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# Tax competition and agglomeration: Main effects and empirical implications

Rikard Forslid*

## Summary

■ This paper summarises some new aspects of tax competition that arise in the new economic geography literature. Generally, in this literature, factors influencing the strength of agglomeration forces matter for tax competition. In particular commodity trade costs are important, and have a non-monotone effect. These effects seem to be at best imperfectly accounted for in the empirical literature to date as revealed by a random pick of some recent empirical studies on tax competition. ■

**JEL Classification**: F12, F15, F21, R 12.
**Key words**: Agglomeration, new economic geography, tax competition.

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# Tax competition and agglomeration: Main effects and empirical implications

Rikard Forslid*

One aspect of the formation of a single market in Europe with free mobility of goods, capital and labour is that it may lead to increased tax competition for mobile factors. That is, governments may be inclined to cut taxes to attract mobile factors—thereby expanding the tax base. This is a matter of concern, in particular in countries with a large public sector and high taxes such as Sweden.

The purpose of this paper is to summarise some new aspects of tax competition that arise in the new economic geography (NEG) literature, and to investigate to what extent these aspects are accounted for in the empirical literature. The NEG literature analyses the relationship between trade integration and industrial location with a particular focus on the tendency for industry to cluster or agglomerate geographically. The seminal papers in the NEG literature are Krugman (1991), Krugman and Venables (1995) and Venables (1996), which show how economic integration can lead to increased concentration of industrial production.[1] The literature is based on the Spence-Dixit-Stiglitz framework of increasing returns to scale and monopolistic competition, together with trade costs. A key feature in these models is that once production has agglomerated in a region, it tends to get stuck there because of demand and supply linkages. A consequence of this is that mobile factors respond less, and possibly not at all, to changes in tax rates if they are located in an industrial cluster.

The existing standard literature on tax competition is vast and goes back to the work on fiscal federalism (Oates, 1972). In the late 1980's, a "standard model" of tax competition emerged (see e.g. Wildasin,

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[1] A recent description of the different brands of new economic geography models can be found in Baldwin et al. (2003).

1988; and de Crombrugghe and Tulkens, 1990). Contrary to the new economic geography literature, the standard model typically assumes perfect competition and that economies are characterized by production functions exhibiting decreasing returns to capital. Increasing the tax rate on capital in one region creates a "fiscal externality" in other regions because the tax increase leads to capital inflow to other regions. In equilibrium, when regions set tax rates non-cooperatively to maximize welfare, taxes tend to be distorted downwards.

Relatively few papers to date address issues of taxes and tax competition in an economic-geography framework. A recurrent observation made in this work, however, is that, once realized, agglomeration economies attenuate tax competition (Ludema and Wooton, 2000; Kind et al. 2000; Andersson and Forslid, 2003). Another observation made by Baldwin and Krugman (2004) is that it may be possible for a dominating country—in the sense of being larger and/or a first mover—to practice "limit taxing"; i.e., to set taxes in such a way that the non-dominating country's optimum choice of taxes does not upset agglomeration in the dominating country.

A model with a home market bias in the procurement of public goods, which constitute a dispersion force, is analysed by Trionfetti (2001). Finally, Forslid and Midelfart Knarvik (2005) analyse optimal taxation of an industrial cluster of upstream and downstream goods.

The theory section in this paper derives some of the main effects of taxes using a simple version of an NEG model developed by Martin and Rogers (1995). Strategic interaction between governments is ruled out to keep things as simple as possible. Agglomeration is driven by market access in all NEG-models, which makes trade costs a crucial parameter in the analysis.

The paper is organised as follows: The next section, Section 1, discusses the main results from the standard tax competition model. Section 2 develops a simple new economic geography model and analyses the effect of tax competition on the long-run equilibrium location of industry in this model. The effect of tax competition is compared to the standard tax competition analysis. Some empirical studies are discussed in Section 3 and, finally, Section 4 concludes.

## 1. Some central results from the standard tax competition literature

The early public choice literature, for example Tiebout (1956), viewed inter-jurisdictional tax competition as a form of competition that tends to be welfare enhancing, since it forces governments to be efficient. By contrast, the dominant theme in the modern public economics literature is a "race to the bottom", that is, the assertion that competition for a mobile tax base produces sub-optimally low taxes, with the mobile factor bearing too little of the tax burden. The reason for this is that when a jurisdiction non-cooperatively selects a tax rate, which attracts a mobile tax base from another jurisdiction, it exerts a negative externality on the jurisdiction losing some of its tax base. The seminal papers here are Gordon (1983), Zodrow and Mierzkowski (1986), Wilson (1986), and Wildasin (1988), with subsequent important contributions by de Crombrugghe and Tulkens (1990), Bucovetsky (1991), Wilson (1991), Wildasin (1991), Kanbur and Keen (1991), and Edwards and Keen (1996).

A major proviso to the sub-optimal-taxation result is the so-called Leviathan government hypothesis, which asserts that self-interested policy makers tend to set taxes too high. Viewed from this perspective, a race-to-the-bottom in taxes on mobile factors may actually yield a welfare improvement (in the second-best meaning).

