Labor Standards and International Trade in a Search-Matching Model*

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Preliminary - Comments welcome

Abstract

In order to shed some theoretical light on the impact of labor standards on trade competitiveness, we develop an international trade model with search-matching frictions. The traditional sector is labor-intensive, while the modern sector is capital-intensive, and exhibits search frictions in its labor market. We assume that workers in the domestic country have a stronger bargaining power than their foreign counterparts. We show that the domestic country has a comparative advantage in the modern sector. This result may explain why several empirical papers find a positive correlation between stronger labor standards and higher manufacturing exports.

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1 Introduction

It is widely acknowledged that better labor standards should be promoted in developing countries. In particular, it is often argued that freedom of association and collective bargaining (FACB) rights should be strongly enforced. The main motivation for such statements is that FACB rights are classified as "civic rights" for workers. As a result, they are linked to civil liberties and democracy, and they have a value *per se*.

On the other hand, some have raised concerns on the potential adverse impact of FACB rights enforcement on the economic competitiveness in developing countries. If a country becomes heavily unionized, it seems reasonable to assume that wages should be pushed up. This would unambiguously erode the comparative advantage of this country, based on cheap, abundant labor. Besides, foreigners would then be reluctant to invest their capital in this country, implying a decrease in inward FDI flows. If this point is taken seriously, the enforcement of FACB rights may therefore slow down the development process.

There may also be some good reasons why FACB rights may be development-enhancing. They may for instance facilitate social dialogue between workers, employers and governments. According to Rodrik (1997), a more democratic environment, in which freedom of association is enforced, may also yield more stability in economic performance, which should induce agents to accumulate more human and physical capital. More political stability should also translate into larger inward FDI flows.

Empirical studies provide mixed evidences. Rodrik (1996), Busse (2001) and Flanagan (2003) find no statistically significant evidence that the ratification of ILO standards affects exports. Using the OECD FACB index, Busse (2001) and Belser (2001) obtain that stronger FACB rights affect trade negatively. In a recent paper, Kucera and Sarna (2006) use a trade gravity model to assess the impact of FACB rights on exports, using their own indicators for FACB rights enforcement. They find a statistically significant relationship between stronger FACB rights and higher manufacturing exports.

In this paper, we provide a new theoretical argument as to why stronger FACB rights can be associated with higher manufacturing exports and more inward FDI flows. We build a two-country, two-sector, two-factor model, in which goods markets are perfectly competitive. Sector T, the traditional sector, uses only labor and exhibits no search frictions: Workers can find a job instantaneously, and they receive the value of their marginal product. Sector M, the modern, manufacturing sector, uses both capital and labor under constant returns to scale. It features search and matching frictions *à la* Pissarides (1985). The matching technology is the same in both countries. After a unit of capital and an unemployed worker are matched, ex post bargaining occurs, which determines the sharing of the surplus. The workers' bargaining power, β, will be taken

as a proxy for FACB rights enforcement. We assume that workers have stronger FACB rights in the domestic country, namely, $\beta > \beta^*$.

As is standard in the trade literature, we start by computing the unique autarkic equilibrium. Doing comparative statics on the value of the bargaining power, we show that the high FACB rights country has a lower autarkic relative price in sector M. As a result, this country has a comparative advantage in the modern, manufacturing sector. This counterintuitive result comes from the presence of search and matching frictions. When workers have higher bargaining power, they anticipate that they will be able to get a higher share of the surplus. This attracts more workers into the unionized sector, which diminishes the relative scarcity of M, leading to a lower autarkic price.

After having found the comparative advantages, it is immediate to derive the patterns of trade. After trade liberalizes, the relative price of good M in the high FACB rights country increases. Thus, this country is a net exporter of good M in equilibrium, and the size of its modern sector grows following trade liberalization, thereby leading to a rise in unemployment in the domestic country. Hence, the presence of search-matching frictions in the modern sector may explain why the empirical results on the impact of FACB rights on manufacturing trade are so inconclusive.

We can then check whether Stolper-Samuelson results still hold in the presence of search frictions. In a frictionless environment, we would expect capital to gain and labor to lose in real terms, as production is moved from the labor-intensive sector to the capital-intensive one. We show that this is indeed true for *searching* factors. However, this may not hold for matched labor: It may well be that a worker employed in the unionized sector *before* trade liberalization gains from trade.

We finally deal with the issue of international capital mobility, by assuming that capital can migrate across country at zero cost. We exhibit the trade-off faced by capitalists when deciding in which country to locate. On the one hand, producing in the home country allows to attract many workers, which lowers the labor market tightness. On the other hand, producing abroad allows to get a larger share of the surplus. Under Cobb-Douglas specification of the matching function, we show that the first effect dominates when the domestic workers' bargaining power is not too high. In this case, the home country would receive inward capital flows. In other words, stronger labor standards could, paradoxically attract some capital, provided that they are not too strong.

