beta}{1-\beta}}\left(Q_{(-j)}/Q_j\right)^{-\frac{\beta-\zeta}{1-\beta}}.$$

15. In the earlier working paper version (Helpman and Itskhoki, 2009*a*), we focused on the case in which there are no labour market frictions in the homogeneous-product sector. The current framework incorporates it as a special case (see footnote 20).

We assume that in the homogeneous-product sector every firm employs one worker. This assumption is common in the search and matching literature (see Pissarides, 2000) and in our case leads to no loss of generality. Since firms in this sector are homogeneous in terms of productivity and produce a homogeneous good, our analysis does not change if we allow firms to hire multiple workers, as long as they remain price takers.

When a firm and a worker match, they bargain over the surplus from the relationship. Since the outside option of each party equals zero at this stage, the surplus—which consists of the revenue from sales of one unit of the homogeneous product—equals 1. Assuming equal weights in the bargaining game then implies that the worker gets a wage $w_0 = 1/2$ and the firm gets a profit $\pi_0 = 1/2$, and these payoffs are the same in every country. We discuss additional details of the labour market equilibrium in this sector in the following section.

In the differentiated-product industry, firms are heterogeneous in terms of productivity but face the same cost of hiring in the labour market. A Θ-firm from country j that seeks to employ h_j workers bears the hiring cost $b_j h_j$ in terms of the homogeneous good, where b_j is exogenous to the firm yet it depends on sectoral labour market conditions, as we discuss below. It follows that a worker cannot be replaced without cost. Under these circumstances, a worker inside the firm is not interchangeable with a worker outside the firm, and workers have bargaining power after being hired. Workers exploit this bargaining power in the wage determination process.

We assume that the h_j workers and the firm engage in strategic wage bargaining with equal weights in the manner suggested by Stole and Zwiebel (1996*a*, *b*), which is a natural extension of Nash bargaining to the case of multiple workers. The revenue function (equation (4)) then implies that the firm gets a fraction $1/(1+\beta)$ of the revenue and the workers get a fraction $\beta/(1+\beta)$.[16] Recall that β determines the concavity of the revenue function in the number of workers; a lower β makes the revenue more concave and reduces the revenue loss from the departure of a marginal worker. Therefore, lower β reduces the equilibrium share of the workers in the division of revenue. This bargaining outcome is derived under the assumption that at the bargaining stage a worker's outside option is unemployment, and the value of unemployment is zero because there are no unemployment benefits and the model is static. In Section 6 we discuss unemployment benefits, and in Helpman and Itskhoki (2009*b*) we show that our bargaining solution carries over to the steady state of a dynamic model.

Anticipating the outcome of this bargaining game, a Θ-firm that wants to stay in the industry chooses an employment level, h_j, and whether to serve the foreign market, $I_{xj} \in \{0,1\}$, that maximize profits. That is, it solves the following problem:

$$\pi_j(\Theta) \equiv \max_{\substack{I_{xj}\in\{0,1\},\\ h_j\geq 0.}} \left\{ \frac{1}{1+\beta}\left[Q_j^{-\frac{\beta-\zeta}{1-\beta}} + I_{xj}\tau^{-\frac{\beta}{1-\beta}} Q_{(-j)}^{-\frac{\beta-\zeta}{1-\beta}} \right]^{1-\beta} \Theta^{1-\beta} h_j^{\beta} - b_j h_j - f_d - I_{xj} f_x \right\}. \quad (5)$$

16. In the solution to the Stole and Zwiebel bargaining game, the firm and a worker equally divide the marginal surplus from their relationship, i.e.

$$\frac{\partial}{\partial h}\left[R_j(\Theta,h) - w_j(\Theta,h)h\right] = w_j(\Theta,h),$$

where $w_j(\Theta,h)$ is the bargained wage rate in a Θ-firm in country j which employs h workers. Therefore, the left-hand side represents the surplus of the firm from employing the marginal worker, accounting for the fact that his departure will impact the wage rate of the remaining workers. The wage on the right-hand side is the worker's surplus. Using the expression for revenue (equation (4)), the above condition represents a differential equation for the wage schedule which yields the solution $w_j(\Theta,h) = \beta/(1+\beta)\cdot R_j(\Theta,h)/h$.

The solution to this problem implies that the employment level of a Θ-firm in country j can be decomposed into

$$h_j(\Theta) = h_{dj}(\Theta) + I_{xj}(\Theta)\, h_{xj}(\Theta),$$

where $h_{dj}(\Theta)$ represents employment for domestic sales, $h_{xj}(\Theta)$ represents employment for export sales, and

$$\begin{aligned} h_{dj}(\Theta) &= \phi_1^{\frac{1}{\beta}} b_j^{-\frac{1}{1-\beta}} Q_j^{-\frac{\beta-\zeta}{1-\beta}} \Theta, \\ h_{xj}(\Theta) &= \phi_1^{\frac{1}{\beta}} b_j^{-\frac{1}{1-\beta}} \tau^{-\frac{\beta}{1-\beta}} Q_{(-j)}^{-\frac{\beta-\zeta}{1-\beta}} \Theta, \end{aligned} \tag{6}$$

where

$$\phi_1 = \left(\frac{\beta}{1+\beta}\right)^{\frac{\beta}{1-\beta}}.$$

Furthermore, a country-j firm with productivity Θ pays wages

$$w_j(\Theta) = \frac{\beta}{1+\beta} \frac{R_j(\Theta)}{h_j(\Theta)} = b_j, \tag{7}$$

where the first equality is the outcome of the bargaining game and the second equality follows from the optimal employment condition (6). Firms find it optimal to increase their employment up to the point at which the bargaining outcome is a wage rate equal to the cost of replacing a worker, b_j. Since this hiring cost is common across all firms, in equilibrium country-j firms of all productivity levels, exporters, and non-exporters alike, pay equal wages, $w_j = b_j$.[17]

Finally, the operating profits of a Θ-firm in country j are

$$\pi_j(\Theta) = \pi_{dj}(\Theta) + I_{xj}(\Theta)\, \pi_{xj}(\Theta),$$

where $\pi_{dj}(\Theta)$ represents operating profits from domestic sales, $\pi_{xj}(\Theta)$ represents operating profits from export sales, and

$$\begin{aligned} \pi_{dj}(\Theta) &= \phi_1\phi_2 b_j^{-\frac{\beta}{1-\beta}} Q_j^{-\frac{\beta-\zeta}{1-\beta}} \Theta - f_d, \\ \pi_{xj}(\Theta) &= \phi_1\phi_2 b_j^{-\frac{\beta}{1-\beta}} \tau^{-\frac{\beta}{1-\beta}} Q_{(-j)}^{-\frac{\beta-\zeta}{1-\beta}} \Theta - f_x, \end{aligned} \tag{8}$$

where

$$\phi_2 = \frac{1-\beta}{1+\beta}.$$

Note that higher labour market rigidity, reflected in a higher b_j, reduces proportionately gross operating profits (i.e. not accounting for fixed costs) in the domestic and foreign market.

17. This equilibrium outcome generalizes to other revenue functions and bargaining concepts as long as firms are allowed to vary their employment and the marginal hiring costs are equal across the firms. In the earlier working paper version (Helpman and Itskhoki, 2007), we generated size wage premium (i.e. higher wages paid by larger firms) and exporter wage premium (i.e. higher wages paid by exporters) by introducing convex hiring costs. Helpman, Itskhoki, and Redding (2009) develop a richer model, in which there is unobserved worker heterogeneity in addition to firm heterogeneity, wages are higher in more productive firms, and exporters pay a wage premium. Bernard and Jensen (1995) and Fariñas and Martín-Marcos (2007) provide evidence to the effect that exporting firms pay higher wages.

Therefore, an increase in b_j is similar to a proportional reduction in the productivity of all country-j firms.

The profit functions in (8) imply that exporting is profitable if and only if $\pi_{xj}(\Theta) \geq 0$, i.e. there exists a cutoff productivity level, Θ_{xj}, defined by

$$\pi_{xj}\left(\Theta_{xj}\right) = 0, \tag{9}$$

such that all firms with productivity above this cutoff export (provided they choose to stay in the industry) and all firms with productivity below it do not export. Firms with low productivity that do not export may nevertheless make money from supplying the domestic market. For this to be the case, their productivity has to be at least as high as Θ_{dj}, implicitly defined by

$$\pi_{dj}\left(\Theta_{dj}\right) = 0. \tag{10}$$

We shall consider equilibria in which $\Theta_{xj} > \Theta_{dj} > \Theta_{\min} \equiv \theta_{\min}^{\beta/(1-\beta)}$, where $\theta_{\min}$ is the lowest productivity level in the support of the distribution $G_\theta(\theta)$. That is, equilibria in which high-productivity firms profitably export and supply the domestic market, intermediate-productivity firms cannot profitably export but can profitably supply the domestic market, and low-productivity firms cannot make money and exit. Anticipating this outcome, a prospective firm enters the industry only if expected profits from entry are at least as high as the entry cost f_e. Therefore, the free-entry condition is

$$\int_{\Theta_{dj}}^{\infty} \pi_{dj}(\Theta)\, dG(\Theta) + \int_{\Theta_{xj}}^{\infty} \pi_{xj}(\Theta)\, dG(\Theta) = f_e, \tag{11}$$

where $G(\Theta)$ is the distribution of Θ induced by $G_\theta(\theta)$. The first integral represents expected profits from domestic sales, while the second integral represents expected profits from foreign sales. In equilibrium expected profits just equal entry costs.

2.4. *Labour market*

A country is populated by families. Each family has a fixed supply of L workers, and the family is the representative consumer whose preferences were described in Section 2.1. We assume that there is a continuum of identical families in every country, and the measure of these families equals 1 in every country.[18]

A family in country j allocates workers to sectors—N_j workers to the differentiated-product sector and $N_{0j} = L - N_j$ workers to the homogeneous-product sector—which determines in which sector every worker searches for work. Once committed to a sector, a worker cannot switch sectors. Thus, there is perfect intersectoral mobility *ex ante* and no mobility *ex post*.

Let the matching function in the homogeneous sector be Cobb–Douglas, so that $H_{0j} = m_{0j} V_{0j}^{\chi} N_{0j}^{1-\chi}$ is the number of matches when the number of vacancies in the sector equals V_{0j} and the number of workers searching for jobs in the sector equals N_{0j}, where $0 < \chi < 1$. We allow the efficiency of the matching process, as measured by m_{0j}, to vary across countries. It follows that output of homogeneous products equals H_{0j}, the probability of a worker finding a job in this sector equals $x_{0j} \equiv H_{0j}/N_{0j} = m_{0j}\left(V_{0j}/N_{0j}\right)^{\chi}$, and the probability of a firm finding

18. When preferences are homothetic rather than quasi-linear, the family interpretation is useful but not essential. See Appendix and Helpman, Itskhoki and Redding (2009) for a discussion of homothetic preferences, risk aversion, and *ex post* inequality.

a worker equals $H_{0j}/V_{0j} = m_{0j}\left(N_{0j}/V_{0j}\right)^{1-\chi} = m_{0j}^{1+\alpha}x_{0j}^{-\alpha}$, where $\alpha \equiv (1-\chi)/\chi > 0$.[19] We shall use x_{0j} as our measure of tightness in the sector's labour market.

Next assume that the cost of posting vacancies equals v_{0j} per worker in country j, measured in terms of the homogeneous good. Then a firm's entry cost into the industry equals v_{0j}. After paying this cost, the firm is matched with a worker with probability $m_{0j}^{1+\alpha}x_{0j}^{-\alpha}$ and not matched otherwise. When the firm is matched with a worker, they bargain over the surplus from the relationship, as described in the previous section; the worker gets a wage $w_0 = 1/2$ and the firm gets a profit $\pi_0 = 1/2$. Under these circumstances, the expected profits equal $m_{0j}^{1+\alpha}x_{0j}^{-\alpha}/2$ and firms enter up to the point at which these expected profits cover the entry cost v_{0j}. In other words, in equilibrium, tightness in the labour market equals[20]

$$x_{0j} = a_{0j}^{-1/\alpha}, \qquad a_{0j} \equiv \frac{2v_{0j}}{m_{0j}^{1+\alpha}} > 1. \tag{12}$$

The derived parameter a_{0j} summarizes labour market frictions in the homogeneous sector; it rises with the cost of vacancies and declines with the efficiency of the matching process. Evidently, tightness in the labour market declines with a_{0j}.

The expected income of a worker searching for a job in the homogeneous sector is $\omega_{0j} = x_{0j}w_{0j}$, which together with equation (12) yields

$$\omega_{0j} = \frac{1}{2}a_{0j}^{-1/\alpha}. \tag{13}$$

That is, the expected income of this worker rises with the efficacy of matching in the homogeneous sector and declines with the cost of vacancies. Finally, note that, as a result of free entry of firms, the cost of hiring per worker, $b_{0j} \equiv v_{0j}V_{0j}/H_{0j} = \left(v_{0j}/m_{0j}^{1+\alpha}\right)x_{0j}^{\alpha}$, equals one-half in the homogeneous sector in both countries:

$$b_{0j} = \frac{1}{2}a_{0j}x_{0j}^{\alpha} = \frac{1}{2}. \tag{14}$$

We now turn to the differentiated sector. Let H_j be aggregate employment in the differentiated sector. An individual searching for work in the differentiated-product sector expects to find a job with probability $x_j = H_j/N_j$, where x_j measures the degree of tightness in the sector's labour market. Conditional on finding a job, an individual expects to be paid a wage $w_j = b_j$ (see (7)). Therefore the expected income from searching for a job in the differentiated sector is $x_j b_j$.

A family allocates workers to sectors so as to maximize its aggregate income. A worker allocated to the homogeneous sector earns an expected income of ω_{0j}, given in equation (13). On the other hand, a worker allocated to the differentiated sector earns an expected income of $x_j b_j$. In an equilibrium with employment in both sectors, the two expected incomes have to be

19. Below we impose parameter restrictions which ensure that matching probabilities are between zero and 1. In a dynamic model with continuous time, these probabilities are replaced by hazard rates which can take arbitrary positive values including the limiting case of frictionless labour market. We show in Helpman and Itskhoki (2009*b*) that this type of dynamic specification yields steady-state outcomes which are similar to our static specification.

20. We assume that $m_{0j}^{1+\alpha} < 2v_{0j} < 1$, which ensures that the probability of a worker finding a job and the probability of a firm finding a worker are both smaller than 1. Alternatively, when $m_{0j}^{1+\alpha} = 2v_{0j} = 1$, workers and firms are matched with probability 1 and there is full employment in the homogeneous sector, as in Helpman and Itskhoki (2009*a*).

equal. That is, a family chooses $0 < N_j < L_j$ only if[21]

$$x_j b_j = \omega_{0j}. \tag{15}$$

Unemployment in the differentiated sector is an equilibrium outcome when $x_j < 1$. We provide below parameter restrictions that ensure this condition.

We now interpret the parameter b_j of the cost-of-hiring function $b_j h$; this variable is exogenous to the firm but endogenous to the industry. As in the homogeneous sector, workers in the differentiated sector are randomly matched with firms. The number of successful matches is $H_j = m_j V_j^{\chi} N_j^{1-\chi}$ in country j, where V_j is the number of vacancies and N_j is the number of individuals searching for jobs in this sector. Note that χ is the same here as in the matching function of the homogeneous sector, but m_j—which measures the efficiency of matching—is allowed to differ across countries and sectors. It follows that when the cost per vacancy is v_j in the differentiated sector of country j, then the cost of hiring is $b_j = v_j V_j / H_j$ per worker, and b_j can be related in a simple way to tightness in the labour market x_j:[22]

$$b_j = \frac{1}{2} a_j x_j^{\alpha}, \qquad a_j \equiv \frac{2v_j}{m_j^{1+\alpha}}, \tag{16}$$

where a_j is our measure of frictions in the differentiated sector's labour market, which is increasing in the cost of vacancies and decreasing in the productivity of matching. Note the symmetry in the modelling of hiring costs in the homogeneous and differentiated sectors (compare (16) with (14)).

