Tax-driven Specialization and International Integration

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First draft — October 20, 1999
This draft — January 6, 2000

Abstract

In the transitional phase towards full economic integration, European countries have the possibility of re-shaping the continental geography of specialization. We develop a two-sector two-country model that shows formally how fiscal policy can be critical in promoting specialization in a phase where increasing returns are strong enough to sustain agglomeration but local barriers are too high for agglomeration to arise endogenously. We show that, in this intermediate phase, the optimal policy is to levy asymmetric taxes on the two sectors in order to induce agglomeration and therefore welfare benefits to both countries.

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*This paper was partly written while Peri was visiting UCLA as exchange scholar in the IEP. We thank IEP for financial support.

1 Introduction

It is common perception that the gains at stake in this period of increasing integration of the European economy are very high.[1] In a period of potential re-definition of the continental geography of specialization and industrial agglomeration, many governments perceive this opportunity as unique. If Germany is able to take advantage of its leadership in the car sector and become the European supplier of cars, the reward for this will be long lasting and important. Similarly, Britain could become the European center for financial services and Italy for the fashion industry. It is, by now, almost eight years (since the Maastricht Treaty of 1992) that this phase of increased integration, reduction of trade barriers and transaction costs across European countries has entered its final stage and yet the member countries are still somewhat in the middle of this process. Increasingly, it appears that technological forces, backward and forward linkages should generate tendencies towards increased agglomeration and specialization; however, local barriers, immobility of factors (labor in particular) and protectionism still preserve national economies with more disperse production structures.

Recent studies have found increasing specialization in manufacturing across European countries beginning in the late eighties (Amiti [1] and Brulhart and Torstensson [3]), a sign of the action of agglomeration forces. Nevertheless Europe is still far from the degree of industrial agglomeration which prevailed in the United States at its peak (see Krugman [7]). This evidence suggests that agglomeration forces may be already present in Europe, and gaining momentum for some industries, but not yet so pervasive to naturally generate a tendency to full agglomeration. This is the phase in which well designed economic policy could be the most effective.

In this paper we show that in the intermediate phase of the globalization process - the phase in which transport costs are low enough to ensure stability of agglomeration but still too high to endogenously generate agglomeration - the government policy of taxing, or spending in, one sector less than the other, is crucial in determining the pattern of specialization of the country. More importantly, if the government is able to induce the agglomeration of one industry with the use of fiscal policy, the welfare of its citizens is increased. In fact, the best policy in this intermediate phase of the process of "globalization" is to reduce taxes on one sector relative to the other up to the point where the asymmetry in the incentives induces agglomeration of one industry in one country.[2] The pattern of specialization determined in this phase will remain in the subsequent period of complete international integration.

The classic result that distortionary taxes decrease the welfare of the representative agent still holds in our model. In the "pre-globalization" phase, where high transport

[1]See, for example, European Commission [4].

[2]Our model delivers complete specialization in all countries; in a more realistic setting, however, there could be crowding effects that prevent complete specialization.

costs (barriers) induce each country to produce in many different sectors rather than specialize, the optimal policy is to tax symmetrically all sectors so as to minimize the distortions. In the fully globalized economy, each country is specialized and taxation could be relatively high in the agglomerated sector, up to the point where the pattern of agglomeration is reversed.[3] Most interesting, though, is the intermediate phase. Here, symmetric taxation is the worst policy in terms of welfare while the best policy is to tax sectors asymmetrically in order to induce full specialization in one sector and benefit from its increased productivity due to increasing returns.

The paper is organized as follows. Section 2 presents the model and solves for the equilibrium without the public sector; Section 3 introduces the government and analyzes the effect of taxation on the pattern of specialization and section 4 considers the effect of public spending on specialization. Section 5 discusses optimal taxation and welfare with positive public spending and when the government taxes one sector to subsidize the other with zero public spending. Section 6 analyzes a simple strategic interaction between two governments. Section 7 concludes.

2 Model

We consider two countries, each with two industries, and a single factor of production, labor, along the lines of the model in Fujita et al. [5], chapter 16. The model is laid out for the Home economy; the Foreign economy is completely symmetric and, when it is necessary to distinguish it from the Home economy, we will do so by using the tilde character $\tilde{}$ on top of the variables. Each country is endowed with one unit of labor, which we assume is inelastically supplied by workers. Labor may be employed in either of the two industries, which we label industry 1 and 2, but it cannot move internationally.

Both industry 1 and 2 produce manufacturing goods and are monopolistically competitive. Both industries have a Cobb-Douglas technology that utilizes labor and intermediate goods both from their own industry and from the other industry. On the demand side, all consumers are identical with demand elasticity for each variety in either industry equal to σ. We first model consumers' behavior, then we move to producers' behavior, and then we introduce the government sector. As the model without tax/spending is rather standard in the new geography literature, we will only sketch the set-up, devoting more detail to the description of the government behavior.

[3] This case is studied in detail by Kind et al. [6].

2.1 Consumers

Each consumer maximizes a utility function of the following type:

$$U = X_1^{\delta} X_2^{1-\delta} \tag{1}$$

where X_1 is a composite index of the consumption of goods manufactured by industry 1 and X_2 is a composite index of the consumption of goods manufactured by industry 2 and δ represents the expenditure share of industry-1 goods. For simplicity, we are going to assume that $\delta = 0.5$. Each composite consumption good X_i is a utility function based on the goods produced in industry i; in each industry, there is a continuum of such goods and we denote by $x_i(j)$ the consumption of each variety j produced in industry i. The consumption index X_i is defined by:

$$X_i = \left[\int_0^{n_i} x_i(j)^{\frac{\sigma-1}{\sigma}} dj \right]^{\frac{\sigma}{\sigma-1}}, \qquad \sigma > 1. \tag{2}$$

It is easy to recognize that (2) is a constant-elasticity-of-substitution function where σ is the elasticity of substitution between any two varieties. The index n_i is the number of varieties produced in industry i.

The price index for the composite consumption good produced in industry i is denoted by G_i, $i = 1, 2$ and it is equal to

$$G_i \equiv \left[\int_0^{n_i} p_i(j)^{1-\sigma} dj \right]^{\frac{1}{1-\sigma}}, \tag{3}$$

where $p_i(j)$ is the price of each manufactured good j produced in industry $i = 1, 2$. Notice that G_i measures the minimum cost of purchasing a unit of the composite good X_i.

Let the income of the representative consumer be Y; then, the budget constraint for the consumer is given by

$$G_1 X_1 + G_2 X_2 = Y \qquad \text{or} \qquad \sum_{i=1}^{2} \left[\int_0^{n_i} p_i(j)\, x_i(j) dj \right] = Y. \tag{4}$$

The consumer problem consists in maximizing (1) subject to the budget constraint (4). The solution to this problem gives the compensated demand function for the zth variety produced in industry i:

$$x_i(z) = x_i = \left[\frac{p_i(z)}{G_i} \right]^{-\sigma} X_i. \tag{5}$$

The demand for variety z, which for the symmetry of the utility function is equal for each variety, depends negatively on its relative price with respect to the price index of the composite good produced in that industry.

To determine completely the demand for $x_i(z)$, we need to solve for X_i, the demand for the composite good produced by industry i. The solution to this problem yields the well-known result that the consumer allocates to the composite good 1 a share δ of her total income and to the composite good 2 a share $1-\delta$ of her total income. Under the assumption that $\delta = 0.5$, the demand for the composite good 1 and 2 are

$$X_i = \frac{Y}{2G_i}, \qquad i = 1, 2. \tag{6}$$

The Home and Foreign economy reside in different geographical locations. Each economy can either have both industries or only one industry producing; in the latter case, the goods that are consumed but not produced locally must be imported from the other economy. Shipping goods is feasible but entails a transport cost that, for simplicity, we model as the iceberg form. More precisely, for each unit of shipped good, only the fraction $1/T$, with $T > 1$, of the good actually arrives at destination. We assume that the iceberg transport cost T is constant and that all shipped goods incur the same transport cost, independently of where the shipment originates.

