How labor market rigidities shape business taxation
in a global economy?*

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Abstract

Empirical facts suggest that some countries with labor market rigidities or re-
inforced regulation on their labor market tend to compensate firms by offering cor-
porate taxation. We show that this compensation effect can be rationalized in a
model of tax competition with imperfect competition and trade costs. We show
that labor market imperfections strengthen tax competition. Our analysis also re-
veals that corporate taxes can increase with trade integration. When labor market
institutions differ between countries, the corporate tax is lower in the country with
labor market imperfections and a majority of capital can be located there. Finally,
trade liberalization always increases the attractiveness of the unionized country.

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1 Introduction

It is now recognized that globalization through its various forces is supposed to lead governments to engage more vigorously in tax competition, a process according to which they compete with each other to attract capital inflows by decreasing their corporate tax rates (Zodrow and Mieszowski, 1986). Through a panel of 21 countries between 1982 and 1999, Devereux, Lockwood and Redoano (2008) show that the relaxation of capital controls put more intense competitive pressure on corporate tax rates. From data on 18 OECD countries over the period 1965-92, Rodrik (1997) finds that taxes on capital respond negatively to trade openness, while taxes on labor respond positively. Although a large literature now addresses the relationship between trade liberalization and corporate tax policies, we fall short of understanding how these links depend on the labor market characteristics. In a context of unemployment and trade liberalization, one strategy to compensate the labor market rigidities for policy makers would be to more intensively reduce the business tax burden to attract capital and, in turn, to reduce unemployment. In this paper, we study how labor market rigidities shape business taxation in a context of trade liberalization. Before delineating the logic of our model, we review some facts on the relationship between corporate tax policies, labor market rigidities and globalization.

Empirical evidence. Different examples reveal that the decision of policy makers to apply corporate tax cuts is also associated with labor market policies. Although there are no serious econometric works on the impact of the labor market rigidities on tax competition, some recent examples reveal that the reduction of business taxation is sometimes a way to compensate firms for increasing labor costs. Indeed, in 1998, the United Kingdom introduced a national minimum wage for the first time (National Minimum Wage Act 1998) and, at the same time, decided significant corporate tax cuts. In May 2007, the US Congress approved the first increase in the federal minimum wage in nearly a decade (Fair Labor Standards Act 2007) but President Bush and Senate Republicans have made business tax breaks a condition for supporting this minimum wage increase. The two chambers finally accepted tax breaks worth $8.3 billion over 10 years.1 Such a strategy has been also adopted by some Canadian provinces after increases in the minimum wage level (e.g. British Columbia in 2001, Ontario in 2003). It is also striking to observe that, all things being equal, the most intense corporate tax rate decreases have been decided in countries

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1 The previous increase in the US minimum wage occurred in 1996 and was also associated with 4.8 billion dollars of tax breaks.
where the collective bargaining coverage rate is high: -13 points between 2000 and 2007 in Germany, -9 points in Austria, -9.5 in Netherlands, -4 points in France, the percentage of workers covered by collective agreements in these countries being above 60%.\(^2\) Hence, it seems clear that tax competition should not be studied without taking into account the labor market imperfections.

However, this is not the end of the story. Increasing trade openness is not without consequences on the labor market performance and, in turn, on tax policies. Indeed, as mentioned by Rodrik (1997), trade liberalization should induce an increase in the labor demand elasticity: “The reason is that employers and the final consumers can substitute foreign workers for domestic workers more easily - either by investing abroad or by importing the products made by foreign workers” (Rodrik, 1997, p. 16). From US data, Slaughter (2001) shows that the demand for production labor has become more elastic in manufacturing overall: the elasticity reached -0.5 by the mid-1970s and around -1.0 in 1991. While Krishna et al. (2001) find no empirical support in Turkey for this relationship from plant-level data, Hasan et al. (2007) show that labor demand elasticities in the manufacturing sector rose after the trade reforms in India. An important implication underlined by Rodrik (1997) relies on the fact that trade liberalization, by inducing higher elasticities, would erode the bargaining power of labor vis-à-vis capital in the sharing of rents. As a result, by lowering negotiated wages, trade liberalization could relax tax competition on capital. Hence, whether trade integration seems to have a negative direct effect on business taxation, its indirect effect via the wage setting could be positive.

To summarize, some empirical facts suggest that labor market imperfections could play an important role in the definition of business tax policies. In a context of globalization, this relationship is more complex because there exists linkages between corporate tax rates and economic integration on the one hand and between labor outcomes and economic integration on the other hand. This paper aims at clarifying this relationship between economic integration (in the sense that trade costs are reduced), labor market outcomes and corporate tax policy.

**Theoretical literature** Our model is linked with different strands in the literature. A first set of papers study the effect of reduced trade costs in an international unionized oligopoly framework. Based on the seminal paper of Brander and Spencer (1988), Naylor (1998, 1999) focuses on the impact that trade liberalization may have on the bargained

\(^2\)Sources: our own calculations from OECD dataset for statutory corporate taxes and CEP OECD Institutions dataset for the collective bargaining coverage rate.
wage in a monopoly trade union wage setting. In these models, reduced trade costs increase the total volume of production. Thus, unions translate the resulting higher labor demand in higher wages without reducing the numbers of jobs. Lommerud, Meland and Sørgard (2003) complete Naylor’s work by introducing the possibility of plant delocation and an asymmetry on the unionization of the labor markets. They show that unionized labor can lose from trade liberalization in terms of welfare because of job losses resulting from higher wages. These models, however, ignore tax policy and its possible interactions with the trade union position. An exception is the recent analysis by Haufler and Mittermaier (2008). They focus on a tax competition setting between a unionized and a non-unionized country for the location of an outside firm. A very interesting result is that attracting this outside firm by a generous tax environment can be a policy option to promote wage moderation. In many cases, the unionized country succeeds in attracting the mobile firm. Nevertheless, the authors do not address the role played by trade liberalization.

Another strand of literature relates to the tax policy outcome in an open economy with labor market imperfections. Lejour and Verbon (1996) analyze the impact of increasing capital mobility on governments’ tax policy when unemployment is generated by a wage-bargaining process with a monopoly union. They show that greater capital mobility leads governments to reduce payroll taxes, which results in an underprovision of social insurance. The issue of tax competition with distorted labor markets has also been investigated by Leite-Monteiro et al. (2003).\(^3\) They show that capital mobility may lead governments to decrease employment subsidies when labor markets are unionized because unions neglect the positive impact of the wage rate on the labor demand elasticity.

This literature improved the understanding of the link between the labor market and tax policies in open economies. Nevertheless, all these papers ignore international trade while it is an important channel of economic integration that can affect the tax competition outcome. The literature on tax competition has been recently revisited in New Economic Geography models that stress the importance of trade integration for tax policies. Assuming monopolistic competition and imperfect trade integration, Kind et al. (2000), Baldwin and Krugman (2004), Andersson and Forslid (2003) and Ottaviano and Van Ypersele (2005) suggest that the combination of increasing returns and trade inte-

\(^3\)These papers belong to a growing body of research. See also, Mezzetti and Dinopulos (1991), Zhao (1995), Straume (2003), Lommerud, Meland and Straume (2008).

\(^4\)See also Ogawa et al. (2006). They extend the model of Zodrow and Mieszkowski (1986) by introducing unemployment caused by an exogenous minimum wage.
migration favors the agglomeration of firms and allows the country where agglomeration takes place to set higher tax rates. All these papers, however, assume full employment and inelastic labor supply\textsuperscript{5}. The relationship between trade, labor markets and taxation is not addressed.

**A new model of tax competition with labor market rigidities** In order to obtain analytic results, we build a simple model of tax competition with trade and imperfections in labor and product markets. More specifically, our model is based on a generalized oligopoly framework.\textsuperscript{6} There are two factors of production: workers who are immobile and capital which is mobile between countries. Labor market rigidities arise from either an exogenously fixed wage or a monopoly union, inducing unemployment. Governments are benevolent and have two tax instruments: a tax on labor and a tax on capital. We adopt a game-theoretic approach where firms, governments, and unions act non-cooperatively. Note also that the oligopolistic industry is characterized by increasing returns and trade costs. Hence, decisions on the location of capital are not simply driven by costs factors (taxes and wages) but also by other economic considerations such as increasing returns, trade costs, and market structures (Head and Mayer, 2004b). More importantly, our framework allows us to take into account not only the role of labor market imperfections in tax setting but also the fact that falling trade costs raises the labor demand elasticity.

Our main results can be summarized as follows. First, we show that labor market imperfections in both countries strengthen tax competition as compared with the case where both labor markets are competitive, regardless of sequences in which governments and unions move. Second, the impact of trade integration on tax policies strongly depends on the configuration of the labor market. When the labor market is competitive in both countries, the Nash corporate tax equilibrium follows a standard U-shaped relationship with trade costs. By contrast, when labor markets are unionized and the relative importance of wages over employment for the trade union is not too low, capital taxes are strictly increasing with trade integration whatever the initial level of trade barriers among countries. This result holds when trade unions act as Stackelberg leaders and when trade unions and governments act simultaneously. When governments are Stackelberg leaders, the capital taxes follow a U-shaped relationship. This shows clearly that the relationship

\textsuperscript{5} An exception is Picard and Toulemonde (2003) but the authors ignore government tax policies.

