Labor Market Rigidities, Trade and Unemployment*

Elhanan Helpman
Harvard University and CIFAR

Oleg Itskhoki
Harvard University

August 17, 2007

Abstract

We study a two-country two-sector model of international trade in which one sector produces homogeneous products while the other produces differentiated products. The differentiated-product industry has firm heterogeneity, monopolistic competition, search and matching in its labor market, and wage bargaining. Some of the workers searching for jobs end up being unemployed. Countries are similar except for frictions in their labor markets. We study the interaction of labor market rigidities and trade impediments in shaping welfare, trade flows, productivity, price levels and unemployment rates. We show that both countries gain from trade but that the flexible country—which has lower labor market frictions—gains proportionately more. A flexible labor market confers comparative advantage; the flexible country exports differentiated products on net. A country benefits by lowering frictions in its labor market, but this harms the country's trade partner. And the simultaneous proportional lowering of labor market frictions in both countries benefits both of them. The model generates rich patterns of unemployment. Specifically, trade integration—which benefits both countries—may raise their rates of unemployment. Moreover, differences in rates of unemployment do not necessarily reflect differences in labor market rigidities; the rate of unemployment can be higher or lower in the flexible country. Finally, we show that the flexible country has both higher total factor productivity and a lower price level, which operates against the standard Balassa-Samuelson effect.

Keywords: labor market frictions, unemployment, productivity, trade, interdependence
JEL Classification: F12, F16, J64

*We thank Pol Antràs and Stephen Redding for comments, Jane Trahan for editorial assistance, and Helpman thanks the National Science Foundation for financial support.

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

Indeed, measures of labor 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 one hundred (where higher values represent larger rigidities). Importantly, countries with very different development levels may have similar labor 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 (which is 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 three and New Zealand has an index of seven, all significantly below the OECD average. Yet some of the much poorer countries also have very flexible labor markets, e.g., both Uganda and Togo have an index of seven.

We develop in this paper a two-country model of international trade in order to study the effects of labor market frictions on trade flows, productivity, price levels, welfare and unemployment. We are particularly interested in the impact of a country's labor market rigidities on its trade partner, and the differential impact of lower trade impediments on countries with different labor market institutions. Blanchard and Wolfers (2000) emphasize the need to allow for interactions between shocks and differences in labor market institutions 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. (2002) emphasize changes over time in labor market institutions as important determinants of the evolution of unemployment in OECD countries. While these studies use rich data on labor market institutions, our theoretical model parametrizes labor market

[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 May 20, 2007. It is important to note that other measures of labor market characteristics are available for OECD countries; see Nickell (1997) and Blanchard and Wolfers (2000).

rigidities in a simple way, which can be related to a variety of labor market features, such as the cost of vacancies and the efficiency of matching in labor markets. Nevertheless, we show that this representation of labor market institutions generates rich patterns of unemployment in response to both variation across countries in labor market frictions and changes in trade impediments.

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.[2] Another approach, due to Matusz (1986), uses implicit contracts. A third approach, exemplified by Copland (1989), incorporates efficiency wages into trade models.[3] 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 labor markets. While two early studies extended the two-sector model of Jones (1965) to economies with this type of labor market friction,[4] Davidson, Martin and Matusz (1999) provide a particularly valuable analysis of international trade with labor markets that are characterized by Mortensen-Pissarides-type search and matching frictions.[5] In their model differences in labor market frictions, both across sectors and across countries, generate Ricardian type comparative advantage.[6]

Our two-sector model incorporates Mortensen-Pissarides-type frictions into a sector that produces differentiated products; another sector manufactures homogeneous goods under constant returns to scale. In the differentiated-product sector heterogeneous firms compete monopolistically, 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.[7] As in models with home market effects, it is costly to trade differentiated products. Moreover, there are fixed and variable trade costs.

We develop the model in stages. The next section describes demand, product markets, labor markets, and the determinants of wages and profits in a closed economy. In Section 3 we examine the general equilibrium impact of labor market rigidities on economic outcomes in a closed economy, and show that the relationship between unemployment and labor market rigidities is hump-shaped.

The model is extended to a world of two trading countries in Section 4. We focus on an equilibrium 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 labor market institutions on trade, welfare, productivity, price levels and real exchange rates in Section 5. There we also study the differential impact of lower trade impediments on countries with different labor market institutions. Impor-

[2] 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.

[3] See also Brecher (1992) and Hoon (2001).

[4] See Davidson, Martin and Matusz (1988) and Hosios (1990).

[5] See Pissarides (2000) for the theory of search and matching in labor markets.

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

[7] A surge of papers has incorporating labor market frictions into models with heterogeneous firms. Egger and Kreickemeier (2006) 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. Mitra and Ranjan (2007) examine offshoring in an environment with search and matching.

tantly, 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 labor market institutions.[8] However, the country with lower frictions in the labor market gains from trade proportionately more. The lowering of labor market frictions in one country raises its welfare, but it harms the trade partner. Nevertheless, both countries benefit from simultaneous proportional improvements in labor market institution across the world.

In Section 5 we also show that labor market flexibility is a source of comparative advantage. The flexible country has a larger fraction of exporting firms and it exports differentiated products on net. Moreover, the share of intra-industry trade is smaller and the total volume of trade is larger the larger are the differences in labor market rigidities. We also show that welfare and productivity are higher in the more flexible country, and that its price level is lower. As a result, productivity is negatively correlated with the price level and positively correlated with the real exchange rate, which is in the opposite direction to the classical Balassa-Samuelson effect. In other words, differences in labor market institutions can operate against this effect.

In Section 6 we take up unemployment. We show that in an open economy the relationship between unemployment and labor market rigidities is hump-shaped, just like it is in a closed economy. An improvement in labor market institutions decreases the sectoral rate of unemployment and induces more workers to search for jobs in the differentiated-product sector, which has the higher sectoral rate of unemployment. These two effects impact unemployment in opposite directions, with the latter dominating in highly rigid labor markets and the former dominating in highly flexible labor markets. As a result, unemployment initially increases and then decreases as a country improves its labor market institutions, starting from high levels of rigidity. Finally, a country's improvement in labor market institutions reduces unemployment in its trading partner by inducing a labor reallocation from the differentiated-product sector to the homogenous product sector.

We also show that lowering trade impediments can increase unemployment in one or both countries, despite its positive welfare effects, and that the interaction between trade impediments and labor market rigidities produces rich patterns of unemployment. Specifically, differences in rates of unemployment do not necessarily reflect differences in labor market institutions; the flexible country can have higher or lower unemployment, depending on the height of trade impediments and the levels of labor market frictions.

The unemployment results depend on certain structural features of the model, while the welfare, productivity, and trade pattern results are less sensitive to these characteristics. In particular, the impact of trade liberalization on unemployment as a function of differences in labor market rigidities depends on the fact that trade impediments are higher in the sector with higher labor market frictions (i.e., the differentiated-product sector). Under these circumstances trade liberalization induces an expansion of activity in the sector with the higher *sectoral* rate of unemployment. It will become clear from the analysis how the results would differ if protection were higher in the

[8] We also show that the combination of variable trade costs and differences in labor market institutions have to satisfy a certain condition for the equilibrium to have incomplete specialization in both countries. However, the welfare results extend to cases with partial or full specialization.

sector with lower frictions in the labor market. To avoid a taxonomy of cases, however, we focus on one case only.

The last section summarizes some of the main insights and states our conclusions.

2 Preliminaries

In order to discuss the links between trade and employment, we develop in this section the building blocks of our analytical model. They consist of a demand structure, technologies, product market structures, determinants of wages and profits, and the structure of the labor market. After describing these ingredients in some detail, we discuss in the next section general equilibrium features of a closed economy, before proceeding to analyze general equilibrium interactions in a two-country world.

2.1 Preferences and Demand

Consider an economy with a representative agent who consumes a homogenous product q_0 and a continuum of brands of a differentiated product. The real consumption index of the differentiated product is a constant elasticity of substitution function

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

In this formulation $q(\omega)$ represents 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.[9] As is well known, these preferences yield a constant elasticity demand function

$$q(\omega) = Dp(\omega)^{-\frac{1}{1-\beta}}$$

for brand ω, where $p(\omega)$ is its price, $1/(1-\beta) > 1$ is its demand elasticity, and D is its demand level. The demand level D equals $QP^{1/(1-\beta)}$, where

$$P = \left[\int_{\omega \in \Omega} p(\omega)^{-\frac{\beta}{1-\beta}} d\omega \right]^{-\frac{1-\beta}{\beta}}$$

is the ideal price index of Q.[10]

Next assume that the consumer's preferences between the homogeneous product, q_0, and the consumption index of the differentiated product, Q, are represented by the quasi-linear utility

[9] Alternatively, we could interpret Q to be a homogeneous product and the $q(\omega)$s to be intermediate inputs.

[10] A solution of the consumer's allocation problem for a spending level E_Q on varieties of the differentiated product yields the demand functions $q(\omega) = Dp(\omega)^{-1/(1-\beta)}$ with $D = E_Q / \int_{\omega \in \Omega} p(\omega)^{-\beta/(1-\beta)} d\omega$. Using the formula for the price index P and the fact that $E_Q = PQ$ then implies that $D = QP^{1/(1-\beta)}$.

function[11]

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

The restriction $\zeta < \beta$ ensures that the varieties are better complements for each other than for the outside good q_0.[12] 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. We therefore normalize the price of q_0 to equal one, so that both $p(\omega)$ and P are measured relative to the price of the homogeneous product.

The utility function $\mathbb{U}$ implies that a consumer with total consumption spending E who faces the price index P for the differentiated product chooses $Q = P^{-1/(1-\zeta)}$, and $q_0 = E - P^{-\zeta/(1-\zeta)}$.[13] Under these circumstances the *indirect* utility function is

$$\mathbb{V} = E + \frac{1-\zeta}{\zeta} P^{-\frac{\zeta}{1-\zeta}} \tag{2}$$

and the demand level D satisfies $D = Q^{-(\beta-\zeta)/(1-\beta)}$. As a result, the demand function for brand ω can be expressed as

$$q(\omega) = Q^{-\frac{\beta-\zeta}{1-\beta}} p(\omega)^{-\frac{1}{1-\beta}}. \tag{3}$$

As usual, the indirect utility function $\mathbb{V}$ is increasing in spending and declining in price.[14] Therefore lower values of Q, where $Q = P^{-1/(1-\zeta)}$, represent lower welfare. Lower values of Q imply in turn higher demand levels, as is apparent from (3). Therefore, in the model, higher demand levels represent lower levels of competitiveness, because the demand level facing an individual firm is higher the higher the price index P is, and the latter is higher either because prices of competing brands are higher or there are fewer of them. In the analysis of equilibria we shall characterize equilibrium values of Q, from which we shall infer welfare levels.

2.2 Technologies and Market Structure

All goods are produced with labor, which is the only factor of production. The homogeneous product requires one unit of labor per unit output and the market for this product is competitive. When h_0 workers are employed in the production of the homogeneous product, its output level equals h_0.

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 homogenous 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 the parameter θ; a θ-firm requires

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

[12] This model can be analyzed without the restriction $\zeta > 0$. This assumption, however, allows us to avoid discussing alternative special cases and brings out some of the interesting results in a clear way.

[13] 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 PQ increases when P falls.

[14] The second term on the right hand side of $\mathbb{V}$ represents consumer surplus.

$1/\theta$ 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.

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. If a firm with productivity θ hires h workers, then (3) implies that its revenue equals $R = Q^{-(\beta-\zeta)} (\theta h)^{\beta}$. This revenue has to cover wages and the fixed cost f_d for production to be profitable.[15] If revenue is insufficient to cover these costs for all employment levels h, the firm closes shop and exits the industry. Otherwise the firm chooses an employment level that maximizes profits. Anticipating these choices after entry, the firm enters if and only if its expected operating profits, i.e., expected revenue minus labor costs minus fixed cost of production, are sufficiently high to cover its entry cost. We elaborate on these decisions below.

2.3 Wages and Profits

There are no labor frictions in the homogeneous-product sector, which means that workers can be replaced there at no cost. As a result the labor market is competitive in this industry and all manufacturers pay the same wages. Since the market for this product is also competitive and the value of the marginal product of labor equals one, the wage rate in this industry equals one.

Unlike the homogeneous-product sector, labor market frictions exist in the differentiated-product industry. In particular, firms in this industry face hiring costs of labor. A θ-firm producing variety ω that seeks to employ h workers bears the hiring cost bh in terms of the homogeneous good, where b depends on labor market conditions, to be discussed 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. We assume that workers exploit this bargaining power in the wage determination process.

Following Stole and Zwiebel (1986), we assume that the workers and the firm engage in multilateral bargaining that leads to the distribution of revenue $R = Q^{-(\beta-\zeta)} (\theta h)^{\beta}$ according to Shapley values. This results in a division of revenue between the firm and its workers in the proportions $1/(1+\beta)$ and $\beta/(1+\beta)$, respectively; that is, the firm gets a share $1/(1+\beta)$ of the revenue while the workers get a share $\beta/(1+\beta)$.[16] This result is derived under the assumption that at the bargaining stage a worker's outside option is unemployment, and the value of unemployment is normalized to zero (no unemployment benefits). Anticipating the outcome of this bargaining game, a θ-firm that wants to stay in the industry chooses an employment level that maximizes its share of revenue minus hiring costs. That is, it chooses h to maximize $(1+\beta)^{-1} Q^{-(\beta-\zeta)} (\theta h)^{\beta} - bh$. The solution to this problem yields

$$h(\Theta) = \left[\frac{\beta}{b(1+\beta)}\right]^{\frac{1}{1-\beta}} Q^{-\frac{\beta-\zeta}{1-\beta}} \Theta, \tag{4}$$

[15] At this point we focus on a closed economy. When we extent the model to an open economy we shall revisit the calculation of profits, accounting for exports.

[16] See Acemoglu, Antrás and Helpman (2007) for a proof.

where $\Theta \equiv \theta^{\beta/(1-\beta)}$ is an alternative measure of productivity. It follows from this solution that more-productive firms hire more workers, and all firms hire more workers the lower the hiring cost b is.

Next note that a Θ-firm has revenue $R(\Theta) = Q^{-(\beta-\zeta)}\Theta^{1-\beta}h(\Theta)^{\beta}$, and the fraction $\beta/(1+\beta)$ of this revenue is paid out as wages. Therefore the wage rate paid by a Θ-firm is $w(\Theta) = \beta R(\Theta) / [(1+\beta)\, h(\Theta)]$, which, using (4), implies

$$w(\Theta) = b. \tag{5}$$

Evidently, all firms pay the same wage, independently of their productivity.[17]

Operating profits of a Θ-firm are $\pi(\Theta) = (1+\beta)^{-1} R(\Theta) - bh(\Theta) - f_d$, which, using $R(\Theta) = Q^{-(\beta-\zeta)}\Theta^{1-\beta}h(\Theta)^{\beta}$ and (4), can be expressed as

$$\pi(\Theta) = \frac{1-\beta}{1+\beta}\left[\frac{\beta}{b(1+\beta)}\right]^{\frac{\beta}{1-\beta}} Q^{-\frac{\beta-\zeta}{1-\beta}}\Theta - f_d. \tag{6}$$

Evidently, more-productive firms have higher profits, and there is a cutoff Θ_d that satisfies

$$\pi(\Theta_d) = 0. \tag{7}$$

If Θ_d is in the interior of the support of the distribution of Θ, which we take to be the interval $[\Theta_{\min}, \infty)$, then entrants whose productivity is below Θ_d choose to close shop and exit, while those with Θ above this cutoff stay and make money. If, on the other hand, $\Theta_d \leq \Theta_{\min}$, then every entrant stays in the industry. In either case a firm that stays in the industry chooses an optimal employment level and its revenue covers its hiring costs, fixed cost of manufacturing, and wages. It follows that all firms with Θ above $\Theta_m \equiv \max\{\Theta_d, \Theta_{\min}\}$ end up manufacturing.

