Globalization, Trade Unions and Aggregate Demand Effects*

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Abstract

Using an economic geography model, we analyze the impact of an increase in trade unions' bargaining strength on firms' location decision. We show that an increase in workers' bargaining power entails two effects. On the one hand, the standard labor cost effect induces firms to relocate their production abroad. On the other hand, trade unions, by stealing profits from foreign capitalists, create a positive aggregate demand effect in their country, which may paradoxically attract firms. We show that the latter effect dominates, provided that transport costs are high enough. However, this result vanishes if trade unions create too much unemployment, or if wage bargaining is efficient.

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1 Introduction

Trade liberalization is certainly one of the most important economic phenomena in the last decades. It led to a tremendous rise in trade and FDI flows across countries. According to trade theory, increased specialization, tougher competition, higher scales of production, larger products diversity and enhanced productivity should give rise to important gains from trade. However, globalization is often seen with skepticism by the lay-man, presumably because of the supposed adverse impact of international trade and outsourcing on employment in

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rich countries. This perception has been strengthened by the crisis faced by trade unions in many rich countries (split of the AFL-CIO in the USA, IG-Metall's concession bargaining in Germany, ...).

The growing concerns over outsourcing to low-wage developing countries have been addressed in several policy reports; see, for instance, Evans (2004) and Fontagné and Lorenzi (2005). These reports typically emphasize the importance of providing strong R&D incentives, supporting industrial clusters, and developing comparative advantages in high value-added industries. While most of the political commentators seem to agree with these broad recommandations, part of the debate on globalization seems to have focused on whether governments should favor decreases in labor costs to prevent firms from outsourcing their production to low-wage countries. On the one hand, right-wing commentators tend to argue that governments should give less bargaining power to trade unions. Lower bargained wages would then decrease firms' incentives to relocate abroad.[1] Their opponents usually reply that lower wages depress aggregate demand, and therefore strengthen incentives to outsource production, since demand is one of the key elements in firms' location decisions.[2]

In this paper, we shed some light on this debate using an economic geography model with wage bargaining. We aim to answer several questions. Is globalization necessarily detrimental to unionized workers? Can trade unions create positive aggregate demand effects? Can these demand effects be sufficiently strong for a unionized country to attract firms, in spite of its higher labor costs?

We modify the footloose capital model of Martin and Rogers (1995) by including wage bargaining. This is a two-country, two-factor, two-sector model. Agriculture is a background sector, which features constant returns to scale and perfect competition. The agricultural good can be traded at zero cost. In the manufacturing sector, firms operate under increasing returns to scale and monopolistic competition; they have to pay an "iceberg" cost if they are willing to export. In the domestic country, trade unions bargain with capitalists so as to share the rents created by monopolistic competition. Throughout most of the paper, we assume that the negotiation takes place in a right-to-manage framework: capitalists and workers bargain over the wage only, and firms are free to make their employment decisions. Capital is perfectly mobile across countries, which implies that, in an interior equilibrium, interest rates will be the same in both countries. By contrast, labor cannot migrate.

Since there are two sectors in this economy, it is crucial to specify the way workers

[1] See Messerlin (2004) for an example of such statements.

[2] See, for instance, Mathieu and Sterdyniak (2005a,b). See also "Vive le Protectionnisme", Interview of Emmanuel Todd, *Le Nouvel Observateur*, October 30 2008.

divide themselves among sectors. To begin with, we assume that workers are risk neutral, so that they migrate as long as an expected wage differential exists between sectors. In this context, trade unions create unemployment. In particular, an increase in the bargained wage instantaneously translates into an increase in manufacturing labor supply which equates the agricultural wage and the expected manufacturing wage. This implies that, when workers are risk neutral, trade unions do not create aggregate demand effects. As a result, when workers' bargaining power increases, some firms relocate their production abroad, due to the standard labor cost effect. However, unionized workers can benefit from trade integration. If their country is rich enough, and if they do not bargain too high a wage, trade liberalization may induce firms to relocate their production in the unionized country, as long as the well-known home market effect dominates the labor cost effect.

We then make the alternative assumption that workers are so risk averse, that they migrate towards the agricultural sector as long as there is a positive probability of unemployment in manufacturing. This assumption implies that all workers are employed in equilibrium. We first solve a simplified version of the model, in which trade in manufacturing is precluded. We show that, under this extreme assumption, since trade unions do not generate unemployment, an increase in the bargained wage always creates a positive aggregate demand effect. Besides, under manufacturing autarky, there is no labor cost effect, since domestic firms do not suffer from foreign competition. This implies that, when transport costs in the manufacturing sector are infinite, an increase in the bargained wage always attracts firms in the domestic country.

Solving the model becomes trickier when we allow for trade in manufacturing. We first show that unionization always creates an expenditure-switching effect: as firms relocate from the foreign country to the home country, union workers' rent increases, which raises the domestic country's share in world income. However, this effect is not strong enough to create circular causality, and generate multiple equilibria. We then show that an increase in the bargained wage always triggers a positive aggregate demand effect, provided that the wage is not too high. This aggregate demand effect dominates the labor cost effect, as long as transport costs are not too low.

As a last step, we assume that the negotiation takes place in an efficient bargaining framework, namely, employers and workers bargain over wages and employment. Again, we show that unionization creates an expenditure-switching effect, which is not strong enough to generate multiple equilibria and catastrophic agglomeration. As before, there is also an aggregate demand effect, which, *ceteris paribus*, tends to make the home country more attractive to capital. However, this effect is always dominated by the labor cost effect, so that an increase in unions' bargaining power always induces relocations in the foreign country.

With this series of results in mind, we conclude that an increase in unions' bargaining strength makes the home country more attractive to capital, if trade unions do not create too much unemployment, transport costs are not too low, and the employers-workers negotiations take place in a right-to-manage framework.

This paper is related to several strands of the literature. The literature on trade unions has, for a substantial part, developed around McDonald and Solow (1981) and Oswald (1982). In particular, Brander and Spencer (1988), Mezzetti and Dinopoulos (1991), Zhao (1995), Bughin and Vannini (1995), Naylor (1998), Naylor (1999) and Lommerud et al. (2003) have extended their models to an open economy context. However, since these models are built around a partial equilibrium framework, none of them address the issue of aggregate demand effects.

This paper is also related to the economic geography literature, which was initiated by Krugman (1991). The model we modify, Martin and Rogers (1995), is much more tractable than Krugman (1991)'s, since, as emphasized by Baldwin et al. (2003), it does not involve demand linkages. The papers which are closest to ours are Méjean and Patureau (2008) and Boulhol (2009). Méjean and Patureau (2008) analyze the impact of imposing a minimum wage in a footloose capital model with two types of workers. They also identify the trade-off between the aggregate demand effect and the labor cost effect, but they do not allow for wage bargaining. Boulhol (2009) adds employers-workers negotiations in a footloose capital model, in which workers' bargaining power is chosen endogenously. Since he solves his model with efficient bargaining, under the assumption that unions generate unemployment, he always obtains that an increase in workers' bargaining power triggers relocations abroad.

The remainder of the paper is organized as follows. In Section 2, we present our model. We solve it in Section 3, under the assumption that workers are risk neutral. Section 4 solves it under the alternative assumption that workers are so risk averse, that the presence of trade unions no longer creates unemployment. We deal with efficient bargaining in Section 5. Section 6 concludes.

2 The model

2.1 Description of the model

This is a two-country (H and F), two-factor (capital K and labor L) two-sector (agriculture A and manufacturing M) model. Throughout the whole paper we will think of home country H as being a high-wage developed country and foreign country F as being a low-wage non-unionized country. “Starred” variables will refer to country F variables.

Endowments There are capitalists and workers living in each country. The world is endowed with K^W units of capital and L^W units of labor. We denote by s_K the fraction of capital owned by domestic country's residents, and s_L the proportion of workers living in country H.

Preferences Consumers in both countries share the same Cobb-Douglas preferences:

$$U = \frac{1}{\mu^{\mu}(1-\mu)^{1-\mu}} C_M^{\mu} C_A^{1-\mu},$$

where C_A is consumption of the agricultural good, C_M is consumption of the manufacturing aggregate, and $0 < \mu < 1$. This aggregate is defined as:

$$C_M = N^{\frac{1}{1-\sigma}} \left[\int_0^N c(s)^{\frac{\sigma-1}{\sigma}} ds \right]^{\frac{\sigma}{\sigma-1}},$$

where $[0, N]$ is the continuum of varieties, $c(s)$ is consumption of variety s, and $\sigma > 1$ is the elasticity of substitution among differentiated products.

Technology The agricultural sector is the usual economic geography background sector. Firms produce a homogenous good under constant returns to scale and perfect competition. The production technology transforms one unit of labor into one unit of the final good. This good, which will be the numeraire, can be freely traded internationally: $p_A = p_A^* = 1$.

The manufacturing sector features monopolistic competition and increasing returns to scale. Firms have to pay a fixed cost f in terms of capital in order to produce a variety. The production of one unit of differentiated product requires one unit of labor. Besides, exporting involves the payment of an “iceberg” transportation cost denoted by $\tau > 1$: a firm needs to produce τx units of good, in order to export x units, since a fraction of the production is consumed by the transportation technology.

Markets Goods markets have already been described in the above paragraph.

There is an integrated world market for capital. We denote by λ the share of capital invested in the domestic country. We assume that capitalists cannot migrate internationally: they are free to invest abroad, but they have to stay in their origin country to consume. Since capital is mobile, its return will be the same in both countries in an interior equilibrium equilibrium: $r = r^*$. Out of equilibrium, or in a corner equilibrium, interest rates will generally not be the same in both countries. For simplicity, we assume that a fraction λ of country H's capital has been invested in H, while a fraction $1 - \lambda$ has been invested in F, so that, on average, capitalists in H and F earn a return $\bar{r} = \lambda r + (1 - \lambda)r^*$.

Workers cannot migrate across countries. The labor market in F is perfectly competitive and workers are perfectly mobile across sectors. This implies that wages have to be equalized across sectors: $w_A = w^*$.[3]

In the foreign country, the agricultural labor market is also competitive, hence $w_A = 1$. However there are trade unions in the manufacturing sector, trying to extract rents from firms. We assume that there is one trade union per firm. In other words, unions are atomistic, just as manufacturing firms. The different trade unions are also assumed not to cooperate with each other. Consequently they do not anticipate the consequences of their wage claims on the price index. Last, we assume that wage bargaining takes place after firms have chosen their locations. Therefore, firms cannot credibly threaten to relocate their production abroad if the negotiation fails.

To model the unions' preferences we use a simple Stone-Geary function: $UR(w, l) = (w - w_A)l(w)$, where $l(w)$ denotes the firm's labor demand. As emphasized by Calvo (1978), this function captures three important elements according to union literature : union members' employment, union wage differential, and alternative sources of employment. We assume that the bargaining takes place in a right-to-manage framework. First, union and firm bargain over the wage. Second, the firm unilaterally sets its amount of employment. We model the wage bargaining using the standard maximization of the Nash product.[4] The workers' outside option is unemployment. For simplicity, we assume away any form of unemployment benefits or home production. Again, for simplicity, we assume that capital is destroyed if the negotiation breaks, which implies that firms have zero outside option as well.[5] We can now

[3]For simplicity, we assume that the parameters' values are such that both countries produce the numeraire for any value of λ.