Almost the entire standard tax competition literature focuses on capital mobility as the sole dimension of economic integration. For instance, most models assume that a single output is produced and that this output is traded at zero cost. An exception is the model developed by Janeba (1998), where tax competition is introduced into a strategic trade model.

The reason for diminishing returns to capital in the standard tax competition literature is the presence of a fixed factor of production. A second set of results corresponds to the implications of asymmetric country size as measured by the supply of this fixed factor. To be specific, consider a model with two nations and two factors of production; capital, K, and labour, L. Each Walrasian (perfect competition and constant returns) economy produces the same, homogenous private good using these two factors. This good is traded costlessly, so that international prices are equalised but factor prices are not (since there are more factors than goods). Capital can move internationally while workers are assumed to be perfectly immobile (capital

owners may also be immobile since they do not have to move with the capital). Capital and labour are taxed in the nation where they are employed (that is, source-based taxes are used). Assume also that one country is considerably larger than the other, but that the relative factor endowments are identical. Free mobility of capital implies that capital will move to equalise after tax returns to capital:

$$\left(1-t^{L}\right)\pi^{L}=\left(1-t\right)\pi, \tag{1}$$

where $t$ is the tax rate, $\pi$ is return to capital, and superscript $L$ indicates the large country.

Suppose now that the large country raises its tax rate on capital. This leads to some outflow of capital, which lowers the return to capital in the small country until the equality in (1) is restored. Note, however, that if the size difference between the two countries is very large, the effect on the capital stock and the return to capital in the large country is very small, the reason being that the outflow of capital necessary to restore the equality in (1) will be negligible in relation to the large country's capital stock. This country is consequently free to set taxes without worrying too much about capital outflows. The situation for the small country, however, is very different. A tax increase in this country will lead to an outflow of capital. This has negligible effects on the large country, and (1) will therefore be restored by an increase in $\pi$, which is created by a reduction in the capital-labour ratio in the small country (diminishing returns to capital ensures that a reduction in $K/L$ increases the real return to capital). A small country will, thus, be constrained in raising taxes by the resulting capital outflows. Put differently: A large country will experience a lower relocation elasticity of its capital stock with respect to changes in the tax rate than a small one. As a consequence, the large country will, *ceteris paribus*, tend to set a higher tax rate in equilibrium.

A corollary to the result that larger countries set a higher tax on capital is that they should be exporters of capital and small countries importers of capital, i.e. capital should flow from large countries with a relatively low capital to labour ratio to smaller countries with relatively higher capital to labour ratios. This implies that capital flows from poor (large) countries to rich (small) countries when richness is defined in terms of per capita income. Other things equal, this also means that small nations should have higher per capita incomes. Sec-

ond, since large countries should have higher tax rates and lower capital labour ratios, we should empirically observe a negative correlation between tax rates and capital labour ratios.

Expanding the model to allow for different taxes on labour and capital, it is obvious that all governments will set zero tax rates on capital but positive rates on labour, in the presence of capital mobility. The reason is quite simple. Since workers own all capital in the representative consumer setting, income-distribution considerations are absent, so the government chooses the most efficient tax structure. With capital mobility, capital taxation is distortionary, but labour taxation is not. As a result, there should be a negative correlation between capital mobility and capital's share of the tax burden.

When capital is immobile, the tax structure is not uniquely determined. That is, the level of taxation will rise until its marginal benefit equals its marginal cost, but the division of this tax burden between K and L is indeterminate because both factors are supplied inelastically. Stepping slightly outside the model, however, and allowing for an unequal distribution of capital among workers, income distribution considerations would resolve the indeterminacy of the tax structure. The exact tax rate on capital would depend on the specific setting, but it would not be zero as it is with capital mobility.

As we shall see in the following section, the analysis of capital taxation in a new economic geography framework leads to some new insights, since it enriches the underlying economy.

## 2. A simple new economic geography model

We here use the model developed by Martin and Rogers (1995), sometimes referred to as the footloose capital (FC) model. It has the advantage of being considerably simpler than the seminal new economic geography models by Krugman (1991), Venables (1996) and Krugman and Venables (1995) (see the contribution by Richard Baldwin in this issue for a presentation of this model).

All new economic geography models show how the manufacturing sector, which consists of firms producing differentiated products under increasing returns to scale, may agglomerate in one region when trade costs are low. Typically, agglomeration of the manufacturing sector is the result of demand and supply linkages: With the Chamberlinian large group assumption, firms set price as a constant markup on marginal cost which, in turn, implies operation profit to be a

constant fraction of nominal sales. Suppose now that there are two markets of different size separated by trade costs. Firms clearly prefer, *ceteris paribus*, to locate in the large market to minimise trade costs and maximise sales and operating profits. Consequently, there will be a *proportionally* larger equilibrium share of manufacturing firms in the larger market, because it provides better market access.[2] This is the "home-market" effect identified by Krugman (1980) and Helpman and Krugman (1985). Combining this effect with expenditure shifting creates a circular causality that may produce agglomeration. Such agglomeration is obtained in Krugman (1991) by having labour moving with firms, and in Krugman and Venables (1995) and Venables (1996) by assuming that firms buy goods from each other as intermediate inputs. The home market effect and expenditure shifting together are named the demand linkage in the new economic geography literature. The second agglomeration force is called the supply linkage, which stems from the fact that a region with many firms has a lower price index with CES preferences. The demand and supply linkages imply positive feedback creating the possibility of highly non-linear dynamics.