Let $G(\Theta)$ be the cumulative distribution of Θ. Then a potential entrant's expected operating profits are $\int_{\Theta_m}^{\infty} \pi(\Theta)\, dG(\Theta)$. A firm enters the industry if these expected profits are at least as large as the entry cost f_e; otherwise it does not enter. Since entry is free, in an equilibrium with positive entry

$$\int_{\Theta_m}^{\infty} \pi(\Theta)\, dG(\Theta) = f_e. \tag{8}$$

Finally note that (1) can be used to compute the real consumption index Q from the output levels of active firms. A Θ-firm produces an output level $q(\Theta) = \Theta^{(1-\beta)/\beta}h(\Theta)$, where $h(\Theta)$ is

[17] The analysis can be carried out with a more general hiring function, bh^{γ}, where $\gamma > \beta$. We discuss this more general specification in the Appendix, where we show that for $\gamma \neq 1$ wages vary across firms. In particular, when $\gamma > 1$, more-productive firms pay higher wages. Since more-productive firms are larger, both because they are more productive and because they employ more workers, this also implies that larger firms (as measured by output or revenue) pay higher wages, in line with the evidence (see Katz and Summers, 1989). On the other hand, $\gamma < 1$ has the counterfactual implication that larger firms pay lower wages. It can also be shown that similar wage structures emerge when multilateral bargaining is replaced with bilateral bargaining between the firm and every worker, so that the wage rate equals a fraction of the value of the marginal product of labor. In other words, the correlation between firm size and wages is not driven by multilateral bargaining. Yashiv (2000) estimates $\gamma > 1$ from Israeli data, and Merz and Yashiv (2007) estimate $\gamma > 1$ from U.S. data.

given in (4). Therefore, if a measure M of firms have entered the industry, then

$$Q = \left[M \int_{\Theta_m}^{\infty} \Theta^{1-\beta} h\left(\Theta\right)^{\beta} dG\left(\Theta\right) \right]^{\frac{1}{\beta}}. \tag{9}$$

2.4 Labor Market

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 a continuum of identical families of this type, and the measure of these families equals one.[18]

A family allocates workers to sectors—N workers to the differentiated-product sector and $L-N$ 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. The homogeneous-product sector has no labor market frictions and every job pays a wage of one. Therefore workers seeking jobs in this sector expect to be employed with probability one and to obtain a wage $w_0 = 1$.

Unlike the homogeneous-product sector, labor market frictions exist in the differentiated-product sector. Some workers seeking jobs in this sector become unemployed when the sector's aggregate employment falls short of the number of job seekers. Aggregate employment in the sector is

$$H = M \int_{\Theta_m}^{\infty} h\left(\Theta\right) dG\left(\Theta\right). \tag{10}$$

Therefore there is unemployment when $H < N$.

An individual searching for work in the differentiated-product sector expects to find a job with probability H/N, and conditional on finding a job, his expected wage rate is

$$\bar{w} = \frac{M}{H} \int_{\Theta_m}^{\infty} w\left(\Theta\right) h\left(\Theta\right) dG\left(\Theta\right),$$

where $w\left(\Theta\right)$ is given in (5). It follows that the expected income of such a worker is $\bar{w}H/N$. A family allocates workers to sectors so as to maximize the family's aggregate wage income. Therefore a family chooses $0 < N < L$ only if $\bar{w}H/N = w_0 = 1$, so that the average income of the N workers in the differentiated-product sector is the same as the average income of the $L-N$ workers in the homogeneous-product sector. As a result,

$$N = M \int_{\Theta_m}^{\infty} w\left(\Theta\right) h\left(\Theta\right) dG\left(\Theta\right). \tag{11}$$

In other words, the aggregate wage bill in the differentiated-product sector—the right hand side of (11)—just equals the number of workers searching for jobs in this sector.[19]

[18] When preferences are homothetic rather than quasi-linear, the family interpretation is useful but not essential. See the Appendix for a discussion of homothetic preferences, risk aversion and ex-post inequality.

[19] One can generalize the model to allow wages to vary in the homogeneous product sector. A simple modification would be the following: Suppose that the homogeneous-product sector uses labor and a sector-specific input under constant returns to scale. Then the wage rate in this sector, w_0, is a decreasing function of labor employment, $L-N$.

We now interpret the parameter b of the cost-of-hiring function bh. As we have seen, N workers search for work in the differentiated-product sector and only H of them find a job. Assuming that to attract workers firms have to post vacancies—which are then only partially filled by individuals searching for jobs—implies that b depends on the degree of tightness of the labor market, as measured by $x = H/N$. This is a standard implication of the Mortensen-Pissarides model of search and unemployment (see, for example, Pissarides (2000)). In particular, we assume that

$$b = ax^{\alpha}, \quad x \equiv \frac{H}{N}, \tag{12}$$

where $a > 1$ and α is positive.[20] We consider a to be a measure of frictions in the labor market; higher values of a can result from higher costs of vacancies or from less efficient matching between workers and firms.[21] We shall say that a country has better labor market institutions if it has a smaller a.

This completes our description of the building blocks. In the next section we discuss equilibria in a closed economy in order to clarify the impact of labor market frictions on unemployment. The rate of unemployment is given by $u = (N - H)/L$, which is a function of the number of individuals searching for jobs in the differentiated-product sector and the employment level in this sector. This unemployment rate can be expressed as

$$u = \frac{N}{L}(1 - x), \tag{13}$$

which is a weighted average of the sectoral unemployment rates, where the weights are the fractions of workers seeking jobs in every sector. Since there is full employment in the homogeneous-product sector, this weighted average equals the share of workers seeking jobs in the differentiated-product sector, N/L, times the unemployment rate in that sector, $1 - x$. It follows that the unemployment rate can rise either because it rises in the differentiated-product sector or because more individuals search for work in the sector with higher unemployment, which is the differentiated-product sector.

In a more general framework one would allow frictional unemployment in both sectors. Yet in this case too the economy's unemployment rate would be a weighted average of the sectoral unemployment rates, with the fractions of workers seeking jobs in various sectors serving as weights.

In this event the left hand side of (11) has to be replaced with $w_0(L - N)N$, where $w_0(\cdot)$ is a decreasing function. The other equilibrium conditions do not change.

[20] We focus on the case $a > 1$. For $a = 1$ our equilibrium system describes a full-employment economy. Our description of an equilibrium is not complete for the case $a < 1$. One way to handle the case $a < 1$ is to assume that whenever there is a tendency toward overemployment, firms offer workers a fixed payment in order to join the firm and after they join there is bargaining of the type described in the text. In this event there exists a well defined equilibrium with full employment.

[21] To justify this formulation, let $a_1 V^{\eta} N^{1-\eta}$, $a_1 > 0$, $0 < \eta < 1$, be a matching function, where V represents aggregate vacancies and N represents the number of individuals searching for work. Then $H = a_1 V^{\eta} N^{1-\eta}$, which implies $V/H = a_1^{-1/\eta} x^{(1-\eta)/\eta}$. It follows that a firm that wants to hire h workers needs to post $v = a_1^{-1/\eta} x^{(1-\eta)/\eta} h$ vacancies. Next assume that the cost of posting v vacancies is $a_2 v$ in terms of the homogeneous good, where $a_2 > 0$ is a parameter. Then a firm that wants to hire h workers has to bear the hiring cost $ax^{\alpha}h$, where $a = a_2/a_1^{1/\eta}$ and $\alpha = (1 - \eta)/\eta > 0$. That is, a is rising with the cost of posting vacancies, a_2, and declining in the productivity of the matching technology, a_1.

As a result, changes in the rate of unemployment would result either from changes in sectoral unemployment rates or from the relocation of workers across sectors. Our simple structure captures these channels of influence, and it is analytically more convenient.

3 Equilibrium in a Closed Economy

To characterize the equilibrium of a closed economy, substitute the equations for the employment levels, wages and profits of individual firms, (4)-(6), into the equilibrium conditions (7)-(11). The resulting five equations together with (12) can then be solved for the cutoff Θ_d, the measure of tightness in the labor market x, real consumption Q, the number of entrants M, employment H, and the number of individuals searching for work in the differentiated-product sector, N.

First divide (10) by (11), using (4), (5) and (12), to obtain

$$\left.\begin{aligned} x &= a^{-\frac{1}{1+\alpha}}, \\ w(\Theta) = b &= a^{\frac{1}{1+\alpha}}. \end{aligned}\right\} \tag{14}$$

These imply that there is equilibrium unemployment (i.e., $x < 1$ whenever $a > 1$); tightness in the labor market and wages in the differentiated-product sector depend *only* on labor market institutions; and countries with better labor market institutions have tighter labor markets and lower wages in the differentiated-product sector.[22] Importantly, features of the economy other than labor market frictions, such as entry costs or the distribution of productivity, impact neither x nor $w(\Theta)$.[23]

Unemployment emerges because workers search for jobs in the high-wage high-unemployment sector, and given the economy's structural features, it is not possible to fill these high-wage jobs without unemployment. As a result, unemployment plays an allocative role. Nevertheless, it can be shown that our equilibrium is generally not constrained Pareto-efficient (due to bargaining and search-and-matching externalities), in the sense that a planner facing the same frictions as the market can improve the allocation of resources and raise welfare.

Now consider an equilibrium with $\Theta_m = \Theta_d > \Theta_{\min}$ (we shall see below the circumstances under which this type of equilibrium emerges). Then, using the profit equation (6), the equilibrium cutoff condition (7) and the free entry condition (8) yield

$$f_d \int_{\Theta_d}^{\infty} \left(\frac{\Theta}{\Theta_d} - 1 \right) dG(\Theta) = f_e.$$

The left hand side of this equation is declining in Θ_d. As a result, if there exists a $\Theta_d > \Theta_{\min}$ that solves this equation, it is unique. Indeed, such a solution exists if and only if $\left(\bar{\Theta}/\Theta_{\min}\right) > 1 + f_e/f_d$,

[22] Recall that we measure wages in terms of the homogeneous product, which is the numeraire; real wages depend also on the price index of the differentiated product (see Section 5.3).

[23] We show in the Appendix that with the more general hiring function bh^{γ}, $\gamma \neq 1$, equilibrium tightness in the labor market and wages depend on those characteristics.

where $\bar{\Theta}$ is the unconditional mean of Θ.[24] In this type of equilibrium the cutoff Θ_d does not depend on labor market institutions; it depends on the entry cost, the fixed production cost and the shape of the productivity distribution. The larger the entry cost the lower the cutoff is, and the larger the fixed production cost the higher the cutoff is.

The cutoff condition (7) together with (6) imply

$$\phi_1 \phi_2 \Theta_d = f_d b^{\frac{\beta}{1-\beta}} Q^{\frac{\beta-\zeta}{1-\beta}}, \tag{15}$$

where

$$\phi_1 = \left(\frac{\beta}{1+\beta}\right)^{\frac{\beta}{1-\beta}}, \quad \phi_2 = \frac{1-\beta}{1+\beta}.$$

Therefore, in economies with better labor market institutions, b is smaller and Q is higher. Since the expected wage of every worker equals one, independently of labor market institutions, aggregate income and expenditure is $E = L$, and welfare is higher the higher Q is.[25] It follows that families are better off in countries with better labor market institutions.

Next substitute (4) and (15) into (9) to obtain

$$\phi_2 Q^{\zeta} = M \frac{f_d}{\Theta_d} \int_{\Theta_d}^{\infty} \Theta dG(\Theta). \tag{16}$$

It follows that economies with better labor market institutions, which have higher real consumption Q, have more firms in the differentiated-product sector, M. Finally, substitute (4) and (15) into (11) to obtain

$$\phi_2 N = M \phi_1^{\frac{1-\beta}{\beta}} \frac{f_d}{\Theta_d} \int_{\Theta_d}^{\infty} \Theta dG(\Theta).$$

This condition implies that economies with better labor market institutions, which have more firms in the differentiated-product sector, also have more workers searching for jobs in this sector. Moreover, the number of searching workers per firm, N/M, is independent of labor market frictions. Since x is higher in countries with better labor market institutions, H is also higher in countries with better labor market institutions and proportionately more so than N or M.

Now consider the rate of unemployment (13). Proportional differentiation of this equation yields

$$\hat{u} = \hat{N} - \frac{x}{1-x}\hat{x},$$

[24] Note that the left hand side of the free-entry condition equals $f_d[(\bar{\Theta}/\Theta_{\min}) - 1]$ for $\Theta_d = \Theta_{\min}$, it is declining in Θ_d for $\Theta_d > \Theta_{\min}$, and it goes to zero as $\Theta_d \to \infty$. Therefore there exists a unique solution $\Theta_d > \Theta_{\min}$ if and only if $(\bar{\Theta}/\Theta_{\min}) > 1 + f_e/f_d$. In case the last inequality is not satisfied, the equilibrium of the closed economy has $\Theta_d \leq \Theta_{\min}$. The distribution of productivity can be approximated with a Pareto distribution, for which $G(\Theta) = 1 - (\Theta_{\min}/\Theta)^k$, where $\Theta \geq \Theta_{\min}$ and $k > 2$ (the latter is required for a finite variance). In this case the mean of the distribution is $\bar{\Theta} = \Theta_{\min} k/(k-1)$. Therefore in this case $(\bar{\Theta}/\Theta_{\min}) > 1 + f_e/f_d$ if and only if $k/(k-1) > 1 + f_e/f_d$, i.e., if and only if the shape parameter k is small enough, and this is possible only when $f_e < f_d$ (otherwise $k/(k-1) \leq 1 + f_e/f_d$ for all $k > 2$). However, a smaller value of k implies a larger variance of the productivity distribution. It follows that for $f_e < f_d$ some entering firms choose to exit if and only if the distribution of productivity is sufficiently dispersed.

[25] Wages are the only source of income, because expected profits equal zero after accounting for entry costs.

Figure 1: Unemployment as a function of labor market frictions

where a hat over a variable indicates a proportional rate of change, e.g., $\hat{u} = du/u$. Evidently, improvements in labor market institutions raise x and thereby reduce the rate of unemployment, by reducing the rate of unemployment in the differentiated-product sector. On the other hand, improvements in labor market institutions attract more workers to the differentiated-product sector, i.e., N rises, thereby raising the rate of unemployment. The former dominates if and only if[26]

$$b < 1 + \frac{\beta - \zeta}{\beta\zeta}.$$

This condition is satisfied for small values of b and it is violated for high values of b. As a result, improvements in labor market institutions reduce unemployment when the rigidities in the labor market are small to begin with (i.e., $b = a^{1/(1+\alpha)}$ is small), and they raise unemployment when the labor market rigidities are high. This relationship between b and unemployment is depicted in Figure 1; unemployment starts at zero when $b = 1$, rises with b until it reaches a peak at an intermediate level of labor market frictions, and declines afterwards towards zero.[27] Unemployment is zero when $b = 1$ because in this case $x = 1$, so that there is no unemployment in the differentiated-product sector. And unemployment equals zero when $b \to \infty$ because in this case $N \to 0$, so that no individuals search for jobs in the differentiated-product sector. Importantly, however,

[26] Proof: Recall that $\hat{N} = \hat{M}$. Next note that (15) implies $\hat{Q} = [-\beta/(\beta - \zeta)]\,\hat{b}$ while (16) implies $\hat{M} = \zeta\hat{Q}$. Therefore $\hat{N} = \hat{M} = [-\zeta\beta/(\beta - \zeta)]\,\hat{b}$. From (14) we have $\hat{b} = -\hat{x}$. Therefore

$$\hat{u} = \left(\frac{\zeta\beta}{\beta - \zeta} - \frac{x}{1-x}\right)\hat{x} = \left(\frac{1}{b-1} - \frac{\zeta\beta}{\beta - \zeta}\right)\hat{b}.$$

Since an improvement in labor market institutions reduces b, unemployment declines if and only if the condition in the text holds.

[27] Two assumptions are important for the hump-shaped response of unemployment. First, $\zeta > 0$ ensures that a fall in b, which decreases the sectoral unemployment rate, also leads to an increase in N. Second, the assumption that the unemployment rate in the homogenous product sector is lower than in the differentiated product sector ensures that shifting resources to the latter increases the economy-wide rate of unemployment.

improvements in labor market institutions *raise* welfare, independently of whether unemployment rises or declines.[28]

We summarize the main findings of this section in the following[29]

Proposition 1 *Improvements in labor market institutions: (i) reduce wages in the differentiated-product sector; (ii) raise M and N by the same factor of proportionality; (iii) raise H proportionately more, thereby tightening the labor market; (iv) reduce the rate of unemployment when labor market frictions are low and raise the rate of unemployment when labor market frictions are high; and (v) raise welfare independently of the impact on unemployment.*

4 Open Economies: Preliminaries

In this section we extend the model to a world of two countries, labeled A and B, that trade with each other. Our main interest is in the impact of varying labor market institutions. For this reason we assume that the two countries are identical, except for rigidities in their labor markets. We let a_j be the measure of labor market frictions in country j, $j = A, B$, and we use subscript j to denote variables of country j that are not common to both countries.