Next note that equations (12)–(16) uniquely determine the hiring cost b_j and tightness in the labour market x_j:

$$\begin{aligned} x_j &= x_{0j} \left(\frac{a_{0j}}{a_j} \right)^{\frac{1}{1+\alpha}} = \left(\frac{1}{a_{0j}^{1/\alpha} a_j} \right)^{\frac{1}{1+\alpha}}, \\ w_j &= b_j = b_{0j} \left(\frac{a_j}{a_{0j}} \right)^{\frac{1}{1+\alpha}} = \frac{1}{2} \left(\frac{a_j}{a_{0j}} \right)^{\frac{1}{1+\alpha}}. \end{aligned} \tag{17}$$

Note that $x_j < 1$ and there is unemployment in the differentiated sector if and only if $a_{0j} a_j^{\alpha} > 1$, which we assume to be satisfied. It follows from this characterization that whenever a country has the same labour market frictions in both sectors, so that $a_{0j} = a_j$, it has the same labour market tightness in both sectors and the same cost of hiring in both sectors. Yet, while the cost of hiring is independent in this case of the common level of labour market frictions, because $b_{0j} = b_j = 1/2$, tightness in the sectoral labour markets declines with the level of frictions. This implies that when $a_{0j} = a_j$ in both countries, no country has comparative advantage in one of the sectors (see the discussion in the next section), even when the *level* of labour market frictions varies across countries. In Helpman and Itskhoki (2009*b*), we show that similar patterns arise in the steady state of a dynamic model.

In what follows we assume that $a_A / a_{0A} > a_B / a_{0B}$, so that country B has relatively lower labour market frictions in the differentiated sector. This implies $b_A > b_B$, i.e. country A has a larger hiring cost in the differentiated sector, and $x_A / x_{0A} < x_B / x_{0B}$, i.e. the sectoral labour

21. This is similar to the indifference between staying in the countryside and migrating to the city in the Harris and Todaro (1970) model. A similar condition holds in the Amiti and Pissarides (2005) model, which is otherwise quite different from ours.

22. See Blanchard and Galí (2008) for a similar specification.

market tightness is relatively lower in the differentiated sector of country A. Note, however, that our assumption on relative sectoral labour market frictions has no implications for whether the labour market is tighter in one sector or the other. When $a_j/a_{0j} > 1$ in both countries, sectoral tightness is higher in the homogeneous sector in both countries; when $a_j/a_{0j} < 1$ in both countries, sectoral tightness is higher in the differentiated sector in both countries; and when $a_A/a_{0A} > 1 > a_B/a_{0B}$, sectoral tightness is higher in the homogeneous sector in country A and higher in the differentiated sector in country B. Sectoral labour market frictions can differ because it may be more difficult to match workers with firms in some sectors than in others, and labour market frictions can differ across countries because of differences in matching efficiency or differences in costs of posting vacancies.[23] We allow these possibilities in order to accommodate variation in sectoral rates of unemployment, which feature in the data.[24]

Evidently, the model is bloc recursive, in the sense that the equilibrium wage rate and tightness in the labour market are uniquely determined by labour market frictions. We show in Section 6 that this property also holds with firing costs and unemployment benefits. The implication is that labour market frictions determine $\left(b_j, x_j\right)$ in country j, and these in turn impact other endogenous variables, such as trade, welfare, and unemployment.

The sectoral rates of unemployment are $1 - x_{0j}$ in the homogeneous sector and $1 - x_j$ in the differentiated sector. As a result, the economy-wide rate of unemployment can be expressed as

$$u_j = \frac{N_{0j}}{L}\left(1 - x_{0j}\right) + \frac{N_j}{L}\left(1 - x_j\right), \tag{18}$$

which is a weighted average of the sectoral rates of unemployment, where the weights are the fractions of workers seeking jobs in every sector. It follows that the unemployment rate can rise either because it rises in one or both sectors or because more individuals search for work in the sector with a higher rate of unemployment.

3. EQUILIBRIUM STRUCTURE

We focus on equilibria with incomplete specialization, in which every country produces homogeneous and differentiated products. Conditions for incomplete specialization are described in the Appendix, and in our earlier working paper (Helpman and Itskhoki, 2007) we discuss properties of equilibria with complete specialization. This section is devoted to a description of equilibria and some of their properties. More substantive results, which build on this section, are developed and discussed in subsequent sections.

Equations (8)–(10) yield the following expressions for the domestic market and export cutoffs:

$$\begin{aligned} \Theta_{dj} &= \frac{1}{\phi_1\phi_2} f_d b_j^{\frac{\beta}{1-\beta}} Q_j^{\frac{\beta-\zeta}{1-\beta}}, \\ \Theta_{xj} &= \frac{1}{\phi_1\phi_2} f_x b_j^{\frac{\beta}{1-\beta}} \tau^{\frac{\beta}{1-\beta}} Q_{(-j)}^{\frac{\beta-\zeta}{1-\beta}}. \end{aligned} \tag{19}$$

23. In a dynamic model, sectors may differ in separation rates, which would be equivalent in the static framework to $b_{0j} \neq b_j$ (see Helpman and Itskhoki, 2009*b*). Specifically, we show that if the differentiated sector has a higher separation rate, it leads to greater turnover in this sector and a country with more efficient matching technology has a comparative advantage in this sector. Furthermore, policy differences can be a source of cross-country variation in labour market frictions, which we discuss in Section 6.

24. To illustrate, the BLS reports that in 2007 mining had an unemployment rate of 3.4%, construction had 7.4%, and manufacturing had 4.3% (see http://www.bls.gov/cps/cpsaat26.pdf, accessed on 25 April 2008).

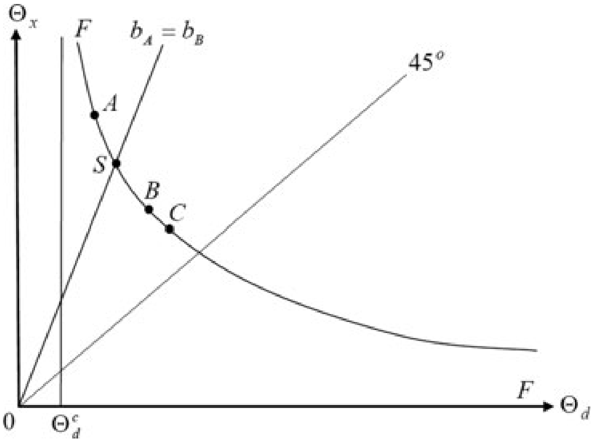

FIGURE 1

Cutoffs in a trading equilibrium

Now substitute these expressions into equations (8) and the resulting profit functions into the free-entry condition (11) to obtain

$$f_d \int_{\Theta_{dj}}^{\infty} \left(\frac{\Theta}{\Theta_{dj}} - 1 \right) dG(\Theta) + f_x \int_{\Theta_{xj}}^{\infty} \left(\frac{\Theta}{\Theta_{xj}} - 1 \right) dG(\Theta) = f_{\mathrm{e}}, \quad j = A, B. \tag{20}$$

This form of the free-entry condition generates a curve in $\left(\Theta_{dj}, \Theta_{xj}\right)$ space on which every country's cutoffs have to be located, because this curve depends only on the common cost variables and on the common distribution of productivity. Moreover, this curve is downward-sloping, as depicted by FF in Figure 1, and each country has to be located above the 45° line for the export cutoff to be higher than the domestic cutoff.[25]

Also note that, as the export cutoff goes to infinity, the domestic cutoff approaches the cutoff of a closed economy, which is represented by Θ_d^c in the figure. It therefore follows that if the cutoff Θ_d in the closed economy is larger than $\Theta_{\min}$, so is Θ_d in the open economy.[26] Finally, note that (19) yields

$$\frac{\Theta_{xj}}{\Theta_{d(-j)}} = \frac{f_x \tau^{\frac{\beta}{1-\beta}}}{f_d} \left(\frac{b_j}{b_{(-j)}} \right)^{\frac{\beta}{1-\beta}}, \quad j = A, B. \tag{21}$$

Equations (20) and (21) can be used for solving the four cutoffs as functions of labour market frictions and cost parameters, as illustrated in Figure 1. As is evident, the cutoffs do not depend

25. Note, from (19), in a symmetric equilibrium, in which $Q_j = Q_{(-j)}$, the export cutoff is higher if and only if $\tau^{\beta/(1-\beta)} f_x > f_d$, which is the condition required for exporters to be more productive in Melitz (2003). We assume for convenience that this condition is satisfied for all $\tau \geq 1$ which requires $f_x > f_d$.

26. The autarky production cutoff is the solution to

$$f_d \int_{\Theta_d^c}^{\infty} \left(\frac{\Theta}{\Theta_d^c} - 1 \right) dG(\Theta) = f_{\mathrm{e}},$$

which does not depend on labour market frictions. Note also that $\Theta_d^c > \Theta_{\min}$ if and only if $\left(\overline{\Theta}/\Theta_{\min}\right) > 1 + f_{\mathrm{e}}/f_d$, where $\overline{\Theta}$ is the mean of Θ, which we assume to be satisfied. This results from the fact that the integral on the left-hand side of the above equation is decreasing in Θ_d^c and assumes its largest value of $\left(\overline{\Theta}/\Theta_{\min}\right) - 1$ when $\Theta_d^c = \Theta_{\min}$.

on the *levels* of the hiring costs b_j but only on their relative size. And once the cutoffs have been solved, they can be substituted into equation (19) to obtain solutions for the real consumption indexes Q_j.

Our primary interest is in the influence of trade and labour market frictions on the trading countries. We therefore use (20) and (21) to calculate the impact of these variables on the cutoffs, obtaining

$$\begin{aligned} \hat{\Theta}_{dj} &= \frac{\delta_{xj}}{\Delta}\left[-\left(\delta_{x(-j)}+\delta_{d(-j)}\right)\left(\hat{b}_j-\hat{b}_{(-j)}\right)-\left(\delta_{d(-j)}-\delta_{x(-j)}\right)\hat{\tau}\right], \\ \hat{\Theta}_{xj} &= \frac{\delta_{dj}}{\Delta}\left[\left(\delta_{x(-j)}+\delta_{d(-j)}\right)\left(\hat{b}_j-\hat{b}_{(-j)}\right)+\left(\delta_{d(-j)}-\delta_{x(-j)}\right)\hat{\tau}\right], \end{aligned} \tag{22}$$

where

$$\delta_{dj}=\frac{f_d}{\Theta_{dj}}\int_{\Theta_{dj}}^{\infty}\Theta dG\left(\Theta\right), \quad \delta_{xj}=\frac{f_x}{\Theta_{xj}}\int_{\Theta_{xj}}^{\infty}\Theta dG\left(\Theta\right), \quad \Delta=\frac{1-\beta}{\beta}\left(\delta_{dA}\delta_{dB}-\delta_{xA}\delta_{xB}\right).$$

Note that δ_{dj}/ϕ_2 is the average revenue per entering firm from domestic sales in country j and δ_{xj}/ϕ_2 is the average revenue per entering firm from export sales.[27] Moreover, δ_{dj} equals average gross operating profits (not accounting for fixed costs) per entering firm from domestic sales and δ_{xj} equals average gross operating profits per entering firm from exporting.

Building on these insights, we prove in the Appendix the following lemmas:

Lemma 1. *Let $b_A > b_B$. Then $\Theta_{dA} < \Theta_{dB}$ and $\Theta_{xA} > \Theta_{xB}$.*

Lemma 2. *An increase in τ raises the export cutoff Θ_{xj} and reduces the domestic cutoff Θ_{dj} in both countries.*

Lemma 3. *Let $b_A > b_B$. Then $Q_A < Q_B$.*

The first lemma shows that in the country with the relatively higher labour market frictions in the differentiated sector exporting requires higher productivity at the firm level and that firms with lower productivity at the bottom of the productivity distribution break even. The former result is quite intuitive; a disadvantage in labour costs needs to be compensated with a productivity advantage to make exporting profitable. The latter stems from the fact that in a country with higher b_j expected profits from exporting are lower at the entry stage, which has to be offset by higher expected profits from domestic sales in order for the free-entry condition to be satisfied. This implies that lower-productivity firms find it profitable to serve the domestic market. The second lemma just restates a well-known result from Melitz (2003) which also holds in our framework: higher variable trade costs cut into export profits, enabling only more productive firms to profitably export. Under the circumstances, lower-productivity firms need to survive entry in order to be able to cover the entry cost. The third lemma states that the

27. To see this, note that profit maximization (equation (5)) implies $\pi_{zj}(\Theta)=\phi_2 R_{zj}(\Theta)-f_z$ for $z=d,x$, where $R_{dj}(\Theta)$ is revenue from domestic sales and $R_{xj}(\Theta)$ is revenue from foreign sales. Then, from the zero profit conditions (9)–(10), we have $R_{zj}(\Theta)=f_z/\phi_2\cdot\Theta/\Theta_{zj}$. As a result, the average revenues per entering firm from domestic sales and exports equal

$$\int_{\Theta_{zj}}^{\infty}R_{zj}(\Theta)dG(\Theta)=\frac{f_z}{\phi_2\Theta_{zj}}\int_{\Theta_{zj}}^{\infty}\Theta dG(\Theta)=\frac{\delta_{zj}}{\phi_2}, \qquad z=d,x.$$

country with higher relative labour market frictions in the differentiated sector has lower real consumption of differentiated products. This stems from the home market effect. Due to the presence of trade costs, a country suffers a disadvantage in the local supply of differentiated products when its b_j is higher in the differentiated industry.

For our equations to describe an equilibrium with incomplete specialization, it is necessary to ensure positive entry of firms in both countries, i.e. $M_j > 0$ for $j = A, B$, where M_j is the number of firms that enter the differentiated sector in country j. This places restrictions on the permissible difference across countries in labour market rigidities. To derive the implications of these restrictions, first recall that $Q_j^{\zeta} = P_j Q_j$ is the total spending on differentiated products in country j, and $M_j \delta_{zj}/\phi_2$ is total revenue from domestic sales when $z = d$ and from foreign sales when $z = x$. Since aggregate spending has to equal aggregate revenue in market j, we have

$$Q_j^{\zeta} = M_j \frac{\delta_{dj}}{\phi_2} + M_{(-j)} \frac{\delta_{x(-j)}}{\phi_2},$$

where the first term on the right-hand side is revenues of domestic firms and the second term is revenues of foreign firms from sales in country j's market. Having solved for the cutoffs, which uniquely determine the δ_{zj}s and the real consumption indexes, Q_js, these equations for $j = A, B$ yield the following solutions for the number of entrants:

$$M_j = \frac{(1-\beta)\,\phi_2}{\beta \Delta} \left[\delta_{d(-j)} Q_j^{\zeta} - \delta_{x(-j)} Q_{(-j)}^{\zeta} \right]. \tag{23}$$

We show in the Appendix that they imply the following:

Lemma 4. *In an equilibrium with incomplete specialization: (i) $\delta_{dj} > \delta_{xj}$ in both countries; (ii) if $b_A > b_B$, then $\delta_{dA} > \delta_{dB}$ and $\delta_{xA} < \delta_{xB}$.*

Lemma 5. *Let $b_A > b_B$. Then $M_A < M_B$.*

Lemma 4 is a technical lemma, which describes conditions that hold in an equilibrium with incomplete specialization. The economic implication of part (i) is that average revenue per entering firm from domestic sales exceeds average revenue per entering firm from export sales in each one of the countries, and the economic implication of part (ii) is that in country A, which has the relatively high labour market frictions in the differentiated sector, average revenue per entering firm from domestic sales is higher and average revenue per entering firm from export sales is lower than in country B. And the last lemma states that there is less entry of firms in the differentiated-product industry in the country in which labour market frictions are relatively higher in this sector—a result which is quite intuitive.