Apart from the labor standard papers cited in the beginning of this introduction, this article is related to several strands of the literature. Obviously, we rely strongly on the traditional trade theory, i.e., trade models of comparative advantages under perfect competition and constant returns to scale; see Jones (1965) and the masterpiece of Dixit and Norman (1980). We also ground heavily on the search and matching literature; see

Pissarides (1985), Pissarides (2000) and Rogerson et al. (2005) for a survey.

Finally, the papers which are closest to ours are Davidson et al. (1988), Hosios (1990) and Davidson et al. (1999), which implement search and matching frictions into an international trade model. However, in the papers by Davidson, Martin and Matusz, the workers' bargaining power is always set at $\frac{1}{2}$, so that FACB rights differentials are never analyzed. In Hosios's paper, the bargaining power of workers is set so as to ensure the efficiency of the search-matching process. Again, the impact of FACB rights on comparative advantages is not studied.

The remainder of the paper is organized as follows. In section 2, we present our model. The autarkic equilibrium is exhibited in section 3. This allows us to derive comparative advantages and to solve for the free trade equilibrium in section 4. Section 5 solves the model under international capital mobility. Section 6 concludes.

2 The model

There are two countries, H (home) and F (foreign), two sectors, T and M and two production factors, capital K and labor L. In the following, "starred" variables will denote the foreign country's variables.

Endowments Both countries are exogenously endowed with L units of capital and K units of labor.

Preferences As is standard in a search-and-matching framework, consumers are risk neutral, and their rate of time preference is equal to the constant r. This implies that workers and capitalists maximize their present discounted value of income. In such a framework, international lending and borrowing will never happen, and trade will be balanced at each period of time.

Besides, in line with the international trade literature, the instantaneous utility flow is assumed to be homothetic. In particular, this implies that the relative demand function can be written as $\frac{C_M}{C_T} = D(\frac{P_M}{P_T})$, where $D(.)$ is downward-sloping.

Technologies Sector T is the traditional sector. Firms in T operate under constant returns to scale and perfect competition. The production technology transforms one unit of labor into one unit of good T. We assume away any kind of technology differences across country. In the following, good T will be taken as the numeraire, so that $P_T = 1$.

Manufacturing sector M is a bit more complicated: Firms still operate under perfect competition and constant returns to scale. But now, some capital is needed in the

production process. We assume the following fixed-proportions technology: One unit of capital together with one unit of labor allow for the production of 1 units of good M. Once again, in order to focus on the impact of labor market imperfections, we consider that both countries have access to the same technology.[1]

Markets As we said before, the goods markets are perfectly competitive.

Throughout all this paper, labor will be immobile internationally. Workers face the following choice. They can either be employed instantaneously in sector T and earn wage w_T. With the constant returns to scale assumption, we immediately get that $w_T = P_T = 1$. Or they can decide to look for a unit of capital in sector M; If they do so, they go through an unemployment spell before finding a match.

More precisely, if N_U is the number of workers looking for a job in sector M, and N_V is the number of units of idle capital, we assume that $m(N_U, N_V)dt$ jobs are created between time t and time $t+dt$. We make all the usual assumptions regarding the matching function: constant returns to scale, concavity and positiveness of partial derivatives. As usual, we can then define parameter $\theta = \frac{N_V}{N_U}$ as the labor market tightness. The instantaneous probability for a unit of idle capital to find a worker is then equal to $M\left(\frac{N_U}{N_V}, 1\right) = M(\theta^{-1}, 1) \equiv q(\theta)$, with $q'(.) < 0$. Similarly, an unemployed worker finds a job at rate $\theta q(\theta)$, with $\frac{d(\theta q(\theta))}{d\theta} > 0$. To allow for the existence of steady state unemployment, we assume that matches are destroyed at rate $\delta > 0$. For the sake of simplicity, we assume away any form of search costs, unemployment benefits or domestic production. This implies that each unit of capital will either be employed or looking for a worker in equilibrium. In line with most of the search and matching literature, we do not allow for on-the-job search either.[2]

Once a worker and a unit of capital have met, ex post Nash bargaining occurs so as to share the surplus created by the match. We assume that workers in the domestic country have more bargaining power than in the foreign one, i.e., $\beta > \beta^*$. Domestic workers are able to capture a larger share of the surplus, because FACB rights are more strongly enforced in country H. Notice that this is the only difference between countries in this economy, hence, the only potential source of comparative advantages. In the absence of increasing returns to scale and imperfect competition, this difference in FACB rights is the only reason why trade occurs in equilibrium.