\textsuperscript{6} See Haufler and Wooton (2007) for a similar framework. Most of the papers on unionised oligopoly with two countries assume an active firm in each country and an outside firm that governments try to attract. As mentioned by Haufler and Wooton (2007), this leads to the comparison of discrete equilibrium allocations and specific scenarios that are difficult to generalize.
between trade liberalization and business taxation depends not only on the preferences of labor market unions but also on whether unions have an advantage enabling them to move first. In addition, we extend our model by analyzing tax policies when countries differ with respect to their labor market institutions. More precisely, we analyze the tax competition outcome when the labor market is competitive in one country and unionized in the other one. We show that the corporate tax is lower in the country suffering from labor market imperfections. The resulting location of capital is ambiguous. A majority of capital is invested in the country with labor market rigidities, provided that the relative importance of wages over employment for the trade union in the other country is not too high. In addition, trade liberalization induces a wage and tax convergence and agglomeration of capital in the unionized country. These results hold whatever the sequence of play.

The rest of the paper is organized as follows. In the next section, we develop the model. In section 3, we analyze the tax competition outcome in the benchmark case, where both labor markets are competitive. In section 4, we deal with the tax competition outcome when countries exhibit the same exogenous fixed wage. In sections 5 and 6, we consider the existence of monopoly unions in symmetric and asymmetric cases. Section 7 checks the robustness of our main results when the governments act as Stackelberg leaders. The last section concludes.

2 Model

The economy consists of two countries, labeled $i = H, F$. Variables associated with each country will be subscripted accordingly. Because we focus on the impact of labor market imperfections and trade liberalization on tax policies, we control for any exogenous advantage by assuming that countries have the same size and the same technology. We denote by $l$ the mass of workers/consumers living in each country. Each individual works and consumes in the country she lives in. Contrary to previous models of trade and location, the individual labor supply is endogenously determined. Moreover, each resident is endowed with $k$ units of capital that she/he inelastically supplies. Thus, there are $n = 2lk$ units of capital in the economy and capital is internationally mobile. Finally, the government of each country is benevolent and maximizes the total welfare of its residents by levying a lump-sum tax on capital ($t_i$) on the source principle and a lump-sum tax on workers ($\rho_i$).
2.1 Preferences

In order to make the model analytically tractable, we assume that all workers have the same quasi-linear utility with respect to a numéraire \( z \) and a homogeneous (manufactured) good and have the same disutility from labor.\(^7\) A consumer residing in country \( i \) then solves the following problem:

\[
\max_{x_i^d, l_i^s} u_i \equiv \left( a - \frac{x_i^d}{2} \right) x_i^d + z - \frac{\eta}{2} (l_i^s)^2
\]

s.t. \( y_i = x_i^d p_i + z \)  \hspace{1cm} (1)

where \( a > 0 \), \( x_i^d \) is the individual consumption level of the manufactured good, \( z \) is the individual consumption of the numéraire, \( l_i^s \) is the individual labor supply and \( \eta > 0 \) is a measure for the preference for leisure. The variable \( y_i \) is the net income which depends on the status of the individual on the labor market:

\[
y_i = \tilde{z} + r\bar{K} + w_il_i^s - \rho_i \text{ for employed workers}
\]

\[
y_i = \tilde{z} + r\bar{K} + b_i \text{ for unemployed workers}
\]

with \( \tilde{z} \) is the quantity of numéraire endowed by each worker, \( w_i \) the national wage rate, and \( r \) the world net return rate to capital. Thus, \( r\bar{K} \) denotes the capital net income of each resident while \( w_il_i^s \) is its labor income. Finally, \( b_i \) are unemployment benefits for each unemployed individual.

2.2 Technology and market structure

Firms produce a homogeneous product under increasing returns to scale and Cournot competition.\(^8\) The production of the manufactured good requires a fixed amount \( f \) of labor units and one unit of capital. Hence, there are \( n \) firms in the economy. For simplicity, the marginal cost of production is assumed to be constant and equal to zero without loss of generality. Shipping the manufactured good is costly. Specifically, firms incur a trade cost of \( \tau > 0 \) units of the numéraire per unit of good shipped between the two countries. We assume that product markets are segmented and that labor markets are national. Each firm determines a quantity specific to the country in which it sells its output and

\(^7\)As shown by Dinopoulos et al. (2007, p.22), quasi-linear preferences behave reasonably well in general-equilibrium settings with international trade.

\(^8\)Using a monopolistic competition model of economic geography à la Ottaviano and Van Ypersele (2005) does not qualitatively change the results. Without product differentiation, the equilibrium prices are lower but react in the same way to a change in trade costs and the spatial distribution of firms.
wages can differ across countries because workers are internationally immobile. Hence, quantities, prices, and wages are specific to each country but interdependent because of capital mobility.

The operating profits of a firm located in country $i$ are given by

$$
\Pi_i = p_i x_{ii} + (p_j - \tau) x_{ij}
$$

(4)

where $x_{ii}$ is the quantity that it supplies to domestic consumers, $x_{ij}$ is the quantity it sells to foreign consumers and $p_i$ is the price prevailing in country $i$. Thus, its net profits are expressed as follows:

$$
\pi_i = \Pi_i - f w_i - r_i - t_i
$$

(5)

where $r_i$ is the rental rate of capital in country $i$, which is equalized across countries in the long run due to capital mobility ($r_H = r_F = r^*$).

2.3 Labor market regimes

We consider three types of wage setting regimes: (i) a competitive labor market, (ii) a minimum wage, and (iii) a trade union. The two latter regimes induce higher wages than the competitive wage, generating unemployment.

A. Wage flexibility  Under the competitive labor market regime, the equilibrium wage ($w^c_i$) is determined by the labor market clearing condition.

B. Exogenous wage rigidity  We first model unemployment in the simplest way, through an exogenous rigidity which takes the form of a fixed wage $\omega$ (see Ogawa et al., 2006 and Leite-Monteiro et al., 2003). This wage rate $\omega$ is supposed to be higher than the level of competitive wage that would occur at the free market equilibrium. Hence, labor supply exceeds labor demand and, in turn, some workers are involuntarily unemployed.

C. Monopoly union  We also consider a monopoly union case which gives rise to one wage set for all firms in the country. The monopoly union can be seen as a special case because unions have all the bargaining power\(^9\). We use this model as a simple representation. Moreover, the combination of linear Cournot oligopoly and monopoly

\(^9\)Our assumption that workers are shareholders is incompatible with a wage bargaining process between firms and unions. In this case, both parties would negotiate for the same interest.
unions is commonplace in the literature. Union preferences are characterized by the following Stone-Geary-type utility function:

\[ U_i = (w_i^u - \bar{w})^\mu (L_i^d)^{1-\mu} \]

where \( w_i^u \) is the wage rate set by the union in country \( i \), \( \bar{w} \) is the reference wage rate, \( L_i^d \) is the level of employment in country \( i \), and \( \mu \in (0, 1) \) represents the relative importance of wages over employment for the trade union. We follow the rent maximization hypothesis (Rosen, 1970; De Menil, 1971) by assuming that the reference wage rate \( \bar{w} \) is the competitive wage which is the same in both countries. Hence, the equilibrium wages set by unions will be higher than the competitive wage rate and lead to unemployment.

2.4 Governments

Governments are assumed to be benevolent. They maximize the welfare of their residents by choosing non-cooperatively the per-unit tax on capital \( (t_i) \) and on employed workers \( (\rho_i) \). So as to abstract from the efficiency considerations of public goods provision, we follow Persson and Tabellini (1992) by assuming that taxes exist only to redistribute income. Given the one-to-one correspondence between firms and capital, the budget constraint is given by:

\[ t_i n_i + \rho_i l_i^e = b_i l_i^u \]

where \( l_i^e \) is the number of workers in employment whereas \( l_i^u \) is the number of unemployed workers. Inserting (2) and (3) in (1), we get the aggregate utility function that each government is supposed to maximize:

\[ W_i = l S_i + r K + l_i^e \left[ w_i l_i^e - \frac{\eta}{2} (l_i^e)^2 - \rho_i \right] + l_i^u b_i + \text{constant} \]

where \( S_i \) denotes the consumers’ surplus. Hence the national welfare is the sum of six terms: total consumers’ surplus, capital income, labor income, disutility from labor, labor tax income, benefits to unemployed residents and a constant equal to the total endowment of numéraire. Therefore, the maximization program of governments is tightly related to the labor market performance. When the labor market is competitive, \( l_i^u = 0 \) and \( l_i^e = l \).


\(^{11}\)Assuming no weights \( (\mu = 1) \) is common in the literature (see. Naylor, 1998, 1999; Straume, 2003; Lommerud et al., 2003). Unlike these papers, we consider a more general approach by considering \( 0 < \mu \leq 1 \).
while \( l_i^u > 0 \) and \( l_i^c < l \) (with \( l_i^u + l_i^c = l \)) under labor market imperfections. When the wage is higher than the competitive wage, we have \( L_i^d = l_i^u l_i^c \) where \( l_i^u \) is the mass of labor units supplied by each worker so that

\[
l_i^c = L_i^d / l_i^u.
\]

2.5 Sequence of events

The model consists in a sequential game whose players are workers, firms, governments and trade unions. In the absence of trade unions, each government decides the level of its per-unit tax on labor and capital in the first stage of the game, taking as given the decision of the other government and anticipating the resulting location equilibrium as well as the private sector outcome. In the second stage, residents choose the location of their capital investment given the tax policy choices announced by the governments and anticipating the private sector outcome. In the last stage, firms and residents make their production, consumption and labor allocation choices, respectively, taking as given the level of taxes chosen by governments.

In the presence of trade unions and governments, there is no consensus on the sequence of events. Our benchmark case consists of assuming that monopoly unions act as Stackelberg leaders. As Hersoug (1985) argues, wage contracts can have a longer duration than one year while changes in the tax policy would occur more frequently. Thus, we first assume that a monopoly union sets the level of wage rate in its country before the government chooses its levels of taxation. Note, however, that governments and unions can act simultaneously. The results under this configuration are reported in the Appendix. Most of them are qualitatively identical. Finally, we cannot exclude from our analysis a case where governments are Stackelberg leaders and strategically adjust their tax policy to affect the wage set by trade unions. The results for this case are reported in the text.