Finally, consider the determinants of the number of workers searching for jobs in the differentiated sector, N_j, and aggregate employment in that sector, H_j. On the one hand, the wage bill in the differentiated sector, $w_j H_j$, equals $\omega_{0j} N_j$, because the wage rate is $w_j = b_j = \omega_{0j}/x_j$ (see (15)) and $x_j = H_j/N_j$ by definition. This implies that aggregate income equals $\omega_{0j} L$, where income $\omega_{0j} N_j$ is derived from the differentiated sector and income $\omega_{0j} N_0 = \omega_{0j}\left(L - N_j\right)$ is derived from the homogeneous sector. On the other hand, the wage bill in the differentiated sector equals the fraction $\beta/(1+\beta)$ of revenue (a result from the bargaining game). Therefore

$$\omega_{0j} N_j = \frac{\beta}{1+\beta} M_j \left(\frac{\delta_{dj}}{\phi_2} + \frac{\delta_{xj}}{\phi_2} \right), \tag{24}$$

where $M_j\left(\delta_{dj}+\delta_{xj}\right)/\phi_2$ is total revenue of country-j firms from domestic sales and exporting. It follows that, once the cutoffs and the numbers of firms are known, this equation determines the number of workers searching for jobs in the differentiated-product industry.[28] Having solved for N_j, aggregate employment in the differentiated sector is

$$H_j = x_j N_j. \tag{25}$$

The remaining $N_{0j} = L - N_j$ workers search for jobs in the homogeneous-good sector, with $H_{0j} = x_{0j}N_{0j}$ of them finding employment and generating H_{0j} units of output of the homogeneous good. This completes the description of an equilibrium with incomplete specialization.

4. TRADE, WELFARE, AND PRODUCTIVITY

In this section we explore channels through which the two countries are interdependent. For this purpose we organize the discussion around two main themes: the impact of a country's labour market frictions on its trade partner, and the differential effects of trade impediments on countries with different labour market frictions.

4.1. *Welfare*

We are interested in knowing how labour market rigidities and trade frictions affect welfare, and in particular their differential impact on the welfare of the two countries. Since aggregate spending in country j, E_j, equals aggregate income, and aggregate income equals $\omega_{0j}L = a_{0j}^{-1/\alpha}L/2$ (see equation (13)), the indirect utility function (3) implies that welfare is higher the larger the real consumption index of differentiated products Q_j is and the lower the friction in the homogeneous sector a_{0j} is. We have already shown that Q_j is higher in country B (see Lemma 3). It follows that welfare is also higher in B as long as the labour market friction in its homogeneous sector, a_{0B}, is not too high relative to that in country A, a_{0A}.

Now combine the formulas for change in the cutoffs (22) with the log-differential of the first equation in (19) to obtain

$$\frac{\beta-\zeta}{1-\beta}\hat{Q}_j = \frac{1}{\Delta}\left[-\delta_{d(-j)}\left(\delta_{xj}+\delta_{dj}\right)\hat{b}_j + \delta_{xj}\left(\delta_{x(-j)}+\delta_{d(-j)}\right)\hat{b}_{(-j)} - \delta_{xj}\left(\delta_{d(-j)}-\delta_{x(-j)}\right)\hat{\tau}\right]. \tag{26}$$

This equation has a number of implications. First, it shows that a reduction in a country's labour market frictions in the differentiated sector, i.e. a decline in a_j which reduces b_j (see (17)), raises its real consumption index Q_j and therefore its welfare, but it reduces the trade partner's welfare. On the other hand, a simultaneous reduction in labour market frictions in the differentiated sectors of both countries at a common rate $\hat{a}_A = \hat{a}_B$, which implies $\hat{b}_A = \hat{b}_B$, raises everybody's welfare.[29] Second, a reduction in a country's labour market frictions at a common rate in both sectors, i.e. a decline in a_{0j} and a_j such that $\hat{a}_{0j} = \hat{a}_j$, does not impact $\hat{b}_j$ and therefore does not impact its real consumption index Q_j nor the real consumption index of its trade partner $Q_{(-j)}$. As a result, the trade partner's welfare does not change, yet j's welfare rises because expected income of a worker, ω_0, rises (see equations (3) and (13), and recall

28. Recall that ω_{0j} is determined by labour market frictions in the homogeneous sector (see equation (13)).
29. This follows from the fact that $-\delta_{d(-j)}\left(\delta_{xj}+\delta_{dj}\right)+\delta_{xj}\left(\delta_{x(-j)}+\delta_{d(-j)}\right) = -\beta\Delta/(1-\beta) < 0$.

that expenditure equals income, $E_j = \omega_{0j} L$). Third, in view of Lemma 4, a reduction in trade impediments raises welfare in both countries. We summarize these findings in:[30]

Proposition 1. *(i) A reduction in labour market frictions in country j's differentiated sector raises its welfare and reduces the welfare of its trade partner. (ii) A simultaneous proportional reduction in labour market frictions in the differentiated sectors of both countries raises welfare in both of them. (iii) A reduction in labour market frictions in country j at a common rate in both sectors raises its welfare and does not affect the welfare of its trade partner. (iv) A reduction of trade impediments raises welfare in both countries and Q_j rises proportionately more in country B, which has relatively lower labour market frictions in the differentiated sector.*

The first part of this proposition is intriguing: it states that a country harms the trade partner by reducing its labour market frictions. Moreover, this happens despite the fact that the trade partner $(-j)$ enjoys better terms of trade as a result of improved labour market conditions in country j, because $(-j)$ pays lower prices for imported varieties from j and gets access to a larger set of foreign varieties. The reason for this result is that lower labour market frictions in country j's differentiated sector act like productivity improvements in this country, which makes foreign firms less competitive and therefore *crowds them out* from this sector. As a result, fewer foreign firms enter the industry. The entry of domestic firms does not fully compensate foreign consumers for the exit of foreign firms due to the home market effect, so that foreign welfare declines, and this negative welfare effect is larger than the welfare gain from improved terms of trade.[31]

The last part of this proposition establishes that both countries gain from trade, because autarky is attained when $\tau \to \infty$.[32] To emphasize this conclusion, we restate it in the following proposition.

Proposition 2. *Both countries gain from trade.*

This proposition is interesting because it is well known that gains from trade are not ensured in economies with non-convexities and distortions (see Helpman and Krugman, 1985), and in

30. The very last part of the proposition follows from the fact that (26) implies

$$\frac{\beta-\zeta}{1-\beta}\left[\hat{Q}_j - \hat{Q}_{(-j)}\right] = -\frac{1}{\Delta}\left[\left(\delta_{dj}+\delta_{xj}\right)\left(\delta_{d(-j)}+\delta_{x(-j)}\right)\left(\hat{b}_j - \hat{b}_{(-j)}\right) + \left(\delta_{d(-j)}\delta_{xj} - \delta_{x(-j)}\delta_{dj}\right)\hat{\tau}\right].$$

Under these circumstances, $\hat{Q}_j > \hat{Q}_{(-j)}$ in response to $\hat{\tau} < 0$, when $b_j < b_{(-j)}$ (by Lemma 4) .

31. Demidova (2008) studies a full employment model with exogenous differences in productivity distributions across countries and finds that (i) productivity improvements in one country hurt its trade partner; and (ii) falling trade costs benefit disproportionately the more productive country, and may even hurt the less productive country. Our results on labour market frictions are similar to these (except that in our case both countries necessarily gain from falling trade costs), because—not withstanding unemployment—labour market frictions have analogous effects to productivity. We stress that these effects are analogous but not identical, because our cross-country differences in relative labour market frictions are not identical to the differences in productivity in Demidova's paper.

32. The following is a direct proof of the gains-from-trade argument. We have seen that the domestic cutoff is higher in every country in the trading equilibrium than in autarky. The first equation in (19) then implies that Q_j is higher in every country in the trading equilibrium, because this equation also holds in autarky. In addition, in the earlier working paper Helpman and Itskhoki (2007), we show that both countries gain from trade when the difference in labour market institutions is large enough to cause the relatively rigid country to specialize in the production of the homogeneous good. Interestingly, in this case the gains from trade accrue disproportionately to the relatively rigid country, although its level of welfare is always lower than that of the relatively flexible country.

addition to the standard non-convexities and distortions that exist in models of monopolistic competition, our model contains frictions in labour markets. The intuition is that every country gains access to a larger variety choice and, in addition, the differentiated sector—which is too small relative to its first-best size—expands. Together, these effects of trade opening dominate the welfare outcome.

4.2. *Trade structure*

From Lemma 1 we know that the country with lower relative labour market frictions in the differentiated sector has a lower export cutoff and a higher domestic cutoff; therefore it also has a larger fraction of exporting firms in the differentiated-product sector. In addition, we know that exports per entering firm equal δ_{xj}/ϕ_2. Therefore exports of differentiated products from j to $(-j)$ are

$$X_j = M_j \frac{\delta_{xj}}{\phi_2}.$$

Lemma 4 states that country B has a larger δ_{xj} and Lemma 5 states that it has more firms. Therefore, $X_B > X_A$, which implies that B exports differentiated products on net. As a consequence, country A exports homogeneous goods.

As in the standard Helpman–Krugman model of trade in differentiated products, there is intra-industry trade. We can therefore decompose the volume of trade into intra-industry and inter-sectoral trade. Because trade is balanced, the total volume of trade equals $2X_B$, the volume of intra-industry trade equals $2X_A$, and the share of intra-industry trade equals

$$\frac{X_A}{X_B} = \frac{\delta_{xA} M_A}{\delta_{xB} M_B}.$$

Using this representation, we show in the Appendix that the share of intra-industry trade declines in b_A/b_B. These results are summarized in the following proposition.

Proposition 3. *Let $b_A > b_B$. Then: (i) A larger fraction of differentiated-sector firms export in country B. (ii) Country B exports differentiated products on net and imports homogeneous goods. (iii) The share of intra-industry trade is smaller the larger b_A/b_B is.*

That is, as in Davidson, Martin, and Matusz (1999), labour market frictions impact comparative advantage, and in our case they also impact the share of intra-industry trade. In addition, under Pareto-distributed productivity, the model also implies that the volume of trade is larger the larger the difference in relative hiring costs across countries, b_A/b_B, and the smaller the trade impediments (see Appendix). These are testable implications of our model.

4.3. *Productivity*

Alternative measures of total factor productivity (TFP) can be used to characterize the efficiency of production. We choose to focus on one such measure—the employment-weighted average of firm-level productivity—which is commonly used in the literature.[33] In the differentiated

33. This corresponds to the measure analysed by Melitz (2003) in the Appendix. Note that Melitz uses revenue to weight firm productivity levels. However, in equilibrium, revenue is proportional to employment, in which case his and our productivity indexes are the same.

sector, this measure is

$$TFP_j = \frac{M_j}{H_j}\left[\int_{\Theta_{dj}}^{\infty} \Theta^{\frac{1-\beta}{\beta}} h_{dj}(\Theta)dG(\Theta) + \int_{\Theta_{xj}}^{\infty} \Theta^{\frac{1-\beta}{\beta}} h_{xj}(\Theta)dG(\Theta)\right]. \tag{27}$$

Recall that $q_{zj}(\Theta) = \Theta^{(1-\beta)/\beta} h_{zj}(\Theta)$ for $z = d, x$. Therefore, TFP_j equals the output of differentiated products divided by employment in the differentiated sector.[34]

Using (6) and (8)–(10), we can express (27) as

$$TFP_j = \frac{\delta_{dj}\varphi_{dj} + \delta_{xj}\varphi_{xj}}{\delta_{dj} + \delta_{xj}} = \varpi_{dj}\varphi_{dj} + \varpi_{xj}\varphi_{xj}, \tag{28}$$

where $\varpi_{dj} = \delta_{dj}/(\delta_{dj} + \delta_{xj})$ is the share of domestic sales in revenue and ϖ_{xj} is the share of exports, i.e. $\varpi_{xj} = 1 - \varpi_{dj}$, $j = A, B$. Moreover,

$$\varphi_{zj} \equiv \varphi(\Theta_{zj}) = \frac{\int_{\Theta_{zj}}^{\infty} \Theta^{1/\beta} dG(\Theta)}{\int_{\Theta_{zj}}^{\infty} \Theta dG(\Theta)}, \quad z = d, x,$$

where φ_{dj} represents the average productivity of firms that serve the home market and φ_{xj} represents the average productivity of exporting firms. It follows that aggregate productivity equals the weighted average of the productivity of firms that serve the domestic market and the productivity of firms that export, with the revenue shares serving as weights. We show in the Appendix that $\varphi(\cdot)$ is an increasing function. Therefore average productivity is higher among exporters, i.e. $\varphi_{xj} > \varphi_{dj}$.

Expression (28) implies that the cutoffs $\{\Theta_{dj}, \Theta_{xj}\}$ uniquely determine the TFP_js, because ϖ_{zj} and φ_{zj} depend only on the cutoffs. Moreover, since the two cutoffs are linked by the free-entry condition (20), TFP_j can be expressed as a function of the domestic cutoff Θ_{dj}. This implies that in a closed economy TFP_j is not responsive to changes in labour market frictions, because Θ_d^c is uniquely determined by the fixed costs of entry and production and the *ex ante* productivity distribution.

Productivity TFP_j is higher in the trade equilibrium than in autarky, however, because $\varphi(\Theta_{xj}) > \varphi(\Theta_{dj}) > \varphi(\Theta_d^c)$, and in autarky $\varpi_x^c = 0$. That is, the average productivity of exporters and non-exporters alike is higher in the trade equilibrium than is the average productivity of firms in autarky. In addition, trade reallocates revenue to the exporting firms, which are on average more productive. For both these reasons, trade raises TFP_j. We summarize these results in the following proposition.

Proposition 4. *(i) In the closed economy, TFP_j does not depend on labour market frictions. (ii) TFP_j is higher in any trade equilibrium than in autarky.*

Next recall that in an open economy a reduction of trade costs raises the domestic cutoff and reduces the export cutoff. In addition, a reduction in country j's labour market frictions in the differentiated sector raises Θ_{dj} and $\Theta_{x(-j)}$ and reduces $\Theta_{d(-j)}$ and Θ_{xj}. Finally, a simultaneous

34. An alternative, and potentially more desirable, measure of productivity would divide output by the number of workers searching for jobs in the differentiated-product sector, N_j. This measure is always smaller than TFP_j by the factor x_j. It follows that labour market liberalization has an additional positive effect on this measure of productivity as compared to the measure used in the main text. Also note that TFP_j measures productivity in the differentiated-product sector only, rather than in the entire economy, and productivity in the homogeneous-product sector is constant given a_{0j}. We discuss in the Appendix a productivity measure that accounts for the compositional effects across sectors.

and proportional decline in both countries' labour market frictions in the differentiated sector (i.e. $\hat{b}_A = \hat{b}_B < 0$) leaves all these cutoffs unchanged (see (22)).