Each one of the two countries has the same structural features as the closed economy. Now, however, consumers can purchase foreign products and firms can export. Following Melitz (2003), we assume that the differentiated-product sector bears a fixed cost of exporting f_x in terms of the homogeneous 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. As is common in models with home market effects, we assume that there are no trade frictions in the homogenous-product sector.

If a country-j firm with productivity Θ chooses to serve only the domestic market, then its operating profits are given by (6), where Q on the right hand side is replaced with Q_j and b is replaced with b_j. If, however, such a firm chooses to serve the foreign market as well as the home market, then its operating profits can be derived as follows: Suppose that the firm hires h_j workers who then produce an output $\Theta^{(1-\beta)/\beta} h_j$. Once the firm has paid the fixed export cost, it allocates

[28] We shall use the derived parameter $b = a^{1/(1+\alpha)}$ instead of the more primitive parameter a as our measure of labor market frictions, because this is notationally more convenient. In a more general framework, in which b might depend not only on a, it would be necessary to use a rather than b.

[29] In the text we focus on equilibria with $\Theta_d > \Theta_{\min}$. Note, however, that equilibria with $\Theta_d \leq \Theta_{\min}$ yield similar results. To see why, consider equilibria for $\left(\bar{\Theta}/\Theta_{\min}\right) \leq 1 + f_e/f_d$, in which case $\Theta_m = \Theta_{\min} \geq \Theta_d$. When $\Theta_d \leq \Theta_{\min}$ all entrants produce, and we can substitute the profit function (6) into the free-entry condition (8) to obtain

$$\phi_1 \phi_2 \bar{\Theta} = (f_e + f_d)\, b^{\frac{\beta}{1-\beta}} Q^{\frac{\beta-\zeta}{1-\beta}}.$$

This equation provides a solution to Q; as labor market institutions improve b declines and therefore Q rises. Comparing this equation to (15) one observes that the impact of changes in b on changes in Q are the same in both cases. Proceeding from here step by step with the analysis conducted for the case $\left(\bar{\Theta}/\Theta_{\min}\right) > 1 + f_e/f_d$, we reach the same conclusions, i.e., improvements in labor market institutions raise N and M by the same factor of proportionality, they raise H proportionately more, and they reduce unemployment if and only if $b < 1 + (\beta - \zeta)/(\beta\zeta)$ holds.

this output between the two markets so as to maximize total revenue, where, from (3),

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

In this specification $(-j)$ is the index of the country other than j while 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 these circumstances they demand $Q^{-(\beta-\zeta)/(1-\beta)} (\tau p_{xj})^{-1/(1-\beta)}$ 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, i.e., the same mill prices, $p_j = p_{(-j)}$. The resulting total revenue then becomes $R_j = Z_j^{1-\beta} \Theta^{1-\beta} h_j^{\beta}$, where

$$Z_j = Q_j^{-\frac{\beta-\zeta}{1-\beta}} + \tau^{-\frac{\beta}{1-\beta}} Q_{(-j)}^{-\frac{\beta-\zeta}{1-\beta}}$$

is the effective demand level facing an exporting firm from country j. Such a firm receives the fraction $1/(1+\beta)$ of this revenue when it bargains with its workers. For this reason it chooses employment h_j to maximize $(1+\beta)^{-1} R_j - b_j h_j$, which yields the employment level (4) with Q replaced by Z_j and b replaced by b_j.

To simplify notation, let $I_j(\Theta)$ be an indicator variable that equals one if a Θ-firm in country j exports and zero if it does not. Then the employment level of a Θ-firm in country j can be decomposed into[30]

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

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

$$\left.\begin{aligned} h_{dj}(\Theta) &= \phi_1^{\frac{1}{\beta}} b_j^{-\frac{1}{1-\beta}} Q_j^{-\frac{\beta-\zeta}{1-\beta}} \Theta, \\ h_{xj}(\Theta) &= \phi_1^{\frac{1}{\beta}} b_j^{-\frac{1}{1-\beta}} \tau^{-\frac{\beta}{1-\beta}} Q_{(-j)}^{-\frac{\beta-\zeta}{1-\beta}} \Theta. \end{aligned}\right\} \tag{17}$$

Moreover, a country-j firm with productivity Θ pays wages[31]

$$w_j(\Theta) = b_j, \tag{18}$$

[30] This convenient decomposition is possible with $\gamma = 1$ in the hiring function but not with $\gamma \neq 1$.

[31] Recall that the wage rate equals the fraction $\beta/(1+\beta)$ of revenue divided by h. Using (17) this implies a wage rate equal to b_j, which is independent of the firm's export status. That is, all firms, exporters and nonexporters alike, pay equal wages. This result changes when the cost of hiring is bh^{γ} and $\gamma \neq 1$. In particular, for $\gamma > 1$ exporters pay higher wages than nonexporters (see Appendix). Fariñas and Martín-Marcos (2007) provide evidence to the effect that exporting firms pay higher wages.

and its operating profits are

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

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

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

It follows 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

$$\pi_{xj}(\Theta_{xj}) = 0, \tag{20}$$

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

$$\pi_{dj}(\Theta_{dj}) = 0. \tag{21}$$

We shall consider equilibria in which $\Theta_{xj} > \Theta_{dj} > \Theta_{\min}$ (conditions for such equilibria are discussed below), i.e., equilibria with high-productivity firms that can profitably export and supply the domestic market, indermediate-productivity firms that cannot profitably export but can profitably supply the domestic market, and low-productivity firms that cannot make money and exit. Under these circumstances the free-entry condition (8) is replaced with

$$\int_{\Theta_{dj}}^{\infty}\pi_{dj}(\Theta)\,dG(\Theta) + \int_{\Theta_{xj}}^{\infty}\pi_{xj}(\Theta)\,dG(\Theta) = f_e. \tag{22}$$

The first integral represents expected profits from domestic sales while the second integral represents expected profits from foreign sales.

We next use (1) to compute the real consumption index Q_j from the output levels of active firms. A Θ-firm produces an output level $q_{dj}(\Theta) = \Theta^{(1-\beta)/\beta}h_{dj}(\Theta)$ for domestic sales if $\Theta \geq \Theta_{dj}$ and an output level $q_{xj}(\Theta) = \Theta^{(1-\beta)/\beta}h_{xj}(\Theta)$ for export if $\Theta \geq \Theta_{xj}$. Foreign buyers consume only $q_{xj}(\Theta)/\tau$ units of these exportables due to the variable trade costs. Therefore, if a measure M_j of firms have entered the industry in country j, then

$$Q_j = \left[M_j\int_{\Theta_{dj}}^{\infty}\Theta^{1-\beta}h_{dj}(\Theta)^{\beta}\,dG(\Theta) + M_{(-j)}\tau^{-\beta}\int_{\Theta_{x(-j)}}^{\infty}\Theta^{1-\beta}h_{x(-j)}(\Theta)^{\beta}\,dG(\Theta)\right]^{\frac{1}{\beta}}. \tag{23}$$

In addition, employment in active firms in country j's differentiated-product sector equals

$$H_j = M_j \left[\int_{\Theta_{dj}}^{\infty} h_{dj}(\Theta)\, dG(\Theta) + \int_{\Theta_{xj}}^{\infty} h_{xj}(\Theta)\, dG(\Theta) \right], \tag{24}$$

and the number of workers searching for jobs in this industry equals

$$N_j = M_j \left[\int_{\Theta_{dj}}^{\infty} w_j(\Theta)\, h_{dj}(\Theta)\, dG(\Theta) + \int_{\Theta_{xj}}^{\infty} w_j(\Theta)\, h_{xj}(\Theta)\, dG(\Theta) \right]. \tag{25}$$

As in the closed economy, the aggregate wage bill in the differentiated-product sector equals the number of workers searching for jobs in this sector, so that the average income of these workers equals one.

Finally, we assume that

$$b_j = a_j x_j^{\alpha}, \quad x_j \equiv \frac{H_j}{N_j},$$

where $a_j > 1$. Using this specification of frictions in labor markets, (18), (24) and (25) imply

$$\left. \begin{aligned} x_j &= a_j^{-\frac{1}{1+\alpha}}, \\ w_j(\Theta) = b_j &= a_j^{\frac{1}{1+\alpha}}. \end{aligned} \right\} \tag{26}$$

It follows that a country's labor market frictions uniquely determine its wage and labor market tightness in the differentiated-product sector, just like in the closed economy. Every country, thus, has its own level of unemployment, given by

$$u_j = \frac{N_j}{L}(1 - x_j). \tag{27}$$

This completes our description of the two-country world.

5 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 labor market frictions on its trade partner, and the differential effects of trade impediments on countries with different labor market institutions.

Equations (19)-(21) yield the following expressions for the domestic market and export cutoffs:

$$\left. \begin{aligned} \phi_1 \phi_2 \Theta_{dj} &= f_d b_j^{\frac{\beta}{1-\beta}} Q_j^{\frac{\beta-\zeta}{1-\beta}}, \\ \phi_1 \phi_2 \Theta_{xj} &= f_x b_j^{\frac{\beta}{1-\beta}} \tau^{\frac{\beta}{1-\beta}} Q_{(-j)}^{\frac{\beta-\zeta}{1-\beta}}. \end{aligned} \right\} \tag{28}$$

Next substitute these expressions into the free entry condition (22) to obtain

$$f_d \int_{\Theta_{dj}}^{\infty} \left(\frac{\Theta}{\Theta_{dj}} - 1 \right) dG(\Theta) + f_x \int_{\Theta_{xj}}^{\infty} \left(\frac{\Theta}{\Theta_{xj}} - 1 \right) dG(\Theta) = f_e \quad \text{for } j = A, B. \tag{29}$$

This form of the free-entry condition generates a curve in the $(\Theta_{dj}, \Theta_{xj})$ 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 2, and each country has to be located above the 45^o line for the export cutoff to be higher than the domestic cutoff. Note, from (28), that 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 that this condition is satisfied for all $\tau \geq 1$, in which case $f_x \geq f_d$.

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.[32] Finally note that (28) yields

$$\frac{\Theta_{xj}}{\Theta_{d(-j)}} = \frac{f_x \tau^{\frac{\beta}{1-\beta}}}{f_d} \left(\frac{b_j}{b_{(-j)}} \right)^{\frac{\beta}{1-\beta}}, \quad j = A, B. \tag{30}$$

Equations (29) and (30) can be used for solving the four cutoffs as functions of labor market frictions and cost parameters. As is evident, the cutoffs do not depend on the *levels* of labor market rigidities, only on their relative size.

Our primary interest is in the impact of τ, b_A, and b_B on the trading economies. We therefore use (29) and (30) to calculate the impact of these variables on the cutoffs, obtaining

$$\left.\begin{aligned} \hat{\Theta}_{dj} &= \frac{\delta_{xj}}{\Delta} \left[-\left(\delta_{x(-j)} + \delta_{d(-j)} \right) \left(\hat{b}_j - \hat{b}_{(-j)} \right) - \left(\delta_{d(-j)} - \delta_{x(-j)} \right) \hat{\tau} \right], \\ \hat{\Theta}_{xj} &= \frac{\delta_{dj}}{\Delta} \left[\left(\delta_{x(-j)} + \delta_{d(-j)} \right) \left(\hat{b}_j - \hat{b}_{(-j)} \right) + \left(\delta_{d(-j)} - \delta_{x(-j)} \right) \hat{\tau} \right], \end{aligned}\right\} \tag{31}$$

where[33]

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

It is straightforward to show that $\Delta > 0$.[34] Therefore an increase in a country's relative labor

[32] We showed in the previous section that $\Theta_d^c > \Theta_{\min}$ if and only if $\left(\bar{\Theta}/\Theta_{\min}\right) > 1 + f_e/f_d$, which we assume to be satisfied.

[33] We show below that δ_{dj}/ϕ_2 is average revenue per entering firm from domestic sales in country j and δ_{xj}/ϕ_2 is average revenue from exports per entering firm. Therefore δ_{dj} represents average profits per entering firm from domestic sales and δ_{xj} represents average profits per entering firm from exporting.

[34] Proof: To show that $\Delta > 0$, observe that $\Theta_{xj} > \Theta_{dj}$ implies $\delta_{dj}/\delta_{xj} > \left(f_d/\Theta_{dj}\right)/\left(f_x/\Theta_{xj}\right)$ for $j = A, B$. Using these inequalities together with (30) then implies $\delta_{dA}\delta_{dB}/\left(\delta_{xA}\delta_{xB}\right) > \tau^{2\beta/(1-\beta)} > 1$, in which case $\Delta > 0$. Also note that $\delta_{dA}\delta_{dB}/\left(\delta_{xA}\delta_{xB}\right) > \tau^{2\beta/(1-\beta)} > 1$ implies $\delta_{dj} > \delta_{xj}$ in at least one country, and that $\delta_{dj} > \delta_{xj}$ is always

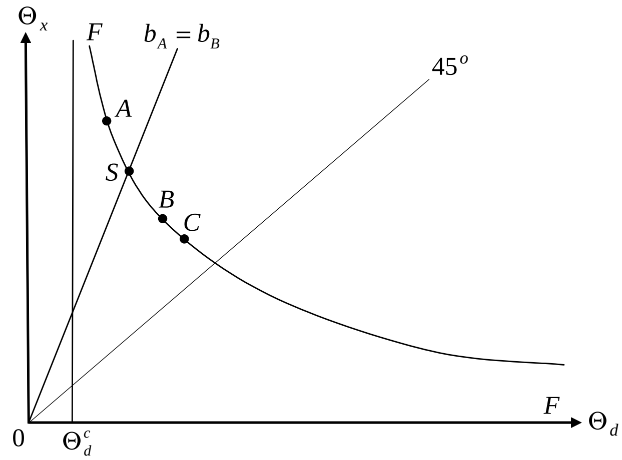

Figure 2: Cutoffs in a trading equilibrium

market frictions, say $b_j/b_{(-j)}$, raises the country's export cutoff and reduces its domestic cutoff, in addition to reducing the foreign country's export cutoff and raising the foreign country's domestic cutoff. Moreover, an increase in the trade cost raises the export cutoff and reduces the domestic cutoff of country j if and only if $\delta_{d(-j)} > \delta_{x(-j)}$. We will shortly show that, indeed, $\delta_{dj} > \delta_{xj}$ in both countries in this type of equilibrium. Therefore an increase in τ raises the export cutoff and reduces the domestic cutoff in both countries.

These insights can be conveniently summarized with the aid of Figure 2. When the two countries have the same labor market rigidities, i.e., $b_A = b_B$, both have cutoffs at point S in the figure, which is the intersection of ray $b_A = b_B$ with FF.[35] If instead country A has worse labor market institutions, then A's cutoffs are at point A while B's cutoffs are at point B.[36] The larger the gap in labor market frictions between these countries, the higher A is on the FF curve and the lower B is. Improvements in the trading environment, which reduce τ, shift down points A and B. These results have important implications for the variation of outcome variables across countries, as well as for the international transmission of shocks, that we discuss below. One immediate implication is that Q_j is higher in the flexible country.[37]

For our set of equations to describe an equilibrium, it is necessary to ensure positive entry of firms in both countries, i.e., that $M_j > 0$ for $j = A, B$. This places restrictions on the permissible difference in labor market rigidities. It proves useful to derive these restrictions in the following

satisfied for both countries in a symmetric equilibrium with $b_A = b_B$ and hence by continuity in its vicinity.

[35] The equation of this ray is derived from (28) to be $\Theta_x = \left[\tau^{\beta/(1-\beta)} f_x/f_d\right] \Theta_d$. Therefore its slope is $\tau^{\beta/(1-\beta)} f_x/f_d > 1$.

[36] As a convention, we choose country A to be the rigid country and B to be the flexible country.