2.2 Producer behavior

As pointed out earlier, industry 1 and 2 produce manufacturing goods and are monopolistically competitive. Both industries have fixed costs of production F, are characterized by economies of scale at the level of the variety and utilize Cobb-Douglas technologies that utilize labor and intermediate goods both from their own industry and from the other industry. More precisely, the production function for the variety j in industry i is

$$c_i^m(j)x_i(j) + F = l_i(j)^{\beta} X_i^{\alpha} X_{-i}^{\gamma}, \qquad i = 1, 2, \tag{7}$$

where $\alpha + \gamma + \beta = 1$, $l_i(j)$ is labor employed for the production of variety j and $-i$ indicates the sector but i. The production technology uses labor, whose share in total costs is β, inputs from the same industry that account for a share α of the costs and inputs from the other industry that account for a share γ of the costs. Notice that manufacturing uses as inputs the same aggregate of varieties demanded by consumers. We are going to assume that $\alpha > \gamma$, which implies that the links within the same industry are stronger than the links between them. This assumption makes co-location of firms in the same sector desirable. We can think of the industry linkages as "strictly speaking" input-output linkages, but they could also involve knowledge flows, if knowledge and information is passed on with the trade of intermediates.

The Home government levies a proportional sale tax τ_i on each firm in industry i in the Home economy; τ_1 and τ_2, the sale tax levied on industry 1 and 2 respectively, need not be equal. Taking the price indices G_1 and G_2 as given, each firm maximizes profits by setting the price (net of taxes) as a mark-up over the marginal cost of production. We suppose that there is free entry and exit in response to profits; hence, the zero-profit condition uniquely defines the equilibrium output for each firm. The equilibrium output ($x^* = F\sigma$) is a constant and it is common to all active firms in the economy.

The prices charged by Home firms in industry i are

$$p_i(1-\tau_i) = w_i^{\beta} G_i^{\alpha} G_{-i}^{\gamma} \tag{8}$$

where w_i is the wage rate paid in industry i. By choosing the fixed cost appropriately so that $x^* = 1/\beta$, we obtain the price index for the Home economy in industry i as

$$G_i = \left[\int_0^{n_i} p_i(j)^{1-\sigma} + \int_0^{\tilde{n}_i} \left(\tilde{p}_i(j)T\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}.$$

This can be written as

$$G_i^{1-\sigma} = l_i w_i^{1-\beta\sigma} G_i^{-\alpha\sigma} G_{-i}^{-\gamma\sigma} \left(\frac{1}{1-\tau_i}\right)^{1-\sigma} + \tilde{l}_i \tilde{w}_i^{1-\beta\sigma} \tilde{G}_i^{-\alpha\sigma} \tilde{G}_{-i}^{-\gamma\sigma} \left(\frac{T}{1-\tilde{\tau}_{-i}}\right)^{1-\sigma}, \tag{9}$$

and it holds for $i = 1, 2$. Each price index depends on the wage rate paid in the economy where the industry is located, on the price indices of both industries in both countries (due to the use of intermediate goods that may be produced in each economy) and on the tax rates applied to the industry in the two countries. An analogous expression holds for the price index of industry i in the Foreign economy.

Notice that we could have alternatively modelled taxes to be levied on consumers rather than producers,[4] but this would have not changed the results qualitatively: producers, who have zero profits, reduce wages to pay the sale tax and reduce consumers' real income, which is equivalent to levying the sale tax directly on consumers.

2.3 Government sector

In each country there is a government that collects sale taxes to finance public spending. The government levies exogenously given industry-specific sale taxes and it spends a fraction ϕ of its revenues on the products of industry 1 and $1-\phi$ on the products of industry 2. For simplicity, we have assumed (see equation (1)) that public spending does not affect individual welfare directly. The budget constraint of the Home government is given by

$$\tau_1 \int_{j=0}^{n_1} p_1(j)x_1(j)\,dj + \tau_2 \int_{j=0}^{n_2} p_2(j)x_2(j)\,dj = G_1 g_1 + G_2 g_2, \tag{10}$$

[4] In this case, consumers would pay a price gross of the sale tax, $p_i(j)(1+\tau_i)$.

where g_1 and g_2 are real public spending on industry 1 and 2, respectively. In equilibrium, government revenues (the left-hand side of (10)) is[5]

$$\frac{\tau_1 w_1 l_1}{\beta(1-\tau_1)} + \frac{\tau_2 w_2 (1-l_1)}{\beta(1-\tau_2)}.$$

Nominal expenditure on industry 1 in the Home economy is given by

$$E_1 = \left[\frac{w_1 l_1 + w_2 l_2}{2}\right] + \left[\frac{\alpha w_1 l_1 + \gamma w_2 l_2}{\beta}\right] + \frac{\phi}{\beta}\left[\frac{\tau_1 w_1 l_1}{1-\tau_1} + \frac{\tau_2 w_2 l_2}{1-\tau_2}\right], \tag{11}$$

and nominal expenditure on industry 2 in the Home economy is

$$E_2 = \left[\frac{w_2 l_2 + w_1 l_1}{2}\right] + \left[\frac{\alpha w_2 l_2 + \gamma w_1 l_1}{\beta}\right] + \frac{1-\phi}{\beta}\left[\frac{\tau_2 w_2 l_2}{1-\tau_2} + \frac{\tau_1 w_1 l_1}{1-\tau_1}\right]. \tag{12}$$

The first term on the right-hand side of (11) is the demand by consumers, who equally divide their labor income between the goods of industry 1 and 2; the second term on the right-hand side is the demand for intermediate goods originating from the industry 1 itself and from industry 2, respectively a fraction α and γ of industry's production. The third term on the right hand side is the nominal expenditure by the government on industry 1, which is a fraction ϕ of its total tax revenues. A similar interpretation holds for (12), namely nominal expenditure on the goods produced by sector 2; notice that here the share of government spending on the sector is $1-\phi$.

At last, the market-clearing condition for industry i in the Home economy is

$$\left[\frac{w_i^{\beta} G_i^{\alpha} G_{-i}^{\gamma}}{1-\tau_i}\right]^{\sigma} = \beta\left[E_i G_i^{\sigma-1} + \tilde{E}_i(\tilde{G}_i)^{\sigma-1} T^{1-\sigma}\right]. \tag{13}$$

By the Walras' law, the market clears for industry $-i$ in the Home country; a market-clearing condition similar to (13) holds for the Foreign economy.

3 Taxes and agglomeration

In this section we study the equilibria supported by this model when the government levies sale taxes. The analysis simplifies substantially under the assumption that both the industries and the countries are symmetric. This implies studying an economy where the values of the endogenous variables for industry 1 in the Home economy are identical to the values for industry 2 in the Foreign economy and vice versa for industry 2; we also assume that the two countries set symmetric tax rates.

[5] To obtain this expression, we made use of the relation $w_i l_i = n_i p_i (1-\tau_i)$.