[4]We consider efficient bargaining in Section 5.

[5]We would certainly obtain much richer results if firms could relocate abroad if negotiation failed. However, this assumption is hard to implement in this model, since the returns to capital will be equalized across countries in equilibrium.

write the Nash product, remembering that $r(w(s))f$ is the profit of firm s:

$$\max_{w(s)} \left((w(s)-1)^{\alpha} l(w(s))\right)^{\gamma} \left(r(w(s))f\right)^{1-\gamma}.$$

To describe the way workers divide themselves among sectors, we make two alternative assumptions.

Assumption 1. *Workers migrate across sector until expected wages are equalized.*

Assumption 2. *Workers migrate towards manufacturing as long as there is excess demand for labor in this sector.*

These assumptions relate to workers' risk aversion. Assumption 1 is similar to the one made by Calvo (1978) in his altered Harris-Todaro model. It means that workers are risk neutral: they only care about the expected wages. Conversely, assumption 2 implies a high degree of risk aversion: if there is a small probability that a worker will turn out being unemployed in manufacturing, it prefers staying in agriculture. In reality, the degree of workers' risk aversion certainly lies in-between. Yet, making alternatively these two two polar assumptions is quite helpful to solve the model.

Timing The sequence of decision making is as follows:

1. Firms choose their locations,
2. Workers in the domestic country divide themselves among sectors, as specified in Assumption 1 or 2,
3. Wage negotiations take place,
4. Firms set their prices non-cooperatively,
5. Production and consumption occur.

2.2 Short-run equilibrium

In this section, we focus on the short-run equilibrium, taking the firms' distribution as given. In other words, we solve the last four stages of the game.

Let us first solve the consumer's program in country H. Results can then be readily transposed to country F. As usual with the Dixit-Stiglitz framework, P_M denotes the perfect price index in the domestic country.

$$P_M = N^{\frac{1}{\sigma-1}} \left[\int_0^N p(s)^{1-\sigma} ds \right]^{\frac{1}{1-\sigma}},$$

where $p(s)$ is the price of variety s in country H.

The representative consumer's budget constraint is then given by:

$$C_A + P_M C_M \leq I,$$

where I denotes country H income.

Solving the representative consumer's problem, we obtain:

$$\begin{aligned} C_A &= (1-\mu)I, \\ C_M &= \mu \frac{I}{P_M}, \\ c(s) &= \left(\frac{p(s)}{P_M} \right)^{-\sigma} \frac{\mu I}{N P_M}. \end{aligned}$$

Since consumers in both countries have the same preferences, we get similar results in country F.

In sector A, labor is paid at its marginal product, implying that $p_A = w_A = 1$ and $p_A^* = w_A = 1^*$.[6]

In manufacturing, firms use their market power to maximize their profit. In this standard framework of monopolistic competition with iceberg transportation costs, we get the usual constant mark-up results. Denote $w(s)$ the wage paid by firm s. If firm s is located in country H, it charges $p(s) = \frac{\sigma}{\sigma-1} w(s)$ in its home market and $p^*(s) = \tau p(s)$ in country F. Conversely, if it is located in country F, it charges $p^*(s) = \frac{\sigma}{\sigma-1} w(s)$ in F and $p(s) = \tau p^*(s)$ in H.

We define $\phi \equiv \tau^{1-\sigma}$, an index of the "freeness" of trade. $\phi \in [0,1]$ increases as trade liberalizes. The payment to capital in firm s, when it is located in country H, is then given by:

$$r(s) = \frac{\mu}{N(\sigma-1)} \omega \left(\frac{\sigma}{\sigma-1} \right)^{-\sigma} \left[\frac{I}{P_M^{1-\sigma}} + \phi \frac{I^*}{P_M {*}^{1-\sigma}} \right],$$

where $\omega \equiv w^{1-\sigma} \in (0,1]$ is an index for wage differentials across countries. When firm s is

[6] Recall that we only consider parameters' values for which no country specializes in the agricultural sector.

located in F, the owner of its capital earns:

$$r(s) = \frac{\mu}{N(\sigma-1)} \left(\frac{\sigma}{\sigma-1}\right)^{-\sigma} \left[\frac{I^*}{P_M*^{1-\sigma}} + \phi \frac{I}{P_M^{1-\sigma}}\right].$$

Free entry into the manufacturing sector pins down the number of firms in equilibrium: $N = \frac{K^W}{f}$.

In the foreign country, the labor market is competitive. Workers migrate until wages are equalized across sectors: $w^* = w_A = 1$.

In order to find the outcome of the wage bargaining, we need to compute the labor demand for each manufacturing firm in the domestic country. It can be written as:

$$l(w(s)) = w(s)^{-\sigma} \left(\frac{\sigma}{\sigma-1}\right)^{-\sigma} \frac{\mu}{N} \left[\frac{I}{P_M^{1-\sigma}} + \phi \frac{I^*}{P_M*^{1-\sigma}}\right]. \tag{1}$$

Since firms and trade unions do not internalize the consequences of their choices on price indexes, the Nash product can be rewritten as:

$$\max_w (w-1)^\gamma w^{1-\sigma-\gamma}.$$

The first-order condition yields

$$w(s) = w = \frac{\gamma + \sigma - 1}{\sigma - 1}. \tag{2}$$

The second order condition holds.

Clearly, $\frac{\partial w}{\partial \gamma} > 0$; a more powerful union gets higher wages. Notice also that $\frac{\partial w}{\partial \sigma} < 0$. σ is the constant elasticity of substitution across varieties. As σ increases the manufacturing sector becomes more competitive, hence it becomes more costly in terms of employment to impose high wages. Notice that the equilibrium value of w does not depend on any endogenous variables. Thus we choose not to replace w by its value (2) in the following.

We can finally rewrite the expressions for the price indexes:

$$\begin{aligned} P_M &= \frac{\sigma}{\sigma-1} \left[\lambda\omega + (1-\lambda)\phi\right]^{\frac{1}{1-\sigma}} \equiv \frac{\sigma}{\sigma-1} \Delta^{\frac{1}{1-\sigma}}, \\ P_M^* &= \frac{\sigma}{\sigma-1} \left[\lambda\omega\phi + (1-\lambda)\right]^{\frac{1}{1-\sigma}} \equiv \frac{\sigma}{\sigma-1} \Delta^{*\frac{1}{1-\sigma}}, \end{aligned}$$

and the interest rates:

$$rK^W = \frac{\mu}{\sigma}\omega\left[\frac{I}{\Delta}+\phi\frac{I^*}{\Delta^*}\right], \tag{3}$$

$$r^*K^W = \frac{\mu}{\sigma}\left[\frac{I^*}{\Delta^*}+\phi\frac{I}{\Delta}\right]. \tag{4}$$

3 Long-Run Equilibrium with Unemployment

In this section, we solve the model under Assumption 1. Workers are risk neutral: they migrate towards the manufacturing sector until expected wages are equalized across sectors. Denoting by L_M^D (respectively L_M^S) the total labor demand (resp. supply) in sector M, this yields the following labor market equilibrium condition: $wL_M^D = L_M^S$.

3.1 Aggregate Incomes

Using equations (3) and (4), the average return to capital can be written as $\bar{r}K^W = \frac{\mu}{\sigma}(I+I^*)$. The labor market equilibrium condition allows us to write simply the income in country H:

$$\begin{aligned} I &= (s_L L^W - L_M^S) + wL_M^D + s_K\bar{r}K^W \\ &= s_L L^W + s_K\frac{\mu}{\sigma}(I+I^*), \end{aligned}$$

and in country F:

$$I^* = (1-s_L)L^W + (1-s_K)\frac{\mu}{\sigma}(I+I^*).$$

Summing the above equations, we get the value of world income:

$$I + I^* = \frac{\sigma}{\sigma-\mu}L^W.$$

Therefore, $i \equiv \frac{I}{I+I^*}$, the domestic country's nominal income share, can be written as follows:

$$i = (1-\frac{\mu}{\sigma})s_L + \frac{\mu}{\sigma}s_K.$$

Hence the income shares in both countries have the same expression as in Martin and Rogers (1995)'s canonical model.[7] Notice in particular that i depends neither on w nor on λ.

[7] Notice however that unionization implies an increase in price indexes in both countries, hence a fall in the real aggregate incomes.

Intuitively, workers migrate towards manufacturing as long as the expected utility in this sector is higher than in agriculture. Since the manufacturing wage is rigid, the adjustment takes place in terms of quantities; in other words the unemployment rate has to increase. A manufacturing wage increase in H is instantaneously followed by a proportional increase in unemployment, which leaves the (nominal) income in H unaffected. Similarly, an increase in λ, which raises the labor demand in the manufacturing sector, is immediately followed by an increase in the labor supply, so that the domestic country's nominal income remains unchanged.

This has two important consequences. First, an increase in the bargained wage does not affect the income distribution, and therefore, does not create an aggregate demand effect. Second, firms' location decisions do not affect income distributions. This implies that circular causality will not be at work under Assumption 1.

3.2 Long-run Equilibrium

Solving for the long-run equilibrium, we obtain the following proposition:

Proposition 1. *The long-run equilibrium exists, and it is unique. Besides, if*

$$\omega \in \left(\frac{\phi}{\phi^2 + i(1-\phi^2)}, \frac{1 - i(1-\phi^2)}{\phi} \right), \tag{5}$$

then, the equilibrium is interior, and

$$\lambda = \lambda^{eq} = \frac{i}{1 - \omega\phi} - \phi \frac{1-i}{\omega - \phi}.$$

Proof. See Appendix A.1. □

Condition (5) tells us that the bargained wage has to be low enough for the solution to be interior. Moreover, if H is a big country, namely, if most of the labor and capital endowments are in H, then, the manufacturing wage has to be high enough, otherwise firms want to agglomerate in the domestic country. We assume in the following that condition (5) holds.

Firms' location decision trades off three effects:

- The market access effect: Firms prefer to be located close to the biggest market. This is the sole agglomeration force.

- The market crowding effect: Firms prefer to locate themselves in the country where competition is less intense. This is the sole dispersion force.
- The labor cost effect: Firms prefer to be located in the country in which labor is cheaper, namely, in country F.

The equilibrium value λ^{eq} reflects the sum of these three effects.

Notice also that the long-run equilibrium is always unique, whatever the parameters' values. This comes from the fact that, contrary to Krugman (1991)'s canonical model, under Assumption 1, our model does not feature circular causality. When a firm relocates its production, it does not affect the world distribution of income. Therefore, it does not modify the market access effect. By contrast, it makes competition more intense in its new location, and less intense in its previous location. This implies that, when a firm moves from one country to another one, it makes the latter country less attractive, which rules out multiple long-run equilibria.

3.3 Comparative Statics

Now that the trade-off driving firms' location decisions is well identified, we can analyze the impact of variations of some exogenous variables on the firms' equilibrium distribution.

Impact of a Demand Shock Assume that the income in the domestic country increases for an exogenous reason: $di > 0$, either because $ds_K > 0$, or because $ds_L > 0$. The market access effect implies that it becomes more interesting for foreign firms to relocate their production in H to exploit its larger demand. As firms relocate in H, the market crowding effect becomes more important, while the labor cost effect remains constant. These effects offset each other when λ reaches an equilibrium value larger than its initial one. We check that $\frac{\partial \lambda^{eq}}{\partial i} = \frac{\phi}{\omega - \phi} + \frac{1}{1 - \phi\omega}$ is strictly positive, as long as condition (5) is satisfied.