We assume that workers are perfectly mobile across sectors, but immobile internationally. In section 5, we will give the possibility for capital to migrate across country.

[1] The assumptions we have made on production technologies are rather extreme. Metaphorically, sector M should be seen as a modern, capital-intensive sector, while T would be a labor-intensive sector.

[2] Once again, the assumptions we make on the labor market in each sector may sound too strong. Sector T should be seen as a labor-intensive sector, in which search-matching frictions are small, namely, it does not take too much time to find a job in this sector.

Equilibrium We focus on steady-state equilibria and ignore the transitional dynamics.

3 Self-sufficiency equilibrium

In this section, we assume that the emergence of trade is precluded. This will allow us to derive autarkic relative prices, hence comparative advantages. To do so, we proceed as follows. First, we find a non-arbitrage condition on the labor market, which gives us the relative price of goods for any level of the labor market tightness. Then, using factor markets clearing conditions together with the Beveridge curve, we get the quantities produced for both goods as functions of θ. Combining these relations with the non-arbitrage condition, we get an upward-sloping relative supply curve, which intersects the relative demand curve once, and only once, yielding a unique equilibrium. In the following, we focus on domestic country variables but, as should be obvious, the same reasoning could be made in the foreign country.

Non-arbitrage condition on the labor market To begin with, let us write the value functions of workers in sector M. We denote by U the present discounted value of looking for a job in sector M, and $W(w)$ the value of being employed at wage w in sector M. We have the following Bellman equations:[3]

$$rU = \theta q(\theta)\left(W - U\right), \tag{1}$$

$$rW(w) = w + \delta\left(U - W(w)\right). \tag{2}$$

Similarly, we define value functions for units of capital. V denotes the present discounted value of being idle, while $J(w)$ denotes the value of being matched with a worker, paid at wage w. The Bellman equations are given by:

$$rV = q(\theta)\left(J - V\right), \tag{3}$$

$$rJ(w) = P_M - w + \delta\left(V - J(w)\right). \tag{4}$$

Once a match is realized, wage bargaining takes place and the surplus is shared. If the negotiation breaks, the worker goes back to unemployment and earns U, while the capital owner earns the value of being idle V. If it succeeds, the latter earns $W(w)$, while

[3]Since we have chosen to rule out the transitional dynamics, we can ignore the time derivatives of the value functions.

the former gets $J(w)$. Formally, the wage is chosen so as to maximize the following Nash product:[4]

$$(W(w) - U)^{\beta} (J(w) - V)^{1-\beta}.$$

As is well known, this implies that the worker gets a share β of the match surplus: $W(w) - U = \beta (J(w) + W(w) - V - U)$. After some algebra, we obtain the bargained wage as a function of the price of good M and the labor market tightness:

$$w = \frac{\beta (r + \delta + \theta q(\theta))}{(1 - \beta)(r + \delta + q(\theta)) + \beta (r + \delta + \theta q(\theta))} P_M. \tag{5}$$

The above expression is obviously increasing in θ. Intuitively, as the labor market tightness increases, the probability for an unemployed worker to receive a job offer goes up. This increases the workers' outside option, leading to a higher bargained wage.

This value can be plugged into the expression of U to get the value of being unemployed:

$$rU = \frac{\beta \theta q(\theta)}{(1 - \beta)(r + \delta + q(\theta)) + \beta (r + \delta + \theta q(\theta))} P_M.$$

In equilibrium, workers have to be indifferent between working in sector T at wage $w_T = 1$ and being unemployed in sector M. Since agents are risk neutral, the present discounted value of the expected income flows have to be equalized across sectors. In other words, rU has to be equal to 1. Straightforward computations yield the non-arbitrage condition:

$$P_M = \frac{\beta \theta q(\theta)}{(1 - \beta)(r + \delta + q(\theta)) + \beta (r + \delta + \theta q(\theta))}. \tag{6}$$

Hence, the relative price of good M is a decreasing function of the labor market tightness θ. This relation is rather intuitive. As the relative price of good M increases, the total surplus from a match in the modern sector increases. This induces some workers to move from sector T to sector M, which lowers the labor market tightness, since the stock of capital is fixed.