[37] Proof: Equation (28) implies $(Q_A/Q_B)^{(\beta-\zeta)/(1-\beta)} = (\Theta_{dA}/\Theta_{dB})\,(b_B/b_A)^{\beta/(1-\beta)}$. It follows that if, say, B is the flexible country, then $b_B/b_A < 1$, and from the previous analysis, $\Theta_{dA}/\Theta_{dB} < 1$. As a result, $Q_A/Q_B < 1$.

way: Substitute the employment levels (17) into (23), and use (28) to obtain[38]

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

Then the solution to the number of firms can be expressed as

$$M_j = \frac{(1-\beta)\,\phi_2}{\beta\Delta}\left[\delta_{d(-j)} Q_j^{\zeta} - \delta_{x(-j)} Q_{(-j)}^{\zeta}\right]. \tag{32}$$

It is straightforward to show that $\delta_{dA} > \delta_{xA}$ in the rigid country A.[39] Under these circumstances (32) implies $M_B > 0$, because Q_j is larger in the flexible country; (32) also implies that a necessary condition for $M_A > 0$ is $\delta_{dB}/\delta_{xB} > (Q_B/Q_A)^{\zeta} > 1$. In other words, in this type of equilibrium we have $\delta_{dj} > \delta_{xj}$ for $j = A, B$. Moreover, the previous results on the cutoffs imply that δ_{dj} is smaller and δ_{xj} is larger in the flexible country. We therefore have

Lemma 1 *In equilibrium with incomplete specialization, $\delta_{dj} > \delta_{xj}$ in both countries. Moreover, δ_{dj} is smaller and δ_{xj} is larger in the flexible country.*

Equation (32) can also be used to calculate the difference in entry. In particular,

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

Therefore[40]

Lemma 2 *M_j is larger in the flexible country.*

We show in the Appendix that for every $\tau > 1$ there exists a unique ratio b_A/b_B, say $\bar{b}(\tau) > 1$, such that $M_j > 0$ for $j = A, B$ if and only if $b_A/b_B < \bar{b}(\tau)$, where A is the rigid country. When $b_A/b_B \geq \bar{b}(\tau)$, the rigid country specializes in homogeneous goods. Evidently, $\bar{b}(\tau)$ provides a bound on differences in labor market institutions that support equilibria which have production of differentiated products in both countries. Given τ, this limit can be depicted by point C on the FF curve in Figure 2, which is located between the $b_A = b_B$ ray and the 45^o line, such that the equilibrium point of the flexible country, point B, has to be above C for both countries to be incompletely specialized.[41]

[38] Using the interpretation of the δs in footnote 33, this equation can be interpreted as Q_j^{ζ} equals the revenue of domestic firms from domestic sales in country j, $\delta_{dj} M_j/\phi_2$, plus the revenue of foreign firms from domestic sales in country j, $\delta_{x(-j)} M_{(-j)}/\phi_2$. This is consistent with the fact that $Q_j^{\zeta} = P_j Q_j$, where P_j is the ideal consumer price index of differentiated products in country j.

[39] Since $\Delta > 0$, it is necessary to have $\delta_{dj} > \delta_{xj}$ in at least one country. However, the rigid country A has a higher export cutoff and a lower domestic cutoff. Therefore $\delta_{dA} > \delta_{xA}$ in the rigid country. Moreover, as shown in footnote 34, $\delta_{dB} > \delta_{xB}$ in the flexible country as well, as long as labor market rigidities do not differ much across countries.

[40] Proof: Let B be the flexible country. Then $\delta_{dB} < \delta_{dA}$, $\delta_{xA} < \delta_{xB}$ because the flexible country has a lower export cutoff and a higher domestic cutoff, and $Q_B > Q_A$, in which case $M_B > M_A$.

[41] In the Appendix we also analyze equilibria with specialization when $b_A/b_B \geq \bar{b}(\tau)$.

5.1 Welfare

We are interested to know how labor market institutions and trade frictions affect welfare, and in particular their differential effects on the welfare of the flexible and rigid countries. We have already shown that Q_j is higher in the flexible country. Now combine the formulas for changes in the cutoffs (31) with (28) to obtain

$$\frac{\beta-\zeta}{1-\beta}\hat{Q}_j = \frac{1}{\Delta}\left[-\delta_{d(-j)}\left(\delta_{xj}+\delta_{dj}\right)\hat{b}_j + \delta_{xj}\left(\delta_{x(-j)}+\delta_{d(-j)}\right)\hat{b}_{(-j)} - \delta_{xj}\left(\delta_{d(-j)}-\delta_{x(-j)}\right)\hat{\tau}\right]. \quad (33)$$

This equation has a number of implications. First, it shows that an improvement in a country's labor market institutions raises its real consumption index Q_j and therefore its welfare, but it reduces the trade partner's welfare.[42] On the other side, a simultaneous improvement in the labor market institutions of both countries, at a common rate $\hat{b}_A = \hat{b}_B$, raises everybody's welfare.[43] Second, in view of Lemma 1, a reduction in trade impediments raises welfare in both countries. We summarize these findings in[44]

Proposition 2 *(i) Welfare is higher in the flexible country. (ii) An improvement in labor market institutions in one country raises its welfare and reduces the welfare of its trade partner. (iii) A simultaneous improvement in labor market institutions in both countries, with $\hat{b}_A = \hat{b}_B$, raises welfare in both of them. (iv) A reduction of trade impediments raises welfare in both countries and Q_j rises proportionately more in the flexible country.*

The last part of this proposition establishes that both countries gain from trade, because autarky is attained when $\tau \to \infty$.[45] Moreover, we show in the Appendix that both countries gain from trade when the difference in labor market institutions is large enough to effect an equilibrium in which the rigid country specializes in the production of homogeneous products. We therefore have

Proposition 3 *Both countries gain from trade.*

This proposition is interesting, because it is well known that gains from trade are not ensured in economies with nonconvexities and distortions (see Helpman and Krugman, 1985). Moreover, in addition to the standard nonconvexities and distortions that exist in models of monopolistic competition, our model contains frictions in labor markets, which makes the gains-from-trade result even more remarkable.

[42] Recall that income in terms of homogeneous goods equals L in every country and that country j's welfare is higher the higher Q_j is.

[43] This follows from the fact that $-\delta_{d(-j)}\left(\delta_{xj}+\delta_{dj}\right) + \delta_{xj}\left(\delta_{x(-j)}+\delta_{d(-j)}\right) = -\beta\Delta/\left(1-\beta\right) < 0$.

[44] The very last part of the proposition follows from the fact that (33) 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 $\hat{Q}_j > \hat{Q}_{(-j)}$ when either $\hat{b}_j < \hat{b}_{(-j)}$ or (by Lemma 1) $\hat{\tau} < 0$.

[45] 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. Equations (15) and (28) then imply that Q_j is higher in every country in the trading equilibrium.

Another interesting result is that a country harms its trade partner by improving its own labor market institutions, despite the positive terms-of-trade effect enjoyed by the trade partner. In this framework lower labor market rigidities improve the competitiveness of home firms, which leads to the *crowding-out* of foreign firms from the differentiated-product sector, lowering thereby the trade partner's welfare.

5.2 Trade Structure

In order to study the structure of trade, consider the revenue from exports of firms in the differentiated-product sector. The demand function (3) implies that the export revenue of a Θ-firm in country j is

$$R_{xj}(\Theta) = \tau^{-\beta} Q_{(-j)}^{-(\beta-\zeta)} \Theta^{1-\beta} h_{xj}(\Theta)^{\beta}.$$

Aggregating this revenue over all exporting firms yields exports of differentiated products from j to $(-j)$. Using (17), these exports can be expressed as

$$\begin{aligned} X_j &= M_j \tau^{-\beta} Q_{(-j)}^{-(\beta-\zeta)} \int_{\Theta_{xj}}^{\infty} \Theta^{1-\beta} h_{xj}(\Theta)^{\beta} dG(\Theta) \\ &= M_j \phi_1 b_j^{-\frac{\beta}{1-\beta}} \tau^{-\frac{\beta}{1-\beta}} Q_{(-j)}^{-\frac{\beta-\zeta}{1-\beta}} \int_{\Theta_{xj}}^{\infty} \Theta dG(\Theta). \end{aligned}$$

Next substitute (28) into this equation to obtain

$$X_j = M_j \frac{f_x}{\phi_2 \Theta_{xj}} \int_{\Theta_{xj}}^{\infty} \Theta dG(\Theta) = M_j \frac{\delta_{xj}}{\phi_2}.$$

From previous sections we know that the country with better labor market institutions has a higher domestic cutoff Θ_{dj} and a lower exporting cutoff Θ_{xj}. From Lemmas 1 and 2 we know that this country also has a larger δ_{xj} and more firms. Therefore this country has both a larger fraction of exporting firms and a larger value of exports of differentiated products X_j, in which case it exports differentiated products on net. Under these circumstances, the flexible country imports homogeneous products.

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 intersectoral trade. Let country A be the rigid country and let B be the flexible country. Then because trade is balanced, the total volume of trade equals $2X_B$ and the volume of intra-industry trade equals $2X_A$. Therefore the share of intra-industry trade equals

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

Using (32) this share can be expressed as

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

Equations (31) and (33) then imply that the share of intra-industry trade is smaller the larger the ratio b_A/b_B is.

The results on trade structure are summarized in

Proposition 4 *(i) A larger fraction of firms export in the flexible country. (ii) The flexible country exports differentiated products on net and imports homogeneous goods. (iii) The share of intra-industry trade is smaller the larger the proportional gap in labor market institutions is.*

Evidently, labor market institutions impact comparative advantage, and variation in labor market frictions feeds intersectoral trade. The model yields testable implications about trade flows.[46]

5.3 Productivity and Price Levels

In this section we discuss the implications of our model for total factor productivity (TFP) and price levels in countries with different labor market institutions. Alternative measures of 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 levels—which is commonly used in the literature.[47] In the differentiated-product sector this measure is

$$TFP_j = \frac{M_j}{H_j}\left[\int_{\Theta_{dj}}^{\infty} \Theta^{\frac{1-\beta}{\beta}} h_{dj}(\Theta)dG(\Theta) + \int_{\Theta_{xj}}^{\infty} \Theta^{\frac{1-\beta}{\beta}} h_{xj}(\Theta)dG(\Theta)\right]. \tag{34}$$

Recall that $q_{zj}(\Theta) = \Theta^{(1-\beta)/\beta} h_{zj}(\Theta)$. Therefore, TFP_j equals the total production of differentiated products divided by employment in the differentiated-product sector.[48] Note that TFP_j measures productivity in the differentiated-product sector only, rather than in the entire economy, and the productivity in the homogeneous-product sector is constant and equal to one. We discuss in the Appendix a productivity measure that accounts for the sectoral composition of resources.

[46] Additionally, under Pareto-distributed productivity, the model also implies that the volume of trade is larger the larger the gap in labor market rigidities is and the smaller the trade impediments are (See Appendix for Section 6.3).

[47] This corresponds to the measure analyzed 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.

[48] 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 labor market liberalization has an additional positive effect on this measure of productivity as compared to the measure used in the main text.

Using (17) and (19)-(21), we can express (34) as

$$TFP_j = \frac{\delta_{dj}\varphi_{dj} + \delta_{xj}\varphi_{xj}}{\delta_{dj} + \delta_{xj}} = \varpi_{dj}\varphi_{dj} + \varpi_{xj}\varphi_{xj}, \tag{35}$$

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, with $\varpi_{xj} = 1 - \varpi_{dj}$, $j = A, B$. 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 only 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 only the home 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., $\varphi_{xj} > \varphi_{dj}$.

Condition (35) implies that the cutoffs $\{\Theta_{dj}, \Theta_{xj}\}$ uniquely determine the TFP_js, because ϖ_{zj} and φ_{zj} depend only on Θ_{zj}. Moreover, since the two cutoffs are linked by the free-entry condition (29), TFP_j can be expressed as a function of the domestic cutoff Θ_{dj}, independently of labor market and trade frictions. This implies that in the closed economy TFP_j is not responsive to changes in labor market institutions, because Θ_d^c is uniquely determined by the fixed costs of entry and production and the ex ante productivity distribution.[49]

Productivity TFP_j is higher in the trading equilibrium than in autarky, 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 nonexporters alike is higher in the trading 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

Proposition 5 *(i) In the closed economy, TFP_j does not depend on the quality of labor market institutions; (ii) TFP_j is higher in any trading 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, an improvement in labor market institutions in country j raises Θ_{dj} and $\Theta_{x(-j)}$ and reduces $\Theta_{d(-j)}$ and Θ_{xj}. Finally, a simultaneous and proportional improvement in labor market institutions in both countries (i.e., $\hat{b}_A = \hat{b}_B < 0$) leaves all these cutoffs unchanged (see (31)).

How do changes in labor market frictions impact productivity? In the case in which the labor market frictions decline in both countries by the same factor of proportionality, the answer is

[49] However, changes in labor market institutions lead to the reallocation of resources from the homogenous product to the differentiated product sector, which raises the economy-wide productivity level if and only if $\varphi_d^c > 1$ (see Appendix).

simple: the TFP_js do not change. As long as productivity is measured with respect 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 frictions in the labor markets; only the *relative* level of these frictions matters. 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 only 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.[50]

The presence of the third effect, which goes against the first two, does not permit us to sign the impact of single-country labor market reforms 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 declines in 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, (35) yields[51]

$$\widehat{TFP}_j = \frac{\delta_{dj}\left(\varphi_{xj} - \varphi_{dj}\right)\left(k - \frac{1-\beta}{\beta}\right)}{\delta_{dj}\varphi_{dj} + \delta_{xj}\varphi_{xj}}\hat{\Theta}_{dj}, \tag{36}$$

where $k > 1/\beta$ and hence $k > (1-\beta)/\beta$ is required for TFP_j to be finite. 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 the flexible country, and an improvement in a country's labor market institutions raises its productivity and reduces the productivity of the country's trade partner. An implication of this result is that the gap in productivity between the flexible and rigid countries is increasing in b_A/b_B, the relative quality of their labor market institutions. These results are summarized in the following

Proposition 6 *Let Θ be Pareto-distributed with a shape parameter $k > 1/\beta$. Then: (i) TFP_j is higher in the flexible country; (ii) an improvement in labor market institutions in country j raises TFP_j and reduces $TFP_{(-j)}$; (iii) a reduction of trade costs raises TFP_j in both countries.*

We next discuss variations in price levels. Since the price of the homogenous good is normalized to one and it is the same in both countries, the overall price level is monotonically increasing in the

[50] 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 $\hat{\varphi}_{xj} < 0$.

[51] In this calculation, an increase in Θ_{dj} is accompanied by a decrease in Θ_{xj} in order to satisfy the free-entry condition (29). See Appendix for derivation of this equation.

price index of the differentiated product, P_j. In particular, the indirect utility function (2) implies that the minimum cost of attaining a utility level equal to one is

$$\mathcal{P}_j = 1 - \left(\frac{1-\zeta}{\zeta}\right) P_j^{-\frac{\zeta}{1-\zeta}},$$

an expression that represents the ideal price index. Using this ideal price index the real exchange rate of country j is $\rho_j = \mathcal{P}_{(-j)}/\mathcal{P}_j$. It therefore follows that the real exchange rate is increasing in $P_{(-j)}$ and declining in P_j.

Now recall that, in equilibrium, $P_j = Q_j^{-(1-\zeta)}$ and that Q_j is higher in the flexible country. As a result, the flexible country has a lower price level and a higher real exchange rate. This observation together with Proposition 6 implies that a country with higher productivity (i.e., the same productivity in the homogenous-product sector and higher productivity in the differentiated-product sector) has a lower price level and a higher real exchange rate. This prediction contrasts with the classical Balassa-Samuelson effect, which suggests that countries with higher productivity have higher price levels and lower real exchange rates.[52] In other words, our model embodies an anti-Balassa-Samuelson effect, which emanates from the fact that higher frictions in the labor market lead to both lower productivity and higher prices.[53]

We summarize these findings in the following

Proposition 7 *Let Θ be Pareto-distributed with a shape parameter $k > 1/\beta$. Then the price level is lower and the real exchange rate is higher in the (more-productive) flexible country.*

6 Unemployment

Before discussing the variation of unemployment across countries with different labor market institutions in Sections 6.2 and 6.3, we first examine the determinants of unemployment in a world of symmetric countries.

6.1 Symmetric Countries

We study in this section countries with $b_A = b_B = b$, in order to understand how changes in the common level of labor market frictions and the common level of variable trade costs 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. From the previous section we know that two symmetric economies are at the same point on the FF curve in Figure 2 (point S), the location of this point is invariant to the common

[52] See Ghironi and Melitz (2006) for a detailed analysis of the Balassa-Samuelson effect in the baseline Melitz model and in its dynamic extension.