Impact of Trade Liberalization We assume here that a shock on transportation technology makes it suddenly more efficient: $d\phi > 0$. We show that $\frac{\partial \lambda^{eq}}{\partial \phi}$ is strictly positive if and only if

$$\omega > \frac{1 + \phi\sqrt{\frac{i}{1-i}}}{\phi + \sqrt{\frac{i}{1-i}}} = \underline{\omega}(i, \phi).$$

Straightforward differentiation shows that $\underline{\omega}(., \phi)$ is a decreasing function of i, with $\underline{\omega}(\frac{1}{2}, \phi) = 1$ for all ϕ. In other words, if $i > \frac{1}{2}$, for all $w < [\underline{\omega}(i, \phi)]^{\frac{1}{1-\sigma}}$, $\frac{\partial \lambda}{\partial \phi} > 0$. In a high-demand country, unionized workers benefit from trade integration as long as the bargained wage is not too high. Moreover, since $\underline{\omega}$ decreases in i, when the domestic country gets richer, its unionized workers can bargain higher wages without suffering from relocations as trade liberalizes. However, if $i < \frac{1}{2}$, $\underline{\omega}(i, \phi)$ is always strictly greater than 1, which implies that globalization always worsens unionized workers' situation when they live in a small country.

Notice also that $\underline{\omega}$ is increasing in ϕ, with $\underline{\omega}(i, 0) = \sqrt{\frac{1-i}{i}}$ and $\underline{\omega}(i, 1) = 1$. In a high-demand country, trade integration does not worsen unionized workers' situation provided that trade costs were initially high enough. If trade costs were initially low, unionized workers are more likely to suffer from globalization. As a result, the share of firms located in country H follows a hump-shaped curve as ϕ goes from 0 to 1.

To grasp the intuition, assume that $i > \frac{1}{2}$. As ϕ increases, the market crowding effect becomes less important; whether a firm decides to locate in H or F has less impact on manufactured price indexes. Similarly, the market access effect becomes smaller, since firms located in the small country can now export more easily, but it tends to diminish faster than the market access effect. *Ceteris paribus*, this should induce firms to agglomerate in the domestic country, in order to take advantage of its high demand. However the labor cost effect may be dissuasive; as ϕ increases it becomes less and less interesting to produce in H, since the difference between labor and transportation costs diminishes. When ϕ is small enough, the sum of the market access effect and the market crowding effect outweighs the labor cost effect, and the domestic country attracts more firms. When ϕ is high, some domestic firms choose to relocate their production abroad, and some unionized workers lose their rents.

These comparative statics are summarized in the following proposition:

Proposition 2. *Assume that condition (5) holds. Then,*

- $\frac{\partial \lambda^{eq}}{\partial i} > 0$*,*
- $\frac{\partial \lambda^{eq}}{\partial \phi} > 0$*, if and only if* $\omega > \underline{\omega}(i, \phi)$*.*

Proof. Immediate. □

3.4 Impact of an Increase in Workers' Bargaining Power

Assume now that trade unions become more powerful ($d\gamma > 0$), so that the manufacturing wage increases: $d\omega < 0$.[8] Then, $\frac{\partial \lambda^{eq}}{\partial \omega} = \phi \left(\frac{i}{(1-\phi\omega)^2} + \frac{1-i}{(\omega-\phi)^2} \right)$ is always strictly positive. Indeed, when w increases, all domestic firms tend to increase their prices, which makes the market crowding effect less important in H. Yet, this effect is largely outweighed by the increase in the implicit tax paid by domestic firms, which now have to give up a larger share of their profits to trade unions. Another way to see this result is that foreign firms unambiguously benefit from a decrease in domestic firms' competitiveness. Since the average return to capital is independent of w, this implies that the domestic return to capital has to decrease. λ has therefore to diminish to equalize interest rates.

Notice in addition that $\frac{\partial^2 \lambda^{eq}}{\partial \omega \partial i} < 0$. The higher i is, the more important is the market access effect relative to the labor cost effect. As a result an increase in the bargained wage has a small impact in high-demand countries in terms of firms' relocations.

This result is summarized in the following proposition:

Proposition 3. $\frac{\partial \lambda^{eq}}{\partial w} > 0$*: Under Assumption (1), an increase in workers' bargaining power always induces firms to relocate abroad.*

4 Long-Run Equilibrium without Unemployment

In this section, we solve the model under Assumption 2. Workers are so risk averse, that they are not ready to accept any positive probability of unemployment. Therefore, all workers will be employed in equilibrium.

In such a framework, countries' incomes have no reason to be independent of firms' distribution, or of the bargained wage. This complicates considerably the model resolution and gives rise to much richer results, as we will see. To exhibit the type of effects we will have to deal with, we first solve the model in a situation where both countries are in industrial autarky, due to infinite transportation costs.[9] Then we consider the general case, with $\phi \in [0, 1)$, which is much more complicated.

4.1 Simplification: Infinite Transportation Costs

In this section, we assume that transport costs in the manufacturing sector are infinite: $\phi = 0$. First, let us write the aggregate incomes, using Assumption 2. We get $I = \left(s_L L^W - L_M\right) +$

[8] Recall that ω is a decreasing function of w.

[9] Notice however that capital and agricultural good remain freely traded.

$wL_M + s_K\overline{r}K^W = s_L L^W + (w-1)L_M + s_K\overline{r}K^W$. Using equation (1), we easily show that $L_M = \lambda(\sigma-1)\frac{1}{w}rK^W$. Hence incomes in both countries can be written as follows:

$$\begin{cases} I &= s_L L^W + \lambda(\sigma-1)\left(1-\frac{1}{w}\right)rK^W + s_K\overline{r}K^W, \\ I^* &= (1-s_L)L^W + (1-s_K)\overline{r}K^W. \end{cases} \tag{6}$$

The return to capital in country H is given by $r = \frac{1}{K^W}\frac{\mu}{\sigma}\frac{I}{\lambda}$. When transportation costs are infinite, the domestic interest rate does not depend directly on the bargained wage.[10] Firms still impose a constant mark-up $(\frac{\sigma}{\sigma-1})$ over their marginal cost (w). However the demand they face is no longer "biased" by transportation costs, since firms no longer suffer from foreign competition. This implies that wage terms cancel out in the interest rate equation. In other words, the direct labor cost effect disappears under industrial autarky. Notice, however, that the market-crowding effect still exists, since r is inversely proportional to λ.

The average return to capital is $\overline{r} = \frac{1}{K^W}\frac{\mu}{\sigma}(I+I^*)$. Substituting r and $\overline{r}$ into (6), we get a system of linear equations in (I, I^*):

$$\begin{cases} I &= s_L L^W + \mu\frac{\sigma-1}{\sigma}\left(1-\frac{1}{w}\right)I + s_K\frac{\mu}{\sigma}(I+I^*) \\ I^* &= (1-s_L)L^W + (1-s_K)\frac{\mu}{\sigma}(I+I^*). \end{cases} \tag{7}$$

We then prove the following lemma:

Lemma 1. *System (7) has a unique solution.*
The domestic country's income share is given by:

$$i = \frac{s_L(\sigma-\mu)+\mu s_K}{\sigma-\mu(\sigma-1)(1-s_L)(1-\frac{1}{w})}. \tag{8}$$

i is increasing in w.

Proof. Solving system (7) yields:

$$\begin{cases} I &= \dfrac{\sigma\left[s_L(\sigma-\mu)+\mu s_K\right]w}{\sigma^2 w-\mu\sigma\left[1+\sigma(w-1)\right]+\mu^2(\sigma-1)(1-s_K)(w-1)}L^W \\ I^* &= \dfrac{\sigma\left[\sigma(1-s_L)w+\mu\left[(\sigma-1)(1-s_L)-((1-s_L)\sigma+s_K-1)\right]\right]}{\sigma^2 w-\mu\sigma\left[1+\sigma(w-1)\right]+\mu^2(\sigma-1)(1-s_K)(w-1)}L^W. \end{cases}$$

Substituting this into $i = I/(I+I^*)$ yields expression (8), which is clearly increasing in w. □

The above lemma tells us that the domestic country's income share is an increasing

[10] Nevertheless, as we will see, r will depend indirectly on w through domestic country income I.

function of w. We refer to this effect as the aggregate demand effect. To see the intuition, consider system (6). When w increases, domestic firms react by increasing their prices, which tends to reduce their sales, and hence, their labor demand. However, this effect is rather weak, since all other firms competing in country H increase their prices as well. This implies that the direct wage effect dominates the labor demand effect, and therefore, the rent earned by unionized workers increases. As pointed out before, this also implies that the domestic returns to capital does not change. As a result, the domestic income rises. This first round effect, the increase in union rents, is then followed by second round effects: the rise in domestic income raises the average interest rate, and hence, the nominal incomes in both countries. Yet, these second round effects are dominated by the first round effect, and the domestic country's income share increases.

Now that we have determined the distribution of world income, we can solve for the long-run equilibrium. We get the following proposition:

Proposition 4. *When $\phi = 0$, the long-run equilibrium exists, and it is unique and interior:*

$$\lambda = i = \frac{s_L(\sigma - \mu) + \mu s_K}{\sigma - \mu(\sigma - 1)(1 - s_L)(1 - \frac{1}{w})}.$$

λ is increasing in w.

Proof. The difference between capital returns in both countries can be written as:

$$\begin{aligned} r - r^* &= \frac{\mu}{\sigma K^W}(I + I^*)(\frac{i}{\lambda} - \frac{1-i}{1-\lambda}), \\ &= \frac{\mu}{\sigma K^W}\frac{I + I^*}{\lambda(1-\lambda)}(i - \lambda). \end{aligned}$$

Therefore, $\lambda = i$ is the unique equilibrium. □

We get the standard result that the home market effect disappears when trade is precluded. More importantly, notice that λ is now an increasing function of w. In this manufacturing autarky framework, unionization allows paradoxically country H's consumers to earn a larger world income share, and hence to attract more firms. In the following we investigate whether this result carries over to the general case.

4.2 Back to the General Case: Aggregate Incomes

We now go back to the general case, where $\phi \in (0, 1)$. Obviously the expressions of I and I^* given by (6) remain valid, and the average interest rate is still equal to $\frac{1}{K^W}\frac{\mu}{\sigma}(I + I^*)$.

However the domestic interest rate formula becomes more complicated, as can be seen in equation (3). Solving for this system of equations, we obtain the following lemma:

Lemma 2. *Equations (3), (6) and* $\frac{1}{K^W}\frac{\mu}{\sigma}(I + I^*)$ *uniquely determines aggregate incomes* I *and* I^**. Besides,* i*, the domestic country's income share, is such that:*

- $\left.\frac{\partial i}{\partial w}\right|_{w=1} > 0$*: there is an aggregate demand effect when the bargained wage is not too high,*
- $\frac{\partial i}{\partial \lambda} > 0$*: there is an expenditure switching effect.*

Proof. See Appendix A.2. □

Notice first that the domestic country's income share is an increasing function of w, for w close enough to 1. An increase in w has two oppositive effects on the rent earned by union workers. On the one hand, domestic firms increase their prices, since they now operate with a higher marginal cost. By contrast, foreign firms do not modify their prices. This implies that the domestic labor demand diminishes. On the other hand, each union worker receives a higher wage. The latter effect dominates the former as long as w is close to 1, and the unions rent increases. Capital incomes are not directly affected by this rise in w. Indeed, the average return to capital is given by $\frac{\mu}{\sigma}\frac{I+I^*}{K^W}$, which does not depend directly on w. This implies that the domestic country's nominal income increases. As in the previous section, there are second round effects: the increase in I implies an increase in $\overline{r}$, which triggers an increase in I^* and a further increase in I, ... At the end of the day, the first round effect dominates the second round ones, and the domestic country's income share rises.