3 Tax competition with perfectly competitive labor markets

We first describe the tax competition outcome in the benchmark case without labor market imperfections. The game is solved by a sub-game perfect Nash equilibrium involving backward induction beginning with the last stage. Hence, to solve the first stage where each government chooses its tax policy, we have to solve the second and third stages.
Let $0 \leq \lambda \leq 1$ stand for the share of capital in country $H$.\footnote{Hereafter, the terms "capital" and "firms" are indifferently used as a firm needs one capital unit to produce.} In order to disentangle the various effects at work, we distinguish between what we call a short-run equilibrium, in which capital is supposed to be immobile, i.e. $\lambda$ is exogenous; and a long-run equilibrium when it is mobile, i.e. $\lambda$ is endogenous. We first present the product and labor market outcomes in the short-run. Then, we describe capital location and governments’ tax policy in the long-run.

### 3.1 Product and labor market outcomes (stage 3)

#### 3.1.1 Product market outcome

Given (1) and (2), the individual demand for the manufactured good in country $i$ is given by $x_i^d = a - p_i$ so that the total demand for this good in this country is $X_i^d = (a - p_i)l$. In addition, maximizing (5) with respect to $x_{ii}$ and $x_{ij}$ yields the following quantity choices at the equilibrium: $x_{ii} = lp_i$ and $x_{ij} = l(p_j - \tau)$. Thus, the supply to the domestic market exclusively depends on the market size (constant in both countries) and on the price at which goods are sold in each market. Additionally, the supply to the foreign market decreases with the level of trade barriers. Finally, the market-clearing condition of the manufacturing sector requires that $X_i^d = n_i x_{ii} + n_j x_{ji}$ where $n_i$ is the mass of firms or capital located in country $i$. Knowing $X_i^d$, $x_{ii}$ and $x_{ij}$, the market-clearing condition gives the equilibrium price in country $i$:

$$p_i^* = \frac{a + \tau n_j}{1 + n} \quad (10)$$

The price in country $i$ increases with trade barriers, because the local firms are more protected against foreign competition, and with the mass of firms located abroad because, in this case, the local competition is less intense. These prices lead to the following operating profits:

$$\Pi_i^* = p_i^{*2}l + (p_j^* - \tau)^2l \quad (11)$$

We assume that the trade cost is non-prohibitive so that prices net of trade costs are positive whatever the spatial distribution of firms:

$$\tau < \tau_{\text{trade}} \equiv \frac{a}{1 + n}.$$
3.1.2 Labor market outcome

By inserting the budget constraint (2) in the resident’s utility function (1) and maximizing the resulting expression with respect to $l_i^s$, we get the following equilibrium individual labor supply in country $i$:

$$l_i^s = \frac{w_i}{\eta}. \quad (12)$$

so that the total supply of labor units is given by $lw_i/\eta$. The national demand of labor units, which depends on the requirement of labor and the number of firms, is given by:

$$L_i^d = fn_i \quad (13)$$

Hence, the equilibrium wage permitting full-employment in country $i$ is given by the labor market clearing condition: $lw_i/\eta = fn_i$. Solving this equality with respect to $w_i$ yields the following wage rate equilibrium in country $i$:

$$w_i^* = fn_i/l \quad (14)$$

Clearly, the competitive wage in a country is an increasing function of the number of firms located in this country and a decreasing function of the number of workers.

3.2 Location of capital (stage 2)

Due to free entry and exit, there are no profits in equilibrium. This implies that

$$r_i^* = \Pi_i^* - fw_i^* - t_i \quad (15)$$

In other words, the equilibrium rental rate is determined by a bidding process for capital, which ends when no firm can earn a strictly positive profit at the equilibrium market price. The location of capital is governed by the spatial difference in net return to capital (15), evaluated at equilibrium prices and quantities. A spatial equilibrium $\lambda \in (0, 1)$ (with $n_H = \lambda n$ and $n_F = (1 - \lambda)n$) is such that no unit of capital can induce a higher return by being invested in another country, conditional upon the fact that the product and labor markets clear at the equilibrium prices (10) and wages (14). Formally, an interior equilibrium arises at $\lambda^{cc} \in (0, 1)$ when $\Pi_H(\lambda^{cc}) - fw_H(\lambda^{cc}) - t_H = \Pi_F(\lambda^{cc}) - fw_F(\lambda^{cc}) - t_F$. Solving this equality with respect to $\lambda^{cc}$ yields the location equilibrium for given taxes:

$$\lambda^{cc} = \frac{1}{2} - \frac{(1 + n)(t_H - t_F)}{4nl\tau^2 + 2\eta f^2 (1 + n)n/l} \quad (16)$$

Some comments are in order. The location equilibrium is mainly the result of three mechanisms. The first one is standard and known as a “price competition effect”. When
a country hosts new firms/capital, existing domestic firms face more competitors in their domestic market and fewer in the foreign market. Thus, the domestic price falls while the foreign one rises (see 10). As domestic sales generate more revenues than foreign sales because of the trade cost (see 11), this competition effect acts as a dispersion force. The pressure on the labor cost induced by the agglomeration of firms is the second force affecting the international allocation of capital. This explains why high fixed requirements in labor (f) and high disutility from labor (η), by inducing high wages, favor the dispersion of firms. Finally, the location choice is affected by the tax wedge. An unilateral rise in the capital tax in a country leads to an outflow of capital from this country (dλcc/dtH < 0).

The tax base elasticity to a change in tax rate in country H is given by:

\[ \varepsilon_{cc}^H (\tau) = - \frac{\partial \lambda_{cc}^H}{\partial t_H} = \frac{(1 + n)t_H}{2nl\tau^2 + \eta f^2 (1 + n) n/l - (1 + n)(t_H - t_F)} \]

and the tax base elasticity in country F can be derived by symmetry. Clearly, trade integration leads capital to become more and more sensitive to a change in tax wedge (dε_{cc}^i/dτ < 0). Hence, we capture the fact as that the world economy is becoming more closely integrated, even small changes in the relative costs of doing business can induce important change in capital location.

It is also worth stressing that the tax base elasticity is weakened by high levels in labor input requirement and in disutility from labor, both raising the equilibrium wage. More generally, when country i decreases its tax on capital, the resulting capital inflow increases the wage cost by shifting labor demand upward. In other words, the attractiveness effect of a tax cut is limited by the upward adjustments of the wage rate.

### 3.3 Equilibrium tax policies (stage 1)

When the labor market is competitive, \( l^u_i = 0 \) and \( l^e_i = l \), so that the government’s budget constraint amounts to:

\[ -\rho l = t_i\lambda_{cc}^i n \]  

(17)

where \( \lambda_{cc}^i \) denotes the share of capital invested in country i when both labor markets are competitive. Notice that, since budgets have to be balanced, the policy problem faced by each government is one-dimensional: the choice of the capital tax rate determines the tax rate on workers required to satisfy the budget constraint.

Inserting the equilibrium level of labor supply (12), prices (10) and competitive wage rates (14) in the welfare function (8), with the constraints that \( l^u_i = 0 \) and \( l^e_i = l \), the
objective function of each government amounts to:

\[ W_i^c = lS_i^c + \frac{r^* n}{2} + t_i \lambda_i^{cc} n + l \left( \frac{(w_i^*)^2}{2\eta} \right) + \text{constant} \]  \hspace{1cm} (18)

where \( r^* \) represents the net return to capital at the location equilibrium while the fourth term represents the gross total wages of residents net of their disutility from labor.

Before proceeding further with the analysis, we isolate how each component of the aggregate welfare reacts in response to a tax variation. Let us first consider the effect of a variation of the capital tax on domestic consumers’ surplus. By introducing equilibrium prices in the consumers’ surplus, we can easily show that in order to favor the decline in price prevailing in its domestic market, and in turn the rise in the domestic consumers’ surplus, each government has an incentive to set a low tax burden on capital:

\[ \frac{dS_i^*}{dt_i} = \frac{\partial S_i^*}{\partial p_i^*} \frac{\partial p_i^*}{\partial \lambda^{cc}} \frac{\partial \lambda^{cc}}{dt_i} < 0 \]

We also evaluate the effect of the tax policy on capital income. We get:

\[ \frac{dr_i^*}{dt_i} = \frac{\partial \Pi_i^*}{\partial p_i^*} \frac{\partial p_i^*}{\partial \lambda^{cc}} \frac{\partial \lambda^{cc}}{dt_i} - f \frac{\partial w_i^*}{\partial \lambda^{cc}} \frac{\partial \lambda^{cc}}{dt_i} - 1 \]

This expression encapsulates one direct effect and two indirect effects. We first focus on these two indirect effects. Indeed, by inducing more price competition among firms, a tax cut reduces the operating profits. In addition, when an unilateral tax cut is decided the labor demand shifts upward and the labor cost rises. Hence, an unilateral decrease of the corporate tax gives rise to a lower gross-of-tax capital income. Nevertheless, a lower tax burden has a direct positive effect on the net capital income.

Assuming that \( t_i > 0 \), the third term in (18) describes the capital tax revenues and thus the fiscal contribution of workers as taxation is assumed to be redistributive. Formally, we have

\[ \frac{d (t_i \lambda_i^{cc} n)}{dt_i} = \lambda_i^{cc} n + t_i n \frac{\partial \lambda^{cc}}{dt_i} = \lambda_i^{cc} n (1 - \varepsilon_i^{cc}) \]

Again, the net effect of an unilateral tax change is ambiguous. Specifically, the tax base elasticity has to be low enough to allow a rise in the capital tax to increase capital tax revenues.