[53] Note that there is no evidence for the Balassa-Samuelson effect within the group of OECD countries (see Rogoff, 1996).

level of labor market frictions, and this point is higher the larger τ is. Moreover, (33) implies that Q is lower the higher are either b or τ, and a lower value of Q leads to lower welfare. In other words, higher frictions in trade or labor markets reduce welfare.

In order to assess the impact of labor market rigidities on unemployment, we need to know their quantitative impact on Q. For this reason we use (33) to obtain

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

Next substitute the employment levels (17) into (23) and (25) to obtain $N = \phi_1^{(1-\beta)/\beta} Q^{\zeta}$, which together with the previous equation yields

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

Finally, from (26) and the unemployment equation (27) we have $\hat{u} = \hat{N} + \hat{b}/\left(b-1\right)$, which together with the formula for $\hat{N}$ implies

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

It is evident from this formula that labor market frictions impact unemployment in the symmetric case in exactly the same way they impact unemployment in a closed economy. That is, better labor market institutions (lower b) reduce unemployment if and only if labor market frictions are low to begin with. If these frictions are high, however, improvements in labor market institutions raise the rate of unemployment. In fact, the relationship between b and the rate of unemployment has the same inverted U shape in an open economy as it has in a closed economy (see Figure 1). It is also easy to show that lower frictions in labor markets lead to increased entry of firms M, an increase in N proportionately to M, and a more than proportional increase in employment H. This similarity with the closed economy emanates from the fact that the domestic and export cutoffs do not change with this type of labor market frictions. As a result, the fractions of exporting firms do not change either.[54]

Now consider changes in trade impediments. As the formula for changes in the rate of unemployment shows, a lower trade cost τ *raises* the rate of unemployment, independently of the common level of frictions in labor markets or the initial level of trade frictions. Since the lowering of trade costs raises welfare, this means that welfare and unemployment respond in opposite directions to changes in trade costs. Since reducing trade impediments does not affect tightness in labor markets, the rise in unemployment is a consequence of an increase in N and H by the same factor of proportionality. Finally, lower trade costs reduce the export cutoffs and increase the domestic cutoffs, thereby raising the fractions of exporting firms.

We summarize the main findings of this section in

[54] In a symmetric world all trade is intra-industry trade.

Proposition 8 *In a symmetric world economy: (i) improvements in labor market institutions, common to both countries, reduce unemployment if and only if frictions in the labor markets are low to begin with; and (ii) reductions in trade impediments raise unemployment and welfare simultaneously.*

The second part of this proposition implies that in a symmetric world trade raises unemployment worldwide. In other words, the rates of unemployment are higher when countries trade with each other than when they do not. However, Proposition 3 implies that such countries gain from trade. Therefore trade is desirable on welfare grounds despite its undesirable consequences for unemployment.

An intriguing result is that lower trade barriers raise unemployment. To understand the intuition behind this result, observe that the lowering of trade impediments makes exporting more profitable in the differentiated-product sector, without affecting tightness in its labor market. As a result, more firms choose to export in this industry and exporters choose to export larger volumes. In addition, domestic firms that do not serve foreign markets become less profitable, which leads to more exit of low-productivity firms. On account of these changes labor demand rises. To accommodate this demand, more individuals search for jobs in the differentiated-product industry. Under these circumstances, the sectoral unemployment rates remain the same, but the economy's unemployment rate rises because more workers choose to attach themselves to the high-wage sector, which has the higher rate of unemployment.

Also note that unemployment can increase or decrease when welfare rises. That is, depending on the nature of the disturbance and the initial institutional environment, unemployment and welfare can move in the same or in the opposite direction. For this reason changes in unemployment do not reflect changes in welfare. This results from the standard property of search-and-matching models, in which unemployment is a productive activity; it enables workers to be employed in both low-wage and high-wage activities. Under these circumstances an expansion of the high-wage\high-unemployment sector results in higher unemployment, but may also raise welfare. In this type of environment, other statistics—such as total employment in the high-wage sector (H)—are a better proxy for welfare than the rate of unemployment.

6.2 Small Asymmetries

Consider a world in which country B has the better labor market institutions, so that $b_A > b_B$. Then the labor market is tighter in the flexible country B, and the unemployment rate is lower in its differentiated-product sector. The question is whether the country's overall unemployment rate is also lower? The reason this may not be the case is that more individuals might be searching for jobs in the high-unemployment sector in the country with lower labor market frictions. We answer this question below for the case in which labor rigidities do not vary much across countries. In the next section we discuss global comparisons for the case in which productivity is distributed Pareto.

Suppose that we start from a symmetric equilibrium with $b_A = b_B$. As a result, the two countries look alike in all respects. Next suppose that the labor market rigidities rise in country

A but do not change in country B, so that $\hat{b}_A > 0$ and $\hat{b}_B = 0$. Then we can use (31) and (33) to calculate the response of the cutoffs and the real consumption index in each of these countries, evaluated at the initially symmetric equilibrium, and we can combine these results with the other equilibrium conditions to derive the proportional change in the number of individuals seeking jobs in the differentiated-product sectors of countries A and B. The technical details are provided in the Appendix, where we show that

$$\hat{N}_A = -\Psi_{NA}\ \hat{b}_A,$$

$$\hat{N}_B = \Psi_{NB}\ \hat{b}_A,$$

where the coefficients Ψ_{Nj} are determined by the initial equilibrium, $\Psi_{NA} > \beta\zeta/(\beta - \zeta)$, $\Psi_{NB} > 0$, and where $\Psi_{NA} \to \beta\zeta/(\beta - \zeta)$ and $\Psi_{NB} \to 0$ as $\tau \to \infty$. Evidently, an increase in labor market frictions in country A reduces the number of individuals searching for jobs in A's differentiated-product sector and increases the number of individuals searching for jobs in country B. Under these circumstances, (27) yields

$$\hat{u}_A = -\left(\Psi_{NA} - \frac{1}{b-1}\right)\hat{b}_A,$$

$$\hat{u}_B = \Psi_{NB}\ \hat{b}_A.$$

The implication is that the deterioration of labor market institutions in A raises unemployment in B, while unemployment rises in A if and only if $\Psi_{NA} < 1/(b-1)$, i.e., if and only if the frictions in the labor markets are low to begin with; otherwise the rate of unemployment declines in A. Since $\Psi_{NA} > \beta\zeta/(\beta-\zeta)$, the open economy A would require even lower labor market frictions than a closed economy for a deterioration in its labor market institutions to raise its unemployment. Moreover, since

$$\hat{u}_A - \hat{u}_B = -\left(\Psi_{NA} + \Psi_{NB} - \frac{1}{b-1}\right)\hat{b}_A,$$

country A has the higher rate of unemployment after a deterioration in its labor market institutions if and only if

$$\Psi_{NA} + \Psi_{NB} < \frac{1}{b-1},$$

or if and only if the initial level of frictions in the labor market is rather low. If the initial level of frictions in the labor markets is high, thereby violating this inequality, then country A has the lower rate of unemployment.

These results are summarized in the following

Proposition 9 *In the vicinity of a symmetric equilibrium: (i) the flexible country has a lower rate of unemployment if and only if the levels of friction in both labor markets are low; otherwise it has a higher rate of unemployment; and (ii) an improvement in a country's labor market institutions reduces the rate of unemployment in its trade partner, yet it reduces home unemployment if and only if the initial levels of friction in both labor markets are low.*

It is evident from this proposition that a country's level of unemployment depends not only on its own labor market institutions but also on those of its trade partner. Moreover, better domestic labor market institutions do not guarantee lower unemployment relative to the trade partner, unless the frictions in both labor markets are low. As a result, one cannot infer differences in labor market institutions from observations of unemployment rates.

To understand the intuition behind these results, first note that an improvement in a country's labor market institutions affects its unemployment rate through two channels: on the one hand, the country's labor market becomes tighter, which reduces the unemployment rate in its differentiated-product sector; on the other hand, more workers search for jobs in the differentiated-product sector. As a result of these opposing effects, the overall rate of unemployment declines when the first channel dominates and rises when the second channel dominates. The first channel dominates when the frictions in the labor markets are small, while the second channel dominates for high levels of labor market rigidities, similar to a closed economy. An interesting implication of Proposition 9 is that improvements of a country's labor market institutions raises the rate of unemployment in its trade partner. This results from the fact that a reduction of frictions in the labor market of country j makes j more competitive in the differentiated-product industry. As a result, the demand shifts from brands of country $(-j)$ to the brands of j. In response, the differentiated-product sector contracts in country $(-j)$, which means that fewer people search there for jobs. Since the labor market frictions do not change in country $(-j)$, the rate of unemployment in its differentiated-product sector does not change either. It therefore follows that the overall rate of unemployment declines in $(-j)$ because fewer workers search there for jobs and the fraction of those who find employment does not change.

We have derived these results for nearly symmetric equilibria. In the next section we study large differences in labor market institutions.

6.3 Large Asymmetries

The results reported so far were derived for either symmetric countries or for a world of small asymmetries. We have not been able to derive general analytical results about unemployment rates for environments with large differences in labor market rigidities. We therefore examine such environments in this section by means of simulations. The following simulations are interesting for two reasons. First, they show how the rates of unemployment compare across countries when labor frictions differ substantially from each other. Second, they show how the degree of similarity in labor market institutions interacts with trade frictions in shaping unemployment rates.

For the purpose of the simulations we assume that productivity is distributed Pareto. Therefore the distribution function is

$$G(\Theta) = 1 - \left(\frac{\Theta_{\min}}{\Theta}\right)^{k}, \text{ for } \Theta \geq \Theta_{\min} \text{ and } k > 2.$$

As is well known, the shape parameter k controls the dispersion of Θ, with smaller values of k

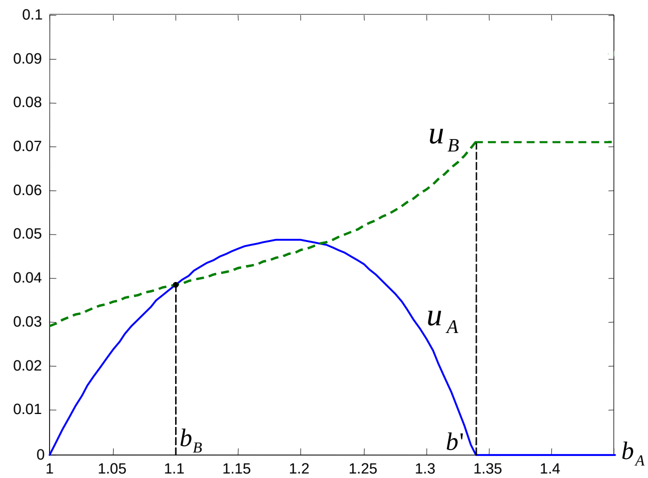

Figure 3: Unemployment as a function of b_A when b_B is low ($b_B = 1.1$ and $\tau = 1.1$)

representing more dispersion. It has to be larger than two for the variance of productivity to be finite. We show in the Appendix the equilibrium conditions when productivity is distributed Pareto, and these are the equations used for the simulations.

Figure 3 depicts the response of unemployment rates to variation in country A's labor market frictions, b_A; the rising broken-line curve for country B and the hump-shaped solid-line curve for country A.[55] Country B has $b_B = 1.1$, and therefore the two countries have the same rate of unemployment when $b_A = 1.1$. As b_A rises, country A becomes more rigid. This raises initially the rate of unemployment in both countries, but the flexible country's rate of unemployment remains lower for a while. At some point, however, the rate of unemployment reaches a peak in the rigid 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 the flexible country and reduce it in the rigid country, so that the rate of unemployment is higher in the flexible country thereafter. The mechanism that operates here is that once the labor market frictions become high enough in country A, the contraction of the differentiated-product sector leads to overall lower unemployment in the rigid country despite the fact that its sectoral unemployment 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 labor market becomes in A. As a result the differentiated-product sector attracts more and more workers in country B, which raises its rate of unemployment. The monotonic impact of country A's labor market rigidities on the unemployment rate in B holds

[55] In Figures 3-4 we use the following parameters: $f_x = 3$, $f_d = 1$, $f_e = 0.5$, $k = 2.5$, $\beta = 0.75$, $\zeta = 0.5$ and $L = 0.1$.

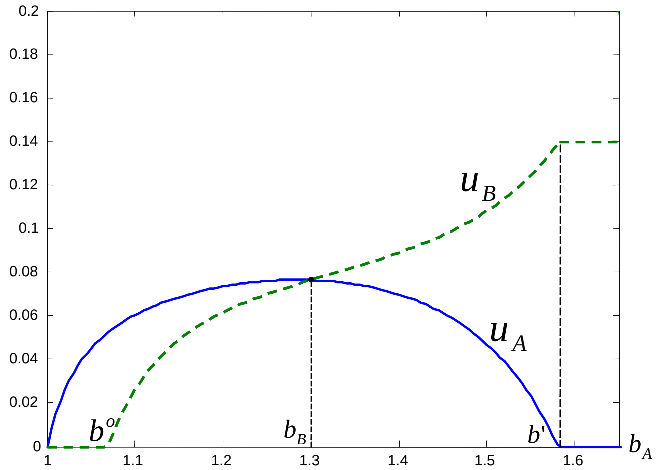

Figure 4: Unemployment as a function of b_A when b_B is high ($b_B = 1.3$ and $\tau = 1.1$)

globally, and not only around the symmetric equilibrium.[56]

Figure 4 is similar to Figure 3, except that now the level of labor market frictions in country B is higher, i.e., $b_B = 1.3$, and therefore the two curves intersect at $b_A = 1.3$. Moreover, starting with a symmetric world that has these higher labor market rigidities, increases in b_A always raise unemployment in B and reduce unemployment in A. As a result, the rigid country has a lower level of unemployment independently of the difference in labor market institutions.

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

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 labor markets, Figure 6 for the case in which frictions are low in the flexible country but high in the rigid country, and Figure 7 for the case in which the frictions are high in both countries.[57] In all three cases unemployment rises as trade friction falls in the flexible country and declines in the rigid country.[58] Nevertheless, the rate of unemployment is not necessarily higher in the rigid country. In particular, unemployment is always higher in the rigid country when frictions in labor markets are low in both countries, yet

[56] In Figures 3-4 country A specializes in the homogenous good when $b_A \geq b'$; similarly, in Figure 4, country B specializes in the homogenous good when $b_A \leq b^o$.

[57] In Figures 5-7 we use the following parameters: $f_x = 5$, $f_d = 1$ $f_e = 0.5$, $k = 2.5$, $\beta = 0.75$, $\zeta = 0.5$ and $L = 0.1$.

[58] This pattern is not general. As we know, in the symmetric case lower trade impediments raise unemployment in both countries. We have also simulated examples in which the rigid country has a hump in its rate of unemployment as trade frictions vary (this requires $b_A \gtrsim b_B$).