How do changes in labour market frictions impact productivity? In the case in which both countries' labour market frictions decline by the same factor of proportionality, the answer is simple: the TFP_js do not change. As long as productivity is measured with regard to the number of employed workers rather than the number of workers searching for jobs, measured sectoral productivity levels are not sensitive to the absolute levels of b_js; only the *relative* levels matter. This result points to a shortcoming of this TFP measure. We nevertheless continue the analysis with this measure, because it is commonly used in the literature.

A shock that raises the domestic cutoff Θ_{dj} and reduces the export cutoff Θ_{xj} affects TFP_j through three channels. First, the reallocation of revenue from firms that serve the home market to exporters raises the weight on the productivity of exporters, ϖ_{xj}, which raises in turn TFP_j. Second, some least efficient firms exit the industry, thereby raising the average productivity of firms that sell only in the home market, φ_{dj}, which raises TFP_j. Finally, some firms with productivity below Θ_{xj} begin to export, thereby reducing the average productivity of exporters, φ_{xj}, which reduces TFP_j.[35]

The presence of the third effect, which goes against the first two, does not enable us to sign the impact of single-country reductions of labour market frictions on productivity; in general, productivity may increase or decrease. The sharp result for the comparison of autarky to trade derives from the fact that, in a move from autarky to trade, the third effect is nil. In the Appendix, we provide sufficient conditions for productivity to be monotonically rising with Θ_{dj}, and therefore declining with b_j and τ and rising with $b_{(-j)}$. In this section, however, we limit our discussion to the case of Pareto-distributed productivity draws, which yields sharp predictions.

Under the assumption of Pareto-distributed productivity, that is, $G(\Theta) = 1 - (\Theta_{\min}/\Theta)^k$ for $\Theta \geq \Theta_{\min}$, (28) results in (see Appendix):

$$\widehat{TFP}_j = \frac{\delta_{dj}\left(\varphi_{xj} - \varphi_{dj}\right)\left(1 + k - 1/\beta\right)}{\delta_{dj}\varphi_{dj} + \delta_{xj}\varphi_{xj}}\hat{\Theta}_{dj}, \tag{29}$$

where $k > 1/\beta$ is required for TFP_j to be finite, and we therefore assume that it holds, and an increase in Θ_{dj} is accompanied by a corresponding decrease in Θ_{xj} in order to satisfy the free-entry condition. As a result, TFP_j is higher the higher Θ_{dj} is (and the lower Θ_{xj} is). It follows that productivity is higher in country B, and a reduction in a country's labour market frictions in the differentiated sector raises its productivity and reduces the productivity of its trade partner. An implication of this result is that the gap in productivity between countries B and A is increasing in b_A/b_B and therefore in a_A/a_B their relative labour market frictions in the differentiated sector. These results are summarized in the following proposition.

Proposition 5. *Let $b_A > b_B$ and let Θ be Pareto-distributed with shape parameter $k > 1/\beta$. Then: (i) TFP_j is higher in B; (ii) a decline in a_j raises TFP_j and reduces $TFP_{(-j)}$; (iii) a reduction of trade costs τ raises TFP_j in both countries.*

In other words, total factor productivity is higher in the country with relatively lower labour market frictions in the differentiated sector, and, while a reduction of labour market frictions in this sector in any country raises its own total factor productivity, this hurts the total factor productivity of the country's trade partner.

35. Formally, this decomposition can be represented as $\widehat{TFP}_j = \hat{\varpi}_{xj}(\varphi_{xj} - \varphi_{dj}) + (1 - \varpi_{xj})\hat{\varphi}_{dj} + \varpi_{xj}\hat{\varphi}_{xj}$ with $\hat{\varpi}_{xj} > 0$, $\hat{\varphi}_{dj} > 0$ and $\hat{\varphi}_{xj} < 0$.

5. UNEMPLOYMENT

Before discussing the variation of unemployment across countries with different labour market frictions in Section 5.2, we first examine the determinants of unemployment in a world of symmetric countries.

5.1. *Symmetric countries*

We study in this section countries with $a_{0A} = a_{0B} = a_0$ and $a_A = a_B = a$, so that $b_A = b_B = b$, in order to understand how changes in the common levels of labour market frictions and the common level of variable trade cost affect unemployment. In such equilibria, the cutoffs Θ_d and Θ_x, the consumption index Q, the number of entrants M, the number of individuals searching for jobs in the differentiated-product sector N, the number of workers employed in that sector H, and the rate of unemployment u are the same in both countries. We therefore drop the country index j for convenience. From Section 3 we know that two symmetric economies are at the same point on the FF curve in Figure 1 (point S), the location of this point is invariant to the common level of labour market frictions, and this point is higher the larger τ is (see (21)). Moreover, (26) implies that Q is lower the higher are either b or τ. When b is higher as a result of higher frictions in the labour market of the differentiated sector, welfare is lower because Q is lower while aggregate income $E = \omega_0 L$ is not affected (recall that welfare is given by equation (3)).

In order to assess the impact of labour market rigidities on unemployment, we need to know their quantitative impact on Q. For this reason, we use (26) to obtain

$$\hat{Q} = -\frac{\beta}{\beta - \zeta}\left(\hat{b} + \frac{\delta_x}{\delta_d + \delta_x}\hat{\tau}\right).$$

Next combine (23) and (24) to obtain $\omega_0 N = \beta Q^{\zeta}/(1+\beta)$, which together with the previous equation yields

$$\hat{N} = -\frac{\beta\zeta}{\beta - \zeta}\left(\hat{b} + \frac{\delta_x}{\delta_d + \delta_x}\hat{\tau}\right)$$

under the assumption that changes in b are driven by changes in a, which is our measure of labour market frictions in the differentiated sector. In other words, in this analysis we keep constant the level of labour market frictions in the homogeneous sector, a_0 (below we discuss the case of simultaneous reductions in labour market frictions in both sectors). Finally, from (17) and (18) together with the formula for $\hat{N}$ we obtain[36]

$$\operatorname{sign}\{\hat{u}\} = \operatorname{sign}\left\{\left[1 - (2b-1)\frac{\beta\zeta}{\beta-\zeta}\right]\hat{b} - (2b-1)\frac{\beta\zeta}{\beta-\zeta}\frac{\delta_x}{\delta_d+\delta_x}\hat{\tau}\right\}.$$

36. In this derivation we use $bx = b_0 x_0 = \omega_0$, where ω_0 is given in (13) and it does not vary with a, the measure of labour market frictions in the differentiated sector. Therefore, $\hat{b} = -\hat{x}$. Also note that $\hat{x}_0 = 0$ since $b_0 \equiv 1/2$. We have

$$uL\hat{u} = \mathrm{d}N(x_0 - x) - N\,\mathrm{d}x = xN\left[\left(\frac{x_0}{x} - 1\right)\hat{N} + \hat{b}\right].$$

From (17), $x_0/x = (a/a_0)^{1/(1+\alpha)} = 2b$. Finally, combining these results with the expression for $\hat{N}$, we obtain the result in the text.

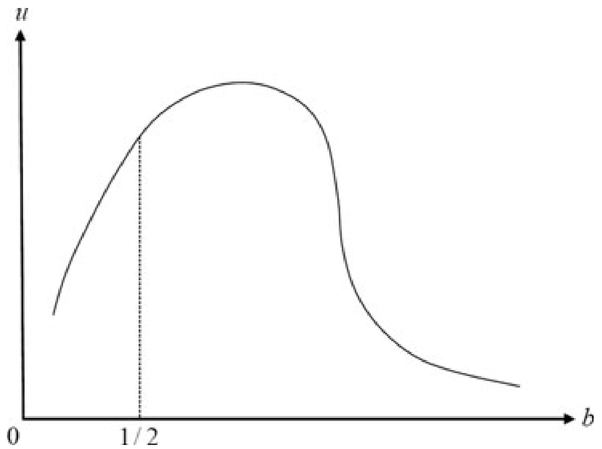

FIGURE 2

Unemployment in a world of symmetric countries

It is evident from this formula that lower frictions in the differentiated sector's labour market (lower b) reduce unemployment if and only if

$$2b = \left(\frac{a}{a_0}\right)^{\frac{1}{1+\alpha}} < 1 + \frac{\beta - \zeta}{\beta\zeta},$$

i.e. if and only if labour market frictions are low in this sector to begin with. This condition is always satisfied when labour market frictions are higher in the homogeneous sector, i.e. $a_0 > a$. If labour market frictions in the differentiated sector are high, however, and the above inequality is reversed, then a reduction in a—and hence in b—may raise the rate of unemployment. In fact, the relationship between b and the rate of unemployment has an inverted U shape as depicted in Figure 2.

To understand this result, note that changes in a impact unemployment through two channels: the rate of unemployment in the differentiated sector $1 - x$, and the fraction of individuals searching for jobs in this sector N/L. Reductions in these labour market frictions raise x and thereby reduce the sectoral rate of unemployment. On the other hand, such reductions attract more workers to the differentiated-product sector and thereby reduce the rate of unemployment if and only if the sectoral rate of unemployment is higher in the homogeneous sector (i.e. $x < x_0$). When $a_0 > a$, the sectoral rate of unemployment is higher in the homogeneous sector and both channels lead to a reduction in the rate of unemployment. On the other hand, when $a > a_0$, the two channels conflict, and the latter, i.e. the reallocation of labour toward the differentiated sector, dominates when labour market frictions are high.[37]

Next consider a proportional reduction in both sectors' labour market frictions, i.e. $\hat{a}_0 = \hat{a} < 0$. This has no effect on the search cost b and does not impact the real consumption index Q (see (17) and (26)). However, it raises the expected income ω_0: from equation (13), $\hat{\omega}_0 = -\hat{a}/\alpha$. It therefore follows from $\omega_0 N = \beta Q^{\zeta}/(1+\beta)$ that $\hat{N} = \hat{a}/\alpha$, and it follows from (17) that $\hat{x} = \hat{x}_0 = -\hat{a}/\alpha$. Using these expressions, and $N_0 + N = L$, the unemployment formula (18) implies that $\operatorname{sign}\{\hat{u}\} = \operatorname{sign}\{\hat{a}\}$. In other words, a reduction of labour market

37. It can also be shown that in the symmetric case lower a leads to increased entry of firms M, an increase in N proportionately to M, and a more than proportional increase in employment H.

frictions at a common rate in both sectors reduces the rate of unemployment. Note that this sort of change in labour market frictions impacts unemployment through two channels, which may operate in opposite directions. On one hand, it raises tightness in each sector's labour market, thereby reducing both sectoral rates of unemployment. On the other hand, it leads to a reallocation of workers from the differentiated to the homogeneous sector. If the sectoral rate of unemployment is higher in the differentiated sector, this reduces the rate of unemployment. But if the sectoral rate of unemployment is lower in the differentiated sector, this raises the rate of unemployment. Nevertheless, the composition effect is dominated by the sectoral effects.[38]

Finally, consider changes in trade impediments. As the formula for the sign of changes in the rate of unemployment shows, a lower trade cost τ *raises* the rate of unemployment if and only if $b > 1/2$ (i.e. $a > a_0$).[39] In this case, the impact on unemployment operates only through the reallocation of labour across sectors, because sectoral unemployment rates do not change. In particular, more workers search for jobs in the differentiated sector when τ declines, and therefore aggregate unemployment rises when the differentiated sector has higher sectoral unemployment and aggregate unemployment falls when the differentiated sector has lower sectoral unemployment. Since the lowering of trade costs raises welfare, this means that welfare and unemployment may respond in opposite directions to changes in trade costs.

We summarize the main findings of this section in the following proposition.

Proposition 6. *In a symmetric world economy: (i) reductions in labour market frictions in the differentiated sectors at the same rate in both countries reduce aggregate unemployment if and only if* $a < a_0 \cdot \left[1 + (\beta - \zeta)/\beta\zeta\right]^{1+\alpha}$*; (ii) reductions in labour market frictions at a common rate in both sectors and both countries reduce aggregate unemployment; (iii) reductions in trade impediments raise aggregate unemployment if and only if* $a > a_0$.

An intriguing result is that lower trade barriers may raise unemployment. Lower trade costs make exporting more profitable in the differentiated-product sector. Moreover, the tightness in its labour market is not affected by falling trade costs. This increases demand for labour in the differentiated sector and leads to reallocation of workers towards this sector. Under these circumstances, the sectoral unemployment rates remain the same, but the aggregate unemployment rate may increase or decrease due to the compositional effect across sectors.[40] The direction of this effect depends on whether the differentiated sector has a higher or lower unemployment rate.

Also note that unemployment can increase or decrease when welfare rises. That is, depending on the nature of the disturbance and the initial labour market frictions, unemployment and welfare can move in the same or in opposite directions. For this reason, changes in unemployment do not necessarily reflect changes in welfare. This results from the standard property of search and matching models, in which unemployment is a productive activity which leads to creation of productive matches. Under these circumstances, an expansion of the high-wage/high-unemployment sector results in higher unemployment, but may also raise welfare.

38. From (18) and $N_0 + N = L$, we obtain $uL\hat{u} = -N_0 x_0 \hat{x}_0 - N x \hat{x} + (x_0 - x) N \hat{N}$, where the first two expressions on the right-hand side represent the sectoral effects and the third represents the composition effect. Since $\hat{x} = \hat{x}_0 = -\hat{N} = -\hat{a}/\alpha$, the sectoral effects dominate.

39. The effect of a reduction in trade costs on unemployment is larger the larger is the share of trade in the sector's revenue, i.e. the larger is $\delta_{xj}/\left(\delta_{dj} + \delta_{xj}\right)$. When the economies are nearly closed, this effect is very small.

40. See Felbermayr, Prat, and Schmerer (2008) for a one-sector search model in which trade causes an increase in sectoral labour market tightness by reducing the real cost of vacancies, but naturally has no compositional effect.

5.2. *Asymmetric countries*

We address in this section the impact of trade and labour market frictions on unemployment when the two countries are not symmetric. We first discuss some analytical results and then turn to numerical examples to illustrate the key mechanisms and various special cases.

In our working paper, Helpman and Itskhoki (2007), we provide analytical results for countries that are nearly symmetric, in the sense that they have no labour market frictions in the homogeneous sector and the difference between their labour market frictions in the differentiated sector is very small. Under these circumstances, $b_A > b_B$ implies that: (i) a reduction in a country's labour market frictions reduces the rate of unemployment in its trade partner, yet it reduces home unemployment if and only if the initial levels of friction in the labour markets are low; and (ii) country B has a lower rate of unemployment if and only if the levels of labour market frictions are low to begin with. Evidently, a country's level of unemployment depends not only on its own labour market frictions but also on those of its trade partner. Moreover, lower domestic labour market frictions do not guarantee lower unemployment relative to the trade partner, unless the frictions in both labour markets are low. As a result, one cannot infer differences in labour market rigidities from observations of unemployment rates. Richer results obtain with large labour market frictions, as we show below.