The domestic country's income share is also an increasing function of λ. As λ increases, the demand for unionized labor rises, which raises the unions' rent. As in the previous paragraph, this tends to increase the domestic country's nominal income, and its world income share. This is reminiscent of the expenditure switching effect in Krugman (1991)'s core-periphery model: when a firm relocates its production from one country to another, the income distribution is affected in favor of the host country, which may lead to further relocations.

4.3 Long-run Equilibrium

As is well known in the economic geography literature, the fact that $\partial i/\partial \lambda > 0$ is an important ingredient, which can create circular causality mechanisms, and hence, give rise to equilibrium multiplicity. In Proposition 5, we show that, even though there is some circularity in this model, it is not sufficient to create catastrophic agglomeration and multiple equilibria. To prove this claim, we make the following assumption:

Assumption 3. $\sigma > \min\{3/2, 2\mu\}$.

Proposition 5. *Under Assumption 3, the long-run equilibrium exists, and it is unique.*

Proof. See Appendix A.3 □

To see the (technical) role played by Assumption 3, it is worth understanding how Proposition 5 is proven. To obtain this proposition, we first compute the difference between the returns to capital in both countries. We show that $r - r^*$ can be written as $(A(s_K, s_L) + \lambda B(s_K, s_L))C$, where $C > 0$, A and B are linear functions of s_K and s_L, and do not depend on λ. This implies that multiple equilibria exist if, and only if, $A \leq 0$ and $A+B \geq 0$. We solve the linear program $\min_{s_K, s_L} A(s_K, s_L)$, subject to $A(s_K, s_L) + B(s_K, s_L) \geq 0$ and $0 \leq s_K,\ s_L \leq 1$. Under Assumption 3, we show that the solution to this program is strictly positive. This implies that, when Assumption 3 holds, for all parameters' values such that no country specializes in the manufacturing sector, there are no multiple equilibria. This is typically the case as long as μ is not too high, and the countries' labor endowments are not too different.

By contrast, when Assumption 3 does not hold, the solution to the above linear program may be negative. Therefore, there may exist s_K and s_L such that $A \leq 0$ and $A + B \geq 0$. These situations are more likely to arise for high values of μ. However, when μ is high, it also becomes more likely that one of the two countries will specialize in the manufacturing sector. If this is the case, then, the expression of $r - r^*$ is no longer valid, and therefore, we cannot be sure that multiple equilibria actually exist. For simplicity, we prefer not to solve the model for parameters' values such that countries specialize. Therefore, we make Assumption 3 to rule out these cases.

4.4 Impact of an Increase in Workers' Bargaining Power

We saw in section 4.2 that an increase in the bargained wage has a positive short-run income effect in the domestic country, as long as w is close enough to 1. In section 3, a wage increase had an unambiguous impact on the domestic interest rate. Here, the labor cost effect may be outweighed by the positive income effect induced by the rise in unionized workers' rent. As before, denote by λ^{eq} the value of λ at the long-run equilibrium. Since $\frac{\partial \lambda^{eq}}{\partial w}$ is too complicated to sign in general, we restrict ourselves to the analysis of $\frac{\partial \lambda^{eq}}{\partial w}|_{w=1}$.

To perform this comparative statics, we need to ensure that the parameters' values are such that the long-run equilibrium is interior. When $w = 1$, Assumptions 1 and 2 are equivalent. Therefore, we can use condition (5), which tells us that the equilibrium is interior if, and only if,

$$\frac{\phi}{\phi^2 + (s_K\frac{\mu}{\sigma} + s_L(1-\frac{\mu}{\sigma}))(1-\phi^2)} \leq 1 \leq \frac{1-(s_K\frac{\mu}{\sigma} + s_L(1-\frac{\mu}{\sigma}))(1-\phi^2)}{\phi}. \tag{9}$$

Defining $\tilde{i} \equiv (s_K\frac{\mu}{\sigma} + s_L(1-\frac{\mu}{\sigma}))$, this condition can be rewritten as:

$$\begin{cases} & \tilde{i} \leq \frac{1}{2} \text{ and } \phi \leq \frac{\tilde{i}}{1-\tilde{i}}, \\ \text{or} & \tilde{i} \geq \frac{1}{2} \text{ and } \phi \leq \frac{1-\tilde{i}}{\tilde{i}}. \end{cases} \tag{10}$$

We obtain the following proposition:

Proposition 6. *Assume that condition (10) holds. Then,*

- *If $\tilde{i} \leq \frac{1}{2}$, then, there exists $\bar{\phi} \in (0, \frac{i}{1-i})$ such that $\frac{\partial \lambda^{eq}}{\partial w}\big|_{w=1} > 0$ if, and only if, $0 \leq \phi < \bar{\phi}$.*
- *If $\tilde{i} \geq \frac{1}{2}$ and $\sigma \geq 2\mu$, then, there exists $\bar{\phi} \in (0, \frac{1-i}{i})$ such that $\frac{\partial \lambda^{eq}}{\partial w}\big|_{w=1} > 0$ if, and only if, $0 \leq \phi < \bar{\phi}$.*

Proof. See Appendix A.4. □

Under Assumption 2, an increase in the bargained wage can attract manufacturing firms, as long as transport costs are not too small. Intuitively, the equilibrium value of λ comes from the trade-off between four effects:

- The market access effect, which induces firms to locate in the high demand country.
- The market crowding effect, which induces firms to locate in the country in which competition is less intense.
- The labor cost effect, which makes the low-labor cost country more attractive.
- The aggregate demand effect, exhibited in Lemma 2, according to which an increase in w raises the domestic country's income share, provided that w is close enough to 1.

When transport costs are high enough, we know from Proposition 4 that an increase in w makes the domestic country more attractive to firms. By contrast, if $\tilde{i} \leq 1/2$, or when $\tilde{i} \geq 1/2$ and $\sigma \geq 2\mu$, when transport costs are small, the labor cost effect becomes stronger, and eventually dominates the aggregate demand effect, so that an increase in the bargained wage makes the domestic country less attractive.

Notice also that, when $\tilde{i} > 1/2$ and $\sigma < 2\mu$, it is possible to find parameters' values such that a small wage increase starting from $w = 1$ always induces some firms to relocate in country H, as long as the long-run equilibrium remains interior. Intuitively, when $\sigma < 2\mu$, most of the world income comes from the manufacturing sector. This implies that the aggregate demand effect can be so strong that it may always dominate the labor cost effect.

5 Efficient Bargaining

In this section, we investigate whether the results derived in the previous section still hold under efficient bargaining. More precisely, we still make Assumption 2, and we assume that trade unions and firms bargain both over wages and employment, so that the Nash surplus is maximized as follows:[11]

$$\max_{w(s),l(s)} \left((w(s)-1)l(s)\right)^{\gamma} \left(r(w(s),l(s))f\right)^{1-\gamma}. \tag{11}$$

We first show how this assumption affects the short-run equilibrium. We then prove the existence and uniqueness of the long-run equilibrium, and perform comparative statics on the equilibrium value of λ.

5.1 Short-run equilibrium

Clearly, efficient bargaining does not affect the representative consumer's program. Therefore, the values of consumptions computed in Section 2.2 remain the same.

The problem solved by manufacturing firms located in H is modified as follows. A firm in the domestic country takes l, its number of employees, as given, and solves the following program:

$$\max_{\{x,x^*\}} p(x)x + p(x^*)x^* - wl$$
$$\text{s.t. } x + \tau x^* \leq l,$$

[11]Under Assumption 1, we would obtain the same results as in Section 3: trade unions do not create aggregate demand effects, and therefore, an increase in workers' bargaining power makes the domestic country less attractive.

where we have dropped variable s for simplicity, and $p(.)$ denotes the inverse demand function for the differentiated product.

Denoting by Λ the Lagrange multiplier corresponding to the employment constraint, and writing down the first order conditions, we get $p(x) = \frac{\sigma}{\sigma-1}\Lambda$ and $p(x^*) = \frac{\sigma}{\sigma-1}\tau\Lambda$. For all $x, x^* \geq 0$ such that $x + \tau x^* \leq l$, $p(x)$ and $p(x^*)$ are strictly positive. Therefore, Λ is positive as well, and the constraint is binding: $x + \tau x^* = l$. Plugging the values of x and x^* into this equality, we get after some algebra:

$$\Lambda = \frac{\sigma - 1}{\sigma} \left\{ \frac{\mu}{N} \frac{1}{l} \left[\frac{I}{P_M^{1-\sigma}} + \phi \frac{I^*}{P_M{*}^{1-\sigma}} \right] \right\}^{\frac{1}{\sigma}}. \tag{12}$$

All these values can be substituted into the expression for the rate of return to capital, which becomes:

$$rf = \left(\left\{ \frac{\mu}{N} \frac{1}{l} \left[\frac{I}{P_M^{1-\sigma}} + \phi \frac{I^*}{P_M{*}^{1-\sigma}} \right] \right\}^{\frac{1}{\sigma}} - w \right) l. \tag{13}$$

We can then use these expressions to solve the bargaining problem. Maximizing the Nash product, we obtain:

$$\begin{aligned} w &= 1 + \frac{\gamma}{\sigma - 1} \\ l &= \left(\frac{\sigma}{\sigma - 1} \right)^{-\sigma} \frac{\mu}{N} \left\{ \frac{I}{P_M^{1-\sigma}} + \phi \frac{I^*}{P_M{*}^{1-\sigma}} \right\}. \end{aligned}$$

This implies, in particular, that $\Lambda = 1$. As a result, the prices are the same as those which would prevail if there were no trade unions: $p = \frac{\sigma}{\sigma-1}$ and $p^* = \frac{\sigma}{\sigma-1}\tau$. Since we have assumed efficient bargaining, this result is not surprising. The firm sets the prices which maximizes the total surplus. A fraction of this surplus is subsequently redistributed to workers through the bargained wage.

We can now write the expressions for the price indexes in both countries:

$$\begin{aligned} P_M &= \frac{\sigma}{\sigma - 1} \left[\lambda + (1 - \lambda)\phi \right]^{\frac{1}{1-\sigma}} \equiv \frac{\sigma}{\sigma - 1} \Delta^{\frac{1}{1-\sigma}}, \\ P_M^* &= \frac{\sigma}{\sigma - 1} \left[\lambda\phi + (1 - \lambda) \right]^{\frac{1}{1-\sigma}} \equiv \frac{\sigma}{\sigma - 1} \Delta^{*\frac{1}{1-\sigma}}. \end{aligned}$$

We can also derive the expressions for the interest rates:

$$rK^W = \frac{\mu}{\sigma}(1-\gamma)\left[\frac{I}{\Delta}+\phi\frac{I^*}{\Delta^*}\right], \tag{14}$$

$$r^*K^W = \frac{\mu}{\sigma}\left[\frac{I^*}{\Delta^*}+\phi\frac{I}{\Delta}\right]. \tag{15}$$

Notice that employment in a manufacturing firm in country H can be written as $l = \frac{\sigma-1}{1-\gamma}rf$.