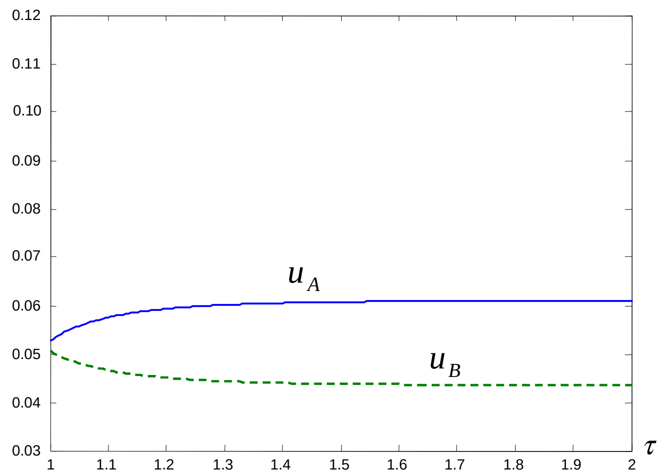

Figure 5: Unemployment as a function of τ when b_A and b_B are low ($b_A = 1.2$ and $b_B = 1.12$)

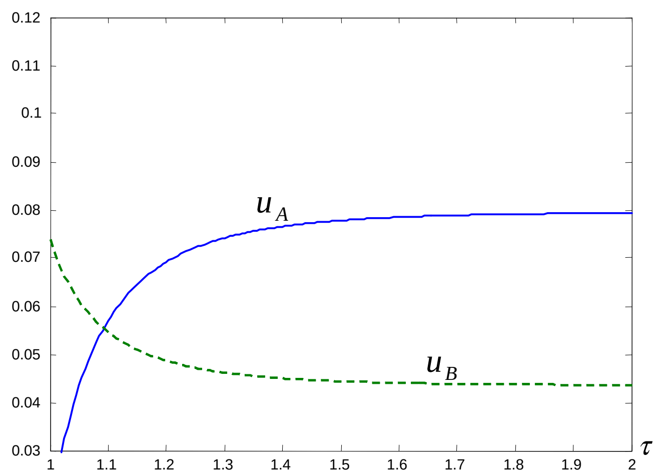

Figure 6: Unemployment as a function of τ when b_A is high and b_B is low ($b_A = 1.35$ and $b_B = 1.12$)

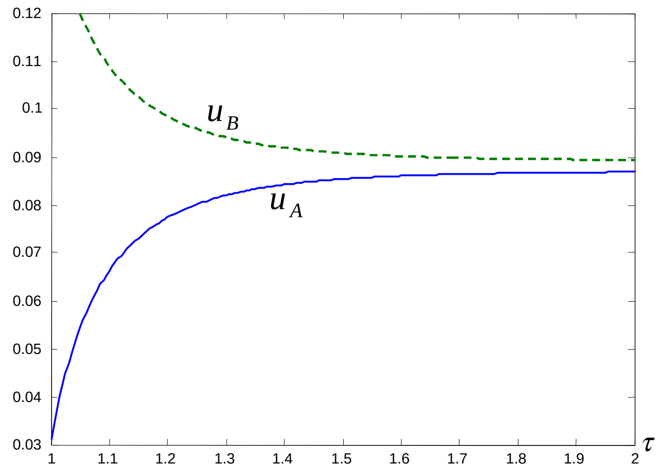

Figure 7: Unemployment as a function of τ when b_A and b_B are high ($b_A = 1.9$ and $b_B = 1.6$)

unemployment is always higher in the flexible country when frictions in labor markets are high in both countries. In between, when labor market frictions are low in the flexible country and high in the rigid country, the relative rate of unemployment depends on trade impediments; it is lower in the rigid country when the trade frictions are low and lower in the flexible country when the trade frictions are high.

7 Concluding Comments

We have studied the interdependence of countries that trade homogeneous and differentiated products with each other, and whose labor markets are characterized by search and matching frictions in the differentiated-product industry. Variation in labor market frictions and the interactions between trade impediments and labor market institutions generate rich patterns of unemployment. For example, better labor market institutions 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, but the gains are unevenly distributed, with the flexible country gaining proportionately more. The latter implies that a country stands to gain more from reforming its labor market when trade frictions are low rather than high. Reducing frictions in the domestic labor market raises the competitiveness of home 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 (i.e., the terms-of-trade improvement in the foreign country is overwhelmed by the competitiveness effect). Nevertheless, across-the-board improvements in labor market institutions raise welfare in both countries.

These results have a number of policy implications. First, trade and labor market policies are complementary to each other. On the one hand, the lower the trade frictions are the more a country stands to gain from lower frictions in its labor market; and vise versa, the lower the frictions in the labor market are the more a country stands to gain from lower trade frictions. On the other hand, when one country improves its labor market institutions and thereby hurts its trade partner, the trade partner can offset the resulting welfare loss by also improving its labor market institutions. These results contrast with the implications of models of comparative advantage in which movements in the terms of trade dominate the outcomes.[59]

We also show that labor market institutions confer comparative advantage, and that differences in these institutions shape trade flows. In particular, the flexible country exports differentiated products on net and imports homogeneous goods. Moreover, the larger the difference in labor market institutions the larger is the volume of trade and the lower is the share of intra-industry trade. These are testable implications about trade flows and international patterns of specialization.

Finally, we show that trade raises total factor productivity in the differentiated-product sectors of both countries (productivity is constant in the homogeneous good sector). Importantly, however, productivity is higher and the price level is lower in the flexible country. As a result, the flexible country has a higher (depreciated) real exchange rate. This negative correlation across countries between productivity and the price level, or the positive correlation between productivity and the real exchange rate, is opposite to the Balassa-Samuelson effect. The implication is that labor market rigidities produce a bias against the Balassa-Samuelson effect, which may help to explain the failure to find this effect in the sample of OECD countries.

[59] See, for example, Brügemann (2003) and Alessandria and Delacroix (2004). The former examines the support for labor market rigidities in a Ricardian model in which the choice of regime impacts comparative advantage. The latter analyze a game in which governments control firing taxes, using a Ricardian-style model of complete specialization. They 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.

Appendix

An alternative specification with homothetic preferences for Section 2

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 utility is $\mathbb{U} = \mathcal{C}^{1-\sigma}/(1-\sigma)$, where $\sigma \in [0,1)$ is the relative risk aversion coefficient and $\mathcal{C}$ is a CES bundle of homogenous and differentiated goods:

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

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 homogenous good p_0 is again normalized to one and P is the price of the differentiated product in terms of the homogenous good.

The demand for homogenous 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 homogenous good. Using these demand equations, we derive the indirect utility function

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

Since $\mathcal{P}$ is increasing in P, the indirect utility is falling in P for a given E. 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.

Most of the remaining derivation of equilibrium conditions remains unchanged, with D given above instead of $D = Q^{-(\beta-\zeta)/(1-\beta)}$ used 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. The only difference is the no-arbitrage condition which features now a risk premium for employment seeking in the sector with labor market frictions:

$$x w^{1-\sigma} = 1,$$

so that $xw > 1$ when $x < 1$ and there is a chance of being unemployed. Finally, the equilibrium wage is still equal to $b = ax^{\alpha}$, which now leads to

$$x = b^{-(1-\sigma)} = a^{\frac{-(1-\sigma)}{1+\alpha(1-\sigma)}},$$
$$w = b = a^{\frac{1}{1+\alpha(1-\sigma)}}.$$

With homothetic preferences, the family interpretation is not necessary as long as $\sigma < 1$. In this case, the structure of demand and indirect utility does not change if the worker becomes unemployed, and aggregation is straightforward, yielding $E = L$ at the aggregate, where L is the number (measure) of individual workers.[60] This specification can be used to analyze 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 closed economy with homothetic preferences. Specifically, we consider labor market deregulation. We have $\hat{D} = \beta/(1-\beta)\hat{b}$, so that, as before, P decreases and Q increases as b falls. This also implies an increase in welfare. The effect on unemployment is again ambiguous:

$$\hat{u} = \left[\frac{1}{b-1} - \frac{1}{\frac{\beta-\zeta}{\beta\zeta} + \frac{1-\zeta}{\zeta}P^{-\frac{\zeta}{1-\zeta}}}\right]\hat{b},$$

so that unemployment falls if initial labor market institutions are flexible enough and increases otherwise. These results are qualitatively the same as those derived in the text for quasilinear preferences.

Finally, as before, we have that the total number of workers searching for jobs in the differentiated-product sector equals

$$N = \phi_1^{\frac{1-\beta}{\beta}}\phi_2^{-1}M\delta_d = \phi_1^{\frac{1-\beta}{\beta}}PQ,$$

and it is decreasing in b (which is the source of ambiguity in the comparative statics for unemployment). With these results, we can discuss ex post inequality. A fall in b increases $H = xN$ and reduces w (which exceeds one), so that both lead to lower ex-post inequality. At the same time, total unemployment $(1-x)N$ may increase (if the initial b is high), which would then contribute to higher inequality. It follows that the comparative statics of inequality are potentially ambiguous in the same way as the results for unemployment are.

[60] Note that if $\sigma \geq 1$, we still need to recur to the family risk-sharing interpretation in order to avoid an infinite risk premium for employment-seeking in the differentiated product sector with a possibility of being unemployed. Alternatively, we can introduce unemployment benefits to resolve this issue, and make the risk premium finite.

Extension of results on wage profiles for Sections 2.3 and 4

We describe here the wage structure when the hiring function is nonlinear and takes the form $b_j h^\gamma$. To avoid corner solutions, we impose $\gamma > \beta$. Under these circumstances a Θ-firm's profit maximization is given by[61]

$$\max_h \left\{ \tfrac{1}{1+\beta} A_j \Theta^{\frac{\gamma-\beta}{\gamma}} h^\beta - b_j h^\gamma \right\},$$

where now transformed productivity is $\Theta \equiv \theta^{\frac{\gamma\beta}{\gamma-\beta}}$ and the demand parameter is

$$A_j \equiv A_j(\Theta) = \left[Q_j^{-\frac{\beta-\zeta}{1-\beta}} + I_j(\Theta) \cdot \tau^{-\frac{\beta}{1-\beta}} Q_{(-j)}^{-\frac{\beta-\zeta}{1-\beta}} \right]^{1-\beta}.$$

As before, $I_j(\Theta)$ equals one if the Θ-firm in country j exports and zero otherwise. In other words, A_j does not vary across exporters and it does not vary across non-exporters. It is higher, however, for exporters.

The solution to this problem yields

$$h_j(\Theta) = \left(\frac{\beta}{1+\beta} \frac{A_j}{\gamma b_j} \right)^{\frac{1}{\gamma-\beta}} \Theta^{\frac{1}{\gamma}},$$

which is, as before, increasing in productivity across nonexporters and across exporters. When $\gamma > 1$, optimal employment increases less than proportionally with productivity within each group, and, as a result, more-productive firms are both larger and pay higher wages, because the wage is

$$w_j(\Theta) = \gamma b_j h_j(\Theta)^{\gamma-1} = \gamma b_j \left(\frac{\beta}{1+\beta} \frac{A_j}{\gamma b_j} \right)^{\frac{\gamma-1}{\gamma-\beta}} \Theta^{\frac{\gamma-1}{\gamma}}.$$

Specifically, the elasticity of the wage rate with respect to the productivity of the firm is $\frac{\gamma-1}{\gamma}$ and with respect to the size of the firm, as measured by employment, it is $(\gamma-1)$. On top of that, workers in exporting firms receive a discrete wage premium compared to workers in nonexporting firms. That is, firms with Θ just above Θ_{xj} pay discretely higher wages than firms just below the export cutoff.

We still assume $b_j = a_j x_j^\alpha$ and $x_j = H_j / N_j$. Using the definitions of H_j and N_j, we have

$$x_j = \frac{\int_{\Theta_{dj}}^\infty h_j(\Theta) \mathbf{d}G(\Theta)}{\int_{\Theta_{dj}}^\infty w_j(\Theta) h_j(\Theta) \mathbf{d}G(\Theta)} = \frac{\int_{\Theta_{dj}}^\infty A_j(\Theta)^{\frac{\gamma}{\gamma-\beta}} \Theta \mathbf{d}G(\Theta)}{\gamma b_j \int_{\Theta_{dj}}^\infty A_j(\Theta)^{\frac{1}{\gamma-\beta}} \Theta^{\frac{1}{\gamma}} \mathbf{d}G(\Theta)},$$

where $A_j(\Theta)$ equals A_j, which is higher above the export cutoff. Finally, using the definition of b_j, we obtain a condition for x_j in terms of other endogenous variables:

$$\gamma a_j x_j^{1+\alpha} = \frac{\int_{\Theta_{dj}}^\infty A_j(\Theta)^{\frac{\gamma}{\gamma-\beta}} \Theta \mathbf{d}G(\Theta)}{\int_{\Theta_{dj}}^\infty A_j(\Theta)^{\frac{1}{\gamma-\beta}} \Theta^{\frac{1}{\gamma}} \mathbf{d}G(\Theta)}.$$

[61] Under bilateral Nash bargaining instead of the multilateral bargaining we use, the main results are the same. The reason is that the structure of the firm's profit maximization problem is similar, because both revenue and hiring costs are power functions of h. One can show that the problem of the firm becomes in this cases:

$$\max_h \left\{ \tfrac{1-\beta_N \beta}{1+\beta_N \gamma} A_j \Theta^{\frac{\gamma-\beta}{\gamma}} h^\beta - b_j h^\gamma \right\},$$

where β_N is the worker's bargaining weight. In fact, the two problems are identical when $\beta_N = \frac{\beta}{\beta+\beta^2+\gamma}$. Therefore, all the qualitative results below are also true under bilateral Nash bargaining.

Therefore, when $\gamma \neq 1$, it is no longer possible to identify x_j and $w_j(\cdot)$ without solving for other endogenous variables of the model. Other structural relationships in the model are preserved, and we can solve for the x_js, outputs and cutoffs simultaneously now. Note, however, that within the pool of exporters as well as within the pool of nonexporters, we have

$$\frac{w_j(\Theta')}{w_j(\Theta)} = \left(\frac{\Theta'}{\Theta}\right)^{\frac{\gamma-1}{\gamma}} = \left[\frac{h_j(\Theta')}{h_j(\Theta)}\right]^{\gamma-1}.$$

This relationship does not depend on the other equilibrium conditions.

Derivation and extension of results for Section 5

We derive here a limit on b_A/b_B which secures an equilibrium in which both countries are incompletely specialized. Then we discuss equilibria for which this condition is violated and the rigid country specializes in homogeneous products. Throughout we assume for concreteness that A is the rigid country, so that $b_A/b_B \geq 1$. Following the main text, we assume $\zeta > 0$. For brevity, we will analyze only the equilibria with $\Theta_{xB} > \Theta_{dB} > \Theta_{\min}$, so that in the flexible country not all producing firms export and there also are firms that exit. The whole analysis can be carried out in a similar manner when either of the inequalities fails, and the results are broadly similar. Finally, for concreteness, we assume that $f_x \geq f_d$. This assumption is useful because it guarantees that $\delta_{xB} < \delta_{dB}$ in the type of equilibria that we consider which allows us to avoid the discussion of separate possible cases. Again the same analysis can be carried out when $f_x < f_d$ and it yields similar results.

Equation 32 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 have, using (28), that

$$\delta_{dB}\left[\frac{\Theta_{xB}}{\Theta_{dB}}\frac{f_d}{f_x}\tau^{\frac{-\beta}{1-\beta}}\right]^{\zeta\frac{1-\beta}{\beta-\zeta}} = \delta_{xB}. \tag{37}$$

Note that this relationship is a (generally nonlinear) upward-sloping 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 $b_A = b_B$).[62]

We can now prove the following

Lemma 3 *For any given $\tau \geq 1$, there exists a unique $\bar{b}(\tau)$ with $\bar{b}'(\cdot) > 0$ which turns (37) into equality. For $b_A/b_B < \bar{b}(\tau)$, there is incomplete specialization in equilibrium so that $M_A > 0$. For $b_A/b_B \geq \bar{b}(\tau)$, country A specializes in the homogenous 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. (31) 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 (37), imply that $\bar{b}(\tau)$ is unique and increasing in τ whenever it is finite.[63] Finally, Q_A/Q_B is decreasing in b_A/b_B. Therefore, from (32), $M_A > 0$ whenever $b_A/b_B < \bar{b}(\tau)$ and $M_A = 0$ whenever $b_A/b_B \geq \bar{b}(\tau)$.

[62] In the special case of Pareto distribution it is a ray through the origin.

[63] Note that $\bar{b}(\cdot) > 1$ by construction since $\Theta_{xB} = \Theta_{dB}\tau^{\beta/(1-\beta)} f_x/f_d$ when $b_A = b_B$.

We consider now equilibria with complete specialization. By Lemma 3 complete specialization in country A occurs whenever $b_A/b_B \geq \bar{b}(\tau)$ so that $M_A = 0$. The equilibrium system in this case consists of 5 equations jointly determining $\{\Theta_{dB}, \Theta_{xB}, Q_A, Q_B, M_B\}$:

$$\begin{aligned}
\phi_1\phi_2\Theta_{dB} &= f_d b_B^{\frac{\beta}{1-\beta}} Q_B^{\frac{\beta-\zeta}{1-\beta}}, \\
\phi_1\phi_2\Theta_{xB} &= f_x \tau^{\frac{\beta}{1-\beta}} b_B^{\frac{\beta}{1-\beta}} Q_A^{\frac{\beta-\zeta}{1-\beta}}, \\
Q_A^{\beta\frac{1-\zeta}{1-\beta}} &= \phi_1 M_B b_B^{\frac{-\beta}{1-\beta}} \tau^{\frac{-\beta}{1-\beta}} \int_{\Theta_{xB}}^{\infty} \Theta dG(\Theta), \\
Q_B^{\beta\frac{1-\zeta}{1-\beta}} &= \phi_1 M_B b_B^{\frac{-\beta}{1-\beta}} \int_{\Theta_{dB}}^{\infty} \Theta dG(\Theta), \\
f_d \int_{\Theta_{dB}}^{\infty} \left(\frac{\Theta}{\Theta_{dB}} - 1\right) dG(\Theta) + f_x \int_{\Theta_{xB}}^{\infty} &\left(\frac{\Theta}{\Theta_{xB}} - 1\right) dG(\Theta) = f_e
\end{aligned}$$

The first two equations are the cutoffs conditions – counterparts of (28) in the text, but only for country B now since country A does not produce differentiated goods. Third and fourth equations come from the definitions of Q_js, equivalent to (23), in which we plug (17), the optimal employment levels of the firms in country B. The final equation is the free entry condition (29).