The equilibrium conditions are spelled out in details in appendix A; they consist of nine equations for the Home country and, of course, nine equations for the Foreign country. The nine equations for the Home economy are: the market-clearing condition (13) and the zero-profit condition (8), one for each industry; the equilibrium price index (9), one for each industry; the spending equations (11) and (12); the government budget constraint (10); and a price normalization, which we have chosen as the wage in industry 1, i.e. $w_1 \equiv 1$. These nine equations determine nine endogenous variables: $w_2, G_1, G_2, p_1, p_2, g_1, g_2, E_1$ and E_2. The structure of our model plus the symmetry assumptions imply that

$$w_1 = \tilde{w}_2 \quad w_2 = \tilde{w}_1 \quad G_1 = \tilde{G}_2 \quad G_2 = \tilde{G}_1 \quad l_1 = \tilde{l}_2 \quad l_2 = \tilde{l}_1$$

$$g_1 = \tilde{g}_2 \quad g_2 = \tilde{g}_1 \quad E_1 = \tilde{E}_2 \quad E_2 = \tilde{E}_1.$$

Notice that labor mobility across industries within the same country implies that, in equilibrium, $w_1 = w_2$ and the symmetry assumption implies that $w_1 = \tilde{w}_2$. Hence, nominal and real wages are identical in the two countries once labor has moved between industry in order to equalize wages. These two further conditions determine the equilibrium values of l_1, l_2. We will study equilibria of this model and their stability, by plotting the function of real wages in each industry against the share of workers in industry 1. It is known that the comparison of the behavior of the two real wage functions at the equilibrium points gives the informal conditions for stability, which can be inspected graphically from the simulated plot. This graphic treatment is done only for sake of simplicity and without loss of generality. In fact, it is shown by Baldwin [2] that these informal conditions for stability coincide with formal conditions at the equilibrium points.

Two sets of equilibria are of particular interest to us: equilibria with complete agglomeration of industries and equilibria with diversification. With complete agglomeration, the Home economy has one industry and the Foreign economy has the other. Suppose the Home economy specializes in industry 1 and the Foreign economy in industry 2; then $l_1 = \tilde{l}_2 = 1$. Moreover, since industry 1 operates in the Home country only and vice versa for industry 2, the relationship between the price indices simplifies to $\tilde{G}_1 = TG_1$ and $G_2 = T\tilde{G}_2$.[6] The wage ratio in the Home country as a function of the parameters can be expressed as

$$\left(\frac{w_2}{w_1}\right)^{\beta} = T^{\gamma-\alpha}\left(\frac{1-\tau_2}{1-\tau_1}\right)\left\{\frac{T^{1-\sigma}}{2}\left[(1-\gamma+\alpha)(1-\tau_1)+2\phi\tau_1\right]\right. \tag{14}$$
$$\left. + \frac{T^{\sigma-1}}{2}\left[(1+\gamma-\alpha)(1-\tau_1)+2(1-\phi)\tau_1\right]\right\}^{\frac{1}{\sigma}}.$$

[6] Notice that the symmetry assumption about taxes is necessary for this result.

Agglomeration in industry 1 is sustainable only if industry 2 does not pay higher wages, that is if $w_1 \geq w_2$ and the wage ratio in (14) is greater than one. The first term on the right-hand side represents the backward linkages, namely the share of Home expenditure on industry 1 and 2. The third term on the right-hand side represents the forward linkages, namely the importance of domestic (with higher weight) and foreign (with lower weight) demand. The second term on the right-hand side contains the effect of taxes on the wage ratio. Taxes and the allocation of public spending have an important role on the sustainability of agglomeration. Higher taxes on industry 2, τ_2, reduce the wage ratio because firms in industry 2 pay lower wages to their workers. Higher taxes on industry 1, τ_1, raise the wage ratio if ϕ (the share of spending in sector 1 by the government) is small enough and reduce it otherwise.[7] The intuition for this result is that taxes on an industry have a direct negative effect on wage in the industry but an indirect positive effect via government spending that depends on the fraction of government revenues spent in the industry. An increase in ϕ, leaving taxes unchanged, increases the likelihood of agglomeration as the third term on the right-hand side of (14) declines. Appendix B describes the values for the variables G_1, G_2, E_1, E_2 in the fully agglomerated equilibrium.

The other set of equilibria that can emerge in this model implies diversification in the industrial structure: each country has both industries. If both industries are taxed equally ($\tau_1 = \tau_2 = \tau$) and government spending is equally divided on each industry ($\phi = 0.5$), our model delivers dispersion: each country has half of each industry. At this symmetric scenario:

$$E = \frac{1}{2\beta(1-\tau)}, \qquad G^{1-\sigma\beta} = \frac{1+T^{1-\sigma}}{2(1-\tau)^{1-\sigma}}.$$

The symmetric equilibrium is abandoned when transport costs fall enough to make agglomeration feasible and, after that, necessary. The level of transport cost at which agglomeration becomes feasible is

$$T^{\sigma-1} = \frac{(1-\tau)^{1-\sigma}[(\alpha-\gamma)^2+\rho]+(\alpha-\gamma)(1+\rho)}{(1-\tau)^{1-\sigma}[(\alpha-\gamma)^2+\rho]-(\alpha-\gamma)(1+\rho)}. \qquad (15)$$

The higher the tax, the lower the transport cost at which agglomeration becomes feasible when $\alpha - \gamma > 0$.[8]

To study further how taxes affect agglomeration, we simulate the economy for the parameter values:

$$\sigma = 6, \quad \alpha = 0.35, \quad \gamma = 0.05, \quad \beta = 0.6,$$

[7] More precisely, a sufficient condition for an increase in τ_1 to raise the wage ratio on the left-hand side of (14) is that $\phi < \alpha + \beta/2$.

[8] Notice that agglomeration is not feasible when $\alpha - \gamma < 0$.

which are very close to those chosen by Fujita et al. [5], chapter 16. Figure 1 illustrates the Home country's real wages in each industry as a function of the share of labor force in industry 1, l_1;[9] real wages are simply the nominal wages deflated by the price index:

$$\omega_i = w_i(G_1G_2)^{-\frac{1}{2}}.$$

Thanks to our symmetry assumption, the real wage in industry 1 in Home is equal to the real wage in industry 2 in Foreign, and so on. Figure 1 has been drawn for no taxes, high transport costs and government spending equally divided among the two sectors: $\tau_1 = \tau_2 = 0$, $T = 1.4$ and $\phi = 0.5$. For high transport costs, the unique equilibrium is at the intersection of the two curves, where $\omega_1 = \omega_2$ and $l_1 = l_2 = 0.5$. This can be called the "de-specialized equilibrium" and it is stable because an increase in the labor force in industry 1 brings a reduction in the real wage in that industry. Agglomeration is not sustainable because shipping goods between countries would imply incurring high trade costs and reducing welfare; this can be easily double-checked in figure 1, which shows that $\omega_1 < \omega_2$ when $l_1 = 1$ and the Home economy is fully specialized in industry 1, and vice versa when the Home economy is fully specialized in industry 2.

As transport costs fall and taxes remain unchanged (at zero level), agglomeration becomes sustainable and real wages increase. Figure 2 depicts real wages for $\tau_1 = \tau_2 = 0$, $T = 1.34$ and $\phi = 0.5$. There are now five equilibria: specialization in industry 1, specialization in industry 2, dispersion, and two intermediate equilibria between dispersion and full specialization. The two intermediate equilibria are unstable whereas dispersion and full specialization in either sector are stable equilibria. Notice that not only is specialization sustainable ($\omega_1 > \omega_2$ at $l_1 = 1$ and $\omega_2 > \omega_1$ at $l_2 = 1$) and stable, but it is also welfare improving over dispersion, as the real wages at full specialization are higher than the real wages at dispersion. Intuitively, firms incur lower trade costs on intermediate products under industrial agglomeration, thereby raising real wages and consumption for individuals. Hence, agglomeration of one industry in one country is welfare improving at intermediate transport costs.

At low transport costs, industrial diversification becomes unstable and agglomeration becomes the only stable outcome. Real wages for $\tau_1 = \tau_2 = 0$, $T = 1.2$ and $\phi = 0.5$ are shown in figure 3: the equilibrium at $l_1 = l_2 = 0.5$ is now unstable, as a small increase in l_1 leads to an increase in ω_1. Because of the built-in symmetry of our model, the Home economy is indifferent and may specialize in either industry.