Equilibrium on the factors markets In the following, we fix the relative price of good M. We have seen that this yields a unique value for the labor market tightness. First, let us write the factor markets clearing conditions (remembering the fact that $N_V = \theta N_U$):

[4]We are aware of Hall and Milgrom (2005)'s criticism. In such a framework, the outcome of the negotiation depends heavily on non-credible threats, which is inconsistent with Binmore et al. (1986)'s theory of sequential bargaining. We choose to keep on using Pissarides (2000)'s framework anyway, since it is still widely accepted in the literature.

$$
\begin{aligned}
K &= M + \theta N_U, \\
L &= T + M + N_U.
\end{aligned}
$$

Since we have chosen to focus on steady states, we can use the Beveridge curve: $\delta M = N_U \theta q(\theta)$, which basically states that destroyed jobs have to be replaced by newly created jobs in equilibrium. We have thus 3 equations, 3 unknowns, with θ as a parameter. This system has a unique solution:

$$
\begin{aligned}
N_U &= \frac{\delta}{\delta + q(\theta)} \frac{1}{\theta} K, && (7) \\
T &= L - \frac{\delta + \theta q(\theta)}{\delta + q(\theta)} \frac{1}{\theta} K, && (8) \\
M &= \frac{q(\theta)}{\delta + q(\theta)} K. && (9)
\end{aligned}
$$

One sees immediately that M is a decreasing function of θ. Intuitively, as θ gets higher, there are less workers looking for a job in sector M. That also means that there are less workers actually employed in sector M, hence less production. A similar reasoning can be made to show that the production of sector T increases as labor market tightness rises.[5] Therefore, the ratio $\frac{M}{T}$ is a decreasing function of θ.

Relative supply curve and autarkic equilibrium Let us now summarize. The price P_M uniquely determines the labor market tightness through the non-arbitrage condition on the labor market. This value of θ then uniquely determines the relative supply of goods through the factor markets clearing conditions and the Beveridge curve. We have just exhibited the relative supply curve. Let us check that it is positively sloped:

$$
\frac{\partial P_M}{\partial M/T} = \frac{\partial P_M}{\partial \theta} \frac{\partial \theta}{\partial M/T}.
$$

Both terms in the right-hand side product are strictly negative, therefore, the relative supply curve is upward sloping. On the consumers side, we assumed that the relative demand function was downward sloping. These two curves intersect each other once, and

[5] However, the formal proof is a bit trickier. After some cumbersome computations, one gets the following expression for the partial derivative of T with respect to θ:

$$
\frac{\partial X}{\partial \theta} = \frac{K\delta}{\theta^2 \left(\delta + q(\theta)\right)^2} \left\{ \delta + (\theta q(\theta))' - \theta^2 q'(\theta) \right\},
$$

which is positive thanks to the assumptions we have made on the matching function.

only once. That result is summarized in the following proposition:

Proposition 1. *Autarkic equilibrium exists, and it is unique.*

4 Free trade equilibrium

We now consider the polar case in which all barriers to trade have been removed. As usual in a trade model with perfect competition, we first compare the autarkic relative prices of the two countries, which will give us the comparative advantages, hence, the patterns of trade. We then evaluate the impact of trade openness on the domestic country's endogenous variables.

4.1 Comparative advantages and free trade equilibrium

Comparative advantages As we said before, the only difference between the two countries is the enforcement of FACB rights. Therefore, to exhibit each country's comparative advantage, we have to investigate the impact on the autarkic price of an increase in β. Obviously, a change in β will not affect the relative demand curve. Hence, the only channel through which the relative autarkic price can be affected is the supply curve.

Fix the ratio $\frac{M}{T}$. We know that this uniquely determines a value of θ, which does not depend on β (see equations (8) and (9)). Using the non-arbitrage condition on the labor market, we can now compute the partial derivative of the price ratio with respect to β, taking the value of θ as given. We get:

$$\frac{\partial P_M}{\partial \beta} = -\frac{1}{\beta^2}\frac{r+\delta+q(\theta)}{\theta q(\theta)}, \tag{10}$$

which is strictly negative. For a given ratio $\frac{M}{T}$, P_M is lower when β is larger. In other words, as β rises, the relative supply curve shifts downwards. The relative price of good M has then to decrease to restore equilibrium on the goods markets, as can be seen in Figure 1. Therefore, the relative price of good M is an increasing function of workers' bargaining power β. Since, by assumption, $\beta > \beta^*$, the autarkic relative price of good M is higher in the domestic country. We can now state the following proposition:

Proposition 2. *The higher FACB rights country has a comparative advantage in good M.*

This result may sound a bit counterintuitive: After all, since domestic workers have more rights, the labor cost should be higher in the domestic country, imposing an upward pressure on the price of good M. The latter reasoning does not take into account the presence of search and matching frictions. If workers have weak FACB rights, they are