5.2 Long-run Equilibrium

To focus on the relevant cases, we make the following assumption:

Assumption 4. $\gamma + \phi < 1$.

If the above inequality did not hold, it would never be profitable for a firm to locate its production in country H, and the only equilibrium would be such that $\lambda = 0$. Paying the trade costs ϕ would indeed be less costly than giving up a fraction γ of the profits.

Now, we can derive two curves: the II-curve and the LL-curve, which enable us to compute the long-run equilibrium.

The II-curve Aggregate income in country H can be written as follows:

$$\begin{aligned} I &= s_L L^W + (w-1)\lambda l N + s_K \bar{r} K^W \\ &= s_L L^W + \lambda\gamma\frac{\mu}{\sigma}\left[\frac{I}{\Delta}+\phi\frac{I^*}{\Delta^*}\right] + s_K\frac{\mu}{\sigma}\left\{\lambda(1-\gamma)\left[\frac{I}{\Delta}+\phi\frac{I^*}{\Delta^*}\right]+(1-\lambda)\left[\phi\frac{I}{\Delta}+\frac{I^*}{\Delta^*}\right]\right\}. \end{aligned}$$

Country F's income is given by

$$I^* = (1-s_L)L^W + (1-s_K)\frac{\mu}{\sigma}\left\{\lambda(1-\gamma)\left[\frac{I}{\Delta}+\phi\frac{I^*}{\Delta^*}\right]+(1-\lambda)\left[\phi\frac{I}{\Delta}+\frac{I^*}{\Delta^*}\right]\right\}. \tag{16}$$

Summing these two expressions, we obtain:

$$I + I^* = \frac{\sigma}{\sigma-\mu}L^W.$$

In other words, as in Section 3, one of the important features of the footloose capital model extends when efficient bargaining is added: total world income does not depend on the firms' locations. This result comes once again from our efficient bargaining assumption. Since the goods' prices are not distorted (with respect to the non-union case), total revenues are not affected by the trade unions. The negotiations affect only the way these revenues are shared, across factors and across countries.

Define as before $i = \frac{I}{I+I^*}$, the share of world income earned by country H's residents. Equation (16) implies:

$$1 - i = s_A(1 - s_L) + (1 - s_A)(1 - s_K)\left\{1 - \gamma\lambda\left[\frac{i}{\Delta} + \phi\frac{1-i}{\Delta^*}\right]\right\}, \tag{17}$$

where $s_A \equiv \frac{\sigma-\mu}{\sigma}$ denotes the share of labor in value added, not accounting for the fact that a fraction of capital incomes are stolen by trade unions. Equation (17) defines the II-curve: it gives country H's income share i as a function of λ, the share of firms located in the domestic country. Its main properties are summarized in the following lemma:

Lemma 3. *The II-curve is upward sloping:* $\frac{\partial i}{\partial \lambda}\Big|_{II} > 0$.
It shifts upwards[12] *when* γ *increases.*

Proof. See Appendix A.5. □

The fact that the II-curve is upward sloping indicates that the expenditure switching effect is still present under efficient bargaining. When a firm relocates its production from country F to country H, a fraction of its profit is captured by its unionized workers. As union workers get richer, the aggregate demand increases in the domestic country, and i goes up. As in the right-to-manage framework, we will wonder later on whether this effect can be strong enough to induce circular causality and multiple equilibria.

There is also an aggregate demand effect. When γ increases, trade unions manage to capture a larger share of the rents from firms, which, once again, increases the aggregate demand in the domestic country.

The LL-curve A second curve is needed to obtain the equilibrium value of λ. We derive it by using the non-arbitrage condition on the international capital market: on the LL-curve, for any given i, λ must be such that no firm wants to relocate its production in another country. Let $i \in (0, 1)$. The following function gives the interest rate differential across countries (up to a factor $\frac{\mu}{\sigma}$) as a function of λ:

$$\Psi : (\lambda, i, \gamma) \mapsto (1 - \gamma)\left(\frac{i}{\Delta} + \phi\frac{1-i}{\Delta^*}\right) - \left(\frac{1-i}{\Delta^*} + \phi\frac{i}{\Delta}\right).$$

[12] In the (λ, i) plane.

Its first derivative with respect to λ,

$$\frac{\partial \Psi}{\partial \lambda} = -(1-\phi)\left\{\frac{i}{\Delta^2}(1-\gamma-\phi) + \frac{1-i}{\Delta^{*2}}(1-\phi(1-\gamma))\right\},$$

is strictly negative for all λ, by Assumption 4. Therefore, the interest rate differential across countries is decreasing in λ: this is the market crowding effect.

Since $\Psi(., i, \gamma)$ is strictly decreasing, the LL-curve is well-defined. If $\Psi(., i, \gamma) < 0$, then $\lambda(i) = 0$. If $\Psi(., i, \gamma) > 0$, then $\lambda(i) = 1$. Otherwise, $\lambda(i)$ is the unique λ such that $\Psi(\lambda, i, \gamma) = 0$. The following lemma investigates the main properties of the LL-curve.

Lemma 4. *The LL-curve is upward-sloping.*
It shifts upwards[13] *when* γ *increases.*

Proof. See Appendix A.6. □

When the domestic country's income increases, the market access effect implies that this country becomes more attractive to capital. The number of firms competing in country H has therefore to increase, which strengthens the market crowding effect in this country, and hence, restores the non-arbitrage condition in capital markets.

When the workers' bargaining power becomes more important, trade unions manage to steal more profits from capitalists. A quick inspection at equation (14) shows that γ is similar to a tax on capital incomes in the domestic country. When the tax rate increases, it becomes less profitable to be located in the domestic country. The number of domestic firms has then to decrease to lower the competitive pressure in country H, and restore the non-arbitrage condition in capital markets: the LL-curve shifts to the right. This is the labor cost effect.

Existence and uniqueness of the equilibrium The following technical lemma is useful to characterize the long-run equilibrium of the model:

Lemma 5. *The II-curve and the LL-curve intersect each other at most once in* $(0, 1)$.

Proof. We just need to solve for the system of equations $\Psi(\lambda, i, \gamma) = 0$, and (17) in (i, λ). There is a unique λ, which solves this system:

$$\lambda = \frac{(1-\gamma)(1-\phi^2)\left[s_A s_L + (1-s_A)s_K\right] - \phi\left[1-\phi(1-\gamma)\right]}{(1-\phi)\left[1-\phi-\gamma(1-s_A(1-s_L)(1+\phi))\right]},$$

which may, or may not, lie in $(0, 1)$. □

[13] In the (λ, i) plane.

We know from Lemmas 3 and 4 that the II-curve and the LL-curve are upward-sloping. Besides, by Lemma 5, these two curves intersect each other at most once in (0,1). This implies that four cases can arise, as depicted in figure 1.

Among these four cases, only case (b) features multiple equilibria: two equilibria in which the manufacturing sector agglomerates in one of the two countries, and an interior equilibrium. The potential for multiple equilibria comes directly from the expenditure switching effect described. When a firm relocates its production in country i, it increases the aggregate demand in this country, which may lead to further relocations. However, the following proposition states that this circular causality mechanism is not strong enough to give rise to multiple equilibria. In other words, case (b) never arises.

Proposition 7. *The long-run equilibrium exists, and it is unique.*

Proof. See Appendix A.7. □

The expenditure switching effect is not strong enough to yield multiple equilibria: only cases (a), (c) and (d) arise. In the following, we focus on case (a), by assuming that the two countries are not too different, so that the manufacturing sector does not agglomerate in one single country. We denote by λ^{eq} the share of firms located in the domestic country in the interior long-run equilibrium.

5.3 Comparative statics: Impact of an increase in workers' bargaining power

In this section, we investigate whether an increase in the workers' bargaining power leads to relocations abroad.

Proposition 8. *Under efficient bargaining, an increase in the workers' bargaining power induces some firms to relocate their production in the foreign country:*

$$\frac{\partial \lambda^{eq}}{\partial \gamma} < 0.$$

Proof. Let us compute the derivative of λ^{eq} with respect to γ:

$$\frac{\partial \lambda^{eq}}{\partial \gamma} = -\frac{(1+\phi)\{s_A(1-s_L)(s_A s_L+(1-s_A)s_K)+(1-s_A(1-s_L))(s_A(1-s_L)+(1-s_A)(1-s_K)\phi)\}}{(1-\phi-\gamma(1-s_A(1-s_L)(1+\phi)))^2},$$