For our numerical illustrations, we use a Pareto distribution of productivity levels,

$$G(\Theta) = 1 - \left(\frac{\Theta_{\min}}{\Theta}\right)^k, \quad \text{for } \Theta \geq \Theta_{\min}.$$

As is well known, the shape parameter k controls the dispersion of Θ, with smaller values of k representing more dispersion. It has to be larger than 2 for the variance of productivity to be finite. We show in the Appendix how the equilibrium conditions are simplified when productivity is distributed Pareto, and these equations are used to generate our numerical examples. One convenient implication of the Pareto assumption is that condition (11) implies $\delta_{dj} + \delta_{xj} = kf_{\mathrm{e}}$, and therefore revenue of an average firm in the differentiated sector is independent of labour market frictions and is the same in both countries. For the simulations, we also assume that $a_{0A} = a_{0B} = a_0$, so that labour market frictions in the homogeneous sector are the same in both countries, as a result of which expected income of workers, ω_{0j}, is also the same in both countries, i.e. $\omega_{0A} = \omega_{0B} = \omega_0$. In addition, we assume that $a_A > a_B > a_0$, so that labour market frictions are larger in the differentiated sectors of both countries than in their homogeneous sectors, and particularly so in country A. This implies $b_A > b_B > 1/2$.

Combining equations (23) and (24), we obtain the following expression for global revenues generated in the differentiated sector:

$$Q_A^{\zeta} + Q_B^{\zeta} = \frac{1}{\phi_2}\big[M_A(\delta_{dA} + \delta_{xA}) + M_B(\delta_{dB} + \delta_{xB})\big] = \frac{1+\beta}{\beta}\omega_0(N_A + N_B).$$

Therefore, whenever $Q_A^{\zeta} + Q_B^{\zeta}$ rises, the world-wide allocation of workers to the differentiated sector, $N_A + N_B$, must also increase.[41] Next note that Proposition 1 establishes that a reduction in trade costs raises Q_j in both countries. Therefore, the above discussion implies that a

41. Note that this result does not rely on the Pareto assumption. Under the Pareto assumption, however, we additionally have $Q_A^{\zeta} + Q_B^{\zeta} = kf_{\mathrm{e}}(M_A + M_B)/\phi_2$, so that the total number of entrants into the differentiated sector must also increase. Moreover, in the Appendix we show that in this case $\omega_0 N_j / M_j = \beta k f_{\mathrm{e}}/(1-\beta)$. That is, the number of workers searching for jobs in the differentiated sector relative to the number of firms depends on expected income ω_0, but does not depend on the trade cost or labour market frictions in the differentiated sector.

reduction in trade costs increases $N_A + N_B$. In the Appendix we also show that N_A/N_B declines with reductions in τ when $b_A > b_B$. This then implies that N_B, the number of job-seekers in the differentiated sector of country B, necessarily increases. Since a fall in τ does not affect sectoral labour market tightness, we conclude that a reduction in trade costs increases unemployment in country B, which has lower labour market frictions in the differentiated sector. The effect on N_A and hence on the unemployment rate in country A is ambiguous, as we illustrate below.

The intuition behind this result is the following. Lower trade impediments increase the global size of the differentiated sector, which features increasing returns to scale and love of variety. As a result, the country with a more flexible labour market, which has a competitive edge in this sector, becomes more specialized in differentiated products. That is, the number of entering firms, employment, and the number of job-seekers in the differentiated sector, all increase in country B. This compositional shift leads to a higher rate of unemployment in this country because the sectoral rate of unemployment is higher in the differentiated sector. Finally, the reallocation of labour in country A may shift in either direction, depending on how strong the comparative advantage is (see below).

Figure 3 depicts the response of unemployment rates to variation in country A's labour market frictions a_A, which changes monotonically with b_A; the rising broken-line curve represents country B and the hump-shaped solid-line curve represents country A.[42] Country B has $b_B = 0.55 > 1/2$, and therefore the two countries have the same rate of unemployment when $b_A = 0.55$. As b_A rises, country A becomes more rigid. This raises initially the rate of unemployment in both countries, but B's rate of unemployment remains lower for a while. At some point, however, the rate of unemployment reaches a peak in country A, and it falls for further increases in b_A. As a result, the two rates of unemployment become equal again, after which further increases in rigidity in country A raise the rate of unemployment in country B and reduce it in country A, so that the rate of unemployment is higher in country B thereafter. The mechanism that operates here is that, once the labour market frictions become high enough in country A, the contraction of the differentiated-product sector leads to overall lower unemployment in A despite the fact that its sectoral unemployment rate is high. When b_A is very high, the sectoral unemployment rate is very high, but no individuals search for jobs in this sector, as a result of which there is no unemployment at all. This explains the hump in A's curve. Note that in the range in which the rate of unemployment falls in country A, the rate of unemployment keeps rising in country B. The reason is that there is no change in market tightness in country B and its differentiated-product sector becomes more competitive the more rigid the labour market becomes in A. As a result, the differentiated sector attracts more and more workers in country B, which raises its rate of unemployment. The monotonic impact of country A's labour market rigidities on the unemployment rate in B holds globally, and not only around the symmetric equilibrium.[43]

Figure 4 is similar to Figure 3, except that now the level of labour market frictions in country B is higher, i.e. $b_B = 0.65 > 1/2$, and therefore the two curves intersect at $b_A = 0.65$. Moreover, starting with a symmetric world that has these higher labour market rigidities, increases in b_A always raise unemployment in B and reduce unemployment in A. As a result, country A has lower unemployment when $b_A > b_B$ and higher unemployment when $b_A < b_B$.

42. In Figures 3–4 we use the following parameters: $m_0 = 2v_0 = 1, f_x = 3, f_d = 1, f_e = 0.5, k = 2.5, \beta = 0.75, \zeta = 0.5$, and $L = 0.1$.

43. In Figures 3–4, country A specializes in the homogeneous good when $b_A \geq b'$; in Figure 4, country B specializes in the homogeneous good when $b_A \leq b^o$; in Figure 3 country B specializes in the differentiated good for $b_A \geq b''$.

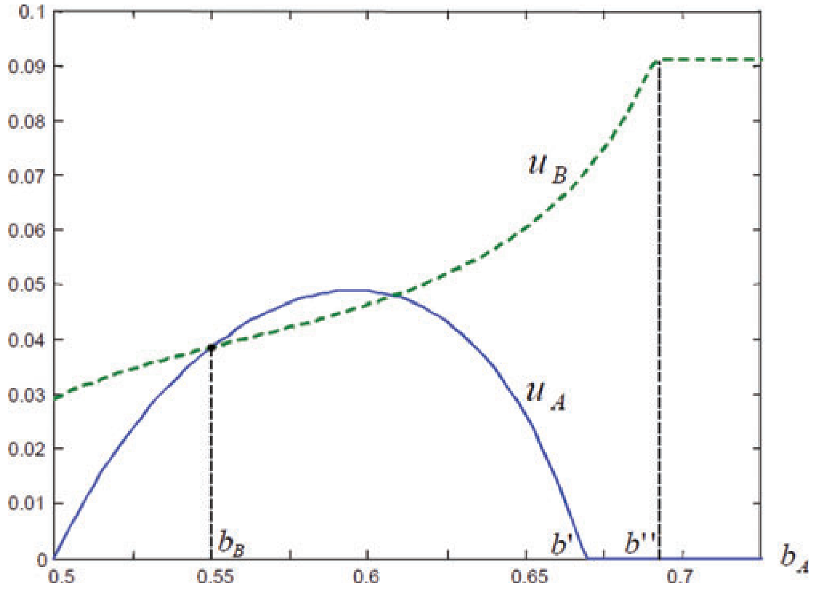

FIGURE 3

Unemployment as a function of b_A when b_B is low ($b_B = 0.55$ and $\tau = 1.1$)

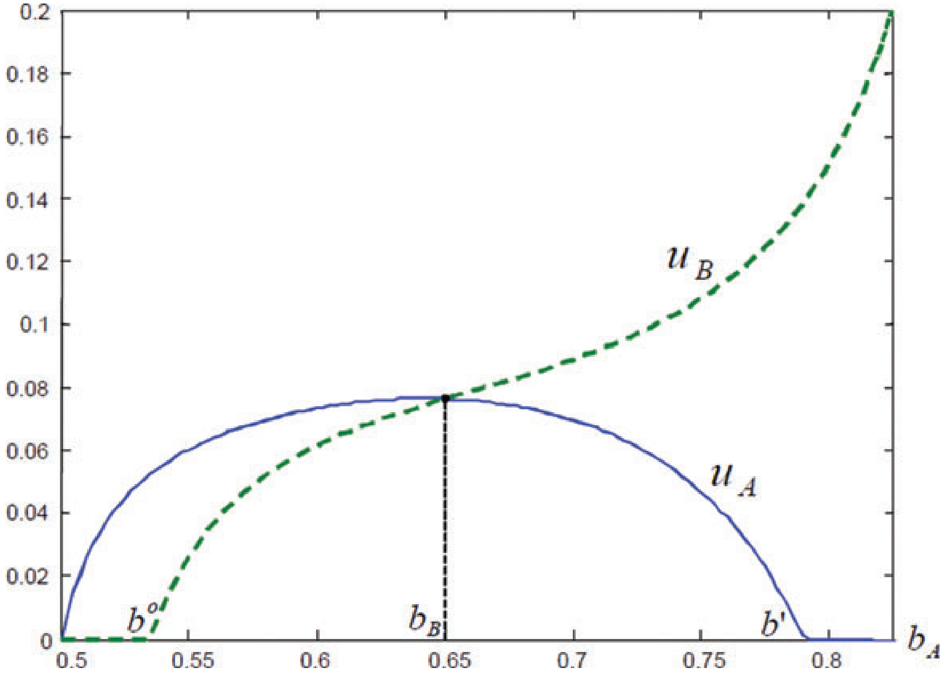

FIGURE 4

Unemployment as a function of b_A when b_B is high ($b_B = 0.65$ and $\tau = 1.1$)

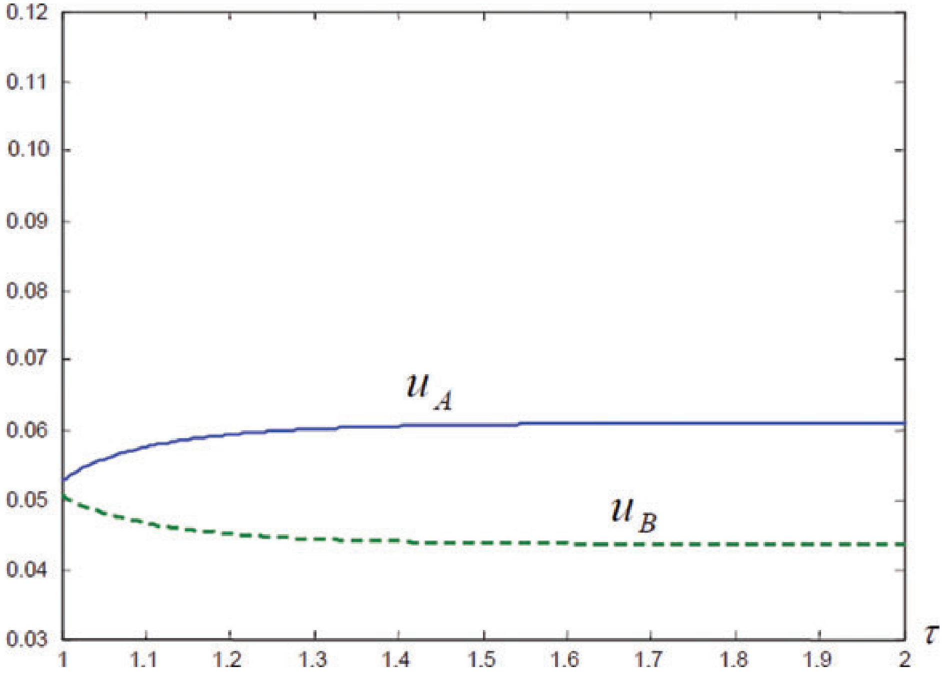

FIGURE 5

Unemployment as a function of τ when b_A and b_B are low ($b_A = 0.6$ and $b_B = 0.56$)

That is, in this case a more rigid country always has a lower unemployment rate when it specializes (incompletely) in the low-unemployment sector.

A comparison between Figures 3 and 4 demonstrates the importance of the overall level of labour market rigidities for unemployment outcomes. When labour market frictions are high, a relatively more flexible country always has a higher rate of unemployment. Moreover, the rates of unemployment in the two countries move in opposite directions as labour market frictions change in either of the countries. In contrast, when labour market rigidities are low and the difference in labour market frictions across countries is not large, the rate of unemployment is lower in a more flexible country and the rates of unemployment in both countries co-move in response to changes in labour market frictions.

The next three figures depict variations in unemployment in response to trade frictions, in the form of variable trade costs τ: Figure 5 for the case of low frictions in labour markets, Figure 6 for the case in which frictions are low in country B but high in A, and Figure 7 for the case in which frictions are high in both countries.[44] In all three cases, unemployment rises in B and falls in A when trade frictions decline.[45] Nevertheless, the rate of unemployment is not necessarily higher in A. In particular, unemployment is always higher in A when frictions in labour markets are low in both countries, yet unemployment is always higher in B when

44. In Figures 5–7 we use the following parameters: $m_0 = 2v_0 = 1, f_x = 5, f_d = 1, f_e = 0.5, k = 2.5, \beta = 0.75, \zeta = 0.5$, and $L = 0.1$.

45. This pattern is not general. As we know, in the symmetric case lower trade impediments raise unemployment in both countries, which is also the case when countries are nearly symmetric. We can also provide examples in which the rigid country has a hump in its rate of unemployment as trade frictions vary.

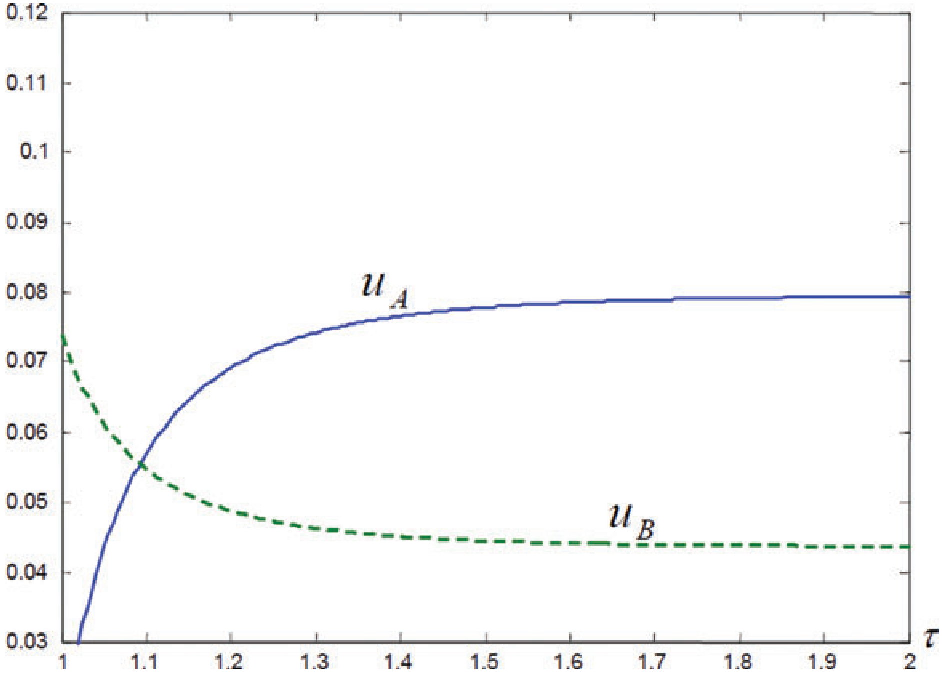

FIGURE 6

Unemployment as a function of τ when b_A is high and b_B is low ($b_A = 0.68$ and $b_B = 0.56$)

frictions in labour markets are high in both countries. In between, when labour market frictions are low in B and high in A, the relative rate of unemployment depends on trade impediments; it is lower in A when the trade frictions are low and lower in B when the trade frictions are high. This shows that labour market frictions interact with trade impediments in shaping unemployment.