Let's now explore the role of taxes on the industrial structure. The case we concentrate on is the intermediate phase in the passage from high to low transport costs. In this case, agglomeration is sustainable; however, if the economy starts in the symmetric, dispersed equilibrium, the market sustains dispersion as long as transport costs remain

[9] For the symmetry of our model, we can read on the same graph (but from right to left) the real wage of workers in the Foreign economy as a function of employment in sector 1, $\tilde{l}_1 = 1 - l_1$.

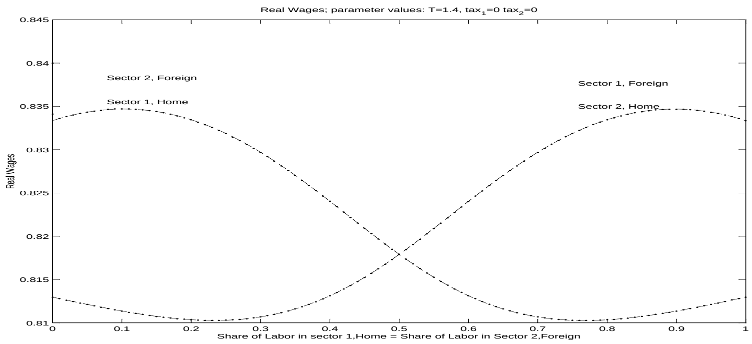

Figure 1: Real wages, $T = 1.4$

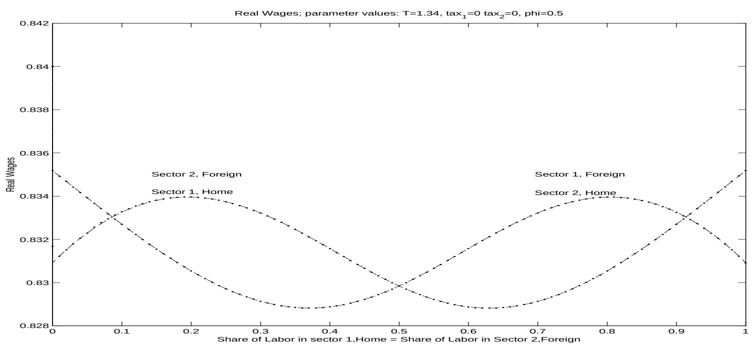

Figure 2: Real wages, $T = 1.34$

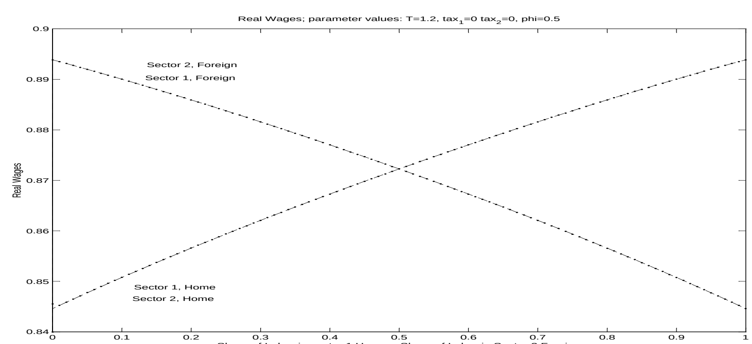

Figure 3: Real wages, $T = 1.2$

high enough. In this situation, a tax/subsidy policy can induce welfare-improving agglomeration with higher wages for both countries. Moreover, the pattern of specialization which emerges in this phase will be also maintained in the following phase of low transport costs. Let's consider how.

When the government levies the same tax on both industries and equally divides its spending on the two industries, taxation simply reduces real wages and welfare: firms pay lower nominal salaries and public spending crowds out private spending. Figure 4 shows real wages for $\tau_1 = \tau_2 = 0.04, \phi = 0.5$ and $T = 1.34$, which is the same "intermediate" transport cost used in figure 2; the number and properties of the equilibria are the same as in figure 2 and the only difference is that both real wage curves have shifted down.

Asymmetric taxation, as well as asymmetric public spending, has important consequences on the industrial structure of the economy. In figure 5, we investigate the role of asymmetric taxation by setting $\tau_1 = 0.04, \tau_2 = 0.043, \phi = 0.5$ and $T = 1.34$. Higher taxes on industry 2 make real wages fall in industry 2 with respect to industry 1 and wage equalization between the two industries implies that a larger fraction of the work force will choose to work in industry 1. There are only three equilibria now: agglomeration in industry 1, partial diversification (with a bias toward industry 1 for Home and towards industry 2 for Foreign), and an intermediate equilibrium that is unstable. Agglomeration in industry 2 ceases to be sustainable because of higher taxes on the industry. Most importantly, taxation can bring agglomeration by taxing one industry more heavily than the other (or subsidizing one industry at the other's expenses) and making the diversified equilibrium unstable.

Figure 6 shows real wages for $\tau_1 = 0.04, \tau_2 = 0.045, \phi = 0.5$ and $T = 1.34$: the tax on industry 2 is now high enough to eliminate industry 2 at Home and generate agglomeration of industry 1, which is the only sustainable and stable equilibrium allocation in the economy. Of course, the welfare gains from agglomeration must be weighted against the welfare costs of taxation; however, a policy of taxation/subsidies may well be welfare improving. Consider, for example, the case of an economy whose industrial structure is dispersed, perhaps because transport costs or trade barriers were high in the past, but these costs have fallen so that agglomeration is sustainable; the government can levy higher tax on one industry and lower on another to achieve agglomeration (and the higher welfare associated with it). The transition involves adjustment costs, that we have not modelled at all here, as a fraction of the labor force must change jobs and these workers suffer a real wage loss in the process;[10] such losses are larger the more imperfect the labor market, the harder re-training, etc.

[10] For an analysis of the effects of frictional costs on the dynamics of specialization, see Peri [9].