which is strictly negative for any values of the parameters. □

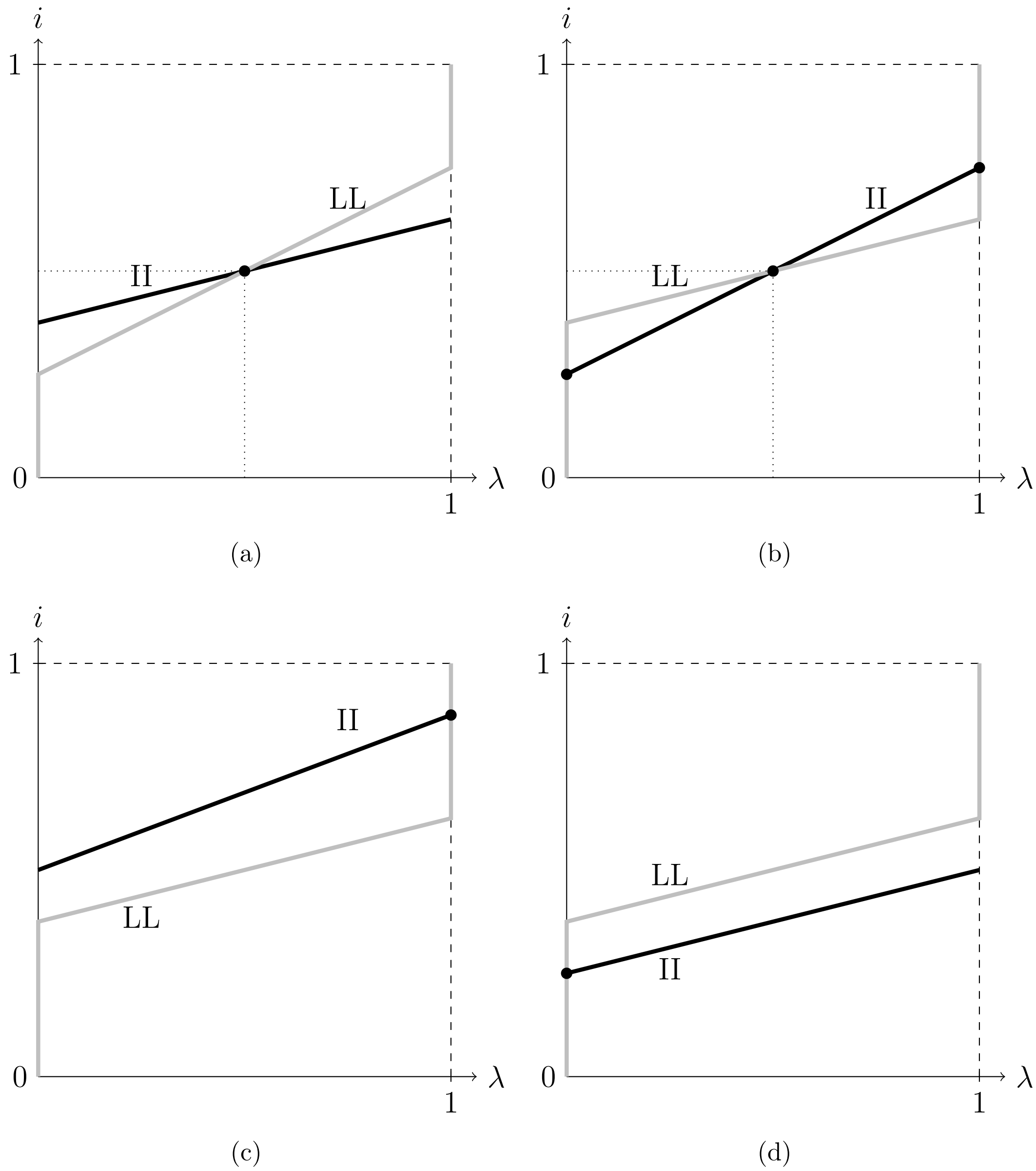


Figure 1: The four potential cases

This proposition can be interpreted simply in terms of II- and LL-curves shifts, as depicted in Figure 5.3. When γ increases, the trade unions capture a larger share of the firms' profits. On the one hand, this increases the aggregate demand in the domestic country, which should attract some firms. As shown in Lemma 3, the II-curve shifts upwards. On the other hand, the labor cost increases, and the implicit tax paid by firms becomes larger, which should induce some firms to relocate their production in the foreign country. As stated in Lemma 4, the LL-curve shifts upwards. It turns out that, in this efficient bargaining framework, the labor cost effect always dominates the aggregate demand effect: an increase in unions' bargaining power always pushes some firms to move to the foreign country.

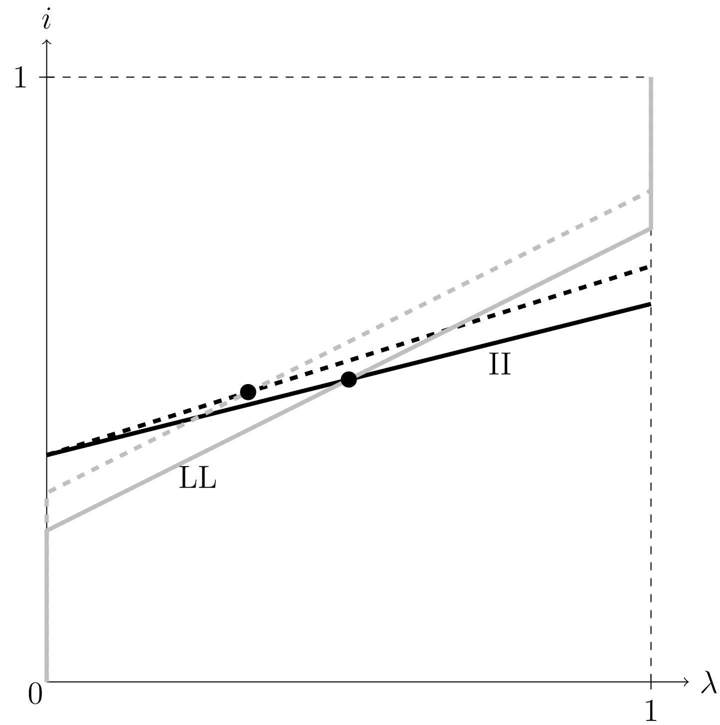


Figure 2: Impact of an increase in γ

Under efficient bargaining, the negotiation maximizes the joint surplus of capitalists and workers, taking all other firms and trade unions' decisions as given. *Ceteris paribus*, this effect should make the domestic country more attractive to capital under efficient bargaining than in a right-to-manage framework. On the other hand, in a right-to-manage framework, the firm makes its employment decision after observing the value of the bargained wage. For unions to obtain a positive share of the surplus, this wage has to be larger than 1. Therefore, the perceived marginal cost of a firm is larger under efficient bargaining, which implies that manufacturing prices in the domestic country are higher as well. In other words, bargaining in a right-to-manage framework allows firms to alleviate the competitive externalities in the manufacturing sector. Propositions 6 and 8 tell us that relaxing competition in manufacturing is more important than maximizing the joint surplus of employers and workers. This implies in particular that an increase in unions' bargaining power can make the home country more attractive in a right-to-manage framework, whereas it implies relocations abroad under efficient bargaining.

6 Conclusion

We have developed an economic geography model to investigate whether the presence of trade unions in a country can create aggregate demand effects and make this country more attractive to capital. We have shown that, aggregate demand effects, when they exist, are never strong enough to induce circular causality, and generate catastrophic agglomeration and multiple equilibria. Whether an increase in unions' bargaining strength can make a country more attractive to capital has be proven to depend on three main factors. First, trade unions should not generate too much unemployment in the manufacturing sector; otherwise, aggregate demand effects are weak, and an increase in the bargained wage induces firms to relocate abroad. Second, transport costs for manufacturing products should be high enough for the aggregate demand effect to dominate the labor cost effect. Last, negotiations should take place in a right-to-manage framework, so that wage bargaining helps alleviating competitive externalities in the home country.

A Appendix

A.1 Proof of Proposition 1

Proof. $r - r^*$, the interest rate differential between the domestic and the foreign country, can be written as follows:

$$r - r^* = \frac{\mu(I + I^*)}{\sigma\Delta\Delta^* K^w}\left[-\lambda(\omega - \phi)(1 - \omega\phi) + i(\omega - \phi) - (1 - i)(1 - \omega\phi)\phi\right]. \tag{18}$$

If $\omega < \phi$, then,

$$\begin{aligned}\frac{(r-r^*)K^W\sigma\Delta\Delta^*}{\mu(I+I^*)} &\leq (\phi-\omega)(1-\omega\phi) - i(\phi-\omega) - (1-i)(1-\omega\phi)\phi, \\ &\leq -\omega(1-\omega\phi) + i\omega(1-\phi^2), \\ &\leq -\omega(1-\omega\phi) + \omega(1-\phi^2), \\ &\leq -\omega\phi(\phi-\omega) < 0.\end{aligned}$$

Therefore, when $\omega < \phi$, $r < r^*$ for all λ, and $\lambda = 1$ is the unique long-run equilibrium. It is then immediate to prove the same result when $\omega = \phi$.

Assume now that $\omega > \phi$. Then, the expression inside the brackets in equation (18) is strictly decreasing in λ. Therefore, if $-(\omega-\phi)(1-\omega\phi) + i(\omega-\phi) - (1-i)(1-\omega\phi)\phi \geq 0$, then, $r > r^*$ for all $\lambda \in [0,1)$, and $r \geq r^*$ for $\lambda = 1$. This implies that the unique equilibrium features agglomeration in country H: $\lambda = 1$.

If $i(\omega-\phi) - (1-i)(1-\omega\phi)\phi \leq 0$, then, $r < r^*$ for all $\lambda \in (0,1]$, and $r \leq r^*$ for $\lambda = 0$. The unique equilibrium features agglomeration in country F.

Last, if

$$-(\omega-\phi)(1-\omega\phi) + i(\omega-\phi) - (1-i)(1-\omega\phi)\phi < 0 < i(\omega-\phi) - (1-i)(1-\omega\phi)\phi,$$

which is equivalent to condition (5) after rearranging terms, we can define

$$\frac{i}{1-\omega\phi} - \phi\frac{1-i}{\omega-\phi}.$$

Then, we have that $r > r^*$ if and only if $\lambda < \lambda^{eq}$, $r < r^*$ if and only if $\lambda > \lambda^{eq}$, and $r = r^*$ if and only if $\lambda = \lambda^{eq}$. Therefore, $\lambda = \lambda^{eq}$ is the unique long-run equilibrium. $\square$

A.2 Proof of Lemma 2

Proof. Solving the equations mentioned in the statement of the lemma, we get:

$$I = \frac{\sigma L^W((1-\lambda)\phi+\lambda\omega)\{w(1-\lambda)(s_K\mu+s_L(\sigma-\mu))+\lambda[s_Lw\sigma+\mu(1-\sigma+w(\sigma-1+s_K)+s_L(\sigma-1-w\sigma))]\omega\phi\}}{w(1-\lambda)^2(\sigma-\mu)\sigma\phi+\lambda(1-\lambda)[(1-s_K)(w-1)\mu^2(\sigma-1)(1-\phi^2)+w\sigma(\sigma(1-\mu)+\phi^2(\sigma-\mu))+\mu\sigma(\sigma-1)]\omega+\lambda^2(w\sigma(1-\mu)+\mu(\sigma-1))\phi\omega^2}, \tag{19}$$

$$I^* = \frac{\sigma L^W\{w(1-\lambda)(\mu(s_L-s_K)+(1-s_L)\sigma)\phi+\lambda[(w(1-s_K)-1+s_L)\mu+(1-s_L)(w(1-\mu)+\mu)\sigma]\omega\}(1-\lambda(1-\omega\phi))}{w(1-\lambda)^2(\sigma-\mu)\sigma\phi+\lambda(1-\lambda)[(1-s_K)(w-1)\mu^2(\sigma-1)(1-\phi^2)+w\sigma(\sigma(1-\mu)+\phi^2(\sigma-\mu))+\mu\sigma(\sigma-1)]\omega+\lambda^2(w\sigma(1-\mu)+\mu(\sigma-1))\phi\omega^2}. \tag{20}$$

Therefore, the domestic country's income share is given by:

$$i = \frac{(\lambda\omega+(1-\lambda)\phi)\{w(1-\lambda)(s_K\mu+s_L(\sigma-\mu))+\lambda[s_L w\sigma(1-\mu)+\mu((\sigma-1)(w-1)+ws_K+(\sigma-1)s_L)]\omega\phi\}}{w(1-\lambda)^2\sigma\phi+\lambda(1-\lambda)[w\sigma(1+\phi^2)-(1-s_L)(w-1)\mu(\sigma-1)(1-\phi^2)]\omega+w\lambda^2\sigma\phi\omega^2}$$