6. FIRING COSTS AND UNEMPLOYMENT BENEFITS

Our analysis has focused on search and matching as the main frictions in labour markets, and we used $a_{0j} = 2v_{0j}/m_{0j}^{1+\alpha}$ and $a_j = 2v_j/m_j^{1+\alpha}$ as measures of labour market rigidity. Evidently, in this specification rigidity in a sector's labour market is higher if either it is more costly to post vacancies in this sector or the matching process is less efficient in it.

We can also incorporate firing costs and unemployment benefits as additional sources of labour market rigidity. These labour market policies are widespread and they differ greatly across countries. But note that governments can also influence search and matching costs by facilitating the flow of information about job vacancies and about unemployed workers. Moreover, in some countries there are government agencies that directly assign unemployed workers to firms, and workers need to try these jobs in order to be eligible for unemployment benefits. In other words, government policies can influence not only firing costs and unemployment benefits but also our measures of labour market frictions, a_{0j} and a_j, which were analysed above.

In order to save space, we briefly describe in this section results of a formal analysis conducted in our working paper (Helpman and Itskhoki, 2009a), under the simplifying assumption

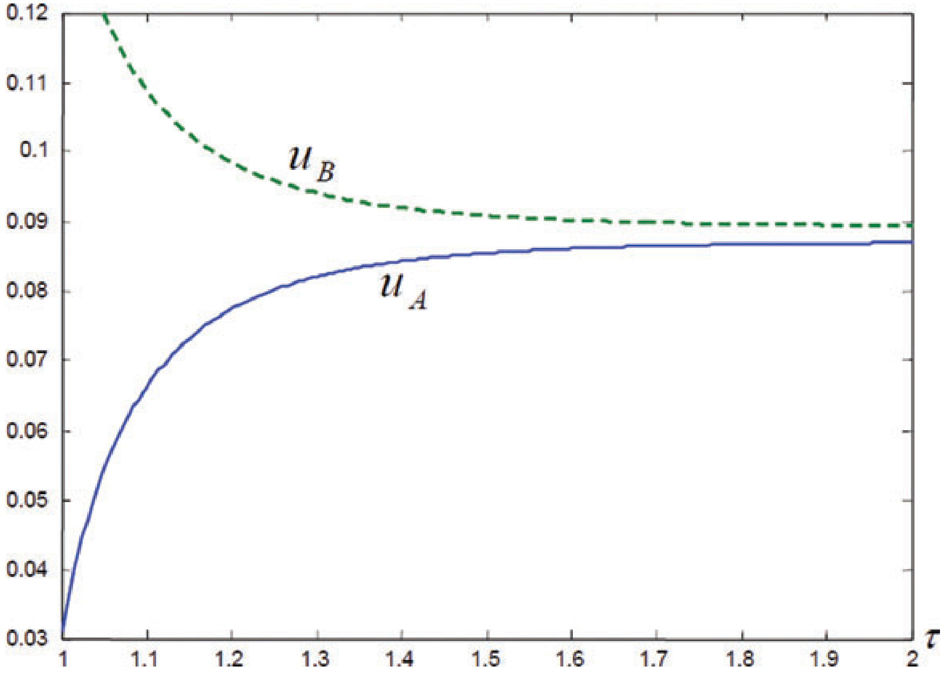

FIGURE 7

Unemployment as a function of τ when b_A and b_B are high ($b_A = 0.95$ and $b_B = 0.8$)

that there is full employment in the homogeneous sector. This analysis can be extended to allow for labour market frictions in the homogeneous-good sector, as in the earlier sections of the current paper.

With firing costs and unemployment benefits, (x_j, b_j) remains a sufficient statistic for labour market frictions, with b_j reinterpreted to represent the overall effective labour cost for a differentiated-sector firm, while the definition of x_j does not change; it remains the same measure of labour market tightness in the differentiated sector. Importantly, the effects of x_j and b_j on the equilibrium outcomes described in Sections 3–5 do not change, except for the qualification of welfare effects to be discussed below.

Firing costs operate similarly to matching frictions, yielding a type of equivalence between the hiring and firing costs. Specifically, higher firing costs reduce labour market tightness x_j and increase the effective labour cost b_j. Moreover, as long as unemployment benefits are not too high (see below), the effects of firing costs on welfare, trade patterns, productivity, and unemployment in trading economies, are the same as those of matching frictions. That is, all the earlier results of this paper extend to the case in which there are positive firing costs in addition to matching frictions.

Higher unemployment benefits always reduce equilibrium labour market tightness x_j, but they may increase or decrease the effective labour cost b_j. The intuition for this result is that unemployment benefits provide unemployment insurance to the workers on the one hand and a better outside option in the wage bargaining game on the other. Because higher unemployment benefits provide better unemployment insurance, workers are willing to search for jobs in a less tight labour market, with a higher sectoral rate of unemployment. This effect reduces the cost of hiring for firms. On the other side, the better outside option of workers at the wage bargaining stage improves their bargaining position and increases the effective cost of labour to firms. Either of these effects can dominate. Therefore, b_j may rise or decline in response to higher unemployment benefits. When b_j decreases, it leads to an expansion of the differentiated sector, which raises welfare. But because unemployment benefits need to be financed by (lump-sum) taxes, the additional taxes required to finance higher unemployment benefits reduce disposable income and hurt welfare. Therefore, on net welfare may rise or decline, but it definitely rises in response to a small rise in unemployment benefits which reduces b_j when the initial level of these benefits is small.[46]

We also show that firing costs and unemployment benefits notwithstanding, international trade may raise unemployment in both countries. The reason is that trade attracts more workers to the differentiated sector without affecting sectoral labour market tightness. Therefore, when this sector has the lower labour market tightness, trade increases aggregate unemployment.

7. CONCLUSION

We have studied the interdependence of countries that trade homogeneous and differentiated products, and whose labour markets are characterized by search and matching frictions. Variation in labour market frictions and the interactions between trade impediments and labour market rigidities generate rich patterns of unemployment. For example, lower frictions in a country's labour markets do not ensure lower unemployment, and unemployment and welfare can both rise in response to a policy change.

Contrary to the complex patterns regarding unemployment, the model yields sharp predictions about welfare. In particular, both countries gain from trade. Moreover, changes in one country's labour market frictions can differentially impact welfare of the trade partners. For example, reducing a country's frictions in the labour market of the differentiated sector raises competitiveness of its firms. This improves the foreign country's terms of trade, but also crowds out foreign firms from the differentiated-product sector. As a result, welfare rises at home and declines abroad, because the terms-of-trade improvement in the foreign country is outweighed by the decline in the competitiveness of its firms. Nevertheless, a common reduction in labour market frictions in the differentiated sectors raises welfare in both countries. These results contrast with the implications of models of pure comparative advantage, in which movements in the terms of trade dominate the outcomes.[47]

We also show that labour market frictions confer comparative advantage, and that differences in these labour market characteristics shape trade flows. In particular, the country with relatively lower labour market frictions in the differentiated sector exports differentiated products on net and imports homogeneous goods. Moreover, the larger the difference in these relative frictions, the lower the share of intra-industry trade. These are testable implications about trade flows and international patterns of specialization.

In addition, we show that trade raises total factor productivity in the differentiated-product sectors of both countries, while productivity does not change in the homogeneous sector. And productivity is higher in the country with relatively lower labour market frictions in the differentiated sector.

46. Severance pay affects labour costs similarly to unemployment benefits, except that it has no impact on disposable income.

47. See, for example, Brügemann (2003) and Alessandria and Delacroix (2008). The former examines the support for labour market rigidities in a Ricardian model in which the choice of regime impacts comparative advantage. The latter analyses a two-country model with two goods, in which every country specializes in a different product and governments impose firing taxes. The authors find that a coordinated elimination of these taxes yields welfare gains for both counties, yet no country on its own has an incentive to do it.

An important conclusion from our analysis is that simple one-sector macro models that ignore compositional effects may be inadequate for assessing labour market frictions, and especially so in a world of integrated economies. Moreover, a focus on terms-of-trade as the major channel of the international transmission of shocks misses the impact of competitiveness, which can dominate economic outcomes.

APPENDIX A

A.1. *An alternative specification with homothetic preferences*

We consider here an alternative specification of the model, with CRRA-CES preferences instead of quasi-linear preferences used in the main text, leaving the rest of the setup unchanged. The expected utility is $\mathbb{U} = \mathbb{E}\mathcal{C}^{1-\sigma}/(1-\sigma)$, where $\mathbb{E}$ is the expectations operator, $\sigma \in [0, 1)$ is the relative risk aversion coefficient, and $\mathcal{C}$ is a CES bundle of homogeneous and differentiated goods:

$$\mathcal{C} = \left[\vartheta^{1-\zeta} q_0^{\zeta} + (1-\vartheta)^{1-\zeta} Q^{\zeta}\right]^{1/\zeta}, \qquad \zeta < \beta, \quad 0 < \vartheta < 1.$$

The ideal price index associated with this consumption bundle is

$$\mathcal{P} = \left[\vartheta + (1-\vartheta) P^{\frac{-\zeta}{1-\zeta}}\right]^{-\frac{1-\zeta}{\zeta}},$$

where the price of the homogeneous good p_0 is again normalized to 1 and P is the price of the differentiated product in terms of the homogeneous good.

The demand for homogeneous and differentiated goods is given by

$$q_0 = \vartheta \mathcal{P}^{\zeta/(1-\zeta)} E = \frac{\vartheta E}{\vartheta + (1-\vartheta) P^{\frac{-\zeta}{1-\zeta}}},$$

$$Q = (1-\vartheta)\left(\frac{P}{\mathcal{P}}\right)^{\frac{-1}{1-\zeta}} \frac{E}{\mathcal{P}} = \frac{(1-\vartheta) P^{\frac{-1}{1-\zeta}} E}{\vartheta + (1-\vartheta) P^{\frac{-\zeta}{1-\zeta}}},$$

where E is expenditure in units of the homogeneous good. Using these demand equations, we derive the indirect utility function

$$\mathbb{V} = \frac{1}{1-\sigma} \mathbb{E}\left(\frac{E}{\mathcal{P}}\right)^{1-\sigma}.$$

Since $\mathcal{P}$ is increasing in P, the indirect utility is falling in P for a given $\mathbb{E}E^{1-\sigma}$. Also Q is decreasing in P.

Next, the demand level for differentiated varieties is

$$D \equiv Q P^{\frac{1}{1-\beta}} = \frac{(1-\vartheta) P^{\frac{\beta-\zeta}{(1-\beta)(1-\zeta)}} E}{\vartheta + (1-\vartheta) P^{\frac{-\zeta}{1-\zeta}}},$$

which increases in P given $\beta > \zeta$. It proves useful to introduce the aggregate revenue variable

$$R \equiv PQ = D^{1-\beta} Q^{\beta} = \frac{(1-\vartheta) P^{\frac{-\zeta}{1-\zeta}} E}{\vartheta + (1-\vartheta) P^{\frac{-\zeta}{1-\zeta}}},$$

which, like Q and opposite to D, decreases in P. Note that with homothetic utility, demands and revenues are linear in income, E, which allows for simple aggregation. Specifically, in the expressions above, E can be interpreted as aggregate income equal to $E = \omega_0(L - N) + wxN$ and we normalize $L = 1$ since under homothetic demand it is without loss of generality.

Most of the remaining derivation of equilibrium conditions remains unchanged, with D replacing $Q^{-(\beta-\zeta)/(1-\beta)}$ in the text. Specifically, after this substitution the free-entry condition and zero-profit conditions are unchanged, which allows us to solve for equilibrium cutoffs and equilibrium Ds in the same manner as in the text. Qualitatively, all the relationships still hold, except that now instead of Q as the sufficient statistic for welfare and demand level it is more convenient to express all aggregate variables as functions of P. Additionally, $R = PQ$ replaces Q^{ζ} in the expressions for M and N.

One block of the equilibrium system that changes is the indifference conditions of workers between sectors which now becomes

$$x_0 w_0^{1-\sigma} = x w^{1-\sigma}.$$

The wage rate in the homogeneous sector is still $w_0 = b_0 = 1/2$ and equations characterizing x_0 and $\omega_0 = x_0 w_0$ (12) and (13) still hold. The wage rate in the differentiated sector is still $w = b$, where $b = a x^{\alpha}$ is the hiring cost (and similarly b_0). As a result, when $a = a_0$, we have $b = b_0 = 1/2$, $x = x_0$, and $w = w_0$ and $a > a_0$ implies $b > b_0 = 1/2$, $x < x_0$, and $w > w_0$. In the latter case, there is a risk premium for searching for a job in the differentiated sector so that $xw > \omega_0 = x_0 w_0$ with the size of risk premium depending on risk aversion σ. Finally, since all workers are indifferent between searching for a job in the two sectors, we have for every worker $\mathbb{E}E^{1-\sigma} = x_0 w_0^{1-\sigma} = x_0 (1/2)^{1-\sigma}$, which is pinned down by the labour market friction in the homogeneous sector, a_0. Therefore, holding a_0 constant, the welfare in the economy depends only on the price level, $\mathcal{P}$, which in turn is determined by the price of the differentiated good, P.

Note that with homothetic preferences and $0 \leq \sigma < 1$, we have dropped the family interpretation. In this case, the structure of demand and indirect utility does not change if the worker becomes unemployed, and aggregation is straightforward.[48] As a result, this specification can be used to analyse issues such as the *ex post* income distribution and winners and losers from policy reforms.

Without showing the explicit derivation (which follows the same steps as in the text), we provide as an illustration a few comparative statics results for the symmetric open economies with homothetic preferences. Specifically, we consider proportional labour market deregulation in the differentiated sector of both countries (i.e. a decrease in a holding a_0 constant). We have $\hat{D} = \beta/(1-\beta)\hat{b}$, so that, as before, P decreases and Q and R increase as b falls. This also implies an increase in welfare.

As before, we can express the total wage bill in the differentiated sector as

$$bH = \frac{\beta}{1+\beta} R = \frac{\beta}{1+\beta} M(\delta_d + \delta_x)/\phi_2,$$

where the δ_zs are average revenues per entering firm as defined in the text. We still have $H = xN$. Using $xb^{1-\sigma} = x_0(1/2)^{1-\sigma}$, we have the expression for the number of workers searching for a job in the differentiated sector:

$$N = \frac{\beta}{1+\beta} \frac{R}{b^{\sigma} x_0 (1/2)^{1-\sigma}}$$

Since R is decreasing in b, we have that N decreases in b as before. As a result, there are still two opposing effects on the unemployment rate when $x < x_0$: $\operatorname{sign}\{\hat{u}\} = \operatorname{sign}\left\{(1-\sigma)\hat{b} + \left(x_0/x - 1\right)\hat{N}\right\}$. The change in the unemployment rate is again ambiguous: it still falls if the initial labour market friction is low enough and increases otherwise. These results are qualitatively the same as those derived in the text under quasi-linear preferences.

Additionally, we can discuss now *ex post* inequality. When $b > b_0$, a fall in b increases x and reduces w, which both lead to lower *ex post* inequality. At the same time it increases N, which may increase or reduce the inequality depending on the initial size of the differentiated sector. It follows that the comparative statics for inequality are ambiguous in the same way as those for the rate of unemployment. For discussion of these and other issues, see Helpman, Itskhoki, and Redding (2009) in a related but different model.