The first two equations imply as before

$$\frac{\Theta_{xB}}{\Theta_{dB}} = \tau^{\frac{\beta}{1-\beta}} \frac{f_x}{f_d} \left(\frac{Q_A}{Q_B}\right)^{\frac{\beta-\zeta}{1-\beta}}. \tag{38}$$

Taking the ratios of the conditions for Q_A and Q_B, we have

$$\left(\frac{Q_B}{Q_A}\right)^{\beta\frac{1-\zeta}{1-\beta}} = \tau^{\frac{\beta}{1-\beta}} \frac{f_x}{f_d} \frac{\Theta_{dB}\delta_{dB}}{\Theta_{xB}\delta_{xB}}.$$

The last two results together yield a simple relationship

$$\left(\frac{Q_A}{Q_B}\right)^{\zeta} = \frac{\delta_{xB}}{\delta_{dB}}. \tag{39}$$

We now are ready to prove

Proposition 10 *In equilibrium with specialization ($M_A = 0$), the following comparative statics hold:*

1. *Θ_{dB}, Θ_{xB}, and (Q_A/Q_B) do not respond to changes in b_B. Q_A and Q_B fall proportionally in response to an increase in b_B; M_B also falls but less than proportionally with the Q_js.*
2. *Θ_{dB} increases and Θ_{xB} decreases in response to a fall in τ. M_B, Q_B, and Q_A/Q_B all increase in response to a fall in τ. Thus, the rigid country benefits more from a reduction in trade impediments.*

Proof: We plug (39) into (38) and take the log-derivative:

$$\hat{\Theta}_{xB} - \hat{\Theta}_{dB} = \frac{\beta}{1-\beta}\hat{\tau} + \frac{\beta-\zeta}{\zeta(1-\beta)}\left(\hat{\delta}_{xB} - \hat{\delta}_{dB}\right),$$

where $\hat{\delta}_{zB} = -\left[f_z\Theta_{zB}G'(\Theta_{zB}) + \delta_{zB}\right]\hat{\Theta}_{zB}$ for $z \in \{d, x\}$. From free entry we have

$$\delta_{dB}\hat{\Theta}_{dB} + \delta_{xB}\hat{\Theta}_{xB} = 0.$$

Combining these results we have

$$\left[\frac{\delta_{dB}+\delta_{xB}}{\delta_{xB}}+2\delta_{dB}+f_d\Theta_{dB}G'(\Theta_{dB})+f_x\Theta_{xB}G'(\Theta_{xB})\frac{\delta_{dB}}{\delta_{xB}}\right]\hat{\Theta}_{dB}=-\frac{\beta}{1-\beta}\hat{\tau}$$

so that Θ_{dB} decreases and Θ_{xB} increases in τ. Also note that neither threshold responds to b_B. This result implies that δ_{dB} increases and δ_{xB} decreases in τ and they do not respond to b_B. This observation together with (39) imply that Q_A/Q_B does not respond to b_B and decreases in τ. Log-differentiation of the cutoff condition for Θ_{dB} results in

$$\frac{\beta-\zeta}{1-\beta}\hat{Q}_B=-\frac{\beta}{1-\beta}\hat{b}_B+\hat{\Theta}_{dB}.$$

Therefore, Q_B and Q_A fall proportionally as b_B increases; Q_A and Q_B both decrease in τ and Q_A does so proportionally more. Finally, the results for M_B follow from the equation for Q_B:

$$\hat{M}_B=\zeta\hat{Q}_B-\hat{\delta}_{dB}$$

Therefore, M_B falls in τ; it also falls in b_B but less than proportionally compared to the Q_j's (since $\zeta<1$).

Proposition 10 emphasizes the important difference of equilibria with specialization from that with incomplete specialization (see Proposition 2 in the text). In equilibria with specialization, the rigid country is the one that gains proportionately more from a reduction in trade impediments; moreover, both countries equally gain from the improvements in the labor market institutions in the flexible country. The reason is that now there is no competitiveness effect anymore, which was crowding-out the firms in the rigid country as trade was becoming less costly or as labor market of the trade partner was becoming more flexible. Now the only effect is the terms of trade effect, i.e. the reduction in the price level of the differentiated goods when τ or b_B fall. A reduction in trade costs on top of that makes the consumption baskets (i.e., the number of varieties and their quantities consumed) in the two countries more similar which leads to a partial convergence in the welfare differential between the countries.

Derivation of results on productivity for Section 5.3

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

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

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:

$$\widehat{TFP}_j=\left\{1+\frac{\kappa_{dj}}{\varphi_{xj}-\varphi_{dj}}\left[\frac{\kappa_{xj}}{\kappa_{dj}}\left(\Theta_{xj}^{\frac{1-\beta}{\beta}}-TFP_j\right)+\left(TFP_j-\Theta_{dj}^{\frac{1-\beta}{\beta}}\right)\right]\right\}\frac{\delta_{dj}(\varphi_{xj}-\varphi_{dj})}{\delta_{dj}\varphi_{dj}+\delta_{xj}\varphi_{xj}}\hat{\Theta}_{dj}, \tag{40}$$

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, it fails in general as Θ_{xj} approaches Θ_{dj}. If this condition fails, it is sufficient to have

$$\left[TFP_j - \Theta_{dj}^{(1-\beta)/\beta}\right] / \left[TFP_j - \Theta_{xj}^{(1-\beta)/\beta}\right] \geqslant \kappa_{xj}/\kappa_{dj},$$

which is, in particular, satisfied when $\kappa_{dj} \geqslant \kappa_{xj}$. This latter condition is always satisfied if $\kappa(\cdot)$ is a decreasing function equivalent to

$$-\frac{\Theta G''(\Theta)}{G'(\Theta)} > 2 + \frac{\Theta G'(\Theta)}{\frac{1}{\Theta}\int_{\Theta}^{\infty} \xi dG(\xi)},$$

that is $G''(\cdot)$ has to be negative and large enough in absolute value. This condition is satisfied for the Pareto distribution since in this case $\kappa(\cdot)$ is constant and, thus, $\kappa_{dj} \equiv \kappa_{xj}$. However, it is not satisfied, for example, for the exponential distribution.

Finally, the necessary and sufficient condition is

$$(\kappa_{xj} - \kappa_{dj})TFP_j - \left(\kappa_{xj}\Theta_{xj}^{(1-\beta)/\beta} - \kappa_{dj}\Theta_{dj}^{(1-\beta)/\beta}\right) \leqslant \varphi_{xj} - \varphi_{dj}$$

which is satisfied when

$$\frac{(\kappa_{xj} - \kappa_{dj})\left(TFP_j - \Theta_{dj}^{(1-\beta)/\beta}\right)}{\varphi_{xj} - \varphi_{dj}} = (\kappa_{xj} - \kappa_{dj})\left[\varpi_{xj} + \frac{\varphi_{dj} - \Theta_{dj}^{(1-\beta)/\beta}}{\varphi_{xj} - \varphi_{dj}}\right] \leqslant 1.$$

This condition also does not hold in general; however, it is certainly satisfied for large enough Θ_{xj}.

Now we provide the derivation of equation (36) 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 (35), 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 (29) 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

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

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 (36) in the text

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

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

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

which is a weighted average of 1 (the productivity in the homogenous sector) and $TFP''_j\equiv H_j/N_j\cdot TFP_j$ (productivity in the differentiated-product sector). The weights are the respective fractions of the two sectors in the total labor resources. Note that $\widehat{TFP''_j}=\widehat{TFP}_j-\hat{b}_j$. If $TFP''_j>1$, an extensive increase in the size of the differentiated sector improves productivity. Reduction in trade costs and labor market deregulation additionally shift resources towards the differentiated sector by increasing N_j. These are the additional effects captured by this alternative measure of aggregate productivity.

Derivation of results for Section 6.2

For $\hat{b}_B=\hat{\tau}=0$ and $\hat{b}_A>0$, (31) yield:

$$\hat{\Theta}_{dA}=-\frac{\delta_{xA}}{\Delta}\left(\delta_{xB}+\delta_{dB}\right)\hat{b}_A<0,\qquad \hat{\Theta}_{xA}=\frac{\delta_{dA}}{\Delta}\left(\delta_{xB}+\delta_{dB}\right)\hat{b}_A>0,$$

$$\hat{\Theta}_{dB}=\frac{\delta_{xB}}{\Delta}\left(\delta_{xA}+\delta_{dA}\right)\hat{b}_A>0,\qquad \hat{\Theta}_{xB}=-\frac{\delta_{dB}}{\Delta}\left(\delta_{xA}+\delta_{dA}\right)\hat{b}_A<0.$$

Using these expressions together with (33) we obtain

$$\frac{\beta-\zeta}{1-\beta}\hat{Q}_A=-\frac{\delta_{dB}}{\Delta}\left(\delta_{xA}+\delta_{dA}\right)\hat{b}_A<0,$$
$$\frac{\beta-\zeta}{1-\beta}\hat{Q}_B=\frac{\delta_{xB}}{\Delta}\left(\delta_{xA}+\delta_{dA}\right)\hat{b}_A>0.$$

For an initially symmetric equilibrium these expressions become

$$\hat{\Theta}_{dA}=-\frac{\delta_x\beta}{(1-\beta)\left(\delta_d-\delta_x\right)}\hat{b}_A<0,\qquad \hat{\Theta}_{xA}=\frac{\delta_d\beta}{(1-\beta)\left(\delta_d-\delta_x\right)}\hat{b}_A>0,$$

$$\hat{\Theta}_{dB}=\frac{\delta_x\beta}{(1-\beta)\left(\delta_d-\delta_x\right)}\hat{b}_A>0,\qquad \hat{\Theta}_{xB}=-\frac{\delta_d\beta}{(1-\beta)\left(\delta_d-\delta_x\right)}\hat{b}_A<0$$

and

$$\frac{\beta-\zeta}{1-\beta}\hat{Q}_A=-\frac{\delta_d\beta}{(1-\beta)\left(\delta_d-\delta_x\right)}\hat{b}_A<0,$$
$$\frac{\beta-\zeta}{1-\beta}\hat{Q}_B=\frac{\delta_x\beta}{(1-\beta)\left(\delta_d-\delta_x\right)}\hat{b}_A>0.$$

To examine the impact of labor market institutions on unemployment, consider

$$Q_j^{\beta\frac{1-\zeta}{1-\beta}} = \phi_1 \left[M_j b_j^{-\frac{\beta}{1-\beta}} \int_{\Theta_{dj}}^{\infty} \Theta dG(\Theta) + M_{(-j)} b_{(-j)}^{-\frac{\beta}{1-\beta}} \tau^{-\frac{\beta}{1-\beta}} \int_{\Theta_{x(-j)}}^{\infty} \Theta dG(\Theta) \right].$$

$$N_j = \phi_1^{\frac{1}{\beta}} M_j b_j^{-\frac{\beta}{1-\beta}} \left[Q_j^{-\frac{\beta-\zeta}{1-\beta}} \int_{\Theta_{dj}}^{\infty} \Theta dG(\Theta) + \tau^{-\frac{\beta}{1-\beta}} Q_{(-j)}^{-\frac{\beta-\zeta}{1-\beta}} \int_{\Theta_{xj}}^{\infty} \Theta dG(\Theta) \right].$$

We differentiate these equations, starting from a symmetric equilibrium with $b_A = b_B$, and consider a small increase in b_A. This yields

$$\begin{aligned} \beta\frac{1-\zeta}{1-\beta}\hat{Q}_j =& \sigma_d \left[\hat{M}_j - \frac{\beta}{1-\beta}\hat{b}_j \right] - \mu_d \hat{\Theta}_{dj} + \sigma_x \left[\hat{M}_{(-j)} - \frac{\beta}{1-\beta}\hat{b}_{(-j)} \right] - \mu_x \hat{\Theta}_{x(-j)}, \\ \hat{N}_j =& \hat{M}_j - \frac{\beta}{1-\beta}\hat{b}_j - \frac{\beta-\zeta}{1-\beta}\sigma_d \hat{Q}_j - \mu_d \hat{\Theta}_{dj} - \frac{\beta-\zeta}{1-\beta}\sigma_x \hat{Q}_{(-j)} - \mu_x \hat{\Theta}_{xj}, \end{aligned}$$

where

$$\sigma_d = \frac{\int_{\Theta_d}^{\infty} \Theta dG(\Theta)}{\int_{\Theta_d}^{\infty} \Theta dG(\Theta) + \tau^{-\frac{\beta}{1-\beta}} \int_{\Theta_x}^{\infty} \Theta dG(\Theta)} \quad \text{and} \quad \sigma_x = 1 - \sigma_d < \sigma_d$$

and

$$\mu_z \equiv \sigma_z \frac{f_z}{\delta_z} G'(\Theta_z)\Theta_z, \qquad z \in \{d, x\}.$$

The first two equations can be expressed as

$$\begin{aligned} \sigma_d \hat{M}_A + \sigma_x \hat{M}_B &= \left[-\Psi_A + \tfrac{\beta\sigma_d}{1-\beta} \right] \hat{b}_A, \\ \sigma_x \hat{M}_A + \sigma_d \hat{M}_B &= \left[\Psi_B + \tfrac{\beta\sigma_x}{1-\beta} \right] \hat{b}_A, \end{aligned}$$

where

$$\begin{aligned} \Psi_A &\equiv \frac{\beta}{1-\beta}\frac{1}{\delta_d - \delta_x}\left[\beta\frac{1-\zeta}{\beta-\zeta}\delta_d + \mu_d\delta_x + \mu_x\delta_d \right] > 0, \\ \Psi_B &\equiv \frac{\beta}{1-\beta}\frac{1}{\delta_d - \delta_x}\left[\beta\frac{1-\zeta}{\beta-\zeta}\delta_x + \mu_d\delta_x + \mu_x\delta_d \right] > 0. \end{aligned}$$

This system then yields the solution

$$\begin{aligned} \hat{M}_A &= \left[\frac{\beta}{1-\beta} - \Psi_{MA} \right] \hat{b}_A, \qquad & \Psi_{MA} &\equiv \frac{\sigma_d \Psi_A + \sigma_x \Psi_B}{\sigma_d - \sigma_x}, \\ \hat{M}_B &= \Psi_{MB} \hat{b}_A, \qquad & \Psi_{MB} &\equiv \frac{\sigma_x \Psi_A + \sigma_d \Psi_B}{\sigma_d - \sigma_x}. \end{aligned}$$

Note that

$$\Psi_{MA} - \frac{\beta}{1-\beta} > \frac{\beta}{1-\beta}\left[\frac{\sigma_d + \sigma_x\frac{\delta_x}{\delta_d}}{\sigma_d - \sigma_x}\frac{\delta_d}{\delta_d - \delta_x}\beta\frac{1-\zeta}{\beta-\zeta} - 1 \right] > \frac{\beta}{1-\beta}\left[\beta\frac{1-\zeta}{\beta-\zeta} - 1 \right] = \frac{\beta\zeta}{\beta-\zeta} > 0.$$

Therefore, M_A unambiguously decreases in b_A and M_B increases in b_A. Also note that as $\tau \to \infty$, δ_x, μ_x and σ_x all go to 0 and $\sigma_d \to 1$. This implies that $\Psi_{MB} \to 0$ as well and $\Psi_{MA} \to \frac{\beta}{1-\beta}\frac{\beta(1-\zeta)}{\beta-\zeta}$ so that $\hat{M}_B = 0$

and $\hat{M}_A = -\frac{\beta\zeta}{\beta-\zeta}\hat{b}_A$, which is exactly the case of the closed economy.