Computing the derivative of i with respect to w at $w = 1$, we get:

$$\frac{\partial i}{\partial w}\Big|_{w=1} = \frac{(1-s_L)\mu\lambda(\sigma-1)\big[\sigma\phi(\lambda(1-\phi)+\phi)+s_K(1-\lambda)\mu(1-\phi^2)+s_L(1-\lambda)(\sigma-\mu)(1-\phi^2)\big]}{\sigma^2(1-\lambda(1-\phi))(\lambda(1-\phi)+\phi)},$$

which is strictly positive.
The derivative of i with respect to λ is given by:

$$\begin{aligned}
\frac{\partial i}{\partial \lambda} \;=\;& (1-s_L)(w-1)\mu(\sigma-1)\omega\phi\left\{w(1-\lambda)^2(\sigma\phi^2+(\sigma-\mu)(1-\phi^2)+s_K(1-\phi^2)\mu)\right.\\
&+2w\lambda(1-\lambda)\sigma\phi\omega+\lambda^2\left[w\sigma s_L\phi^2+(1-\phi^2)w\mu(1-s_K)+(1-s_L)(w\sigma-\mu(1+\sigma(w-1)))\right]\omega^2\left.\right\}\\
&/\left\{w(1-\lambda)^2\sigma\phi+\lambda(1-\lambda)\left[w\sigma(1+\phi^2)-(1-s_L)(w-1)\mu(\sigma-1)(1-\phi^2)\right]\omega+w\lambda^2\sigma\phi\omega^2\right\}^2,
\end{aligned}$$

which is positive. □

A.3 Proof of Proposition 5

Proof. Taking the values of nominal incomes in both countries from the proof of Lemma 2, we can compute the difference between the domestic and the foreign interest rate. We get:

$$(r-r^*)K^W = \frac{L^W(A(s_K,s_L)+\lambda B(s_K,s_L))}{w(1-\lambda)^2(\sigma-\mu)\sigma\phi+\lambda(1-\lambda)\big[(1-s_K)(w-1)\mu^2(\sigma-1)(1-\phi^2)+w\sigma(\sigma(1-\mu)+\phi^2(\sigma-\mu))+\mu\sigma(\sigma-1)\big]\omega+\lambda^2(w\sigma(1-\mu)+\mu(\sigma-1))\phi\omega^2},$$

where

$$\begin{aligned}
A(s_K,s_L) &= \mu w\big[-\sigma\phi(1-\omega\phi)+\omega\mu s_K(1-\phi^2)+s_L(\sigma-\mu)(1-\phi^2)\omega\big],\\
A(s_K,s_L)+B(s_K,s_L) &= \mu\omega\big[(w-1)\mu(\sigma-1)(1-\phi^2)-w\sigma(1-\omega\phi)+s_K w\mu(1-\phi^2)+s_L(1-\phi^2)(\sigma w(1-\mu)+\mu(\sigma-1))\big].
\end{aligned}$$

Since $0 < \phi < 1$, $w \geq 1$, $0 < \omega \leq 1$, $\sigma > 1$, $0 < \mu < 1$ and $0 \leq s_K \leq 1$, it follows that the denominator of $(r - r^*)K^W$ is strictly positive. Therefore, $r - r^*$ has the same sign as $A(s_K, s_L) + \lambda B(s_K, s_L)$.

To prove the uniqueness of the equilibrium, we want to show that inequalities $A(s_K, s_L) \leq 0$ and $A(s_K, s_L)+B(s_K, s_L) \geq 0$ cannot hold simultaneously. To do so, we solve the following linear program: $\min_{s_K,s_L} A(s_K, s_L)$, subject to $A(s_K, s_L)+B(s_K, s_L) \geq 0$ and $0 \leq s_K, s_L \leq 1$, and we show that its solution is strictly positive.

Notice first that $A+B$ increases in s_K and s_L. Therefore,

$$\begin{aligned} A(s_K,s_L)+B(s_K,s_L) &\leq A(1,1)+B(1,1), \\ &\leq w\mu\sigma\phi\omega(\omega-\phi). \end{aligned}$$

Therefore, if $\omega < \phi$, then, $A+B$ is negative for all $s_K,\ s_L$, and $A \leq 0$ and $A+B \geq 0$ cannot hold simultaneously.

Now, assume that $\omega \leq \phi$. Then, the constraints set of the above linear program is non-empty. To solve the program, we want to obtain a graphical representation of this set. First, we show that $(0,0)$ is not in the constraints set. When $s_K = s_L = 0$, we have:

$$A+B = \mu\omega\left[(w-1)\mu(\sigma-1)(1-\phi^2) - w\sigma(1-\omega\phi)\right].$$

Deriving the expression inside the brackets with respect to w, and remembering the fact that ω is a function of w, we get:

$$\mu(\sigma-1)(1-\phi^2) - \sigma + (2-\sigma)\omega\phi,$$

which is clearly negative if $\sigma \geq 2$. If $\sigma < 2$, then,

$$\begin{aligned} \mu(\sigma-1)(1-\phi^2) - \sigma + (2-\sigma)\omega\phi &\leq \mu(\sigma-1)(1-\phi^2) - \sigma + (2-\sigma), \\ &\leq (\sigma-1)(\mu(1-\phi^2)-2) < 0. \end{aligned}$$

Therefore, $\frac{A(0,0)+B(0,0)}{\mu\omega}$ decreases in w. Since $w \geq 1$, we get:

$$A(0,0)+B(0,0) \leq -\mu\omega\sigma(1-\phi) < 0,$$

and $(0,0)$ is not in the constraints set.

When $s_K = 0$ and $s_L = 1$, we have:

$$A+B = w\mu\omega\left[\sigma\phi(\omega-\phi) - \mu(1-\phi^2)\right].$$

Since $A+B$ increases in s_L, this implies that:

- If $\sigma\phi(\omega-\phi) \geq \mu(1-\phi^2)$, then, there exists $\bar{s}_L \in (0,1]$ such that, $A(0,s_L)+B(0,s_L) \geq 0$ if and only if $s_L \geq \bar{s}_L$.

- Otherwise, $A(0,s_L)+B(0,s_L) < 0$ for all s_L.

Similarly, when $s_L = 0$ and $s_K = 1$, we have:

$$A + B = \mu\omega \left[\mu(1-\phi^2)(1+\sigma(w-1)) - w\sigma(1-\omega\phi)\right].$$

Again, since $A + B$ increases in s_L, this implies that:

- If $\mu(1-\phi^2)(1+\sigma(w-1)) \geq w\sigma(1-\omega\phi)$, then, there exists $\bar{s}_K \in (0,1]$ such that, $A(s_K, 0) + B(s_K, 0) \geq 0$ if and only if $s_K \geq \bar{s}_K$.
- Otherwise, $A(s_K, 0) + B(s_K, 0) < 0$ for all s_K.

Therefore, we have to distinguish four cases, depending on which of these inequalities hold. They are depicted in Figure A.3.

Let us start with case (a). Since we are solving a linear program, we know that the optimum is reached at one of the vertices of the constraints polyhedron, i.e., at C_a, D_a, E_a, or F_a. Since function A is increasing in both s_K and s_L, we can exclude points E_a and F_a right away.

Now we want to show that A decreases when going from vertex D_a to vertex C_a along the edge $[D_aC_a]$. For each point on this edge, we have:

$$s_L = \tilde{s_L}(s_K) \equiv \frac{w\sigma(1-\omega\phi) - \mu(1-\phi^2)(\sigma(w-1)+1-w(1-s_K))}{(1-\phi^2)(w\sigma(1-\mu)+\mu(\sigma-1))}.$$

The impact of a change in s_K and s_L along the edge $[D_aC_a]$, from D_a to C_a is therefore given by:

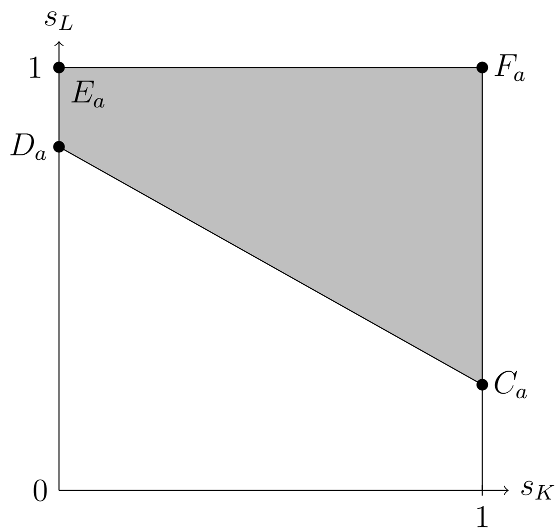
$$\frac{d}{ds_K}\left(A(s_K, \tilde{s_L}(s_K))\right) = -\frac{(w-1)w\mu^3(\sigma-1)(1-\phi^2)\omega}{w\sigma(1-\mu)+\mu(\sigma-1)} < 0. \tag{21}$$

This implies that A decreases when moving from vertex D_a to vertex C_a. As a result, the optimum of the linear program is reached at vertex C_a. At this point, A is equal to:

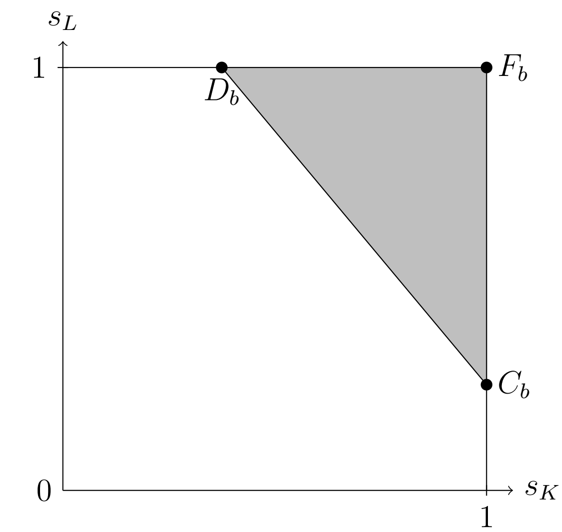
$$A = \frac{w\mu\sigma(\omega-\phi)\left[\sigma(1-\mu)w + \mu(\sigma-1) - w(\sigma-\mu)\omega\phi\right]}{w\sigma(1-\mu)+\mu(\sigma-1)}. \tag{22}$$

Now, let us derive the terms inside the brackets with respect to μ (the other terms are positive). We get:

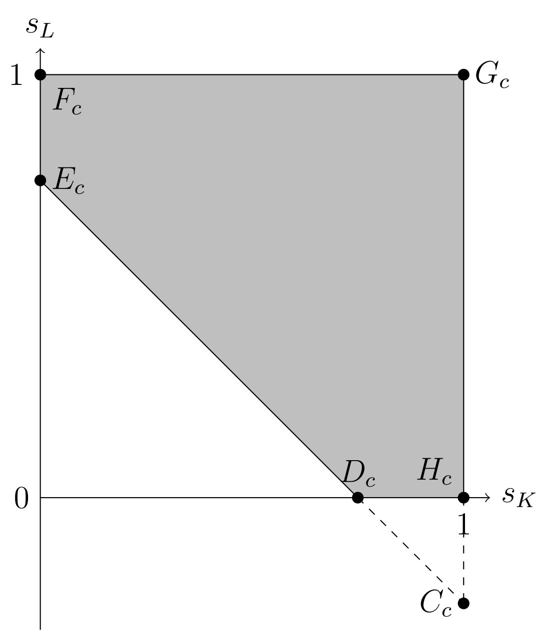
$$\frac{d}{d\mu}\left[\sigma(1-\mu)w + \mu(\sigma-1) - w(\sigma-\mu)\omega\phi\right] = -\sigma(w-1) + \omega\phi w.$$