Finally, we can investigate the effect of the tax policy on the labor market component of the welfare equation, that is the before-tax labor incomes net of the disutility from labor. After substitutions and simplifications, we get

\[ \frac{d \left( l \left( w_i^* \right)^2 / 2\eta \right)}{dt_i} = \frac{f^2 \eta m^2}{2l} \frac{\partial (\lambda^{cc})^2}{dt_i} < 0 \]
Clearly, reducing the tax burden on capital positively affects the wage rate net of the disutility from labor. The mechanism at work is simple: a tax cut generates an inflow of capital that increases the level of the competitive wage.

Maximizing (18) with respect to $t_i$, we get the equilibrium taxe rate on capital in each country

$$t_i^{cc} = -\frac{n\tau [2a - \tau (2n + 3)]}{2(1+n)^2} \equiv t^{cc}$$

(19)

Trivial calculations reveal $t^{cc} > 0$ as long as $\tau > \bar{\tau}$ with:

$$\bar{\tau} \equiv \frac{2a}{2n + 3} < \tau_{trade}$$

Below a threshold level of trade cost ($\bar{\tau}$), governments give a subsidy to capital and levy a positive tax on labor income. Furthermore, capital taxes describe a U-shaped curve with respect to $\tau$ since we have:

$$\frac{\partial t^{cc}}{\partial \tau} \geq 0 \text{ when } \tau \geq \frac{\bar{\tau}}{2}$$

Starting from high trade costs ($\tau \geq \bar{\tau}$), a gradual fall in trade barriers reduces the capital taxes. When trade costs reach intermediate levels ($\tau > \bar{\tau}$), decreasing trade costs induce each government to provide an increasing level of subsidies to capital. When trade costs decline below $\bar{\tau}/2$, the cost for workers to finance higher subsidies for firms exceeds the benefits they enjoy from this policy. Consequently, the levels of subsidy to capital shrink. This means that competition among countries to attract capital is relaxed when trade costs reach very low values.

To summarize,

**Proposition 1** Assume that labor markets are competitive in both countries. Starting from a high level of trade barriers, gradual trade integration strengthens capital tax competition. When trade barriers become low enough, trade integration relaxes capital tax competition.

Given the perfect symmetry of the model, the location equilibrium is symmetric at the Nash taxes (that is, $\lambda^{cc} = 1/2$). Inserting this location equilibrium in the competitive wage (14), we get the level of wages in each country at the location equilibrium, which is the same as at the free market equilibrium (when $t_H = t_F = 0$):

$$w_i^* = \frac{f\eta n}{2l} \equiv \bar{w} \forall i = H, F.$$  

(20)
4 Tax competition and exogenous wage rigidity

In this section, we parametrize labor market rigidities in a simple and extreme way. We consider that the wage rate in each country is set exogenously at level $\omega$. The product market outcome arising at the third stage of the game is given by expressions (11) and (10) (Section 3.1.1.). We now solve the previous stages where firms make their location choices and governments set their tax policy.

4.1 Capital location and tax base elasticities (stage 2)

Assuming an exogenous wage in both countries (which is assumed to be identical in both countries), the location equilibrium $\lambda^{rr}$ does not depend on the labor cost as the labor markets are neutral to the spatial distribution of capital. The equilibrium allocation of capital is expressed as follows:

$$\lambda^{rr} = \frac{1}{2} \frac{1 + n}{(1 + n)(t_H - t_F)} \frac{1 + n}{4nl^2}$$

(21)

The resulting tax base elasticity in country $H$ is given by:

$$\varepsilon_H^{rr}(\tau) = -\frac{\partial \lambda^{rr}}{\partial t_H} \frac{t_H}{\lambda^{rr}} = \frac{1 + n}{2nl^2} \frac{(1 + n)t_H}{(1 + n)(t_H - t_F)}$$

and a symmetric expression holds for the tax base elasticity in country $F$. As in the benchmark case with competitive labor markets, a unilateral increase in the capital tax yields a capital outflow and the tax base elasticity of capital is magnified by trade integration ($d\varepsilon_i^{rr}(\tau)/d\tau < 0$). However, the tax base elasticity is higher when both countries adopt $\omega$ as the exogenous wage:

$$\varepsilon_i^{rr}(\tau) > \varepsilon_i^{cc}(\tau) \forall i = H, F.$$ 

Indeed, the positive impact of agglomeration on the labor cost under a flexible labor market disappears with a rigid wage, as does the resulting dispersion force.

4.2 Nash tax policies (stage 1)

Recall that the exogenous wage is supposed to be higher than the competitive wage at the free market equilibrium, so that $\omega > \overline{w}$. Each government is now faced with two categories of households depending on their position in the labor market (employed or unemployed). The labor tax is levied exclusively on employed residents and each national
government provides benefits $b$ to unemployed residents. As a result, for a fixed wage rate $\omega$, the governments’ budget constraint amounts to:

$$t_i \lambda_i^{rr} n + \rho_i l_i^e = b_i(l - l_i^e)$$  \hspace{1cm} (22)$$

where $l_i^e = L_i^d / L_i^s = \eta f \lambda_i^{rr} n / \omega$. This yields to well-known and intuitive relationships as unemployment increases with the wage rigidity and decreases with the number of firms, the fixed requirement of labor and the preference for leisure. With (22) and after rearrangements, the objective function of each government is given as:

$$W_i^{rr} = l S_i^* + \frac{r^* n}{2} + \frac{\omega^2}{2\eta} l_i^e + t_i \lambda_i^{rr} n + \text{constant}$$  \hspace{1cm} (23)$$

where $\omega^2 / 2\eta$ represents the labor income net of the disutility from labor. The first-order condition for each country is now given by:

$$l \frac{\partial S_i^*}{\partial p_i^*} \frac{\partial p_i^*}{\partial \lambda_i^{rr}} \frac{\partial \lambda_i^{rr}}{\partial t_i} + \left( \frac{\partial \Pi_i^*}{\partial p_i^*} \frac{\partial \lambda_i^{rr}}{\partial t_i} - 1 \right) + \lambda_i^{rr} n(1 - \varepsilon_i^{rr}) + \frac{\omega f n \partial \lambda_i^{rr}}{2} \frac{\partial \lambda_i^{rr}}{\partial t_i} = 0$$

The introduction of a wage rigidity results in three changes in the first-order condition. First, the introduction of an exogenous wage implies that the tax policy is no more an instrument with which government can modify the wage rate. Second, the government can affect the number of employed people $l_i^e$, which is an increasing function of the share of capital located in its country $\lambda_i^{rr}$. Third, capital location reacts differently to an identical change in capital tax rate. We have $0 > \partial \lambda_i^{cc} / \partial t_i > \partial \lambda_i^{rr} / \partial t_i$ because wages do not adjust in response to a change in tax rates with a rigid labor market. Hence, the labor market rigidity strengthens the consumers’ surplus effect and the incentive to set low levels of capital tax. In contrast, a fixed wage amplifies the incentive to set high taxes to moderate the price competition effect and increase the operating profits. Finally, a fixed wage has an ambiguous effect on the impact of tax rate on tax revenues because, for a given $t_i$, we know that $\lambda_i^{rr} > \lambda_i^{cc}$ while $\varepsilon_i^{rr} > \varepsilon_i^{cc}$ is checked for all tax rates.

By maximizing (23) with respect to $t_i$, we get the following Nash tax equilibrium in each country:

$$t_i^{rr} = t_i^{cc} - \omega f / 2 \equiv t_i^{rr}$$

Clearly, the equilibrium capital tax is lower when labor markets are regulated through an exogenously fixed wage than when labor markets are competitive, regardless of the level of trade costs. Recall that for a flexible wage setting, the capital inflow arising from decreasing capital tax burden raises the equilibrium wage rate. This effect does not occur for fixed wage rates. Thus, capital being more responsive to the taxation policy, tax
competition is strengthened when labor markets exhibit rigidities \( t^{rr} < t^{cc} \). Note also that \( t^{rr} \) and \( t^{cc} \) react identically to a change in trade costs. Hence, the existence of a fixed wage implies that the configuration where workers become the net-contributors of the public sector emerges earlier in the process of trade integration.

To sum up:

**Proposition 2** *The existence of a rigid wage rate in both countries strengthens capital tax competition.***

5 Union and tax interactions

We now consider that the wage rate is fixed by a monopoly union in each country instead of being exogenous. Such a strategy allows us to take into account the fact that a change in trade costs may indirectly affect wages through its impact on monopoly unions preferences. Because our model is now a fourth-stage game, we begin to solve the game by assuming that unions act as Stackelberg leaders. The case where governments and unions play simultaneously gives rise to qualitatively similar results and is reported in the appendix.

To complete our analysis, a third scenario where governments are Stackelberg leaders is briefly presented in section 7. We will see that the main results are unaltered when the sequences are changed.