It should be noted, however, that agglomeration may happen for other reasons than demand and supply linkages. Examples are technology spillovers or labour market pooling, in which case trade costs may be less crucial. These latter types of agglomeration forces have a limited geographical reach, but may be important to explain agglomerations or clusters such as Sillicon Valley or the IT-cluster in Kista Stockholm. The geographical scope of agglomerations based on market access, as modelled in the NEG-literature, is larger; for instance the entire market in a country.

The FC-model used here is similar in structure to the core-periphery model by Krugman (1991). However, the mobile factor is physical capital rather than labour, and the return to capital is repatriated to immobile owners. Because physical capital moves according to nominal returns and is unaffected by the price index, the supply linkage is absent from this model. Moreover, there is no expenditure shifting since the return to capital is repatriated. Taken together, this implies that there is no circular causality which, in turn, makes the dynamics much simpler. In particular, starting from a symmetric equi-

[2] An exception is when a physically smaller market actually provides better access e.g. because of asymmetric trade costs.

librium, there will be no relocation of capital and industry as trade costs are reduced. However, when regions are of asymmetric size, the home market effect will still gradually cause agglomeration as trade costs are reduced. Thus, the model is simple and analytically solvable, but it can still produce agglomeration of industry when regions are inherently asymmetric.

### 2.1. Basics

There are two countries (or regions), called 1 and 2, two sectors, called agriculture and manufacturing, and two factors, called labour and capital. Physical capital, amounting to $K^W$ worldwide, can move freely between regions, but capital owners cannot. Workers can move freely between sectors but are immobile between regions. Country $j$ is endowed with the share $s_j$ of the world endowment of labour, $L^W$, and capital, $K^W$. This assumption implies that countries may be of different size, but they have identical capital-labour ratios. A homogeneous good ($A$ for agriculture) is produced with a constant-returns technology only using labour, while differentiated manufactures ($M$) are produced with increasing-returns technology using both capital and labour.

Each country employs a tax rate $t_j$, $j$ = 1,2, on capital and, for simplicity, it is assumed that the proceeds from the tax are spent according to the average consumption basket. That is, the government spends its tax revenues in exactly the same way as private agents spend their income. This implies that aggregate world expenditures are unaffected by the size of the tax.[3] All individuals have the following Cobb-Douglas utility function

$$U = C_M^{\mu} C_A^{1-\mu}, \tag{2}$$

[3] An alternative is to assume that tax revenues are used to produce a public good. This produces similar results but complicates the analysis. See Andersson and Forslid (2003).

where $\mu$ is the constant budget share spent on manufacturing products and $C_A$ is consumption of the homogenous agricultural good. Manufactures enter the utility function through the index $C_M$ defined by

$$C_M = \left[ \int_0^N c_i^{\frac{\sigma-1}{\sigma}} di \right]^{\frac{\sigma}{1-\sigma}}, \tag{3}$$

$N$ being the mass of varieties consumed, $c_i$ the amount of variety $i$ consumed, and $\sigma$ the elasticity of substitution.

It is well-known from the literature on trade under monopolistic competition that the resulting expression for demand in country $j$ for a domestically produced variety is

$$c_{ij} = \mu \frac{p_i^{-\sigma}}{\int_{k=1}^{N} p_k^{1-\sigma} dk} E_j, \tag{4}$$

where $p_i$ is the price of variety $i$, and $E_j$ total expenditures in country $j$.

The unit factor requirement of the homogeneous good is one unit of labour. This good is freely traded and chosen as the numeraire, implying that wages will be equal to one in both countries (i.e. $p_A = w = 1$). In the production of differentiated goods, the fixed cost consists of capital whereas the variable cost consists of labour. The total cost of producing $x_i$ units of manufactured commodity $i$ in region $j$ is

$$TC_{ij} = \alpha \pi_j + \beta x_i, \tag{5}$$

where $\alpha$ is the fixed cost of capital, and $\beta$ the requirement of unskilled labour per unit $x$. The units of capital are chosen so that $\alpha = 1$, which implies that the world capital stock equals the world mass of firms $K^W = N^W$.