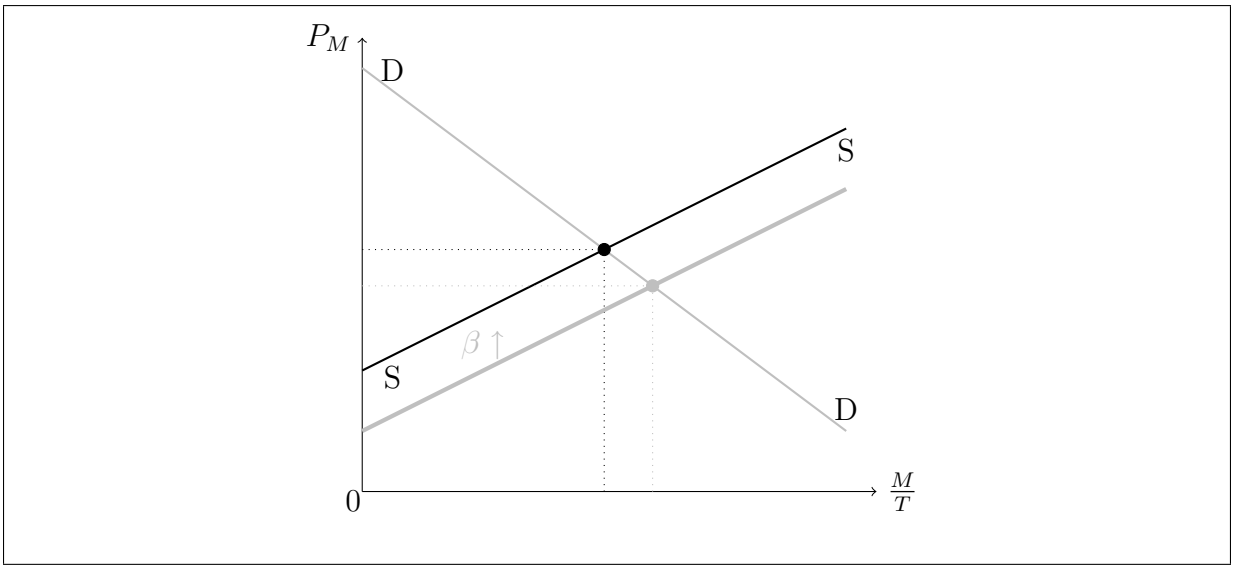

Figure 1: Comparative advantages

reluctant to start searching in sector M, since they anticipate that they will not be able to bargain a high wage. This tends to increase the relative scarcity of good M, hence its relative price. To put it another way, in this economy, a high bargaining power provides a strong incentive for workers to look for a job in M, which makes good M cheaper.

Free trade equilibrium In the following, superscript a stands for autarkic variables, while superscript ft stands for free trade variables. We can now characterize the free trade equilibrium.

As usual in trade theory, the free trade price P_M^{ft} has to lie between both autarkic prices. Indeed, if it were above P_M^{a*}, both countries would want to be net exporters of good M. Similarly, if it were below P_M^a, they would both want to export good T. That being said, we can derive the equilibrium patterns of trade: The domestic country will be net exporter of good M, while the foreign country will be net exporter of good T. The following proposition summarizes these results:

Proposition 3. *Assume that both countries engage in free trade. Then there exists a unique equilibrium, in which*

- P_M^{ft} *lies between* P_M^a *and* P_M^{a*}*,*
- *country* H *exports good* M *while country* F *exports good* T*.*

Proof. We first prove the existence, and then the uniqueness of the free trade equilibrium. Denote by $m_M(P) = C_M(P) - Y(P)$ the domestic demand for import of good M when the international relative price is equal to P.

The representative consumer's budget constraint is given by: $PC_M(P) + C_T(P) = PM(P) + T(P)$, which can be rewritten as $PC_M(P)(1 + \frac{1}{PD(P)}) = PM(P) + T(P)$, given the homothetic preferences assumption. It follows that the demand for export is:

$$m_M(P) = \frac{1}{1 + PD(P)} \left(D(P)T(P) - M(P) \right).$$

By definition of the autarkic equilibrium price, and by continuity of the above function, we know that $m_M(P) < 0$ iff $P > P_M^a$, $m_M(P) > 0$ iff $p > P_M^a$, and $m_M(P) = 0$ iff $P = P_M^a$. The same results hold for foreign country, when replacing m_M by m_M^* and P_M^a by P_M^{a*}.

Let us now define $m_M^W(P) = m_M(P) + m_M^*(P)$ the world excess demand for good M. Then we know that $m_M^W(P)$ is strictly positive for $P > P_M^{a*}$, and strictly negative for $P > P_M^a$. By continuity, there exists at least one $p \in]P_M^a, P_M^{a*}[$ such that $m_M^W(p) = 0$. If the international price is equal to such a P, the market for good M clears. By Walras' law, the market for good T clears as well. The existence of the free trade equilibrium is proven.