5.1 Trade unions as Stackelberg leaders

Let \( \lambda^{uu} \) denote the share of capital located in country \( H \) when both labor markets are unionized. The choice of capital location is made for given level of wages chosen by unions \((w^{u}_i)\) and given corporate taxes in each country. Thus, the location equilibrium \( \lambda^{uu} \) arises when \( \Pi^*_H(\lambda^{uu}) - t_H - f w^u_H = \Pi^*_F(\lambda^{uu}) - t_F - f w^u_F \). Solving this equality with respect to \( \lambda^{uu} \) yields the following location equilibrium:

\[
\lambda^{uu}(t_i, w^u_i) = \frac{1}{2} - \frac{(1 + n)[f (w^u_H - w^u_F) + t_H - t_F]}{4l\tau^2n}.
\] (24)

From this expression, we can deduce the tax base elasticity for capital invested in country \( H \):

\[
\varepsilon^{uu}_H(\tau) = -\frac{\partial \lambda^{uu}}{\partial t_H} \frac{t_H}{\lambda^{uu}} = \frac{t_H (n + 1)}{2ln\tau^2 - (n + 1) (t_H - t_F) - f (w^u_H - w^u_F) (n + 1)}
\]

and a symmetric expression holds for the tax base elasticity in country \( F \). Here again, trade integration leads capital location to become more sensitive to a change in tax wedge \((d\varepsilon^{uu}_i/d\tau < 0)\).
5.1.1 Nash tax policies (stage 2)

The welfare function of country \( i \) is similar to (23) and given by:

\[
W_u^i = lS^*_i + \frac{r^* n}{2} + t_i n \lambda_{uu}^i + \frac{1}{2} \frac{(w_u^i)^2}{\eta} l_i^c + \text{constant} \tag{25}
\]

where \( \lambda_{uu}^i \) is given by equation (24). At this stage, the wage rate is exogenous and the governments do not have the power to affect the spatial distribution of capital by indirectly changing the wage claims of the domestic union. Nevertheless, the tax policy will have a direct effect on the spatial distribution of capital and then on the number of workers employed \( l_i^c \). By maximizing (25) with respect to \( t_i \) for each government, we get the following Nash tax equilibrium:

\[
t_i^u = t_{cc} + f \left[ \frac{w^u_j (2n + 3) - w^u_i (10n + 13)}{4 (4n + 5)} \right] \tag{26}
\]

with \( j \neq i \). Several comments are in order. First, for given wages, the tax rate in each country reacts to a change in trade costs in exactly the same way as when both labor markets are competitive (\( dt_i / d \tau \geq 0 \) when \( \tau \geq \tilde{\tau} / 2, \forall i = H, F \)). Secondly, observe that the tax rate in a country decreases with the national wage rate and increases with the wage rate of its trading partner (\( dt_i^u / dw_i^u < 0 \) and \( dt_i^u / dw_j^u > 0 \)). Thus, the intensity of tax competition is tightly related with the labor market outcome and this preliminary result illustrates the possibility to use taxation to compensate firms for high labor costs.

5.1.2 Equilibrium wage rates (stage 1)

Having described the optimal choice of tax rates by governments, we can solve the maximization program of monopoly unions to define the equilibrium wage rate in each country. Each labor union set non-cooperatively \( w_i^u \) to maximize (6) with \( L_i^d = f n \lambda_{uu}^i (w_i^u, w_j^u) \) by anticipating capital location and the tax choices of governments. Hence, in stage 1, the location of capital is now given by:

\[
\lambda_{uu}^i (t_{i}^*, w_i^u) = \frac{1}{2} - \frac{(w_H^u - w_F^u) (1 + n)^2 f}{4 (4n + 5) \tau^2 n} \tag{27}
\]

where we have introduced (26) in (24).

Let us first have a look at the resulting labor demand schedule and its sensitivity to trade integration. Inserting this location equilibrium in the national labor demand function \( L_i^d \), we can verify that a high wage reduces labor demand (\( dL_i^d / dw_i^u < 0 \)). Nevertheless, observe that the response of the labor demand to wages is the result of two opposite forces.
First, high wages have a standard negative effect in terms of attractiveness, which shifts downward the labor demand. Secondly, monopoly unions anticipate that high wages will lead the government to set low tax rates on capital (26). This will counteract the negative impact of the high wage claims of the domestic union on capital location. Specifically, the labor demand elasticity with respect to the wage rate in country $i$ is expressed as follows:

$$\xi_i = \frac{dL_i^d w_i^u}{dw_i^u} = \frac{w_i^u f (1 + n)^2}{2ln\tau^2 (4n + 5) - f (1 + n)^2 (w_i^u - w_j^u)}$$

with $\xi_i > 0$ at the symmetric equilibrium. Observe that $\xi_i$ decreases with $\tau$. In other words, trade integration increases the labor demand elasticity. Interestingly, this result illustrates Rodrik’s intuition that “trade increases the degree to which employers can react to changes in prevailing wages by outsourcing or investing abroad” (Rodrik, 1997, p. 12-13).

Now, we can describe the trade-off for monopoly unions. While choosing higher wages increases workers’ gross income, it reduces labor demand and leads more people to become unemployed. The total effect of a wage increase on the wage bill depends on the relative strength of each effect. Inserting the labor demand function in the monopoly union’s objective function and maximizing the corresponding expression with respect to $w_i^u$, we get the following first-order condition for each country:

$$w_i^u = \mu w_j^u + (1 - \mu)\bar{w} + \mu \frac{2l\tau^2 n (4n + 5)}{f (n + 1)^2}$$

As a consequence, the equilibrium wage rates are given by:

$$w_{i H}^{u*} = w_{i F}^{u*} = \bar{w} + \frac{\mu}{1 - \mu} \frac{2l\tau^2 n (4n + 5)}{(n + 1)^2 f}$$ (28)

Interestingly, the wage rate decreases with trade integration ($dw_i^{u*}/d\tau > 0$ and $d^2 w_i^{u*}/d\tau^2 > 0$). By increasing the labor demand elasticity to the wage rate, trade integration forces trade unions to lower the wage rates in order to reduce the negative effect of a high wage on the labor demand and the resulting level of employment. This result is the opposite of Naylor’s one (1998), according to which wages increase with trade integration when the spatial distribution of firms is exogenous. Thus, ignoring the fact that high wages might deter investments, Naylor’s model cannot capture the effect of trade costs on the aggregate labor demand elasticity. The only channel through which trade costs affect labor demand comes from the positive impact of a decline in trade costs on total output and employment.

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13 At these levels of equilibrium wages, the second-order condition is checked.
of each firm. By contrast, in our model with capital mobility, trade integration increases the tax base elasticity and, in fine, raises the labor demand elasticity.

**Proposition 3** Assume monopoly unions in each country playing as Stackelberg lead-
ers. Under tax competition with capital mobility, the equilibrium wage rate set by unions decreases with trade integration.

Having determined the equilibrium level of wages in each country, we can evaluate the capital taxes at the subgame Nash perfect equilibrium (SNPE). By introducing (28) in (26), we get:

\[
t_{i}^{uu} = t^{cc} - \frac{f \bar{w}}{2} - \frac{\mu}{1 - \mu} \frac{t^{2} n (5 + 4n)}{(1 + n)^2} \equiv t^{uu}
\]

with \(t^{uu} < t^{cc}\). Clearly, the fact that trade unions set a wage rate above the competitive level requires a more aggressive tax policy to compensate for capital income losses. As expected, the higher the importance attached to the wage in the union’s objective function, the lower the level of capital tax \(dt^{uu}/d\mu < 0\).

How do capital taxes at the SNPE react to trade integration under this scenario where unions can affect tax policies? Some calculations reveal that the equilibrium level of capital tax rate increases with trade integration provided that the relative importance of wages over employment for the trade union is high enough. Indeed, we have:

\[
d\frac{t^{uu}}{d\tau} < 0 \text{ iff } \frac{\mu}{1 - \mu} > \frac{(2n + 3)(\tau - \bar{\tau}/2)}{2 (4n + 5) \tau}
\]

Hence, when \(\tau < \bar{\tau}/2\), both \(t^{cc}\) and \(t_{i}^{uu}\) are always increasing with trade integration. However, when \(\tau > \bar{\tau}/2\), a fall in trade costs decreases \(t^{cc}\) but raises \(t^{uu}\) if and only if \(\mu\) is high enough. The latter relationship arises for the following reason. The third term in (29) captures the negative effect of the wage set by unions on the corporate tax, and this effect is magnified with high levels of \(\mu\). Thus, provided that \(\mu\) is high enough, the erosion of this negative wage effect on taxation due to trade integration counterbalances the opposite direct effect on \(t^{cc}\). Hence, contrary to the configuration with a competitive wage, trade integration always relaxes tax competition when \(\mu\) is high enough. When the importance attached to the employment in the union’s objective function is relatively high, wages tend to be closer to the reference wage rate (\(\bar{w}\)) so that the magnitude of the changes in wages is lower. Thus, the subgame Nash tax equilibrium is less dependent on the labor market outcome and increases with trade costs.

To summarize:
Proposition 4 Assume monopoly unions in each country both playing as Stackelberg leaders. When trade costs are above $\bar{\tau}/2$, trade openness relaxes tax competition, provided that the relative importance of wages over employment for unions is high enough. Once trade costs decline below $\bar{\tau}/2$, trade integration relaxes capital tax competition, regardless of the relative importance of wages over employment for unions.

Consequently, this proposition suggests that when trade unions have a high enough preference for wage, trade integration can lead to higher corporate taxes whatever the initial level of trade barriers between the trading partners. We show in the Appendix that the main results described in proposition 3 and 4 hold when governments and unions act simultaneously.