Ownership of capital is assumed to be fully internationally diversified. Suppose that capital owners in country $j$ own a share $s_j$ of the total capital stock. They will then own a share $s_j$ of the capital stock in each country and pay $s_j\left(t_j n_j \pi_j + t_k n_k \pi_k\right)$ in taxes, where $n$ is a measure of the number of manufacturing firms in a region. Tax reve-

nues in country *j* are $t_j n_j \pi_j$. Taken together, this implies that expenditures in country *j* are given by

$$E_j = s_j\left(L^W + \bar{\pi}K^W\right) + \left(1 - s_j\right)t_j n_j \pi_j - s_j t_k n_k \pi_k, \tag{6}$$

where $\bar{\pi}$ is the average return to capital. The average return to capital is determined by the condition $K^W\bar{\pi} = \mu E^W/\sigma$, which states that the world return to capital equals the world operating profit.[4] World expenditure, in turn, simply equals world factor income $E^W = L^W + \mu E^W/\sigma$, since tax revenues are spent according to the average consumption basket. This gives $E^W = L^W/\left(1-(\mu/\sigma)\right)$ and the average return to capital is therefore constant and given by[5]

$$\bar{\pi} = g\frac{L^W}{K^W}, \qquad g \equiv \frac{\mu}{\sigma - \mu}. \tag{7}$$

Distance is represented by trading costs. Shipping the manufactured good involves a frictional trade cost of the "iceberg" form: for one unit of good from country j to arrive in country k, $\tau_{jk} > 1$ units must be shipped. Trade costs are also assumed to be equal in both directions so that $\tau_{jk} = \tau_{kj}$.

Profit maximisation by manufacturing firms leads to producer price

$$p = \frac{\sigma}{\sigma - 1}\beta \tag{8}$$

for each differentiated product.[6] By choosing units of $x$ so that $\beta \equiv (\sigma - 1)/\sigma$, we get $p = 1$.

[4] The operating profit is simply $1/\sigma$ times sales because of constant markup pricing.

[5] Note that $\bar{\pi}$ and therefore $Y_j$ are constant irrespective of the location of capital, i.e. even if we are out of the long-run equilibrium. This feature of the model makes it considerably easier to solve.

[6] Note that the price will be the same everywhere because wages are the same everywhere, which is why we have dropped the region subscript.

There is a fixed capital stock and capital owners will receive the entire Ricardian surplus; that is, the reward to the capital operating in region j will equal the operating surplus of firms producing in this region,

$$\pi_j = (1-\beta)x_j, \tag{9}$$

which, using the definition of $\beta$, implies that

$$x_j = \sigma\pi_j. \tag{10}$$

### 2.2. Short-run equilibrium

In the short run, the allocation of $N^W$ is taken to be fixed. The model is closed by imposing market clearing for manufacturing products; that is, we set supply, given by (10), equal to the sum of demand from both regions given by expressions such as that in (4). Exploiting the property that the producer price of all varieties is equal to one, we get

$$\sigma\pi_j = \frac{\mu E_j}{P_j^{\sigma-1}} + \frac{\phi_{jk}\mu E_k}{P_k^{\sigma-1}}, \tag{11}$$

where

$$P_j^{1-\sigma} = n_j + \phi_{jk} n_k, \tag{12}$$

$n_j$ is the mass of varieties produced in region $j$ and $\phi_{jk} \equiv \tau_{jk}^{1-\sigma}$ is a parameter ranging between 0 and 1, which captures the "freeness" of trade between the two regions (0 is autarky and 1 is completely free trade).

These equilibrium conditions hold under the condition that the agricultural sector, which pins down the wage rate, is active in all regions. A sufficient condition for this is that any region would maintain some agricultural production even if all manufacturing industry were to locate in that region. The amount of labour employed in manufacturing equals $N^W\beta x$. To rule out corner solutions, we must then ensure that for both regions, there will be some labour left for the agricultural sector even if they end up producing all manufactur-

ing output. Substituting $x$ from (10) gives $N^W \beta x_j = N^W(\sigma\text{-}1)\pi_j$, which tells us how much labour will be employed in manufacturing in country $j$ if that country ends up hosting all manufacturing industry. We rule out corner solutions by assuming that the condition $s_j \geq \left((\sigma-1)\pi_j N^W\right)\Big/ L^W = g(\sigma-1)$ holds for any region $j$ hosting all manufacturing industry.

### 2.3. Long-run equilibrium

In the long run, capital is fully mobile between countries and responsive to the incentives provided by the after tax returns that can be attained in the two countries. There are two types of long-run equilibria; (i) interior equilibria characterised by the allocation of some capital in each country and the same after tax return to capital in the two countries and (ii) corner solutions entailing one country without any capital because capital would enjoy a lower return in that location.

Contrary to most new economic geography models, the model in this paper does not display circular causality and, accordingly, it does not display multiple equilibria or bifurcations. The reason is that the usual demand and supply links are absent, since return to capital is repatriated and capital moves according to nominal return which removes the price index effect. However, due to the "home market effect", the model still produces agglomeration when regions are of different size. Essentially, this is a market access effect; the manufacturing sector saves transport costs by concentrating in larger markets. However, increased local competition when firms concentrate in one market dampens this effect, and precludes full agglomeration from always being the equilibrium.