A.2. *Conditions for incomplete specialization*

We derive here a limit on b_A/b_B which secures an equilibrium in which both countries are incompletely specialized. When this condition is violated, the country with a relatively more rigid labour market (higher b) specializes in the production of the homogeneous good. Throughout we assume for concreteness that A is the relatively more rigid country, so that $b_A/b_B \geq 1$. We assume that L is large enough in both countries so that both countries always produce the homogeneous good. Following the main text, we analyse only equilibria with $\Theta_{xj} > \Theta_{dj} > \Theta_{\min}$, so that not all

48. In the case of $\sigma \geq 1$, we need to introduce unemployment benefits in order to dispense with the family risk-sharing.

producing firms export and there are also firms that exit. As shown in the text, this requires $f_x > f_d$ which we assume holds.

Given $b_A > b_B$, incomplete specialization implies that there is positive entry of firms in the differentiated sector of country A, i.e. $M_A > 0$. Equation (23) in the text implies that $M_A = 0$ whenever

$$\delta_{dB}\left(\frac{Q_A}{Q_B}\right)^{\zeta} \leq \delta_{xB}.$$

When this condition is satisfied with equality, we also find, using (19), that

$$\delta_{dB}\left[\frac{\Theta_{xB}}{\Theta_{dB}}\frac{f_d}{f_x}\tau^{\frac{-\beta}{1-\beta}}\right]^{\zeta\frac{1-\beta}{\beta-\zeta}} = \delta_{xB}. \tag{A1}$$

Note that this relationship is an upward-sloping (generally non-linear) curve in $(\Theta_{dB}, \Theta_{xB})$-space, lying between the 45°-line and $\Theta_{xB} = \Theta_{dB}\tau^{\beta/(1-\beta)}f_x/f_d$ (i.e. the equilibrium condition when $b_A = b_B$).[49]

We can now prove the following:

Lemma 6. *Let $\tau > 1$ and $b_A > b_B$. Then there exists a unique function $\overline{b}(\tau) > 1$, with $\overline{b}'(\tau) > 0$, such that* (A1) *holds for $b_A/b_B = \overline{b}(\tau)$. For $b_A/b_B < \overline{b}(\tau)$, there is incomplete specialization in equilibrium so that $M_A > 0$. For $b_A/b_B \geq \overline{b}(\tau)$, country A specializes in the homogeneous good so that $M_A = 0$.*

Proof. Recall that Θ_{dB} is decreasing and Θ_{xB} is increasing in τ. This implies that δ_{dB}/δ_{xB} is increasing in τ. Equation (22) implies that $\tau^{\frac{-\beta}{1-\beta}}\Theta_{xB}/\Theta_{dB}$ is increasing in τ. Next, Θ_{xB}/Θ_{dB} and δ_{dB}/δ_{xB} are decreasing in b_A/b_B. These considerations, together with (A1), imply that $\overline{b}(\tau)$ is unique and increasing in τ whenever it is finite.[50] Finally, Q_A/Q_B is decreasing in b_A/b_B. Therefore, from (23), $M_A > 0$ whenever $b_A/b_B < \overline{b}(\tau)$ and $M_A = 0$ whenever $b_A/b_B \geq \overline{b}(\tau)$. ‖

Evidently, Lemma 6 implies that there is an upper bound on how different the relative labour market frictions can be in the two countries for complete specialization not to occur in equilibrium. As we show in the numerical examples of Section 5.2, a wide range of $b_A/b_B > 1$ is consistent with incomplete specialization equilibrium. See the working paper version, Helpman and Itskhoki (2007), for the analysis of equilibria with complete specialization.

A.3. *Proof of Lemmas 1–5 and Proposition 3*

Proof of Lemma 1. This follows immediately from (22). First note that in equilibria with $\Theta_{dj} < \Theta_{xj}$, we have $\Delta = \frac{1-\beta}{\beta}\left(\delta_{dA}\delta_{dB} - \delta_{xA}\delta_{dB}\right) > 0$. Indeed, $\Theta_{dj} < \Theta_{xj}$ implies

$$\frac{\delta_{dj}}{\delta_{xj}} > \frac{f_d}{f_x}\frac{\Theta_{xj}}{\Theta_{dj}}.$$

Using these inequalities for $j = A, B$ together with (21) implies $\delta_{dA}\delta_{dB}/\left(\delta_{xA}\delta_{xB}\right) > \tau^{2\beta/(1-\beta)} > 1$, in which case $\Delta > 0$.[51] Then an increase in b_A/b_B reduces Θ_{dA} and Θ_{xB} and increases Θ_{dB} and Θ_{xA} (see (22)). Therefore, $b_A > b_B$ implies $\Theta_{dA} < \Theta_{dB}$ and $\Theta_{xA} > \Theta_{xB}$ since in a symmetric equilibrium these relationships hold with equality. ‖

Proof of Lemma 2. This also follows immediately from (22) and the fact that $\delta_{dj} > \delta_{xj}$, which we prove below (Lemma 4). ‖

Proof of Lemma 3. This follows from (19) and Lemma 1. Note that (19) implies:

$$\left(\frac{Q_A}{Q_B}\right)^{\frac{\beta-\zeta}{1-\beta}} = \frac{\Theta_{dA}}{\Theta_{dB}}\left(\frac{b_B}{b_A}\right)^{\frac{\beta}{1-\beta}}.$$

When $b_A > b_B$, Lemma 1 implies $\Theta_{dA} < \Theta_{dB}$ and hence we have $Q_A < Q_B$. ‖

49. In the special case of a Pareto distribution, (A1) is a ray through the origin.

50. Note that $\overline{b}(\tau) > 1$ by construction, since $\Theta_{xB} = \Theta_{dB}\tau^{\beta/(1-\beta)}f_x/f_d$ when $b_A = b_B$.

51. This also implies $\delta_{dj} > \delta_{xj}$ in at least one country and in both countries in the vicinity of a symmetric equilibrium.

Proof of Lemma 4. This follows from (23), the incomplete specialization requirement $M_j > 0$ and Lemmas 1 and 3. Specifically, when $b_A > b_B$, $M_A > 0$ together with (23) imply

$$\frac{\delta_{dB}}{\delta_{xB}} > \left(\frac{Q_B}{Q_A}\right)^{\zeta} > 1,$$

where the last inequality follows from Lemma 3. Lemma 1 implies that $\delta_{dA} > \delta_{dB}$ and $\delta_{xA} < \delta_{xB}$ since δ_{zj} is a decreasing function of Θ_{zj} ($z = d, x$ and $j = A, B$). Therefore, $\delta_{dA}/\delta_{xA} > \delta_{dA}/\delta_{xA} > 1$. ∥

Proof of Lemma 5. This follows from (23) and Lemmas 3 and 4. Specifically, (23) implies

$$M_A - M_B = \frac{(1-\beta)\phi_2}{\beta\Delta}\left[\big(\delta_{dB} + \delta_{xA}\big)Q_A^{\zeta} - \big(\delta_{dA} + \delta_{xB}\big)Q_B^{\zeta}\right].$$

When $b_A > b_B$, Lemma 3 implies $Q_A < Q_B$ and Lemma 4 implies $\delta_{dA} > \delta_{dB} > \delta_{xB} > \delta_{xA}$. Therefore, in this case $M_A < M_B$. ∥

Proof of Proposition 3. This follows from Lemmas 1, 4, and 5 and the definition of intra-industry trade. When $b_A > b_B$, Lemma 1 states that $\Theta_{xA} > \Theta_{xB}$ and $\Theta_{dA} < \Theta_{dB}$, which implies that a larger fraction of firms export in country B: $\left[1 - G(\Theta_{xj})\right]/\left[1 - G(\Theta_{dj})\right]$ is greater in B.

In the text we show that exports of differentiated products is equal to $X_j = M_j\delta_{xj}/\phi_2$. When $b_A > b_B$, Lemma 4 states that $\delta_{xB} > \delta_{xA}$ and Lemma 5 states that $M_B > M_A$, which implies $X_B > X_A$; that is country B exports differentiated goods on net. Balanced trade implies that is has to import the homogeneous good.

In the text, the share of intra-industry trade is shown to equal $X_A/X_B = \delta_{xA}M_A/\big(\delta_{xB}M_B\big)$. Using equation (23), we have:

$$\frac{X_A}{X_B} = \frac{\frac{\delta_{dB}}{\delta_{xB}} - \left(\frac{Q_B}{Q_A}\right)^{\zeta}}{\frac{\delta_{dA}}{\delta_{xA}}\left(\frac{Q_B}{Q_A}\right)^{\zeta} - 1}.$$

From equations (22) and (26) and using Lemma 4, an increase in b_A/b_B leads to a decrease in δ_{dB}/δ_{xB} and to increases in δ_{dA}/δ_{xA} and Q_B/Q_A. Therefore, an increase in b_A/b_B reduces X_A/X_B. ∥

In Appendix A.5, we prove additionally that under Pareto-distributed productivity the total volume of trade increases in the proportional gap between relative labour market frictions, b_A/b_B.

A.4. *Derivation of results on productivity for Section 4.3*

We first show that $\varphi_{zj} = \varphi(\Theta_{zj})$ is monotonically increasing in Θ_{zj}. The log-derivative of $\varphi(\Theta_{zj})$ is

$$\hat{\varphi}_{zj} = \Theta_{zj}G'(\Theta_{zj})\left[\frac{\Theta_{zj}}{\int_{\Theta_{zj}}^{\infty}\Theta dG(\Theta)} - \frac{\Theta_{zj}^{1/\beta}}{\int_{\Theta_{zj}}^{\infty}\Theta^{1/\beta}dG(\Theta)}\right]\hat{\Theta}_{zj} \qquad \text{for } z = d, x.$$

The term in the square brackets is positive since

$$\frac{\Theta_{zj}^{1/\beta}}{\int_{\Theta_{zj}}^{\infty}\Theta^{1/\beta}\frac{dG(\Theta)}{1-G(\Theta_{zj})}} < \left(\frac{\Theta_{zj}}{\int_{\Theta_{zj}}^{\infty}\Theta\frac{dG(\Theta)}{1-G(\Theta_{zj})}}\right)^{1/\beta} < \frac{\Theta_{zj}}{\int_{\Theta_{zj}}^{\infty}\Theta^{1/\beta}\frac{dG(\Theta)}{1-G(\Theta_{zj})}},$$

where the first inequality follows from Jensen's inequality and the second inequality comes from the fact that $\beta < 1$ and $\Theta_{zj} < \int_{\Theta_{zj}}^{\infty}\Theta\frac{dG(\Theta)}{1-G(\Theta_{zj})}$.

Next we provide the general expression for a log-change in aggregate productivity:

$$\widehat{TFP}_j = \left\{1 + \frac{\kappa_{dj}}{\varphi_{xj} - \varphi_{dj}}\left[\frac{\kappa_{xj}}{\kappa_{dj}}\left(\Theta_{xj}^{\frac{1-\beta}{\beta}} - TFP_j\right) + \left(TFP_j - \Theta_{dj}^{\frac{1-\beta}{\beta}}\right)\right]\right\}\frac{\delta_{dj}(\varphi_{xj} - \varphi_{dj})}{\delta_{dj}\varphi_{dj} + \delta_{xj}\varphi_{xj}}\hat{\Theta}_{dj}, \tag{A2}$$

where

$$\kappa_{zj} \equiv \kappa(\Theta_{zj}) = \frac{f_z \Theta_{zj} G'(\Theta_{zj})}{\delta_{zj}} = \frac{\Theta_{zj} G'(\Theta_{zj})}{\frac{1}{\Theta_{zj}} \int_{\Theta_{zj}}^{\infty} \Theta dG(\Theta)}.$$

A series of sufficient conditions can be suggested for the terms in curly brackets to be positive. Since $TFP_j \geqslant \Theta_{dj}^{(1-\beta)/\beta}$ is always true, it is sufficient to require that

$$TFP_j \leqslant \Theta_{xj}^{(1-\beta)/\beta},$$

which holds for large enough Θ_{xj}, i.e. when the economy is relatively closed. However, this inequality fails to hold when Θ_{xj} approaches Θ_{dj}. Tighter but less intuitive sufficient conditions are provided in the working paper version (Helpman and Itskhoki, 2007).

Now we provide the derivation of equation (29) under the assumption of Pareto-distributed productivity draws. When Θ is distributed Pareto with the shape parameter $k > 1/\beta$, there is a straightforward way of computing the change in TFP_j. Taking the log derivative of equation (28), we have

$$\widehat{TFP}_j = \left[\frac{\delta_{dj}\varphi_{dj}\hat{\delta}_{dj} + \delta_{xj}\varphi_{xj}\hat{\delta}_{xj}}{\delta_{dj}\varphi_{dj} + \delta_{xj}\varphi_{xj}} - \frac{\delta_{dj}\hat{\delta}_{dj} + \delta_{xj}\hat{\delta}_{xj}}{\delta_{dj} + \delta_{xj}} \right] + \frac{\delta_{dj}\varphi_{dj}\hat{\varphi}_{dj} + \delta_{xj}\varphi_{xj}\hat{\varphi}_{xj}}{\delta_{dj}\varphi_{dj} + \delta_{xj}\varphi_{xj}}.$$

Under the Pareto assumption, the free-entry condition (20) can be written as $\delta_{dj} + \delta_{xj} = kf_e$, which implies $\delta_{dj}\hat{\delta}_{dj} + \delta_{xj}\hat{\delta}_{xj} = 0$. We use this to simplify

$$\widehat{TFP}_j = \frac{\delta_{dj}\varphi_{dj}\left(\hat{\delta}_{dj} + \hat{\varphi}_{dj}\right) + \delta_{xj}\varphi_{xj}\left(\hat{\delta}_{xj} + \hat{\varphi}_{xj}\right)}{\delta_{dj}\varphi_{dj}}.$$

Next note that $\delta_{zj} = f_z \frac{k}{k-1}(\Theta_{\min}/\Theta_{zj})^k$ so that $\hat{\delta}_{zj} = -k\hat{\Theta}_{zj}$ and $\varphi_{zj} = \frac{k-1}{k-1/\beta}\Theta_{zj}^{(1-\beta)/\beta}$, implying $\hat{\varphi}_{zj} = (1-\beta)/\beta\hat{\Theta}_{zj}$. Thus, the log-derivative of the free-entry condition can also be written as $\delta_{dj}\hat{\Theta}_{dj} + \delta_{xj}\hat{\Theta}_{xj} = 0$. Therefore,

$$\delta_{dj}\left(\hat{\delta}_{dj} + \hat{\varphi}_{dj}\right) = -\delta_{xj}\left(\hat{\delta}_{xj} + \hat{\varphi}_{xj}\right) = -\left[k - (1-\beta)/\beta\right]\delta_{dj}\hat{\Theta}_{dj}.$$

Using this, we obtain our result (29) in the text.

Finally, we discuss an alternative measure of productivity which takes into account the sectoral composition of resource allocation:

$$TFP'_j = \frac{L - N_j}{L}\frac{H_{0j}}{N_{0j}} + \frac{N_j}{L}\frac{H_j}{N_j}TFP_j,$$

which is a weighted average of $x_{0j} = H_{0j}/N_{0j}$ (the productivity in the homogeneous sector) and $TFP''_j \equiv x_j \cdot TFP_j$ (productivity in the differentiated-product sector). The weights are the respective fractions of the two sectors in the labour force. Note that both sectoral productivity measures take into account unemployment of labour. Further, note that $\widehat{TFP''_j} = \widehat{TFP}_j + \hat{x}_j$. If $TFP''_j > x_{0j}$, an increase in the size of the differentiated sector improves productivity. Reduction in trade costs or labour market frictions in the differentiated sector (decreases in a_j/a_{0j}) shifts resources towards the differentiated sector by increasing N_j. Moreover, decreases in labour market frictions improve sectoral labour market tightness and hence increase productivity. These are the additional effects captured by this alternative measure of aggregate productivity.