To complete our analysis, we briefly investigate the level of unemployment and the labor tax at the SNPE. With the assumption that the reference wage $\bar{w}$ is equal to the competitive wage at the free market equilibrium, the number of unemployed people in each country is given by:

$$l_{i}^{u*} = \frac{4\lambda l^2 \mu (4n + 5) \bar{\tau}^2}{\tau^2 4\lambda^2 \mu (4n + 5) + f^2 (n + 1)^2 (1 - \mu)} > 0$$  \hspace{1cm} (30)

It is worth noting that as trade integration results in a lower wage set by the union, it also reduces unemployment in the economy ($d l_{i}^{u*} / d \tau > 0$). Turning to the impact of a trade cost reduction on the level of the labor tax is a more complex task. From the budget constraint (22), the labor tax in country $i$ is given by:

$$\rho_i = \frac{bl_{i}^{u*} - t_{i}^{uu} n_{i}}{l_{i}^{e}}$$  \hspace{1cm} (31)

Clearly, reduced trade costs may have an ambiguous effect on the labor tax at the SNPE. By expanding the tax base ($l_{i}^{e}$) and reducing the budget share going to unemployment benefits ($b_{i}l_{i}^{u}$), trade integration would result in a lower tax burden on labor. Nevertheless, the net effect also depends on the impact of trade costs on $t_{i}^{uu}$, the spatial distribution of capital being equal among countries at the SNPE ($n_{i} = 1/2$). As corollary of Proposition 4, below the threshold level ($\bar{\tau}/2$), the labor tax unambiguously decreases with trade integration. Above this threshold level, $\rho_i$ may decrease with trade liberalization provided that the wage claims are high enough to give rise to a positive relationship between capital tax and trade integration. Finally, it is straightforward to check that trade integration effects passing through $b_{i}l_{i}^{u}$ and $l_{i}^{e}$ are weakened when $\mu$ tends to zero, as the labor market tends to a flexible wage setting.
6 Difference in labor market institutions

Countries can be very different with respect to their labor market institutions, and these differences could partly explain the differences in labor market performance across countries (Blanchard and Wolfers, 2000). In this section, we keep the assumption that monopoly unions are Stackelberg leaders but we analyze tax competition between countries that differ with respect to their labor market institutions. More precisely, we investigate the tax competition outcome between a country with a competitive labor market and a country in which the wage rate is set by a monopoly union.

6.1 Capital location and tax base elasticities (stage 3)

Assume that the national wage in country $F$ is fixed by a monopoly union while there is no labor market imperfections in the other country. The spatial equilibrium $\lambda^{cu}$ is achieved when $\Pi^*_H(\lambda^{cu}) - t_H - f w^u_H(\lambda^{cu}) = \Pi^*_F(\lambda^{iu}) - t_F - f w^u_F$. The resulting location equilibrium is:

$$\lambda^{cu} = \frac{2l\tau^2 n + w^u_F f (1 + n) - (1 + n)(t_H - t_F)}{4nl\tau^2 + f^2\eta (1 + n) n/l}.$$  \hspace{1cm} (32)

It is not surprising that, as long as the wage rate chosen by the monopoly union in country $F$ is higher than the value of the competitive wage and for given taxes, the other country (country $H$) hosts more capital/firms than in the symmetric configuration ($\lambda^{cu} > \lambda^{cc}$).

The tax base elasticities to a change in tax rates in country $H$ and $F$ are expressed as follows:

$$\varepsilon^{cu}_H(\tau) = -\frac{\partial \lambda^{cu}}{\partial t_H} = \frac{(1 + n) t_H}{2l\tau^2 n + w^u_F f (1 + n) - (1 + n)(t_H - t_F)}$$

$$\varepsilon^{cu}_F(\tau) = -\frac{\partial (1 - \lambda^{cu})}{\partial t_F} \frac{t_F}{1 - \lambda^{cu}} = \frac{(1 + n) t_F}{2l\tau^2 n + f (1 + n)(f\eta n/l - w^u_F) + (1 + n)(t_H - t_F)}.$$  \hspace{1cm} (33)

For each country, we compare its tax base elasticity in the asymmetric configuration with the tax base elasticity that would result if both countries adopted a free labor market institution. Some standard calculations show

$$\varepsilon^{cu}_F > \varepsilon^{cc}_F$$

$$\varepsilon^{cu}_H \leq \varepsilon^{cc}_H \text{ iff } w^u_F \geq 2\bar{w}.$$  \hspace{1cm} (34)

Regarding the unionized country, it appears that its tax base elasticity is always higher than if there were no labor market imperfections as in its trading partner. Indeed, following a marginal tax increase in the unionized country, the wage does not shift downward
due to the capital outflow, contrary to what happens with a flexible wage setting. Consequently, the capital location is more sensitive to a change in tax rate.

It is also worth stressing that tax base elasticity in country $H$ reaches lower values when country $F$ is the single country to move from a free labor market to an unionized labor market, provided that the wage set by union is high enough compared to the reference wage rate ($w^u_F > 2\tilde{w}$). For $w^u_F > 2\tilde{w}$, capital invested in country $H$ has a weak incentive to relocate in country $F$ when the former country raises its tax rate because of high wage costs in the latter country.

6.2 Nash tax equilibrium (stage 2)

We now describe the Nash tax equilibrium. As the labor market legislation differs between countries, each national government has a different objective function and a different budget constraint. The objective function of country $H$ is given by (18), whereas the objective function of the government of country $F$, which has to deal with unemployment, is given by (23), except that the spatial equilibrium is now given by (32).

Solving the first-order condition for each government, we get the following Nash tax equilibrium:

$$t^c_{iu} = t^c_{cc} + \Omega_i (w^u_F, \tau)$$

with

$$\Omega_H (w^u_F, \tau) \equiv \frac{(2n + 3)(w^u_F l - \eta f n)f l}{4f^2 l^2 (4n + 5) + \eta (1 + n)^2 / \tau^2}$$

$$\Omega_F (w^u_F, \tau) \equiv \frac{\eta (1 + n)^2 f^2 (\eta n f - 3lw^u_F) + l^2 \tau^2 [(2n + 3) \eta n f - (10n + 13) lw^u_F]}{4l [\eta f (1 + n)^2 + l^2 \tau^2 (4n + 5) / f]} < 0.$$ 

It appears that $t^c_{iu} < t^c_{cc}$ (because $w^u_F$ is higher than the reference wage rate as long as $\mu > 0$) whereas $t^c_{iu} > t^c_{cc}$ if and only if $w^u_F > 2\tilde{w}$. In other words, a shift from a flexible labor market to a unionized labor market in a single country (here country $F$) lowers the capital tax rate in this country. This result arises from the higher tax base elasticity in the latter labor market regime (see (33)). In contrast, tax pressure on capital raises in the country keeping a flexible labor market, provided that the union wage in its trading partner is high enough. Indeed, in this case, the tax base elasticity reaches lower values in country $H$ allowing its government to set higher tax pressure on capital (see (34)).

In addition, it easy to check that

$$t^c_{iu} - t^c_{iu} \equiv \Delta > 0$$
if and only if \( w^u_F > \bar{w} \). Because this latter inequality holds, the existence of trade unions in a country enables its trading partner to set a higher capital tax rate. Moreover, it is easy to check that an increasing wage set by the union in country \( F \) induces a higher tax wedge. Indeed, the labor cost disadvantage being higher in country \( F \), its government has to decide on a tax cut to maintain capital while country \( H \) can increase the tax burden on capital. In addition, for a given wage in country \( F \) \( (w^u_F) \), it is straightforward to check that \( \partial \Delta / \partial \tau > 0 \) if and only if \( w^u_F > 2\bar{w} \). Hence, trade integration favors a lower tax wedge when the wage set by the union is not too low.

Finally, we know that an increase in \( w^u_F \) positively affects the capital tax rate in country \( H \) and negatively the tax rate prevailing in the other country. Hence, if an increase in \( w^u_F \) favors the location of capital in country \( H \), that also magnifies the tax wedge and thus favors the location of capital in country \( F \). Thus, the effect of the wage set by the monopoly union on the international allocation of capital is ambiguous. At Nash equilibrium tax rates, we get the following location equilibrium:

\[
\lambda^{cu} = \frac{1}{2} + \frac{f (n + 1)^2 (lw^u_F - nf\eta)}{4n[f^2\eta(1 + n)^2 + l^2\tau^2 (4n + 5)]}
\]

revealing that an increase in \( w^u_F \) favors the location of capital in the country without wage rigidities. In addition, it is worth stressing that \( \lambda^{cu} > 1/2 \) if and only if \( w^u_F > 2\bar{w} \). Hence, the country having labor market rigidities can accommodate the majority of capital provided that the wage set by the union is not too high.

### 6.3 Equilibrium wage rate (stage 1)

We now solve the first stage of the game. By inserting (36) in the labor demand schedule and by maximizing the union’s objective function with respect to \( w^u_F \), we get the following equilibrium wage rate in the unionized country:

\[
w^u_F = \bar{w} + \mu \left( \frac{3f\eta n}{l} - \bar{w} \right) + \mu \frac{2l\tau^2 n (4n + 5)}{(1 + n)^2 f}
\]

which is increasing with the relative importance of wages over employment for the union \( (dw^u_F/d\mu > 0) \) and trade costs \( (dw^u_F/d\tau > 0) \). By introducing (37) in (35), it appears that the impact of trade costs on the capital tax rates is ambiguous. Indeed, we have

\[
(a) \frac{d\tau_H}{d\tau} = \frac{d\tau}{d\tau} + \frac{d\Omega_H(w^u_F, \tau)}{d\tau} \quad (b) \frac{d\tau_F}{d\tau} = \frac{d\tau}{d\tau} + \frac{d\Omega_F(w^u_F, \tau)}{d\tau}
\]

Recall that the first term in (38-a) and (38-b) is not affected by wage rigidities in country \( F \) and describes a non-monotonous relationship between the level of taxation and trade
costs (see Section 3.3). The second term defines an additional effect of trade integration passing through the labor market in country $F$. It is easy to check that $\Omega_F$ decreases with $\tau$. This effect reveals the negative impact of trade integration on the wage claim of the union in the unionized country and, in turn, induces an incentive to increase capital tax burden in this country. Concerning the sign of the total effect of trade openness on capital tax rate in the unionized country, it is easy to verify that \textit{trade openness increases the corporate tax rate in the unionized country} provided that trade costs are low enough ($\tau < \tilde{\tau}/2$) or, otherwise, that the union sufficiently values wages over employment. For example, when the union has an equal preference for wage and employment ($\mu = 1/2$), the capital tax rate prevailing in country $F$ always increases with trade integration.\footnote{The proof is available upon request.}

The effect of trade integration on tax burden on capital located in the non-unionized country differs. Indeed, as trade integration gives rise to a fall in the labor cost in the unionized country, the government of country $H$ has an incentive to adjust its taxation downward ($\left(\partial \Omega_H / \partial w^u_F \right) \left(\partial w^u_F / \partial \tau \right) > 0$). Some trivial calculations reveal that the trade costs effect on capital taxation is more likely to be positive when $\mu$ reaches high values. In the other words, \textit{trade openness may lower the corporate tax rate in the non-unionized country}, provided that preferences on wages over employment are high enough.