Assuming symmetric trade costs, and using (6), (7), (11), and (12), the model may be solved for interior equilibria where

$$(1-t_1)\pi_1 = (1-t_2)\pi_2. \tag{13}$$

### 2.4. Welfare

The nominal wage is constant and equal in all countries, as is the nominal return to capital, given by (7). However, a region with many firms has a higher real wage and return to capital, since more varieties are sold without trade cost in this region, which makes the price index

lower. The tax rate and the price index therefore determine welfare. Solving the model for an interior equilibrium using (6), (7), and (11) gives the price index:

$$P_j = \left[(1+\phi)s_j\right]^{-a}, \qquad a \equiv \frac{\mu}{\sigma - 1}. \tag{14}$$

In this model, higher trade freeness will always lead to a higher real wage as shown by the equation above, even if a region or country is losing its entire manufacturing base in the process. This feature of the model indicates that it is a bit too stylised for being used as the basis of a serious welfare analysis. Many potential rationales for regional policy are outside the model, e.g. localised pure externalities associated with production, and adjustment costs associated with changes in employment or location. Because of this, we will not consider effects on welfare in the subsequent analysis, but instead focus on the positive implications of this analysis.

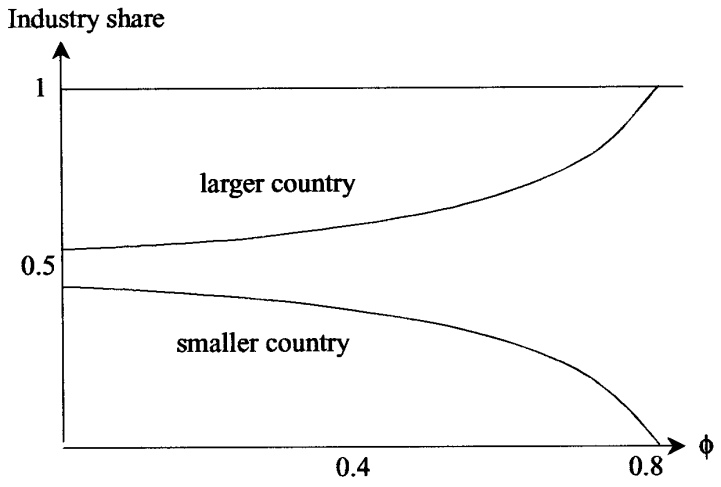
*The case with no taxes, $t_1$=$t_2$=0*

To illustrate the effects of agglomeration forces in the model, we will first analyse a case with no taxes. Note that we have assumed that trade costs are symmetric, implying that $\phi \equiv \phi_{jk} = \phi_{kj}$. The location of capital for $t_1 = t_2 = 0$ is then given by

$$n_j = \frac{1}{2} + \left(s_j - \frac{1}{2}\right)\frac{1+\phi}{1-\phi}. \tag{15}$$

Thus, the mass of firms in a region depends on its size and the level of trade costs. Note that the only parameters determining location are $\phi$ and $s_j$; the manufacturing consumption share $\mu$ is absent since only relative market size is of importance. The agglomeration effect is easily seen from (15), which shows that $n_j$ increases more than proportionally to $s_j$ for $\phi > 0$. The effect increases in trade freeness and becomes arbitrarily large as trade costs approach zero. This implies that even if we start out with one region just slightly larger than the others, it will obtain the entire manufacturing sector if trade costs are sufficiently low, as illustrated in Figure 1, where we have assumed that $s_1$=0.55.

**Figure 1. The effect of economic integration (lower trade costs)**



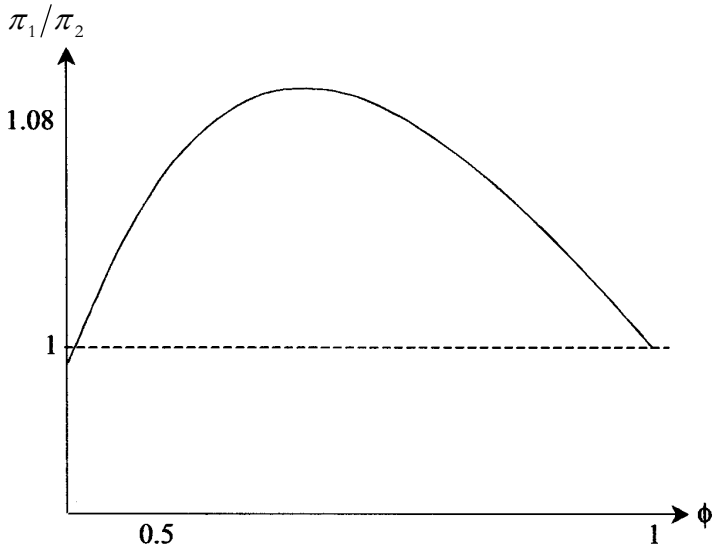

We reach a corner solution with all manufacturing industry in the larger region j exactly when $\phi = \left(1 - s_j\right) \Big/ s_j$. After this point, the net returns to capital will cease to be equalised, and further integration (increase in $\phi$) leads to a divergence in the profits of firms in the large region and the profit that a deviating firm would earn in the small region.