After some straightforward computations, one can prove that:

$$(1 + PD(P))m_M^W(P) = D(P) \left[T(p) + T^*(p) \right] - \left[M(p) + M^*(p) \right].$$

The second term on the right-hand side is strictly decreasing in P (see equations (6) and (8)). By assumption, $D(.)$ is downward sloping; and $[M(.) + M^*(.)]$ is strictly increasing. Therefore, the right-hand side of the above equation is strictly increasing. There exists only one value of P which cancels it. □

Paradoxically, the size of the modern sector ends up increasing under free trade. Put differently, stronger FACB rights can accelerate the development by shifting labor from the traditional sector to the modern sector. Once again, this is due to the fact that the prospect to bargain high wages attracts many domestic workers in the modern sector. Therefore, for any level of the relative price, the domestic country produces larger quantities of good M than the foreign one.

4.2 Hat calculus

We now investigate the way endogenous domestic variables are affected while moving from autarky to free trade. Comparing the values of these variables at price P_M^{ft} with their values at price P_M^a would be a bit messy. So, in line with the trade literature, we investigate the impact of a small increase in P_M: $dP_M > 0$. This will give us the direction of change when moving from autarky to free trade. In the following, hatted variables

denote percentage changes: $\hat{x} \equiv \frac{dx}{x}$.

Impact on equilibrium quantities Using the non-arbitrage condition, one immediately sees that $\hat{\theta}$ is strictly negative when $\hat{P}_M$ is strictly positive. When P_M increases, it becomes more interesting to look for a job in sector M, since the surplus to be shared after a match increases. Some workers move from T to M, which lowers the labor market tightness. This reallocation process stops when the adverse impact on the bargained wage becomes large enough.

Obviously, when $\hat{P}_M < 0$, the domestic country produces less good T and more good M, as can be seen by combining equations (8) and (9) with $\hat{\theta} < 0$.

This decrease in the labor market tightness has an adverse impact on unemployment ($\hat{N}_U > 0$): as more workers look for a job in the high unemployment sector, the unemployment rate increases. In this model, international trade, combined with labor market imperfections can indeed have an important impact on unemployment.

Stolper-Samuelson effects We now analyze the impact of trade integration on real factor returns. In a standard trade model *à la* Jones (1965), we would just need to look at factor prices. In our framework with search and matching frictions, we have to distinguish three types of Stolper-Samuelson effects: the impact on factor prices, the impact on returns to searching factors and the impact on returns to matched factors. The following proposition lists the results, and summarizes the impacts on equilibrium quantities:

Proposition 4. *Consider an increase in the relative price of good M: $\hat{P}_M > 0$. Then,*

- *Unemployment increases, sector M grows and sector T shrinks: $\hat{N_U} > 0$, $\hat{M} > 0$, and $\hat{T} < 0$;*
- $0 < \hat{w} < \hat{P_M}$*, i.e., the impact on the real wage in sector M is ambiguous;*
- $0 = r\hat{U} < \hat{P_M}$*, i.e., sector T workers and unemployed sector M workers unambiguously lose;*
- $0 < r\hat{W} < \hat{P_M}$*, i.e., the impact on the well-being of matched workers is ambiguous;*
- $0 < \hat{P_M} < r\hat{V}$*, i.e., idle capital unambiguously wins;*
- $0 < \hat{P_M} < r\hat{J}$*, i.e., employed capital unambiguously wins.*

Proof. Consider first the impact on the bargained wage. Its expression as a function of P_Y is given by equation 5, which we log-differentiate. We get:

$$\hat{w} = d\log\left\{\frac{\beta}{1+\frac{1-\beta}{\beta}\frac{r+\delta+q(\theta)}{r+\delta+\theta q(\theta)}}\right\} + \hat{P_M}.$$

The first term on the left-hand side is clearly negative, since $\hat{\theta} < 0$, therefore, $\hat{w} < \hat{P_M}$. Plugging the non-arbitrage condition to get rid of the P_M term, and log-differentiating, we obtain:

$$\hat{w} = d\log\left\{\frac{r+\delta+\theta q(\theta)}{\theta q(\theta)}\right\} > 0.$$

So, at the end of the day, we get that $0 < \hat{w} < \hat{P_M}$. In other words, the real wage can either increase or decrease, depending on the shape of the utility function. The standard Stolper-Samuelson theorem does not apply here.

Consider now the value of being unemployed. We know, from the non-arbitrage condition that $rU = 1$, so $\hat{rU} = 0 < \hat{P_M}$: Unemployed workers unambiguously lose, when moving from autarky to free trade.

We can easily show that the value of being employed in sector M is given by: $rW = \frac{r+\theta q(\theta)}{\theta q(\theta)}$. The ratio on the right-hand side is decreasing in θ, therefore, $\hat{rW} > 0$. Once again, we rewrite rW as a function of P_M: $rW = \frac{\beta(r+\theta q(\theta))}{(1-\beta)(r+\delta+q(\theta))+\beta(r+\delta+\theta q(\theta))}P_M$. Since the ratio on the right-hand side is increasing in θ, we deduce that $\hat{rW} < \hat{P_M}$.