The impact of trade costs on the tax wedge can be described as follows:

$$\frac{d\Delta}{d\tau} = \frac{d\Omega_H}{d\tau} - \frac{d\Omega_F}{d\tau}$$

Trivial calculations show that $d\Delta/d\tau \geq 0$ when $\mu \geq \hat{\mu}$ with:

$$\hat{\mu} = \frac{(1 + n)^4 \, \eta^2 \, f^4}{f^4 \, (48n + 65) \, (1 + n)^4 \, \eta^2 + 16l^2 \tau^2 \, (3n + 4) \, (4n + 5) \, [2f^2 \eta (1 + n)^2 + l^2 \tau^2 (4n + 5)]}$$

where $\hat{\mu}$ is strictly decreasing with $\tau$ and equals $1/(65 + 48n)$ when trade integration is perfect ($\tau = 0$). Consequently, for a very large range of $\mu$ values, trade integration induces a fall in the international corporate tax wedge.

We now turn to the location of firms at the SNPE. One key question we have to address is whether country $F$ can be a net-importer of capital or host a majority of firms despite its labor market rigidities. By inserting the equilibrium level of $w^u_F$ in the location equilibrium (36), we get

$$\chi^{cu} = \frac{1}{2} + \frac{1}{8} \frac{\eta (n + 1)^2 (5\mu - 1) f^2 + 4\mu l^2 (4n + 5) \tau^2}{\eta (n + 1)^2 \, f^2 + l^2 \tau^2 \, (4n + 5)} \geq \frac{1}{2}.$$
when \( \mu \geq \bar{\mu} \) with

\[
\bar{\mu} = \frac{\eta f^2 (n + 1)^2}{4l^2 \tau^2 (5 + 4n) + 5f^2 \eta (n + 1)^2} < \frac{1}{2}
\]

Clearly, the country with labor market rigidities can host a higher share of firms (\( \lambda^{cu} < 1/2 \)). Such a scenario occurs when the relative importance of wages over employment for the trade union is not too high (low \( \mu \)). Otherwise, the tax advantage of country \( F \) does not compensate its labor cost disadvantage and the country with a free labor market attracts the majority of firms. Indeed, the equilibrium wage rate in country \( H \) at the SNPE verifies:

\[
w^*_H = \frac{fn\eta (n + 1)^2 (8\mu + 3)f^2 + 4l^2 \tau^2 (2\mu + 1)(5 + 4n)}{[f^2 \eta (n + 1)^2 + l^2 \tau^2 (5 + 4n)](1 + \mu)} < w^*_F.
\]

Finally, observe that the mass of capital in the country with a free labor market is decreasing with trade integration (\( d\lambda^{cu}/dt > 0 \)). This result comes from the different impact of trade integration on wages in each country. Indeed, the competitive wage in country \( H \) is decreasing with trade integration but less strongly than the wage in the unionized country (\( d(w^*_F - w^*_H)/dt > 0 \)) so that trade integration induces a wage convergence. Hence, on the one hand trade integration reduces ‘fiscal’ incentives to locate in the unionized country and, on the other hand, the ‘labor cost’ incentive to locate in the country with a competitive labor market. As the mass of capital invested in country \( H \) is decreasing with trade integration, we can conclude that the second effect dominates.

**Proposition 5** Assume a monopoly union in a country while the labor market of the other country is competitive. The unionized country sets a lower corporate tax and attracts a higher share of capital provided that the relative importance of wages over employment for the monopoly union is not too high. The mass of capital invested in this country increases with trade integration.

In the Appendix, we show that results hold when governments and unions act simultaneously.

### 7 Governments act as Stackelberg leaders

We now describe the tax competition outcome when governments act as Stackelberg leaders, as in Palokangas (1989) and Fuest and Huber (1999). Thus, we consider that in the first stage, each government chooses its tax policy by anticipating the wage set by unions and the location of capital. In the second stage, each monopoly union chooses its
level of wage, taking as given governments’ tax policies, and anticipating the impact of their choice on the location of capital. The following stages of the game are unchanged. We show that this change in the sequence of events only affects our Proposition 4 for trivial reasons. Propositions 3 and 5 still hold.

7.1 Symmetric case

We first present the results when both labor markets are unionized. The product market outcome at the fourth stage of the game is described in section 3.1.1. while the location equilibrium for given taxes and wages is given by (26). We now solve the second stage of the game where monopoly unions set their level of wages, taking as given tax choices of governments and anticipating the resulting private sector outcome.

The monopoly union in country $i$ determines $w_i^u$ to maximize $U_i = (w_i^u - \bar{w})^\mu (L_i^d)^{1-\mu}$ with $L_i^d = f n \lambda_i^{uu}$, taking as given $w_j^u$ as well as $t_i$ and $t_j$. The fact that the government acts as a Stackelberg leader changes the trade-off the monopoly union is faced with since the labor demand elasticity to the wage rate becomes sensitive to the taxes. More precisely, we have:

$$\xi_i = \frac{f (1 + n) w_i^u}{2n l^2 + (1 + n) (f w_j^u - f w_i^u + t_j - t_i)}$$

with $d\xi_i/d\tau < 0$, $d\xi_i/dt_i > 0$ and $d\xi_i/dt_j < 0$. Thus, the labor demand elasticity in a country increases with its capital tax. As a consequence, the higher the capital tax, the more the trade union will tend to lower the wage rate in order to limit the negative impact of its intervention on the level of employment.

Solving the union’s maximization program for each country leads to the following equilibrium wages:

$$w_i^{u*} = \bar{w} + \frac{\mu}{1 - \mu} \frac{2n l^2}{f (1 + n)} + \frac{\mu}{1 + \mu} \frac{t_j - t_i}{f}$$

As expected, the level of wage chosen by a monopoly union in a country is decreasing with the capital tax rate in this country and increasing with the capital tax rate in the other country.

We can now solve the maximization program of each government:

$$W_i^u = L S_i^* + \frac{r^* n}{2} + t_i n \lambda_i^{uu} + \frac{1}{2} \left(\frac{w_i^{u*}}{\eta}\right)^2 l_i^e + \text{constant}.$$
the equilibrium wage rate and to reduce the unemployment rate through a capital inflow. On the other hand, each government has also an additional incentive to increase capital taxation in order to reduce the unemployment rate through the decline in the wage set by union. The tax reaction function of each country is given by

$$t_i = \frac{2}{6} (1 + \mu) n + 3 + \mu + 5\mu t_j + \Phi(\mu, \tau)$$

These functions reveal that the impact of $t_j$ on $t_i$ is positive and is negatively affected by $\mu$. However, because $\mu$ is identical in both countries and enters symmetrically into the tax reaction functions, we get the following tax equilibrium

$$t_{H}^{uu} = t_{F}^{uu} = t^{cc} - \bar{w}f/2 < t^{cc}$$

which are not related to $\mu$. Hence, the fact that the governments act as Stackelberg leaders does not alter our main result when the countries are symmetric: labor market rigidities strengthen tax competition. It should also be noted that the equilibrium taxes follow a U-shaped relationship with trade integration ($d t_{H}^{uu} / d \tau \geq 0$ when $\tau \geq \tau/2$), as when labor markets are competitive. This result is very intuitive. Since the tax equilibrium does not depend on the unions’ wage claim, trade integration does not have a positive indirect effect on capital taxation through the wage rate set by unions. No forces affect the U-shaped relationship also obtained with flexible labor markets. Such a result differs from the case where the union is the first mover. Nevertheless, observe that when monopoly unions have different preferences for wages over employment ($\mu_H \neq \mu_F$), the tax reaction functions are no longer perfectly symmetric and both preferences matter for the level of the tax equilibrium. In this case, trade integration affects capital taxes through its effect on the labor market outcome that governments anticipate.

Secondly, the equilibrium taxes are higher than when monopoly unions act as Stackelberg leaders (see 29). Indeed, the tax base elasticity is lower when governments act as Stackelberg leaders because, in this case, the tax base erosion effect is limited by the fact that an increase in capital taxation is partly compensated by the decrease in the wage rate set by monopoly unions. By contrast, when governments set their tax policy after trade unions have decided the level of wages, this wage adjustment does not exist so that an increase in capital taxation induces a more important capital outflow.

Finally, inserting these equilibrium taxes (40) in (39), we get the equilibrium wage rate.
rate in each country at the SPNE:

\[ w_i^{uu} = \bar{w} + \frac{\mu}{1 - \mu} \frac{2ln\tau^2}{f (1 + n)} \]

Since governments set higher taxes when they act as Stackelberg leaders, the equilibrium wage set by monopoly unions at the following stage is lower than its level when they take their decision before governments. Moreover, \( w_i^{uu} \) decreases with trade integration and Proposition 3 still holds.