Figure 2 shows relative operating profits $\pi_1 / \pi_2$, which is a measure of the agglomeration rents, as a function of $\phi$.[7] Parameters $\mu$ and $\sigma$ now matter and determine the strength of the agglomeration forces. A higher $\mu$ implies a higher expenditure share on manufacturing goods and therefore, a stronger tendency for production to concentrate in the large market. A lower elasticity of substitution $\sigma$ means more market power for each individual firm and therefore, a higher price mark-up on marginal cost. The notable feature of Figure 2 is that agglomeration rents are hump-shaped in trade freeness. This is a common feature of the NEG models and is explained by the following intuition: trade is costly when $\phi$ is low, which counteracts agglomeration, since agglomeration means that the periphery has to be served by export. It becomes more attractive to locate in the large

[7] In this figure, we have assumed that $s_1 = 0.7$, $\mu = 0.3$ and $\sigma = 4$.

market (agglomerate) as trade costs fall and exports become easier, and we therefore see a gradual relocation of industry towards the large country. The magnitude of relocation is regulated by the condition that firms must earn equal profits in both markets. However, equalisation of profits ceases to hold once full agglomeration is attained, since no more relocation is possible. Further increases in $\phi$ therefore lead to an increase in $\pi_1/\pi_2$, where profits in the region without any manufacturing production is defined as the profit of a marginal firm that deviates to this market. But market access also becomes less important as trade costs are reduced and, at free trade, location does not matter at all. Agglomeration rents must therefore start to decline at some level of trade freeness, which produces the hump-shaped relationship between trade freeness and these rents.

**Figure 2. Hump-shaped agglomeration rents**



*The case with taxes*

Next we introduce taxes in the model. We will start by analysing the effect of taxes for interior solutions; that is, when both countries host some manufacturing production. The interior solution with positive and symmetric taxes, corresponding to (15), is given by

$$n_j = \frac{1}{2} + \left( s_j - \frac{1}{2} \right) \frac{tb - 1}{tb - Z}, \tag{16}$$

where $t_1 = t_2 = t$, $b \equiv \mu/\sigma$ and $Z \equiv (1-\phi)/(1+\phi)$. $b$ is a measure of agglomeration forces and $Z$ a measure of trade costs ranging from zero (free trade) to one (autarky). Lower trade costs ($Z$) will again lead to increased concentration of firms in the larger region. The introduction of taxes in the model implies a new demand link since a larger region, which attracts more firms, will have a larger tax base which, in turn, means higher expenditures in that region. The higher the *general* tax level, $t$, the stronger is this effect, as can be seen from (16). That is, a higher general tax level will lead to a stronger concentration of firms in the large region. It may also be noted from (16) that the agglomeration force introduced by taxes is increasing as trade costs ($Z$) are reduced.

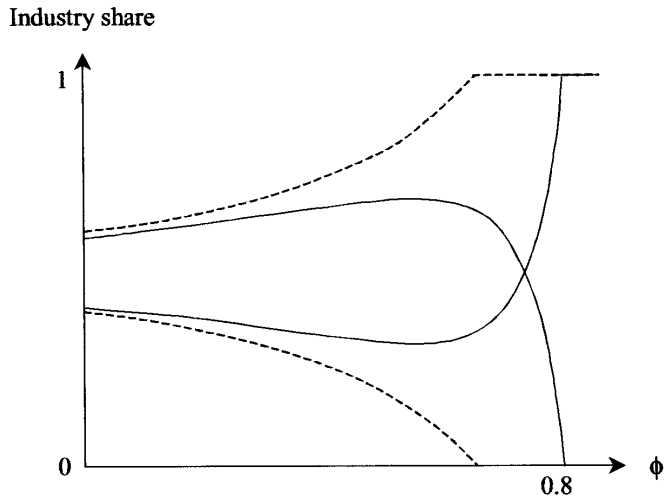
Next, consider the effect of a unilateral tax increase. The effect of a small tax increase in country $j$, evaluated at zero taxes, is given by

$$\left. \frac{dn_j}{dt_j} \right|_{t_1 = t_2 = 0} = -\frac{(1 - s_j)(1+\phi)\left[ b\phi + s_j(1-b)(1+\phi) \right]}{(1-\phi)^2} < 0. \tag{17}$$

A higher tax rate will lead to a loss of industry, and the magnitude of this effect depends positively on the level of trade freeness as seen from (17). It can also be seen that stronger agglomeration forces (higher $b$) will make the number of manufacturing firms in $j$ ($n_j$) less sensitive to taxes if the capital owners in region $j$ own a sufficiently large share of the total capital stock ($s_j$ is large enough).

The effect of taxes is illustrated in Figure 3, which plots (16) for a case where region 1's tax rate is higher than that of region 2.[8] As a comparison, the dotted curve shows the case without taxes. The figure illustrates how the higher tax rate in the larger region leads to a loss of industry compared to the zero tax case, and how this effect becomes more pronounced as $\phi$ increases (trade costs fall). Agglomeration forces decline for increases in $\phi$ from a sufficiently high level, as illustrated in Figure 2, and taxes will then dominate the location choice of firms.