Next we turn to the analysis of N_j, H_j and u_j. Using the condition for N_j above and the results for M_j we have

$$\hat{N}_A = \left[-\Psi_{MA} + \frac{\beta}{1-\beta}\frac{1}{\delta_d - \delta_x}\left\{\sigma_d\delta_d - \sigma_x\delta_x + \mu_d\delta_x - \mu_x\delta_d\right\}\right]\hat{b}_A \equiv -\Psi_{NA}\ \hat{b}_A,$$
$$\hat{N}_B = \left[\Psi_{MB} - \frac{\beta}{1-\beta}\frac{1}{\delta_d - \delta_x}\left\{\sigma_d\delta_x - \sigma_x\delta_d + \mu_d\delta_x - \mu_x\delta_d\right\}\right]\hat{b}_A \equiv \Psi_{NB}\ \hat{b}_A,$$

where the first term in the square brackets comes from the changes in M_j and b_j and the second term comes from the change in the thresholds and outputs. Next note that

$$\Psi_{NA} = \frac{\beta}{1-\beta}\frac{1}{\delta_d - \delta_x}\frac{1}{\sigma_d - \sigma_x}\left[2\sigma_x\mu_d\delta_x + 2\sigma_d\mu_x\delta_d + 2\sigma_d\sigma_x(\delta_d + \delta_x) + \frac{\zeta(1-\beta)}{\beta-\zeta}(\sigma_d\delta_d + \sigma_x\delta_x)\right] > 0,$$
$$\Psi_{NB} = \frac{\beta}{1-\beta}\frac{1}{\delta_d - \delta_x}\frac{1}{\sigma_d - \sigma_x}\left[2\sigma_x\mu_d\delta_x + 2\sigma_d\mu_x\delta_d + 2\sigma_d\sigma_x(\delta_d + \delta_x) + \frac{\zeta(1-\beta)}{\beta-\zeta}(\sigma_d\delta_x + \sigma_x\delta_d)\right] > 0.$$

When $\tau \to \infty$, we have $\Psi_{NA} \to \frac{\beta\zeta}{\beta-\zeta}$ and $\Psi_{NB} \to 0$, and when $\tau < \infty$ we have $\Psi_{NA} > \frac{\beta\zeta}{\beta-\zeta}$.

Total employment in the differentiated sector changes according to:

$$\hat{H}_A = \hat{N}_A + \hat{x}_A = -(1+\Psi_{NA})\hat{b}_A \qquad \text{and} \qquad \hat{H}_B = \hat{N}_B = \Psi_{NB}\ \hat{b}_A$$

and unemployment responds as

$$\hat{u}_A = \hat{N}_A - \frac{x}{1-x}\hat{x}_A = -\left[\Psi_{NA} - \frac{1}{b-1}\right]\hat{b}_A \qquad \text{and} \qquad \hat{u}_B = \hat{N}_B = \Psi_{NB}\ \hat{b}_A.$$

Note that if an economy is effectively open (i.e., there is trade in equilibrium) we have

$$\Psi_{NA} - \frac{1}{b-1} > \frac{\beta\zeta}{\beta-\zeta} - \frac{1}{b-1}.$$

Therefore, unemployment at home will rise in response to increased flexibility in the home labor market in an open economy whenever it does so in a closed economy, but not necessarily the opposite.

Solution of the model under the Pareto assumption for Section 6.3

We characterize here the solution of the model under the assumption that productivity draws Θ are distributed Pareto with the shape parameter $k > 2$. That is, $G(\Theta) = 1 - (\Theta_{\min}/\Theta)^k$ defined for $\Theta \geq \Theta_{\min}$. We later use this characterization in order to solve numerically for the equilibrium response of unemployment to different shocks.

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

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

so that $\hat{\delta}_{zj} = -k\hat{\Theta}_{dj}$. As a result, we can rewrite the free entry condition (29) as

$$f_d\Theta_{dj}^{-k} + f_x\Theta_{xj}^{-k} = (k-1)f_e\Theta_{\min}^{-k} \qquad \Leftrightarrow \qquad \delta_{dj} + \delta_{xj} = kf_e.$$

Manipulating cutoff conditions (28) and the free entry condition above, we can obtain two equations to solve for $\{\Theta_{dj}, \Theta_{xj}\}$. For concreteness, consider $j = A$:

$$f_d\Theta_{dA}^{-k}+f_x\Theta_{xA}^{-k} = (k-1)f_e\Theta_{\min}^{-k},$$

$$f_x\left[\tau^{\frac{\beta}{1-\beta}}\frac{f_x}{f_d}\psi^{-\frac{\beta}{1-\beta}}\right]^{-k}\Theta_{dA}^{-k}+f_d\left[\tau^{\frac{\beta}{1-\beta}}\frac{f_x}{f_d}\psi^{\frac{\beta}{1-\beta}}\right]^{k}\Theta_{xA}^{-k} = (k-1)f_e\Theta_{\min}^{-k},$$

where $\psi \equiv b_A/b_B$ is the relative labor market rigidity of country A. This is a linear system in $\{\Theta_{dA}^{-k}, \Theta_{xA}^{-k}\}$ and there are similar conditions for country B, with ψ^{-1} replacing ψ. The solution to this system is given by

$$\Theta_{dA}^{-k} = \frac{f_x}{\Delta_\Theta}\left[\tau^{\frac{\beta k}{1-\beta}}\left(\frac{f_x}{f_d}\right)^{k-1}\psi^{\frac{\beta k}{1-\beta}}-1\right],$$

$$\Theta_{xA}^{-k} = \frac{f_d}{\Delta_\Theta}\left[1-\tau^{\frac{-\beta k}{1-\beta}}\left(\frac{f_x}{f_d}\right)^{-(k-1)}\psi^{\frac{\beta k}{1-\beta}}\right],$$

where

$$\Delta_\Theta = \frac{f_x^2\Theta_{\min}^k}{(k-1)f_e}\tau^{\frac{-\beta k}{1-\beta}}\left(\frac{f_x}{f_d}\right)^{-k}\psi^{\frac{\beta k}{1-\beta}}\left[\tau^{\frac{2\beta}{1-\beta}}\left(\tau^{\frac{\beta}{1-\beta}}\frac{f_x}{f_d}\right)^{2(k-1)}-1\right] > 0.$$

Using this result we can derive a condition on primitive parameters for $\Theta_{dj} < \Theta_{xj}$ to hold in equilibrium:

$$\frac{f_d}{f_d+f_x}\left(\tau^{\frac{\beta}{1-\beta}}\frac{f_x}{f_d}\right)^{k}+\frac{f_x}{f_d+f_x}\left(\tau^{\frac{\beta}{1-\beta}}\frac{f_x}{f_d}\right)^{-k} > \max\left\{\psi^{\frac{-\beta k}{1-\beta}}, \psi^{\frac{\beta k}{1-\beta}}\right\}, \tag{41}$$

which is satisfied for large τ and for $\psi \equiv b_A/b_B$ not very different from one. Next note that as $\tau \to \infty$, $\Theta_{xA} \to \infty$ and $\Theta_{dA} \to \left[\frac{f_d}{(k-1)f_e}\right]^{1/k}\Theta_{\min} \equiv \Theta_d^c$. Therefore, the condition for $\Theta_d^c > \Theta_{\min}$ is $k < 1 + f_d/f_e$ which is equivalent to the condition in the text. One can also show that Θ_{dA} decreases in τ in the range $\tau \in (\tau^*, \infty)$ where

$$\tau^* = \tau^*(\psi, f_x/f_d): \qquad (\tau^*)^{\frac{\beta k}{1-\beta}} = (f_d/f_x)^{k-1}\left[\psi^{\frac{\beta k}{1-\beta}}+\sqrt{\psi^{\frac{2\beta k}{1-\beta}}-1}\right].$$

The first cutoff condition in (28) allows to solving for Q_j once Θ_{dj} is known; Q_j is also decreasing in τ in the range (τ^*, ∞). It is straightforward to show that Q_j decreases in b_A and increases in b_B. Using the Pareto assumption and the equation for M_j (32), we get

$$M_j = \phi_2\frac{k-1}{k}\Theta_{\min}^{-k}\frac{f_dQ_j^\zeta\Theta_{d(-j)}^{-k}-f_xQ_{(-j)}^\zeta\Theta_{x(-j)}^{-k}}{f_d^2\Theta_{dA}^{-k}\Theta_{dB}^{-k}-f_x^2\Theta_{xA}^{-k}\Theta_{xB}^{-k}}. \tag{42}$$

The condition for $M_A > 0$ can then be written as

$$\left(\frac{\Theta_{xB}}{\Theta_{dB}}\right)^k\left(\frac{Q_A}{Q_B}\right)^\zeta > 1.$$

One can show that this inequality imposes a restriction on parameters $\{\tau, \psi, f_x/f_d\}$ such that $\tau > \tau^*(\psi, f_x/f_d)$, which implies that Q_j is decreasing in τ whenever there is no complete specialization ($M_j > 0$ for both j). This is consistent with Lemma 1 in the text.

Finally, using the condition for N_j (25), the the optimal employment levels (17) and conditions (28), we get

$$N_j = \phi_1^{\frac{1-\beta}{\beta}} \phi_2^{-1} M_j \left[\delta_{dj} + \delta_{xj}\right] = \phi_1^{\frac{1-\beta}{\beta}} k f_e M_j,$$

that is, under Pareto assumption, N_j is always proportional with M_j. The remaining equilibrium conditions are

$$H_j = N_j / b_j \qquad \text{and} \qquad u_j = (1 - b_j^{-1}) N_j / L.$$

We use the equations above to solve for equilibrium comparative statics numerically. Certain analytical results can also be obtained under the Pareto assumption for M_j, N_j and u_j departing from (42).

Remark for Section 5.2: Under the Pareto assumption we can get a simple prediction about the response of 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 (28)) 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 $Q_B > Q_A$.

References

[1] Acemoglu, Daron, Pol Antràs and Elhanan Helpman (2007), "Contracts and Technology Adoption," *American Economic Review* 97, pp. 916-943.

[2] Agell, Jonas and Per Lundborg (1995), "Fair Wages in the Open Economy," *Economica* 62, pp. 335–351.

[3] Alessandria, George and Alain Delacroix (2004), "Trade and the (Dis)Incentive to Reform Labor Markets: The Case of Reform in the European Union," Federal Reserve Bank of Philadelphia, Working Paper No. 04-18.

[4] Blanchard, Olivier and Justin Wolfers (2000), "The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence," *Economic Journal* 110, pp. C1-C33.

[5] Botero, Juan C., Simeon Djankov, Rafael La Porta, Florencio Lopez-de-Silanes and Andrei Shleifer (2004), "The Regulation of Labor," *Quarterly Journal of Economics* 119, pp. 1339-1382.

[6] Brecher, Richard (1974), "Minimum Wage Rates and the Pure Theory of International Trade," *Quarterly Journal of Economics* 88, pp. 98-116.

[7] Brecher, Richard (1992), "An Efficiency-Wage Model with Explicit Monitoring: Unemployment and Welfare in an Open Economy," *Journal of International Economics* 32, pp. 179-191.

[8] Brügemann, Björn (2003), "Trade Integration and the Political Support for Labor Market Rigidity," mimeo, Yale University.

[9] Chor, Davin (2006), "Unpacking Sources of Comparative Advantage: A Quantitative Approach," mimeo, Harvard University.

[10] Copland, Brian (1989), "Efficiency Wages in a Ricardian Model of International Trade," *Journal of International Economics* 27, pp. 221-244.

[11] Costinot, Arnaud (2006), "On the Origins of Comparative Advantage," mimeo, UCSD.

[12] Cuñat, Alejandro and Marc Melitz (2007), "Volatility, Labor Market Flexibility, and the Pattern of Comparative Advantage," NBER Working Paper No. 13062.

[13] Davidson, Carl, Lawrence Martin and Steven Matusz (1988), "The Structure of Simple General Equilibrium Models with Frictional Unemployment," *Journal of Political Economy* 96, pp. 1267-1293.

[14] Davidson, Carl, Lawrence Martin and Steven Matusz (1999), "Trade and Search Generated Unemployment," *Journal of International Economics* 48, pp. 271-299.

[15] Davidson, Carl and Steven Matusz (2006a), "Long-run Lunacy, Short-run Sanity: a Simple Model of Trade with Labor Market Turnover," *Review of International Economics* 14, pp. 261-276.

[16] Davidson, Carl and Steven Matusz (2006b), "Trade Liberalization and Compensation," *International Economic Review* 47, pp. 723-747.

[17] Davis, Donald (1998), "Does European Unemployment Prop Up American Wages? National Labor Markets and Global Trade," *American Economic Review* 88, pp. 478-494.

[18] Davis, Donald and James Harrigan (2007), "Good Jobs, Bad Jobs, and Trade Liberalization," mimeo, Columbia University.

[19] Egger, Harmut and Udo Kreickemeier (2006), "Firm Heterogeneity and the Labour Market Effects of Trade Liberalization," GEP Research Paper 2006/26.

[20] Fariñas, José C. and Ana Martín-Marcos (2007), "Exporting and Economic Performance: Firm-Level Evidence of Spanish Manufacturing," *The World Economy* 30, 618-646.

[21] Ghironi, Fabio and Marc J. Melitz (2005), "International Trade and Macroeconomic Dynamics with Heterogenous Firms," *Quarterly Journal of Economics* 120, 865-915.

[22] Hoon, Hian Teck (2001), "Adjustment of Wages and Equilibrium Unemployment in a Ricardian Global Economy," *Journal of International Economics* 54, pp. 193-209.

[23] Hosios, Arthur J. (1990), "Factor Market Search and the Structure of Simple General Equilibrium Models," *Journal of Political Economy* 98, pp. 325-355.

[24] Jones, Ronald W. (1965), "The Structure of Simple General Equilibrium Models," *Journal of Political Economy* 73, pp. 557-572.

[25] Katz, Lawrence F. and Lawrence H. Summers (1989), "Industry Rents: Evidence and Implications," *Brookings Papers on Economic Activity. Microeconomics* 1989, pp. 209-290.

[26] Kreickemeier, Udo and Douglas Nelson (2006), "Fair Wages, Unemployment and Technological Change in a Global Economy," *Journal of International Economics* 70, pp. 451–469.

[27] Levchenko, Andrei A. (2007), "Institutional Quality and International Trade," forthcoming in the *Review of Economic Studies* 74, pp. 791-819.

[28] Matusz, Steven J. (1986), "Implicit Contracts, Unemployment and International Trade," *Economic Journal* 96, pp. 71-84.

[29] Melitz, Marc J. (2003), "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica* 71, pp. 1695-1725.

[30] Merz, Monika and Eran Yashiv (2007), "Labor and the Market Value of the Firm," forthcoming in the *American Economic Review*.

[31] Mitra, Devashish and Priya Ranjan (2007), "Offshoring and Unemployment," mimeo, Syracuse University.

[32] Moore, Mark P. and Priya Ranjan (2005), "Globalisation vs Skill-Biased Technological Change: Implications for Unemployment and Wage Inequality," *Economic Journal* 115, pp. 391-422.

[33] Nickell, Steven (1997), "Unemployment and Labor Market Rigidities: Europe Versus North-America," *Journal of Economic Perspectives* 11, pp. 55-74.

[34] Nickell, Steven, Luca Nunziata, Wolfgang Ochel and Glenda Quintini (2002), "The Beveridge Curve, Unemployment and Wages in the OECD from the 1960s to the 1990s," Center for Economic Performance, the LSE.

[35] Nunn, Nathan (2007), "Relationship-Specificity, Incomplete Contracts, and the Pattern of Trade," *Quarterly Journal of Economics* CXXII, pp. 569-600.

[36] Pissarides, Christopher A. (2000), *Equilibrium Unemployment Theory* (Cambridge, MA: The MIT Press, second edition).

[37] Rogoff, Kenneth (1996), "The Purchasing Power Parity Puzzle," *Journal of Economic Literature* 34, pp. 647-668.

[38] Stole, Lars A. and Jeffrey Zwiebel (1996a), "Organizational Design and Technology Choice under Intrafirm Bargaining," *American Economic Review* 86, pp. 195-222.

[39] Stole, Lars A. and Jeffrey Zwiebel (1996b), "Intra-Firm Bargaining under Non-Binding Contracts," *Review of Economic Studies* 63, pp. 375-410.

[40] Yashiv, Eran (2000), "The Determinants of Equilibrium Unemployment," *American Economic Review* 90, pp. 1297-1322.