After some algebra, the value of an idle unit of capital is obtained as:

$$rV = \frac{1-\beta}{\frac{r+\delta}{q(\theta)} + (1-\beta) + \beta\theta}P_M.$$

The ratio on the right-hand side is decreasing in θ, so $\hat{rV} > \hat{P_M} > 0$.

Similarly, the value of an employed unit of capital is equal to

$$rJ = \frac{(1-\beta)(r+q(\theta))}{(1-\beta)(r+\delta+q(\theta)) + \beta(r+\delta+\theta q(\theta))}P_M,$$

which is decreasing in θ, so $\hat{rJ} > \hat{P_M} > 0$.

□

First, consider the impact of trade integration on wages in sector M. As trade liberalizes, the price of good M raises in the domestic country. The first effect is to increase the bargained wage, since the surplus from a match goes up. This attracts more workers into the modern sector, which has a negative impact on the bargained wage. At the end of the day, the wage increases, but it increases less than P_M. Consequently, it is impossible to tell unambiguously whether or not the real bargained wage increases. This is an important departure with respect to the Stolper-Samuelson theorem. In a frictionless environment, this theorem would state that, since the comparative advantage sector is

relatively more capital-intensive, workers should be made worse off by trade integration.

However, Proposition 4 states that the Stolper-Samuelson applies for searching factor. First of all, the value of being unemployed is pinned down by the non-arbitrage condition. The expected income flow has to be equal to 1, which by assumption increases less than P_M: Unemployed workers unambiguously lose. Idle capital clearly wins for three reasons. First, the price of the good it produces increases. Second, the bargaining position of capital is strengthened by the decrease in labor market tightness. Last, the probability for a unit of capital to find a match increases. We can now restate the Stolper-Samuelson theorem in our search-and-matching framework: $r\hat{U} = 0 < \hat{P_Y} < r\hat{V}$.

The behavior of the return to matched labor is ambiguous. We see from Proposition 4 that the real value of an employed worker can either increase or decrease. Indeed, we have seen that the real bargained wage may go up. There is now a second (discounted) impact: Employed workers anticipate that, when they will be laid off, they will have more difficulties to find another job, because of the decrease in the labor market tightness. The impact on matched capital is clear-cut: It benefits from an improvement in its outside option and from a higher total surplus. These results on matched factors are reminiscent of the Ricardo-Viner specific factor model: Employed factors are somewhat attached to their sector, so they are partially affected by an increase in the profitability of their sector.

5 Capital mobility

We now investigate the impact of capital markets liberalization. We assume in the following that capital is able to migrate across country, without incurring any cost. In an interior equilibrium, i.e., in an equilibrium in which both goods are produced in both countries, the return to idle capital has to be equalized across country.

This section is still "work-in-progress", and has two major flaws. First, we have to specify the matching function in order to be able to make comparison between returns to capital across country. Basically, we need to have a constant elasticity of function $q(.)$ with respect to the labor market tightness. In other words, we have to assume that the matching function is Cobb-Douglas: $M(N_U, N_V) = N_U^{\eta} N_V^{1-\eta}$. Second, as Proposition 5 will state below, the equilibrium with capital mobility will almost surely not be interior. This implies that (almost) one of the two countries will specialize in the production of one good. Which of the two countries specializes first as capital migrate depends in a non-trivial way on world endowments, bargaining powers and other parameters of the model. We still have not been able to exhibit clearly this dependance yet. Therefore, since we cannot tell which country specializes first, we cannot derive any result on the well-being of workers and capitalists in the domestic country.

The only interesting result we have with capital mobility is summarized in the following proposition:

Proposition 5. *Assume that the matching function is Cobb-Douglas. If $\beta^* < \eta$, then there exists $\bar{\beta} > \beta^*$ such that:*

- *If $\beta^* < \beta < \bar{\beta}$, then some capital relocates from the foreign country to the home country. Depending on the parameters of the model, two situations may occur. Either capital agglomerates in the home country, and the foreign country specializes in the production of good T. Or some capital stays abroad, and the home country specializes in the production of good M.*
- *If $\beta = \bar{\beta}$, then no capital migrations occur. In this case, the free trade equilibrium is exactly the one depicted in the previous section.*
- *If $\beta > \bar{\beta}$, then some capital relocates from the home country to the foreign country. As in the first bullet, either country H specializes in the production of good T, or country F specializes in the production of good M.*

If $\beta^* \geq \eta$, some capital relocates from H to F, and we observe specialization of one of the two countries.