A.5. *Solution under Pareto assumption for Section 5.2*

We characterize here the solution of the model under the assumption that productivity draws Θ are distributed Pareto with the shape parameter k. That is, $G(\Theta) = 1 - (\Theta_{\min}/\Theta)^k$ defined for $\Theta \geq \Theta_{\min}$. We use this characterization in Section 5.2 in order to solve numerically for the equilibrium response of unemployment to different shocks. In the end of this appendix, we provide some analytical results under Pareto-distributed productivity referred to in the text.

Pareto-distributed productivity leads to the following useful functional relationship:

$$\delta_{zj} \equiv \frac{f_z}{\Theta_{zj}} \int_{\Theta_{zj}}^{\infty} \Theta dG(\Theta) = f_z \frac{k}{k-1}\left(\frac{\Theta_{\min}}{\Theta_{zj}}\right)^k, \qquad z = d, x,$$

so that $\hat{\delta}_{zj} = -k\hat{\Theta}_{dj}$. As a result, we can rewrite the free entry condition (20) as

$$f_d\Theta_{dj}^{-k} + f_x\Theta_{xj}^{-k} = (k-1)f_{\mathrm{e}}\Theta_{\min}^{-k} \qquad \Leftrightarrow \qquad \delta_{dj} + \delta_{xj} = kf_{\mathrm{e}}.$$

Manipulating cutoff conditions (19) and the free entry condition above, one can obtain two equations linear in Θ_{dj}^{-k} and Θ_{xj}^{-k}. This allows us to solve for all equilibrium variables in closed form. We provide these solutions in the working paper version (Helpman and Itskhoki, 2007).

Using the Pareto assumption and the equation for M_j (23), we get

$$M_j = \phi_2\frac{k-1}{k}\Theta_{\min}^{-k}\frac{f_dQ_j^{\zeta}\Theta_{d(-j)}^{-k} - f_xQ_{(-j)}^{\zeta}\Theta_{x(-j)}^{-k}}{f_d^2\Theta_{dA}^{-k}\Theta_{dB}^{-k} - f_x^2\Theta_{xA}^{-k}\Theta_{xB}^{-k}}. \tag{A3}$$

Finally, using the condition for N_j (24) and the free entry condition under the Pareto assumption, we get:

$$\omega_{0j}N_j = \phi_1^{\frac{1-\beta}{\beta}}\phi_2^{-1}M_j\left[\delta_{dj} + \delta_{xj}\right] = \phi_1^{\frac{1-\beta}{\beta}}kf_{\mathrm{e}}M_j.$$

That is, under the Pareto assumption, N_j is always proportional to M_j.

Volume of trade (remark for Section 4.3). Under the Pareto assumption we can get a simple prediction about the response of the trade volume to τ, b_A, and b_B. Recall that the total volume of trade (when $b_A > b_B$) equals $2X_B$, where we have

$$X_B = \phi_2^{-1}M_B\delta_{xB} = \frac{\frac{\delta_{dA}}{\delta_{xA}}Q_B^{\zeta} - Q_A^{\zeta}}{\frac{\delta_{dA}\delta_{dB}}{\delta_{xA}\delta_{xB}} - 1} = \frac{\frac{f_d}{f_x}\left(\frac{\Theta_{xA}}{\Theta_{dA}}\right)^k Q_B^{\zeta} - Q_A^{\zeta}}{\frac{f_d^2}{f_x^2}\left(\frac{\Theta_{xA}\Theta_{xB}}{\Theta_{dA}\Theta_{dB}}\right)^k - 1} = \frac{\frac{f_d}{f_x}\left(\frac{\Theta_{xA}}{\Theta_{dA}}\right)^k Q_B^{\zeta} - Q_A^{\zeta}}{\tau^{\frac{2\beta k}{1-\beta}}\left(\frac{f_x}{f_d}\right)^{2(k-1)} - 1}.$$

As b_A increases or b_B falls, the denominator remains unchanged while Θ_{xA}/Θ_{dA} and Q_B increase and Q_A decreases. As a result, the volume of trade unambiguously rises. Finally, one can also show that X_B decreases in τ. Substitute the expression for Θ_{xA}/Θ_{dA} (derived from (19)) in the expression for X_B to get

$$X_B = Q_A^{\zeta}\frac{\tau^{\frac{\beta k}{1-\beta}}\left(\frac{f_x}{f_d}\right)^{k-1}\left(\frac{Q_B}{Q_A}\right)^{\zeta + k\frac{\beta-\zeta}{1-\beta}} - 1}{\tau^{\frac{2\beta k}{1-\beta}}\left(\frac{f_x}{f_d}\right)^{2(k-1)} - 1}.$$

Now note that X_B decreases in τ since Q_A and Q_B/Q_A decrease in τ and $Q_B > Q_A$.

Proof that N_A/N_B decreases in τ when $b_A > b_B$. In the text we show that $N_A + N_B$ increases as τ falls. We show now that when $b_A > b_B$, N_A/N_B decreases as τ falls, which implies that N_B necessarily increases. Under the Pareto assumption, $\delta_{dj} + \delta_{xj} = kf_{\mathrm{e}}$. Therefore, equations (23) and (24) imply

$$\frac{\omega_{0A}N_A}{\omega_{0B}N_B} = \frac{M_A}{M_B} = \frac{\delta_{dB}Q_A^{\zeta} - \delta_{xB}Q_B^{\zeta}}{\delta_{dA}Q_B^{\zeta} - \delta_{xA}Q_A^{\zeta}} = \frac{1 - \frac{\delta_{xB}}{kf_{\mathrm{e}}}\left[1 + \left(\frac{Q_B}{Q_A}\right)^{\zeta}\right]}{\frac{\delta_{dA}}{kf_{\mathrm{e}}}\left[1 + \left(\frac{Q_B}{Q_A}\right)^{\zeta}\right] - 1} < 1,$$

where the last inequality comes from Lemma 5 under the assumption that $b_A > b_B$. Recall that ω_{0A}/ω_{0B} depends only on a_{0A}/a_{0B} and does not depend on τ. From Proposition 1, Q_B/Q_A increases as τ falls. Taking this and the fact that $N_A < N_B$ into account, it is sufficient to show that $d\delta_{xB} - d\delta_{dA} = \delta_{xB}\hat{\delta}_{xB} - \delta_{dA}\hat{\delta}_{dA} > 0$ in response to a fall in τ, to establish that N_A/N_B declines in this case. Under Pareto-distributed productivity,

$$\frac{\delta_{xB}\hat{\delta}_{xB} - \delta_{dA}\hat{\delta}_{dA}}{-\hat{\tau}} = \frac{k\left(\delta_{dA}\hat{\Theta}_{dA} - \delta_{xB}\hat{\Theta}_{xB}\right)}{-\hat{\tau}} = k\frac{(\delta_{dB}\delta_{xB} - \delta_{dA}\delta_{xA})(\delta_{dA} - \delta_{xA})}{\Delta} > 0,$$

where the second equality comes from (22) and the inequality is obtained by Lemma 4 and the fact that under the Pareto assumption $\delta_{dA} + \delta_{xA} = \delta_{dB} + \delta_{xB} = kf_{\mathrm{e}}$. This proves that N_B increases as τ falls when $b_A > b_B$. Since changes in τ do not affect labour market tightness, x_{0B} and x_B, the only effect on the unemployment rate u_B is through N_B, and hence the unemployment rate in the flexible country increases in response to trade liberalization.

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REFERENCES

AGELL, J. and LUNDBORG P. (1995), "Fair Wages in the Open Economy", *Economica*, **62**, 335–351.

ALESSANDRIA, G. and DELACROIX, A. (2008), "Trade and the (Dis)Incentive to Reform Labor Markets: The Case of Reform in the European Union", *Journal of International Economics*, **75**, 151–166.

AMITI, M. and PISSARIDES, C. (2005), "Trade and Industrial Location with Heterogeneous Labour", *Journal of International Economics*, **67**, 392–412.

BERNARD, A. B. and JENSEN, B. J. (1995), "Exporters, Jobs, and Wages in US Manufacturing: 1976–87", *Brookings Papers on Economic Activity: Microeconomics*, 67–112.

BLANCHARD, O. and GALÍ, J. (2008), "Labor Markets and Monetary Policy: A New-Keynesian Model with Unemployment" (NBER Working Paper No. 13897).

BLANCHARD, O. and WOLFERS, J. (2000), "The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence", *Economic Journal*, **110**, C1–C33.

BOTERO, J. C., DJANKOV, S., LA PORTA, R., LOPEZ-DE-SILANES, F. and SHLEIFER, A. (2004), "The Regulation of Labor", *Quarterly Journal of Economics*, **119**, 1339–1382.

BRECHER, R. (1974), "Minimum Wage Rates and the Pure Theory of International Trade", *Quarterly Journal of Economics*, **88**, 98–116.

BRECHER, R. (1992), "An Efficiency-Wage Model with Explicit Monitoring: Unemployment and Welfare in an Open Economy", *Journal of International Economics*, **32**, 179–191.

BRÜGEMANN, B. (2003), "Trade Integration and the Political Support for Labor Market Rigidity" (Yale University; http://www.econ.yale.edu/ bb338).

CHOR, D. (2006), "Unpacking Sources of Comparative Advantage: A Quantitative Approach" (Singapore Management University; http://www.mysmu.edu/faculty/davinchor).

COPELAND, B. (1989), "Efficiency Wages in a Ricardian Model of International Trade", *Journal of International Economics*, **27**, 221–244.

COSTINOT, A. (2009), "On the Origins of Comparative Advantage", *Journal of International Economics*, **77**, 255–264.

CUÑAT, A. and MELITZ, M. (2007), "Volatility, Labor Market Flexibility, and the Pattern of Comparative Advantage" (NBER Working Paper No. 13062).

DAVIDSON, C., MARTIN, L. and MATUSZ, S. (1988), "The Structure of Simple General Equilibrium Models with Frictional Unemployment", *Journal of Political Economy*, **96**, 1267–1293.

DAVIDSON, C., MARTIN, L. and MATUSZ, S. (1999), "Trade and Search Generated Unemployment", *Journal of International Economics*, **48**, 271–299.

DAVIDSON, C. and MATUSZ, S. (2006*a*), "Long-run Lunacy, Short-run Sanity: A Simple Model of Trade with Labor Market Turnover", *Review of International Economics*, **14**, 261–276.

DAVIDSON, C. and MATUSZ, S. (2006*b*), "Trade Liberalization and Compensation", *International Economic Review*, **47**, 723–747.

DAVIS, D. (1998), "Does European Unemployment Prop Up American Wages? National Labor Markets and Global Trade", *American Economic Review*, **88**, 478–494.

DAVIS, D. and HARRIGAN, J. (2007), "Good Jobs, Bad Jobs, and Trade Liberalization" (Columbia University; http://www.columbia.edu/ drd28).

DEMIDOVA, S. (2008), "Productivity Improvements and Falling Trade Costs: Boon or Bane?" *International Economic Review*, **49**, 1437–1462.

EGGER, H. and KREICKEMEIER, U. (2009), "Firm Heterogeneity and the Labour Market Effects of Trade Liberalization", *International Economic Review*, **50**, 187–216.

FARIÑAS, J. C. and MARTÍN-MARCOS, A. (2007), "Exporting and Economic Performance: Firm-Level Evidence of Spanish Manufacturing", *The World Economy*, **30**, 618–646.

FELBERMAYR, G., PRAT, J. and SCHMERER, H.-J. (2008), "Globalization and Labor Market Outcomes: Wage Bargaining, Search Frictions, and Firm Heterogeneity" (IZA Discussion Paper No. 3363).

HARRIS, J. and TODARO, M. (1970), "Migration, Unemployment and Development: A Two-Sector Analysis", *American Economic Review*, **60**, 126–142.

HELPMAN, E. and KRUGMAN, P. R. (1985), *Market Structure and Foreign Trade* (Cambridge: MIT Press).

HELPMAN, E. and ITSKHOKI, O. (2007), "Labor Market Rigidities, Trade and Unemployment" (NBER Working Paper No. 13365).

HELPMAN, E. and ITSKHOKI, O. (2009*a*), "Labor Market Rigidities, Trade and Unemployment" (CEPR Discussion Paper No. 7502).

HELPMAN, E. and ITSKHOKI, O. (2009*b*), "Labor Market Rigidities, Trade and Unemployment: A Dynamic Model" (Harvard University; http://www.economics.harvard.edu/faculty/helpman).

HELPMAN, E., ITSKHOKI, O. and REDDING, S. J. (2009), "Inequality and Unemployment in a Global Economy" (CEPR Discussion Paper No. 7353).

HOON, H. T. (2001), "Adjustment of Wages and Equilibrium Unemployment in a Ricardian Global Economy", *Journal of International Economics*, **54**, 193–209.

HOSIOS, A. J. (1990), "Factor Market Search and the Structure of Simple General Equilibrium Models", *Journal of Political Economy*, **98**, 325–355.

JONES, R. W. (1965), "The Structure of Simple General Equilibrium Models", *Journal of Political Economy*, **73**, 557–572.

KREICKEMEIER, U. and NELSON, D. (2006), "Fair Wages, Unemployment and Technological Change in a Global Economy", *Journal of International Economics*, **70**, 451–469.

LEVCHENKO, A. (2007), "Institutional Quality and International Trade", *Review of Economic Studies*, **74**, 791–819.

MATUSZ, S. (1986), "Implicit Contracts, Unemployment and International Trade", *Economic Journal*, **96**, 71–84.

MELITZ, M. (2003), "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", *Econometrica*, **71**, 1695–1725.

MITRA, D. and RANJAN, P. (2007), "Offshoring and Unemployment" (NBER Working Paper No. 13149).

MOORE, M. P. and RANJAN, P. (2005), "Globalisation vs. Skill-Biased Technological Change: Implications for Unemployment and Wage Inequality", *Economic Journal*, **115**, 391–422.

NICKELL, S. (1997), "Unemployment and Labor Market Rigidities: Europe Versus North-America", *Journal of Economic Perspectives*, **11**, 55–74.

NICKELL, S., NUNZIATA, L., OCHEL, W. and QUINTINI, G. (2003), "The Beveridge Curve, Unemployment and Wages in the OECD from the 1960s to the 1990s", in Aghion, P., Frydman, R., Stiglitz, J. and Woodford, M. (eds) *Knowledge, Information and Expectations in Modern Macroeconomics: In Honor of Edmund Phelps* Princeton: (Princeton University Press).

NUNN, N. (2007), "Relationship-Specificity, Incomplete Contracts, and the Pattern of Trade", *Quarterly Journal of Economics*, **122**, 569–600.

PISSARIDES, C. A. (2000), *Equilibrium Unemployment Theory*, 2nd edn (Cambridge: MIT Press).

STOLE, L. A. and ZWIEBEL, J. (1996*a*), "Organizational Design and Technology Choice under Intrafirm Bargaining", *American Economic Review*, **86**, 195–222.

STOLE, L. A. and ZWIEBEL, J. (1996*b*), "Intra-Firm Bargaining under Non-Binding Contracts", *Review of Economic Studies*, **63**, 375–410.