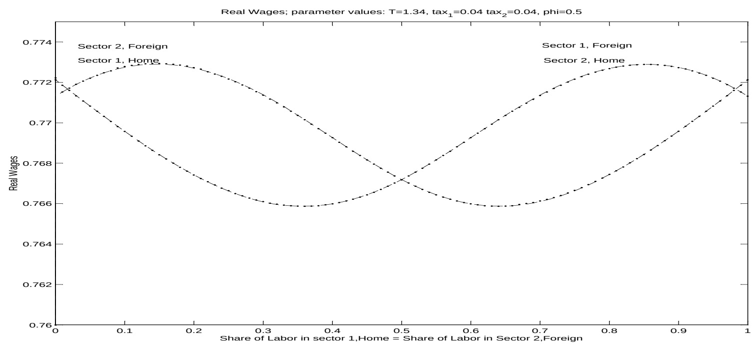

Figure 4: Real wages; T=1.34 and $\tau_1 = \tau_2 = 0.04$

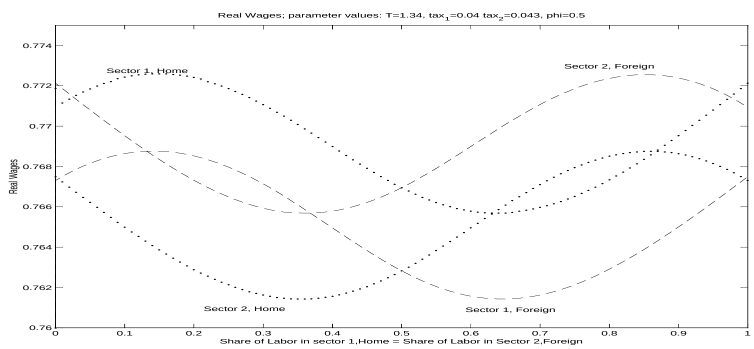

Figure 5: Real wages; T=1.34, $\tau_1 = 0.04$ and $\tau_2 = 0.043$

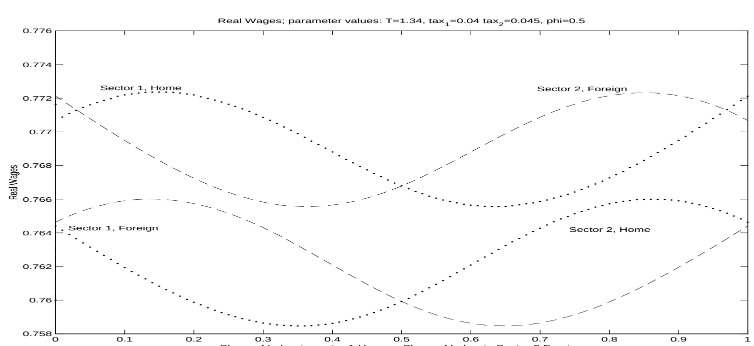

Figure 6: Real wages; T=1.34 , $\tau_1 = 0.04$ and $\tau_2 = 0.045$

4 Public spending and agglomeration

In the analysis of different policies, we have so far assumed that government spending is equally distributed between the two sectors. This reproduces, in the government, the tastes of the private consumers who equally split their total expenditure between the two types of goods. The government is not giving any explicit impulse to either sector, while we have seen that it may be penalizing them asymmetrically by choosing different tax rates. In this section we explore the possibility that the government may be spending asymmetrically and we spell out the consequences of this asymmetry on the patterns of specialization. The difference, compared with the previous section, is that now we set the taxes to an equal rate in the two sectors ($\tau_1 = \tau_2 = 0.04$) and we allow the parameter ϕ to differ from 0.5. This introduces a distortion of public spending in favor of one of the two sectors, as the total expenditure E_1(see expression (11)) increases in the parameter ϕ. Beginning, as usual, from the symmetric situation represented in figure 4, a shift in public spending towards the first type of goods ($\phi = 0.6$) increases the specialization of the Home country in sector 1 (see figure 7). This partially specialized equilibrium becomes unsustainable for ϕ high enough and at the value $\phi = 0.8$ the economy fully specializes in sector 1 (figure 8). Again, as in the previous case, by achieving the complete agglomeration of one sector in one country, the government induces welfare gains for its citizens to be weighted against the welfare losses stemming from the existence of a public sector that, by spending, reduces citizens' income. If these decisions on taxes or spending are not perfectly symmetric between sectors, the government can generate a critical push towards welfare-improving specialization. This role will be particularly important in a phase of intermediate transport costs when agglomerating forces are not strong enough, yet, to ensure naturally arising agglomerations, but are already strong enough to make agglomeration socially desirable. From the numerical experiments is also clear that the government needs to impose a larger asymmetric shift if it uses spending, rather than taxes, in generating industrial agglomeration. A difference between the two tax rates equal to 12% of the tax itself is sufficient to induce full agglomeration, while we need a difference in spending of around 300% to generate agglomeration. This is due to our assumption that public spending is only a small fraction of the total spending in each good and it therefore needs to be changed drastically to induce relevant asymmetries.

The model tells us that, once we endogenize the pattern of specialization of one country by allowing for forward and backward linkages that will set into motion self reinforcing agglomeration economies, there is a very critical period for determining the future specialization of a country. This period is the phase when transport costs are at an intermediate level: low enough to sustain full agglomeration but still too high to undermine the stability of the dispersed equilibrium. In this phase, specific economic policies in the form of taxing one sector rather than another or concentrating

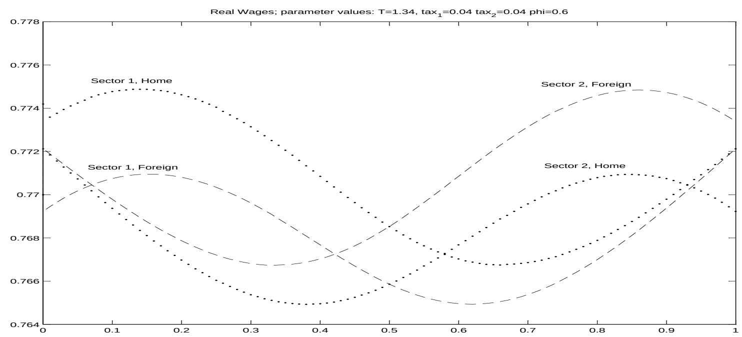

Figure 7: Real wages, $T = 1.34, \phi = 0.6$

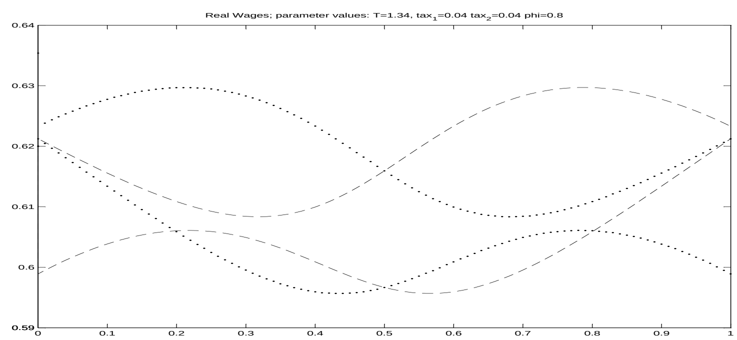

Figure 8: Real wages, $T = 1.34, \phi = 0.8$

public spending in one sector might trigger the agglomeration process and ensure a long lasting specialization of the country in the favored sector. In this sense, there may be an incentive for the government to direct its policies wisely in this phase, targeting one sector and inducing its agglomeration, rather than accepting the non-specialized equilibrium arising from the operating of the markets.

5 Optimal taxation

5.1 Positive Public Spending

In order to analyze the issue of optimal policy, we assume that the government collect taxes in order to finance a given level of public spending in a way that minimizes the distortion for the economy, i.e. which maximizes the utility of the representative citizen. The government therefore chooses the taxes in order to maximize the real wages of the citizens:

$$\omega_i = w_i(G_1G_2)^{-\frac{1}{2}}, \tag{16}$$

subject to the constraint

$$\frac{\tau_1 w_1 l_1}{\beta(1-\tau_1)} + \frac{\tau_2 w_2(1-l_1)}{\beta(1-\tau_2)} = \Theta, \tag{17}$$

where Θ is the (given) government spending.[11] Clearly the values of w_i, G_1, G_2 are those which prevail in the equilibrium. If an equilibrium without agglomeration exists, then we choose it as the starting equilibrium, as our hypothetical story begins with a de-specialized world, due to high transport costs. Only when full agglomeration arises as the unique solution, we assume that the economy will converge to it and we consider this equilibrium as the relevant one. We use the same parameter values as in the previous simulations: $\sigma = 6, \alpha = 0.35, \gamma = 0.05, \beta = 0.6$ and we choose $\Theta = 0.2$, which gives a public spending per capita equal to 20% of personal labor income in the home country. We report the values of ω_i as a function of the ratio (τ_2/τ_1).

In the case of high transport costs ($T = 1.4$, the pre-global phase) the utility function has a maximum in the symmetric tax arrangement $\tau_2/\tau_1 = 1$ (see Figure 11), confirming the intuition that, in this case, the best policy is to keep taxes symmetric and not distort market prices. Symmetric taxes will not change the incentives of workers to move between sectors and, as the market solution is efficient, they will ensure the social optimum.

In the case of very low transport costs ($T = 1.2$, the fully-global case, represented in Figure 10) the utility of the agent does not depend on the tax levied in the sector which has disappeared and therefore, given the tax rate τ_1 that ensures the satisfaction of the budget constraint, utility is the same for any level of τ_2. There is nevertheless a minimum level of τ_2 which allows agglomeration to be sustained. In fact, if τ_2 falls below a threshold, derived in Appendix C, then the incentive to produce in sector 2 becomes very strong and agglomeration unravels. This result is reminiscent of the literature on "fiscal competition" (see Kind et al. [6] for a model in the new-geography style): in taxing a sector (a factor in their case), a country takes advantage of the agglomeration externalities in place and levies higher taxes on the agglomerated sector, but beyond a certain point the incentives reverse and agglomeration is destroyed. For our parameter values, the lower bound of the ratio τ_2/τ_1 is 0.9, with $\tau_2 = 0.10$ and $\tau_1 = 0.11$.