Proof. In an international equilibrium, the law of one price has to hold: $P_M = P_M^*$. Assume that both goods are produced in both countries. Then, using the non-arbitrage condition in both countries, and rearranging terms, we obtain a relationship between θ and θ^*:

$$(r+\delta)\left(\beta\theta q(\theta) - \beta^*\theta^* q(\theta^*)\right) + q(\theta)q(\theta^*)\left(\beta(1-\beta^*)\theta - \beta^*(1-\beta)\theta^*\right) = 0. \tag{11}$$

Solving for the value of an idle unit of capital as a function of a labor market tightness, we get: $rV = \frac{1-\beta}{\beta}\frac{1}{\theta}$ and $rV = \frac{1-\beta^*}{\beta^*}\frac{1}{\theta^*}$. Therefore, to check whether or not some capital wants to relocate, we need to sign the difference between these two values.

Let us introduce a new notation. $h(\theta) \equiv \theta q(\theta)$ is the probability for an unemployed worker to find a job in sector M. Under the assumption of Cobb-Douglas matching function, $h(\theta) = \theta^{1-\eta}$.

Assume first that $rV(\theta) > rV(\theta^*)$. Then, $\beta^*(1-\beta)\theta^* > \beta(1-\beta^*)\theta$. Using relation (11), we deduce that $\beta h(\theta) > \beta^* h(\theta^*)$. Since $\theta^* > \frac{\beta(1-\beta^*)}{\beta^*(1-\beta)}\theta$ and $h(.)$ is strictly increasing, this implies that

$$h(\theta) > \frac{\beta^*}{\beta} h\left(\frac{\beta}{\beta^*}\frac{1-\beta^*}{1-\beta}\theta\right). \tag{12}$$

When applying the Cobb-Douglas specification of the matching technology into the above equation, the θ terms cancel out. We finally get, after rearranging terms: $f(\beta) > f(\beta^*)$, with $f(\beta) \equiv \beta^{\eta}(1-\beta)^{1-\eta}$.

Following the same reasoning, it is easy to show that, if $rV < rV^*$, then $f(\beta) < f(\beta^*)$; if $rV = rV^*$, then $f(\beta) = f(\beta^*)$. We can now state the following result: In an international equilibrium,

- $rV > rV^*$ if, and only if $f(\beta) > f(\beta^*)$,
- $rV < rV^*$ if, and only if $f(\beta) < f(\beta^*)$,
- $rV = rV^*$ if, and only if $f(\beta) = f(\beta^*)$.

To conclude, all we need to do now is analyze function $f(.)$. Straightforward computations show that $f(.)$ is continuous, strictly concave, zero-valued for $\beta = 0$ and $\beta = 1$ and single-peaked. It reaches its maximum for $\beta = \eta$. Hence, if $\beta^* < \eta$, there exists a unique $\bar{\beta} > \eta$, such that

- if $\beta^* < \beta < \bar{\beta}$, then $f(\beta) > f(\beta^*)$,
- if $\beta > \bar{\beta}$, then $f(\beta) < f(\beta^*)$,
- if $\beta = \bar{\beta}$, then $f(\beta) = f(\beta^*)$.

We have just proven the first part of the proposition.

If β^* is above η, there exists no such $\bar{\beta}$. Therefore, for all $\beta > \beta^*$, $f(\beta) < f(\beta^*)$, and capital always wants to relocate from the home country to the foreign one, as long as both goods are produced in both countries. □

The intuition behind Proposition 5 is clear. Domestic workers in sector M get a larger share of the match surplus thanks to their high bargaining power, which should induce domestic capital to relocate abroad. On the other hand, the foreign country has a tighter labor market, since sector M is less attractive to labor. In the limit case in which β would be equal to 1, a unit of capital located in the home country would not earn any profits, and capital would agglomerate abroad. Similarly, in the limit case in which β^* approaches 0, foreign capitalists would not be able to attract any workers in their sector, since workers would anticipate that they would not be able to get a positive surplus. World capital would then agglomerate in the home country. This explains that, in a search and matching framework, a country with stronger labor standards can paradoxically attract capital.

6 Concluding remarks

Since the results and assumption have already been summarized in introduction, we will conclude with some remarks on the work which still has to be done. Obviously, it would be interesting to obtain an in-depth characterization of the free trade equilibrium under international capital mobility. It would be good to have some results on the impact of capital mobility on unemployment, on domestic workers' well-being, ... Another step forward would be to relax the extreme assumptions we made on production technologies and labor markets. For instance, we would like to allow some degree of substitutability between capital and labor in both sectors. We would then have a clear definition of factor intensities. It would also be interesting to check whether our results still hold once a small amount of search frictions are added in sector X.

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