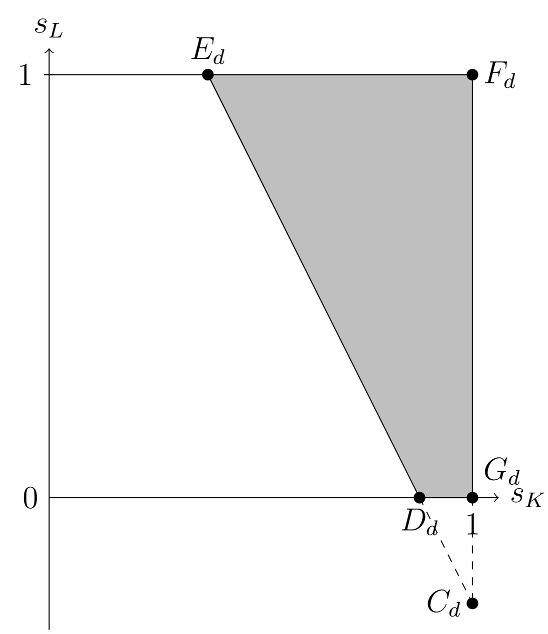
(a) $\mu(1-\phi^2)(1+\sigma(w-1)) \le w\sigma(1-\omega\phi)$, $\sigma\phi(\omega-\phi) \ge \mu(1-\phi^2)$



(b) $\mu(1-\phi^2)(1+\sigma(w-1)) \le w\sigma(1-\omega\phi)$, $\sigma\phi(\omega-\phi) \le \mu(1-\phi^2)$



(c) $\mu(1-\phi^2)(1+\sigma(w-1)) \ge w\sigma(1-\omega\phi)$, $\sigma\phi(\omega-\phi) \ge \mu(1-\phi^2)$



(d) $\mu(1-\phi^2)(1+\sigma(w-1)) \ge w\sigma(1-\omega\phi)$, $\sigma\phi(\omega-\phi) \le \mu(1-\phi^2)$

Figure 3: The constraints set

If $\omega\phi w \geq \sigma(w-1)$, then,

$$\sigma(1-\mu)w + \mu(\sigma-1) - w(\sigma-\mu)\omega\phi \geq \sigma w - w\sigma\omega\phi > 0.$$

If, on the other hand, $\omega\phi w \leq \sigma(w-1)$, then, we use Assumption 3. If $\sigma > 3/2$, then,

$$\begin{aligned}
\sigma(1-\mu)w + \mu(\sigma-1) - w(\sigma-\mu)\omega\phi &\geq (\sigma-1)(1-w\omega\phi), \\
&\geq (\sigma-1)(1-w\omega^2) \\
&\geq (\sigma-1)(1-w^{3-2\sigma}) \\
&> 0,
\end{aligned}$$

since $\sigma > 3/2$ and $w > 1$.
If, on the other hand, $\sigma \leq 3/2$, then, by Assumption 3, $\mu < \sigma/2$. Therefore,

$$\begin{aligned}
\sigma(1-\mu)w + \mu(\sigma-1) - w(\sigma-\mu)\omega\phi &\geq \sigma(1-\frac{\sigma}{2})w + \frac{\sigma}{2}(\sigma-1) - w(\sigma-\frac{\sigma}{2})\omega\phi \\
&\geq \frac{\sigma}{2}(w(2-\sigma-\omega\phi)+\sigma-1) \\
&\geq \frac{\sigma}{2}w(1-\omega\phi), \text{ since } w \geq 1 \\
&> 0.
\end{aligned}$$

Therefore, at vertex C_a, A is strictly positive. This implies that $A > 0$ whenever $A + B \geq 0$.

Now, let us deal with case (b). Again, the minimum is reached at either C_b or D_b. As in case (a), the impact of a change in (s_K, s_L) along edge $[D_bC_b]$, from D_b to C_b is given by expression (21), which is negative. At vertex C_b, the value of A is given by equation (22), which has just been proven to be positive. Again, the solution to the linear program is positive.

Now, consider case (c). Clearly, the minimum is reached at either vertex E_c or vertex D_c. Using the same reasoning as in the above paragraph, we deduce that it is reached at point D_c. Besides, using again the same reasoning, we also know that A is lower at point C_c than at point D_c. The value of A at point C_c is given by equation (22), which is positive. Therefore, the solution to the linear program is positive.

Following a similar argument, we also obtain that the solution to the linear program is positive in case (d). Therefore, whatever the parameters' values, $A + B \geq 0$ implies $A \geq 0$. We can now conclude:

- If $A + B \geq 0$, then, $A \geq 0$, $r - r^*$ is positive for all λ. This implies that $\lambda = 1$ is the unique equilibrium.

- If $A + B < 0$, then,

  - If $A \leq 0$, then, $r - r^*$ is negative for all λ, and $\lambda = 0$ is the unique equilibrium.

– If $A > 0$, then, $\lambda = \frac{A}{-B}$ is the unique equilibrium.

$\square$

A.4 Proof of Proposition 6

Proof. Taking the value of λ^{eq} from Appendix A.3 and deriving it with respect to w for $w = 1$, we get:

$$\left.\frac{\partial \lambda^{eq}}{\partial w}\right|_{w=1} = \frac{\sigma - 1}{\sigma^2(1-\phi^2)} \left(\mu\sigma(1-s_L)\tilde{i} - \sigma(\sigma + \mu(1-s_L)(1-2\tilde{i}))\phi - (1-s_L)\mu\sigma(1-\tilde{i})\phi^2\right). \tag{23}$$

Notice that, as proven in Proposition 4, the above expression if always positive when ϕ is close enough to 0. Notice also that the expression inside the parentheses is a concave polynomial in ϕ.

Assume first that $\tilde{i} \leq \frac{1}{2}$. Then, the equilibrium is interior if, and only if, $\phi \leq \frac{\tilde{i}}{1-\tilde{i}}$. When $\phi = \frac{\tilde{i}}{1-\tilde{i}}$, the expression inside the parentheses in equation (23) is equal to $-\frac{\sigma^2 \tilde{i}}{1-\tilde{i}}$, which is negative. Since this expression is a concave polynomial in ϕ, and since it is positive for $\phi = 0$, this implies that there exists a threshold $\bar{\phi} \in (0, \frac{\tilde{i}}{1-\tilde{i}})$, such that $\left.\frac{\partial \lambda}{\partial w}\right|_{w=1} > 0$ if, and only if, $\phi \in [0, \bar{\phi})$.

Assume now that $\tilde{i} \geq \frac{1}{2}$. The equilibrium is interior if, and only if, $\phi \leq \frac{1-\tilde{i}}{\tilde{i}}$. When $\phi = \frac{1-\tilde{i}}{\tilde{i}}$, the expression inside the parentheses in equation (23) is equal to

$$-\frac{\sigma}{\tilde{i}^2}\left(\mu(1-s_L)(1-\tilde{i}) + (\mu(1-s_K) + (\sigma - 2\mu)(1-s_L))\tilde{i}\right),$$

which is negative if $\sigma \geq 2\mu$. Again, this implies the existence of a threshold $\bar{\phi} \in (0, \frac{1-\tilde{i}}{\tilde{i}})$, such that $\left.\frac{\partial \lambda}{\partial w}\right|_{w=1} > 0$ if, and only if, $\phi \in [0, \bar{\phi})$. $\square$

A.5 Proof of Lemma 3

Proof. Differentiating equation (17) with respect to i and λ, we get:

$$\left\{1 - \gamma(1-s_K)(1-s_A)\frac{\lambda(1-\lambda)(1-\phi^2)}{\lambda(1-\lambda)(1+\phi^2) + \phi(\lambda^2 + (1-\lambda)^2)}\right\} di =$$
$$\gamma(1-s_K)(1-s_A)\phi\left(\frac{i}{\Delta^2} + \frac{1-i}{\Delta^{*2}}\right) d\lambda.$$

Since $\lambda(1-\lambda)(1-\phi^2) < \lambda(1-\lambda)(1+\phi^2)$, and $1-s_K, 1-s_A, \gamma < 1$, the term in the left hand side is strictly positive. Obviously, the right hand side is strictly positive as well, therefore, $\frac{\partial i}{\partial \lambda}\big|_{II} > 0$.

To prove the second part of the lemma, we differentiate equation (17) with respect to i and γ, which yields:

$$\left\{1-\gamma(1-s_K)(1-s_A)\frac{\lambda(1-\lambda)(1-\phi^2)}{\lambda(1-\lambda)(1+\phi^2)+\phi(\lambda^2+(1-\lambda)^2)}\right\} di =$$
$$(1-s_K)(1-s_A)\lambda\left(\frac{i}{\Delta}+\phi\frac{1-i}{\Delta^*}\right) d\gamma.$$

Again, both the left hand side and the right hand side are strictly positive, which implies that the II-curve shifts upwards as γ goes up. □

A.6 Proof of Lemma 4

Proof. Let us sign the partial derivative of Ψ with respect to i:

$$\frac{\partial \Psi}{\partial i} = \frac{1-\gamma-\phi}{\Delta} + \frac{1-\phi(1-\gamma)}{\Delta^*} > 0.$$

Let $i' > i$ in $(0,1)$. If $\lambda(i) = 0$, then, trivially, $\lambda(i') \geq \lambda(i)$. If $\lambda(i) = 1$, then, since Ψ is strictly increasing in i, $\Psi(1, i', \gamma) > \Psi(1, i, \gamma) > 0$. Therefore, $\lambda(i') = 1 \geq \lambda(i)$. Last, if $0 < \lambda(i) < 1$, $\Psi(\lambda(i), i', \gamma) > \Psi(\lambda(i), i, \gamma) = 0$. Therefore, since Ψ is strictly decreasing in λ, $\lambda(i') > \lambda(i)$. The LL-curve is upward sloping.

It is easy to sign the partial derivative of Ψ with respect to γ:

$$\frac{\partial \Psi}{\partial \gamma} = -\left(\frac{i}{\Delta}+\phi\frac{1-i}{\Delta^*}\right) < 0.$$

With the same reasoning as before, we deduce that the LL-curve shifts to the right when γ goes up. □

A.7 Proof of Proposition 7

Proof. The existence is obvious, from figure 1.

Assume that the equilibrium is not unique. Then, the only possible configuration is case (b). We know, from Lemma 5, that the interior solution is given by:

$$\lambda^{eq} = \frac{(1-\gamma)(1-\phi^2)\left[s_A s_L + (1-s_A)s_K\right] - \phi\left[1-\phi(1-\gamma)\right]}{(1-\phi)\left[1-\phi-\gamma(1-s_A(1-s_L)(1+\phi))\right]}. \tag{24}$$

The denominator of this expression is strictly positive, by Assumption 4, and since $s_A, s_L, \phi < 1$. Since this value of λ is interior, $\lambda > 0$. Therefore,

$$(1-\gamma)(1-\phi^2)\left[s_A s_L + (1-s_A)s_K\right] > \phi\left[1-(1-\gamma)\phi\right]. \tag{25}$$

Since we are dealing with case (b), there is also an equilibrium at $\lambda = 0$. At this equilibrium, the interest rate differential has to be such that no firm wants to relocate its production in the foreign country: $r(\lambda = 0) < r^*(\lambda = 0)$. Using the II-curve to evaluate income share i at $\lambda = 0$, we get $i = s_A s_L + (1-s_A)s_K$. Substituting this expression into the LL-curve equation, and rearranging terms, we obtain:

$$(1-\gamma)(1-\phi^2)\left[s_A s_L + (1-s_A)s_K\right] < \phi\left[1-(1-\gamma)\phi\right],$$

which contradicts condition (25). Therefore, the equilibrium is unique. □

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