Finally, the intermediate phase ($T = 1.34$) shows the most interesting but counter-intuitive behavior. Figure 9 shows the tax ratio τ_2/τ_1 on the horizontal axis and the representative agent's utility along the isorevenue on the vertical axis. As it can be seen, symmetric taxation delivers the lowest utility because the economy is non-specialized.

[11] The constraint (17) is the same as (10) with $\Theta = G_1g_1 + G_2g_2$.

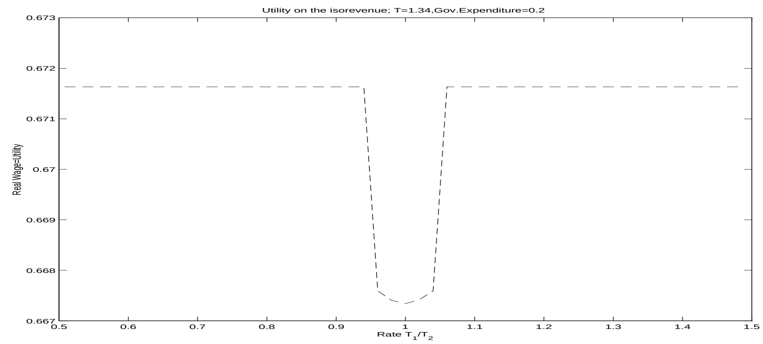

Figure 9: Agent's utiliy on the isorevenue, $T = 1.34$

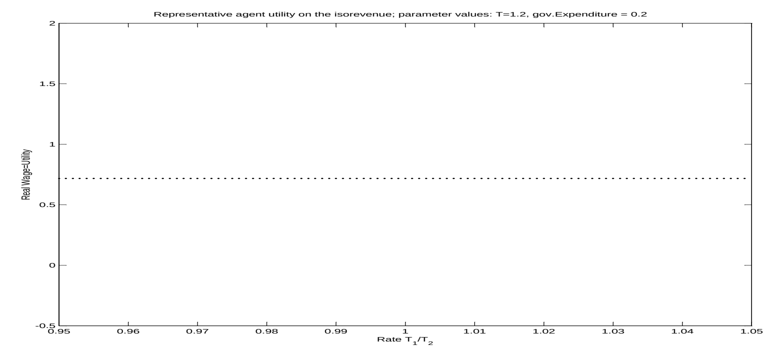

Figure 10: Agent's utility on the isorevenue, $T = 1.2$

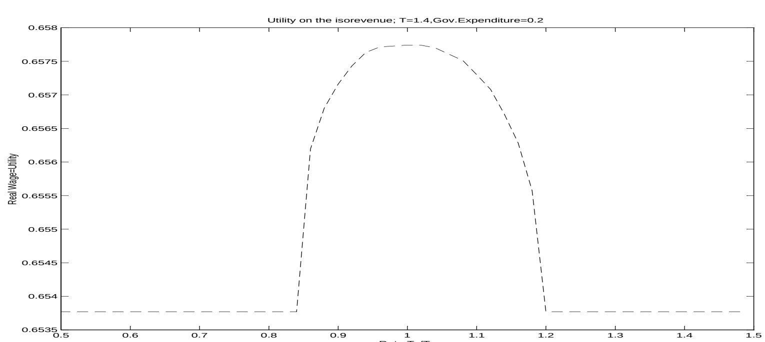

Figure 11: Agent's utility on the isorevenue, $T = 1.4$

As taxes become asymmetric, increasing specialization allows the backward linkages to step in and to benefit the productivity of the sector that becomes concentrated, until full agglomeration is reached. Already at the ratio $\tau_2/\tau_1 = 0.9$ complete agglomeration has been reached and the full benefits of agglomeration have been exploited. In this intermediate phase, therefore, the government should actively pursue a policy that alters the relative price of the products of the two sectors in order to promote agglomeration and benefit from the backward linkages.

5.2 Subsidies with Zero Public Spending

So far we have assumed that the government has to insure a revenue to finance public spending. This spending, though, has no direct impact on people's utility. It is therefore natural to consider what happens, and in particular, what is the optimal fiscal policy when public spending is zero and the government taxes one sector to subsidize the other. This is the ideal setting to evaluate the effects of taxation on welfare via the agglomeration channel only: no resources are subtracted to the private sector due to public spending and the government simply redistributes between sectors via tax/subsidies on sales. Now the government spending is equal to zero, namely $\Theta = 0$, and τ_1 and τ_2 are chosen so as to balance the government budget (17). We represent the utility (real wage) of the worker for increasing values of τ_1 from 0 to 0.01 and let τ_2 to be determined endogenously in order to balance the budget. Again we assume that our world begins in a de-specialized equilibrium and therefore agglomeration arises only when that equilibrium becomes unstable.

Figures 12, 13 and 14 represent the behavior of wages as a function of the tax rate in sector 1, for low, intermediate and high transport costs, respectively. Again, the economies in Home and Foreign are supposed to be in the dispersed equilibrium initially due to high transport costs. As before, we note the reversed behavior in the intermediate case, compared with the other two. With high ($T = 1.4$) and low ($T = 1.2$) transport cost, the tax rate that delivers highest utility is $\tau_1 = 0$. In the low transport cost case (figure 12), we notice that, as we start from full agglomeration of sector 1,[12] an increase in the tax on sector 1 (and subsidy to sector 2) induces the unraveling of that agglomeration and, beyond the level $\tau_1 = 0.004$, agglomeration in the other sector arises. This corresponds to a positive jump in utility, as the country now specializes in the sector with the (endogenously) zero tax rate.

As agglomeration in the other sector is reached, utility jumps back at the level reached for $\tau_1 = 0$ because the country specializes in sector 2 with $\tau_2 = 0$. In the high transport cost case (figure 14), an increase in the tax on sector 1, starting from $\tau_1 = 0$, simply distorts incentives, decreases utility while progressively shifting specialization

[12]Dispersion is not sustainable with low transport costs.