**Figure 3. Industry location with taxes ($t_1 = 0.15$, $t_2 = 0.1$)**




The effect of the size of a country may be seen from

$$\frac{d}{ds_j}\left(\frac{dn_j}{dt_j}\right)\Bigg|_{t_1=t_2=0} = \frac{b(1+\phi)\phi + 2(s_j - 0.5)(1-b)(1+\phi)^2}{(1-\phi)^2}. \qquad (18)$$

This expression is positive for $s_j > 1/2$, meaning that increasing the size of the larger country decreases the elasticity of its capital stock

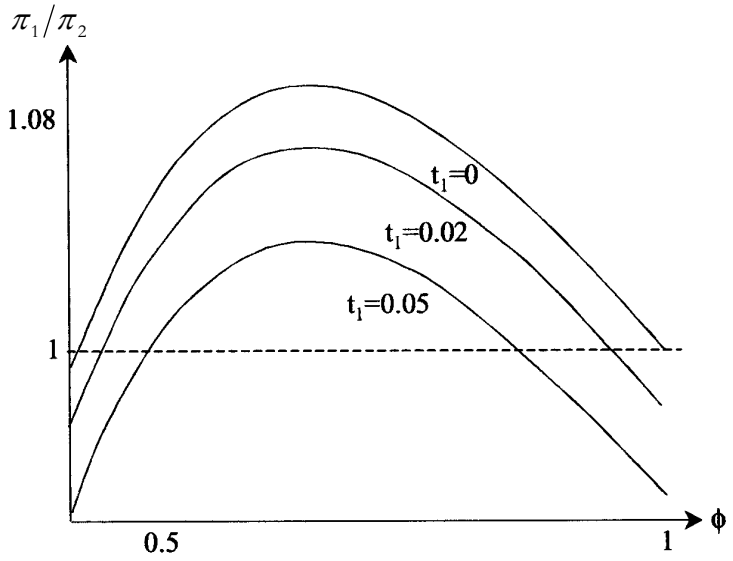
[8] The curve in figure 3 has been plotted for $t_1 = 0.15$, $t_2 = 0.1$, $s_1 = 0.6$, $\mu = 0.3$ and $\sigma = 4$.

with respect to taxes; a result we recognise from the standard tax competition model.

Next, we turn to the corner solution, when all manufacturing industry is agglomerated in the larger region. From (16), we find that we reach full agglomeration with no manufacturing industry in the smaller country whenever $\phi$ is higher than $s_j(1-tb)/(1-s_j(1-tb))$, $s_j$ now being the share of the smaller country. The expression clearly shows how the general level of taxes $t$ has the same effect as the agglomeration forces represented by $b$.

Figure 4 plots $(1-t_1)\pi_1/(1-t_2)\pi_2$ in the agglomerated case for different levels of $t_1$.[9] The uppermost curve in Figure 4 corresponds to the curve in Figure 2, where taxes are set to zero. Higher taxes make the large region less attractive and the parameter space for which agglomeration is sustainable in this region shrinks.

**Figure 4. Agglomeration rents with taxes**




Note that the hump-shaped nature of agglomeration rents means that the capital stock in the agglomerated region becomes elastic with respect to taxes also when trade freeness is high. We may therefore

[9] Other parameter values are $t_2 = 0$, $s_1 = 0.7$, $\mu = 0.3$ and $\sigma = 4$.

observe a non-monotone relationship between the degree of tax competition and the level of economic integration.

### *Summary of results*

Let us now summarise the results from the preceding analysis of tax competition in a simple new economic geography model. The first result is that the general level of taxes matters. High taxes constitute a reason for agglomeration even if they are symmetric between countries, since the tax revenues from capital taxes end up increasing the aggregate expenditures of the taxing country. A similar result is found in an alternative specification (Andersson and Forslid, 2003), where tax revenues are used to produce a public good. A country with a large manufacturing sector and high tax revenues produces more public goods, which again constitute a reason for locating in the larger region. Thus, the theoretical result that a higher general tax level constitutes an agglomeration force seems relatively robust. However, the empirical importance of this effect is not clear. A guess is that it is of second-order importance.

The second result from the preceding analysis is that it is important to distinguish between two cases: *a*) there is tax competition between two industrialised countries (or regions) where the marginal firm is almost indifferent between the two locations and *b*) there is tax competition between countries differing in their degree of industrialization, so that one country hosts an agglomeration of manufacturing industry while the other does not. The first case will be called "symmetric" tax competition and the latter "core-periphery" tax competition in what follows. The difference between the two cases is that firms will respond to marginal tax changes in the symmetric case, whereas this is not the case in the core-periphery case. Firms in the fully agglomerated country (or region) enjoy agglomeration rents, and firms will therefore not move out of the agglomeration because of higher taxes, as long as the tax difference is less than the agglomeration rent. An alternative interpretation of the analysis is that a country with an agglomeration in a *specific sector* has some freedom to tax this sector. This gives the government in the core country some freedom to set taxes without any locational effects.

This means that tax competition between an industrial nation and a developing country or between an industrial region and a rural region may be quite different from tax competition between two indus-

trial countries. When conducting empirical studies of tax competition using cross-country data, one should therefore allow for a difference between the symmetric and core-periphery tax competition case. Mixing the cases would lead to an underestimation of the elasticity of capital with respect to taxes when considering tax competition between industrial countries.