### 7.2 Asymmetric case

We now present the result for the asymmetric configuration where the labor market is competitive in country \( H \) while it is unionized in country \( F \). The product market outcome at the fourth stage of the game is described in Section 3.1.1. We now solve the second stage of the game where the monopoly union in country \( F \) chooses the level of the national wage, taking as given tax choices of governments and anticipating the resulting private sector outcome.

The monopoly union in country \( F \) set \( w_F^u \) to maximize \( U_F = (w_F^u - \bar{w})^\mu (L_F^d)^{1-\mu} \) with \( L_F^d = fn (1 - \lambda^{cu}) \) where \( \lambda^{cu} (t_H, t_F, w_F^u) \) given by (32). Solving this maximization program, we get:

\[ w_F^u = (1 - \mu) \bar{w} - \mu \frac{l (1 + n) (t_F - t_H) - n (2l^2\tau^2 + f^2\eta (1 + n))}{lf (1 + n)} \]  \hspace{1cm} (42)

Replacing \( \bar{w} \) by its expression (20) and solving the maximization program of governments, we get the following equilibrium tax gap:

\[ t_H - t_F = \frac{n[f^2\eta (1 + n) + 4l^2\tau^2] \eta (1 + \mu) (1 + n)^2 f^2 + 4l^2\mu\tau^2 (2n + 3 - \mu)}{8 (1 + n) l^{1}} \frac{\eta (1 + \mu) (1 + n)^2 f^2 + 4l^2\mu\tau^2 (2n + 3 - \mu)}{(1 - \mu)[\eta (1 + n)^2 f^2 + l^2\tau^2 (4n + 5 - \mu)]} > 0. \]

Hence, we can now describe the location equilibrium at the SPNE:

\[ \lambda^{cu} = \frac{13\eta (1 + n)^2 (1 + \mu) f^2 + 4l^2\tau^2 [6\mu (1 + n) + (5 + 4n)(1 - \mu)]}{8 \eta (1 + n)^2 f^2 + l^2\tau^2 (4n + 5 - \mu)} \geq \frac{1}{2} \]

when \( \mu \geq \tilde{\mu} \) with

\[ \tilde{\mu} \equiv \frac{f^2\eta (1 + n)}{3f^2\eta (1 + n) + 8l^2\tau^2} > \tilde{\mu} \]

Evaluating the competitive wage in country \( H \) at this location equilibrium, we get:

\[ u_H^* = \frac{nf\eta 4l^2 (2n\mu + 4n + 5 - \mu) \tau^2 + 3f^2\eta (1 + n)^2 (1 - \mu)}{l^2 (4n + 5 - \mu) \tau^2 + f^2\eta (1 + n)^2} < w_F^u. \]
As in the benchmark case, the competitive wage is lower than the level of wage set by monopoly union in country $F$. Moreover, we observe that it is lower than when the monopoly union in country $F$ acts as a Stackelberg leader.

To conclude, as in the benchmark case, the country with a flexible labor market sets a higher capital tax rate and attracts a higher share of capital provided that the relative importance of wages over employment for the trade union is not too low. We also check that trade integration induces a relocation of capital toward the unionized country ($\frac{d\lambda_{cu}}{d\tau} > 0$). Hence, Proposition 5 still holds.

8 Conclusion

Unemployment might be one of the major reasons why governments try to attract firms through their tax policy. In this paper, we have explored the relationship between labor market imperfections and tax competition in a framework with imperfect competition and trade costs. Our results can be summarized as follows. Firstly, we show that labor market imperfections in both countries strengthen tax competition as compared with the case where both labor markets are competitive. Secondly, the impact of trade integration on tax policies depends on the configuration of the labor market. When the labor market is competitive or regulated through an exogenous wage in both countries, capital tax rates follow a U-shaped relationship with trade costs. By contrast, when labor markets are unionized, capital taxes can increase with trade integration whatever the level of trade cost and provided that preferences of union for wage over employment is high enough. This result holds when trade unions act as Stackelberg leaders and when trade unions and governments act simultaneously. We also analyze the tax competition outcome in the asymmetric case where the labor market is competitive in one country and unionized in the other one. We show that the capital tax rate is lower in the unionized country and that a majority of capital can locate there.

Of course, this model is stylized and ignores important aspects of the wage formation process. It would be interesting to model wage bargaining in a more general case where both unions and firms have bargaining power. Moreover, a welfare analysis is needed in order to know if tax competition is welfare-enhancing or not in presence of labor market imperfections. This welfare analysis is left for further work.

Finally, although our paper is motivated by empirical facts reported in the introduction, an econometric analysis is needed to support our main findings More precisely, by following the literature on tax interactions (Devereux et al., 2008), a tax reaction function
could be estimated. It would consist of regressing corporate taxes on indicators of trade openness, labor market rigidities and on the interaction of these two variables.

References


Appendix

Let assume that governments and unions act simultaneously. Thus, each government and each union chooses its policy by anticipating the location of capital.

**Countries are identical.** We first present the results when both labor markets are unionized. The product market outcome at the fourth stage of the game is described in section 3.1.1. and the location equilibrium for given taxes and wages is given by (24). We now solve the last stage of the game where monopoly unions and governments set wages and tax rates respectively. The maximization program of the monopoly union in country $i$ is given by:

$$
\max_{w_i^u} U_i = (w_i^u - \bar{w})^\mu (L_i^d)^{1-\mu}
$$

with $L_i^d = fn\lambda_i^{uu}$ while the maximization program of each government is given by

$$
\max_{t_i} W_i^u = lS_i^* + \frac{r^*n}{2} + t_i n\lambda_i^{uu} + \frac{1}{2} (w_i^{uu})^2 \ln l_i + \text{constant}
$$

Note that the labor demand elasticity to the wage rate is now given by:

$$
\xi_{L_i^d, w_i} = \frac{f (1 + n) w_i^{uu}}{2n l^2 + (1 + n) (f w_j - f w_i^{uu} + t_j - t_i)}
$$

where $d\xi/d\tau$ is still negative. The new effect lies in the fact that the labor demand elasticity in a country increases with its capital tax rate. As a consequence, the higher the capital tax, the more the trade union is prompted to lower the wage rate in order to reduce the negative impact of its intervention on the level of employment.

The equilibrium tax rates and wage rates are given by:

$$
t_i^{uu} = t_i^{cc} - \frac{f \bar{w}}{2} - \frac{\mu}{1 - \mu} \frac{l_i^2 n}{1 + n} \forall i = H, F
$$

$$
w_i^{uu} = \bar{w} + \frac{\mu}{1 - \mu} \frac{2lnl^2}{f (1 + n)} \forall i = H, F
$$

First, observe that proposition 3 is not altered as we check that $\partial w_i^{uu}/\partial \tau > 0$. Secondly, note that $\partial t_i^{uu}/\partial \tau < 0$ when $\mu > [a - \tau(3 + 2n)]/[a - \tau(5 + 4n)] \in (0, 1)$. Consequently, trade integration can give rise to higher corporate taxes. It will be the case if $\tau > \bar{\tau}/2$ and $\tau < a/(5 + 4n)$ provided that $\mu$ is high enough and if $a/(5 + 4n) < \tau < \bar{\tau}/2$ for all values of $\mu \in (0, 1)$. Thus, the main result mentioned in proposition 4 - the possibility for trade integration to relax tax competition - is checked.
Countries differ in labor market institutions. We now present the case where the labor market is competitive in country $H$ while it is unionized in country $F$. The product market outcome at the fourth stage of the game is described in Section 3.1.1 and the equilibrium location is given by (32). Solving the maximization program of the monopoly union in country $F$ and the maximization program of governments, we obtain the following tax wedge at equilibrium:

$$t_H - t_F = \frac{n[f^2\eta (1 + n) + 4l^2\tau^2] (12l^2 + 8l^2 n) \tau^2 + 3f^2\eta (n + 1)^2 \mu + (1 + n)^2 f^2 \eta}{2(1 + n) l (4 - 3\mu)\eta (1 + n)^2 f^2 + l^2\tau^2(4n + 5 - \mu (3n + 4))} > 0.$$  

so that the location equilibrium is given by:

$$\chi^{cu} = \frac{1}{2} + \frac{f^2\eta (1 + n) - 2\mu(\eta f^2 (n + 1) + 2l^2\tau^2)}{(4 - 3\mu)\eta (1 + n)^2 f^2 + l^2\tau^2(4n + 5 - \mu (3n + 4))} \geq \frac{1}{2}$$

when $\mu \geq \tilde{\mu}$ with

$$\tilde{\mu} \equiv \frac{f^2\eta (1 + n)}{2f^2\eta (1 + n) + 4l^2\tau^2} > \tilde{\mu}$$

Evaluating the competitive wage in country $H$ at this location equilibrium, we get:

$$w^*_F = \overline{w} + \frac{\mu n}{2(1 + n) l} \left[\frac{f^2\eta (1 + n) + 4l^2\tau^2][5\eta f^2 (n + 1)^2 + 4\tau^2 l^2 (4n + 5)]}{(4 - 3\mu)\eta (1 + n)^2 f^2 + l^2\tau^2(4n + 5 - \mu (3n + 4))}\right] > w^*_H.$$  

Hence, the competitive wage is lower than the level of wage set by monopoly union in country $F$. Moreover, we observe that it is lower than when the monopoly union in country $F$ acts as a Stackelberg leader.

To conclude, as under the case where trade unions act as a Stackelberg leader, the country with a flexible labor market set a higher capital tax rate and attracts a higher share of capital provided that the relative importance of wages over employment for the trade union is not too low. We also check that trade integration induces to a relocation of capital toward the unionized country ($d\lambda^{cu}/d\tau > 0$). Hence, Proposition 5 still holds.