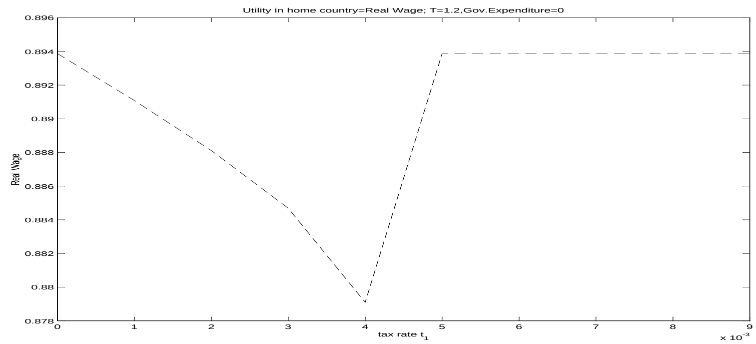

Figure 12: Real wages with $\Theta = 0$, $T = 1.2$

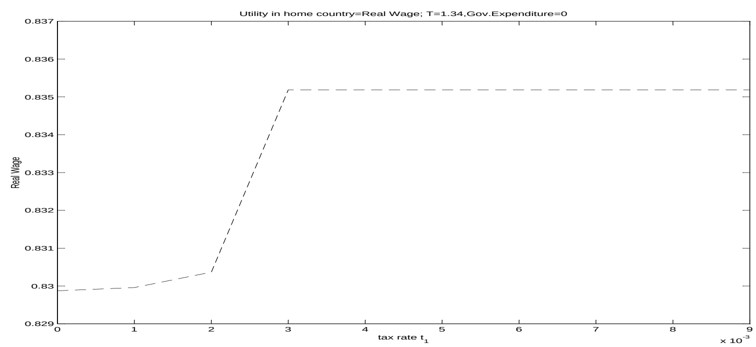

Figure 13: Real wages with $\Theta = 0$, $T = 1.34$

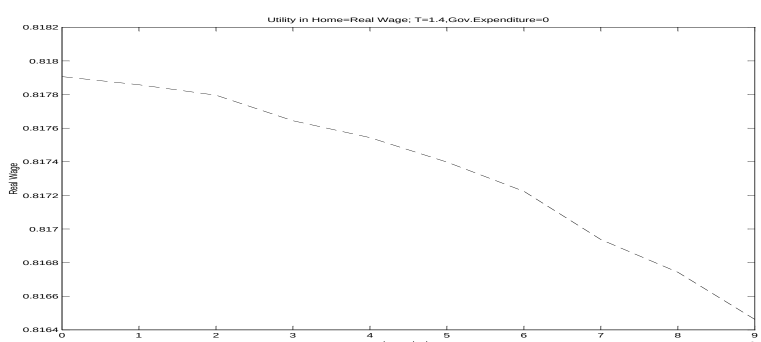

Figure 14: Real wages with $\Theta = 0$, $T = 1.4$

toward sector 2. Finally, and differently from the two previous cases, for the case with intermediate transport cost ($T = 1.34$ in figure 13), the choice of $\tau_1 = 0$ is the worst, while the maximum utility is brought by the those tax rates that induce agglomeration (in our case $\tau_1 \geq 0.3\%$). If we keep increasing τ_1 after that level, real wages do not change as sector 1 has disappeared. The benefits of agglomeration are fully appropriated at the lowest rate that generates such an outcome.

We assume that whenever two tax schemes are indifferent, i.e. they generate the same real wage, the government will choose the one with the smaller (in absolute value) tax rates.[13] With this assumption, there is a well-defined optimal policy in each of the three scenarios. In the pre-and post global phases, the market does its job efficiently and no need arises for government intervention: the optimal scheme is $\tau_1 = 0, \tau_2 = 0$. In the intermediate stage, on the other hand, tax/subsidy policies may be welfare-improving. In particular, the lowest tax rate that is able to induce agglomeration in the subsidized sector is the optimal tax rate to be levied in this phase ($\tau_1 = 0.3\%, \tau_2 = 0$ in the case simulated above).

6 Some strategic considerations between the two governments

In the previous sections we have assumed that a certain tax policy in one country was matched by the symmetric policy in the other. If Home chooses the tax scheme ($\tau_1 = x, \tau_2 = y$) then Foreign chooses ($\tilde{\tau}_1 = y, \tilde{\tau}_2 = x$), always with the restriction that the government budget is balanced. This choice has been done for convenience, as it keeps the model symmetric and allows us to obtain some analytic results. Nevertheless, in order to understand the optimal policy for a country we need to analyze different possible scheme of response. In this section we consider two other potential responses of a government to a change in tax policy of the other government; we calculate the utility under the best choice in each case; finally, we compare the utilities to understand what equilibrium (although restricted to the considered strategies) prevails.

When Home plays ($\tau_1 = x, \tau_2 = y$), we assume that Foreign can respond:

1. symmetrically (as we have assumed so far) so that ($\tilde{\tau}_1 = y, \tilde{\tau}_2 = x$);

2. by matching the choice of Home ($\tilde{\tau}_1 = x, \tilde{\tau}_2 = y$);

3. by doing nothing ($\tilde{\tau}_1 = 0, \tilde{\tau}_2 = 0$).

[13] The rationale for this assumption is that sale taxes generate other distortions in the economy that are not captured by this model.

Given the structure of the problem analyzed so far, we think that these types of interaction are the most relevant to understand what choice prevails. We concentrate on the intermediate phase ($T = 1.34$) which, as seen above, is the most interesting and relevant for policies. As the benefits of positive tax come from agglomeration while the costs come from the distortions generated before (or after) agglomeration, there are only two possible rationales to respond to a tax policy: compete for the agglomeration of the targeted sector or accommodate and get agglomeration in the other sector. Certainly, the government can always do nothing, if it worries about the distortions taxation induces.

We simulate what happens in response to a Foreign policy of a subsidy to sector 2 financed by a tax on sector 1 such that the government budget is balanced; we analyze the response strategy 2. above, i.e. Home matches the Foreign policy and leaves that the tax, set by Foreign, determines the specialization pattern, and the response strategy 3. above, i.e. Home does not respond. The response strategy 1. has been analyzed earlier. In each of these response strategies, we simulate the welfare of the citizens in order to select the best choice available, and then we compare the best choice of each response scheme. This restriction on the potential strategies played is needed in order to keep the model tractable.

First let's consider the case of no response to tax/fiscal incentives (case 3. above). If Home charges no taxes in response to a balanced budget policy of Foreign that subsidize sector 2 and taxes 1, the effect is illustrated in figure 15. Up to the point where complete specialization is reached, Home asymmetrically receives larger advantages, due to increasing agglomeration, without domestic taxes. At the agglomeration point, nevertheless, now reached for $\tilde{\tau}_1 = 0.006$, the utility reached by the two countries is the same and it is equal to the utility level reached for the symmetric case because now the tax on the agglomerated sector is endogenously 0.[14] It is clear that, even in this case, the optimal tax rate for Foreign when Home does not react is the minimal tax that induces agglomeration. The utility reached in this case is the same as in the symmetric case.

The case in which taxes of Foreign are exactly matched by Home generates a situation in which both countries' willingness to produce in industry 2 increases as $\tilde{\tau}_1$ increases. Until a de-agglomerated equilibrium exists, i.e. until both countries have still an incentive to produce in sector 1, utility falls as $\tilde{\tau}_1$ increases (see figure 16). For high taxes on sector 1, in our case larger than 0.3%, both countries would like to specialize in sector 2 and the first country to achieve this (say Foreign) forces the other country (say Home) to specialize in the other sector, thereby breaking the matching strategy and forcing τ_1 to 0. In this case too the best policy for Foreign is to chose the

[14]Recall that, as we impose balanced budget, if one country agglomerates in one industry only the rate on that industry has to be 0.

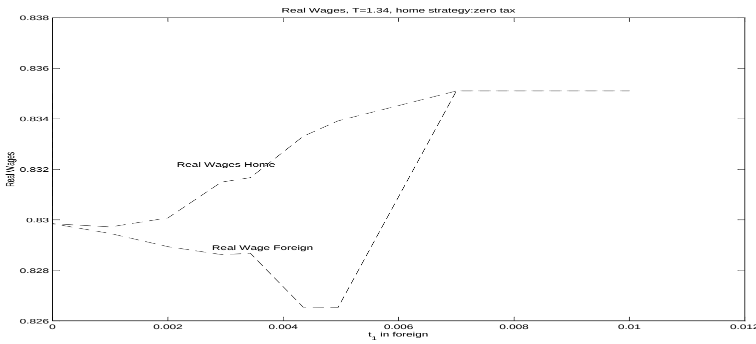

Figure 15: No Home response to Foreign subsidy

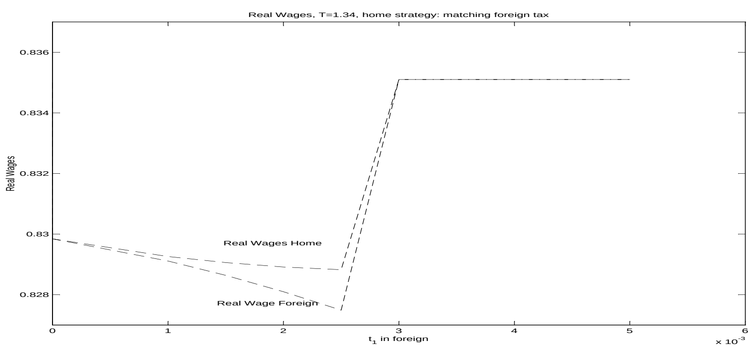

Figure 16: Symmetric Home response to Foreign subsidy

smallest tax that generates agglomeration.