A third result is that the size of countries matters. The elasticity of capital with respect to taxes is lower in a larger region because of agglomeration forces. Interestingly, the same result appears in the standard tax competition model, although for very different reasons. Furthermore, stronger agglomeration forces make capital in the large region less sensitive to tax changes. This implies that the elasticity of "delocation"—the percentage response in the location of industry to a one percent change in the tax rate— should be different in sectors depending on the strength of agglomeration forces.

Finally, the new economic geography framework shows how commodity trade costs matter for agglomeration forces, and therefore for tax competition. High and very low trade costs are associated with weak agglomeration forces, whereas agglomeration forces are maximal for some intermediate level of trade cost. This non-monotone relationship between trade costs and agglomeration forces is a typical feature of NEG-models. The implication is that trade costs should be included as a control variable in empirical studies of tax competition, which should be included in a fashion that accounts for a non-linear and even non-monotone relationship.

## 3. Empirical literature on tax competition

The empirical literature on tax competition is large and has been surveyed in this journal by Devereux and Griffith (2002). This is not the place for another survey; instead, a few well-known recent contributions will be discussed to assess to what extent the effects described in this paper are accounted for.

Within the literature, there are two distinct approaches. The first directly estimates the interdependence of tax rates in different jurisdictions. That is, it estimates to what extent the tax rate in one jurisdiction reacts to a tax change in another jurisdiction. A problem here is that tax rates may be interdependent for other reasons than tax competition, for instance because of fiscal spillovers or common trends. An example of this type of study is Slemrod (2004), which

runs regressions explaining statutory and average corporate tax rates of OECD countries with time dummies and other controls as explanatory variables. According to Slemrod, capital mobility is an important explanatory variable, but he notes that a good measurement of this is hard to come by. Instead, he uses a measure of trade openness as a proxy for capital mobility and includes it in a linear fashion. The openness variable turns out to be negative or insignificant in the regressions. Another example of a study of the interdependence of tax rates is Devereaux, Lockwood and Redoano (2002), estimating reaction functions for OECD countries over the period 1982 to 1999, and finding clear evidence of international tax competition. They control linearly for the ratio of foreign direct investment (FDI) to GNP, but do not use any direct measure of trade openness.

The second approach, sometimes called indirect, estimates the sensitivity of capital or firms to different tax regimes. Net real investment flows would be the natural independent variable when testing for the effect of taxes on the location of capital but, in practice, most studies use FDI flows instead. Examples of such studies are Devereaux and Griffith (1998) and Grubert and Mutti (2000). A problem with using FDI flows is that this is an imprecise measure of the changes in the real capital stock. For instance, if a foreign firm buys the voting majority of a Swedish firm, it will count as FDI. The transaction may, however, not have any effect on the real capital stock in Sweden.[10] Most studies of this type include trade openness as an explanatory variable, since the theory of multinational firms indicates that trade costs are important determinants of FDI. However, trade costs are typically entered linearly and will therefore not capture the possible non-linear effects discussed here.

With reservation for the limited sample of papers surveyed here, the empirical literature on tax competition does not properly account for the effects identified in the NEG-framework: Direct studies of tax competition either do not account for trade openness or include it only as a proxy for capital mobility. Indirect studies typically do include trade openness since it matters for horizontal FDI. However, no account is taken of possible non-monotone effects. A second problem is that the way these studies are carried out implies that observations on symmetric and core-periphery tax competition are pooled. This is less problematic for studies that include only industri-

[10] See e.g. Devereaux and Griffith (2002) for a discussion about these problems.

alised countries in the dataset, but Grubert and Mutti (2000), for instance, pool information on 60 locations world wide as recipients of FDI. Here, it would be important to separately account for less developed countries.

## 4. Conclusion

Recently, taxes have been introduced in the new economic geography framework, where the level of trade costs or the level of integration is crucial for the location decisions of firms. The combination of production with increasing returns and trade costs creates agglomeration tendencies. The degree of agglomeration of firms will, in this setting, crucially depend on the level of trade costs and, as has been discussed here, the relation between agglomeration forces and trade costs is predicted to be hump shaped. Agglomeration forces, in turn, are important for tax competition since they make firms located in agglomerated regions less inclined to move. That is, firms in agglomerated regions will have a lower delocation elasticity with respect to changes in taxes, which tends to attenuate the degree of tax competition for governments in these countries or regions.

The general conclusion from the NEG-literature is that all factors that affect the strength of agglomeration forces also affect the degree of tax competition, implying that all such factors should, in principle, be included as controls in empirical investigations of tax competition. In particular, the effect of trade openness is important, and may be non-monotone (hump-shaped). Moreover, tax competition between two industrialised countries or regions, where marginal firms are close to indifferent to location and therefore responsive to marginal changes in taxes, is very different from tax competition between one country hosting an agglomeration where firms enjoy agglomeration rents and a country without these rents. Marginal tax changes may have no effect on location in the latter case, since firms are locked into the agglomeration by the agglomeration rents. Recent empirical papers on tax competition do not fully account for these results from the NEG-literature. Considering the recent strong interest in tax competition, however, we will most likely see advances in this area in the near future.

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