To sum up, the best policy under the three response strategies analyzed here is to choose the minimum taxes that generate agglomeration. The only risk is that, due to lack of information between the two countries, a government chooses some tax level, different from 0, which would not be enough to induce full agglomeration, therefore only paying the cost of distortion. This model therefore shows that coordination, or at least full knowledge of the other government's strategy, is very important to achieve efficient policies. Lacking this knowledge, it may be better to impose no tax rather raising taxes that generate distortions without benefits.

7 Conclusions

This paper uses the frame of the "new geography" models to analyze the effect of fiscal policy on the pattern of international specialization. Contrarily to well-known models of international fiscal competition that focus on the effect of taxation on mobile factors, this model considers the effect of industry-specific sale taxes on international specialization in an international setting where countries become increasingly more integrated thanks to the reduction of transport costs. The interesting and novel message emerging from our analysis is that there is a phase during which industry-specific taxes generate specialization and improve social welfare. This phase, that we call the "intermediate" phase of the globalization process, resembles the situation that Europe is experiencing in the present years: technological increasing returns are strong enough to support agglomeration, but local barriers are still strong and prevent the agglomerations to arise endogenously. During this phase, the government may attempt to actively affect the pattern of specialization of a country by taxing less the sector in which it wishes to specialize. In so doing, the government ensures future specialization of the country in that sector and also improves, in the medium run, the welfare of its citizens by increasing the efficiency of production thanks to agglomeration economies.

Therefore, national governments have an unprecedented but perhaps brief opportunity to affect the geography of specialization of Europe. The key instruments are not trade policies - long gone in the European Union - but fiscal policies, namely taxation of factors and sectors that favors some products against others. In our model we have assumed that either sector is identical in terms of productivity, so that all the benefits come from specialization that takes advantage of the backward linkages of production. If one sector is more productive than the other, there may be an advantage, besides the benefits of specialization, in anticipating the other governments and appropriating the more productive sectors using fiscal incentives. Notice that the policies analyzed in this paper generate agglomeration even in the absence of international labor mobility, still a characteristics of the European labor markets.

Potentially the model could be extended to two factors of production to show that differential taxation of the two factors delivers similar results, as it generates agglomeration in the sector intensive in the less heavily taxed factor. This is a reason for countries such as Italy - that, still in the 80's, taxed capital more heavily and labor less heavily than Germany and France (see Mendoza et al [8]) - to re-assess their factor-taxation policy.

A Appendix 1

The model we solve consists of the following nine equations for the Home country (and nine symmetric equations for the Foreign country):

$$w_1 = 1 \tag{A.1}$$

$$\left[\frac{w_2^{\beta} G_2^{\alpha} G_1^{\gamma}}{1-\tau_2}\right]^{\sigma} = \beta \left[E_2 G_2^{\sigma-1} + \tilde{E}_2 (\tilde{G}_2)^{\sigma-1} T^{1-\sigma}\right]. \tag{A.2}$$

$$p_1(1-\tau_1) = w_1^{\beta} G_1^{\alpha} G_2^{\gamma} \tag{A.3}$$

$$p_2(1-\tau_2) = w_2^{\beta} G_2^{\alpha} G_1^{\gamma} \tag{A.4}$$

$$G_1^{1-\sigma} = l_1 w_1^{1-\beta\sigma} G_1^{-\alpha\sigma} G_2^{-\gamma\sigma} \left(\frac{1}{1-\tau_1}\right)^{1-\sigma} + \tilde{l}_1 \tilde{w}_1^{1-\beta\sigma} \tilde{G}_1^{-\alpha\sigma} \tilde{G}_2^{-\gamma\sigma} \left(\frac{T}{1-\tilde{\tau}_2}\right)^{1-\sigma}, \tag{A.5}$$

$$G_2^{1-\sigma} = l_2 w_2^{1-\beta\sigma} G_2^{-\alpha\sigma} G_1^{-\gamma\sigma} \left(\frac{1}{1-\tau_2}\right)^{1-\sigma} + \tilde{l}_2 \tilde{w}_2^{1-\beta\sigma} \tilde{G}_2^{-\alpha\sigma} \tilde{G}_1^{-\gamma\sigma} \left(\frac{T}{1-\tilde{\tau}_1}\right)^{1-\sigma}, \tag{A.6}$$

$$E_1 = \left[\frac{w_1 l_1 + w_2 l_2}{2}\right] + \left[\frac{\alpha w_1 l_1 + \gamma w_2 l_2}{\beta}\right] + \frac{\phi}{\beta}\left[\frac{\tau_1 w_1 l_1}{1-\tau_1} + \frac{\tau_2 w_2 l_2}{1-\tau_2}\right], \tag{A.7}$$

$$E_2 = \left[\frac{w_2 l_2 + w_1 l_1}{2}\right] + \left[\frac{\alpha w_2 l_2 + \gamma w_1 l_1}{\beta}\right] + \frac{1-\phi}{\beta}\left[\frac{\tau_2 w_2 l_2}{1-\tau_2} + \frac{\tau_1 w_1 l_1}{1-\tau_1}\right], \tag{A.8}$$

$$\frac{\tau_1 w_1 l_1}{\beta(1-\tau_1)} + \frac{\tau_2 w_2 (1-l_1)}{\beta(1-\tau_2)} = G_1 g_1 + G_2 g_2, \tag{A.9}$$

B Appendix 2

The fully agglomerated equilibrium is characterized by the following values:

$$G_1 = \frac{T^{\frac{\gamma\beta}{\beta\sigma-1}}}{(1-\tau_1)^{\frac{1-\sigma}{1-\beta\sigma}}}, \qquad G_2 = T G_1, \tag{B.10}$$

$$E_1 = \frac{1}{2} + \frac{\alpha}{\beta} + \phi \frac{\tau_1}{\beta(1-\tau_1)}, \quad E_2 = \frac{1}{2} + \frac{\gamma}{\beta} + (1-\phi)\frac{\tau_1}{\beta(1-\tau_1)}. \tag{B.11}$$

C Appendix 3

From equation 14 we can find the condition that ensures the sustainability of the fully agglomerated equilibrium. This condition is that the right hand side of the expression is smaller than one, namely

$$T^{\gamma-\alpha}\left(\frac{1-\tau_2}{1-\tau_1}\right)\left\{\frac{T^{1-\sigma}}{2}\left[(1-\gamma+\alpha)(1-\tau_1)+2\phi\tau_1\right]\right. \tag{C.12}$$

$$\left.+\frac{T^{\sigma-1}}{2}\left[(1+\gamma-\alpha)(1-\tau_1)+2(1-\phi)\tau_1\right]\right\}^{\frac{1}{\sigma}}<1.$$

Isolating τ_2 on one side of the inequality we have that the lower bound for that parameter, still ensuring agglomeration in sector 1, is:

$$\tau_2>\frac{B-1}{B} \tag{C.13}$$

where

$$B=T^{\gamma-\alpha}\left(\frac{1}{1-\tau_1}\right)\left\{\frac{T^{1-\sigma}}{2}\left[(1-\gamma+\alpha)(1-\tau_1)+2\phi\tau_1\right]\right. \tag{C.14}$$

$$\left.+\frac{T^{\sigma-1}}{2}\left[(1+\gamma-\alpha)(1-\tau_1)+2(1-\phi)\tau_1\right]\right\}^{\frac{1}{\sigma}}.$$

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