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Competing for Capital in a Lumpy World

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COMPETING FOR CAPITAL IN A "LUMPY" WORLD

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Working Paper No. 252

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COMPETING FOR CAPITAL IN A "LUMPY" WORLD

Abstract

This paper uses a new economic geography model to analyze tax competition betweeen two countries trying to attract internationally mobile capital. Each government may levy a source tax on capital and a lump sum tax on fixed labor. If industry is concentrated in one of the countries, the analysis finds that the host country will gain from setting its source tax on capital above that of the other country. In particular, the host may increase its welfare per capita by setting a positive source tax on capital and capture the positive externality that arise in the agglomeration. If industry is not concentrated, however, both countries will subsidize capital.

JEL Classification: H25, H54, H87

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1 Introduction

The question of how internationally mobile capital should be taxed has been an issue discussed in at least three separate strands of the public finance literature. The first set of papers, cast in a perfectly competitive setting of no pure profits, find that a small country should not use source-based taxes on internationally mobile capital [see e.g., Gordon (1986), Frenkel, Razin and Sadka (1991), and Bucovetsky and Wilson (1991)]. The reason is that internationally mobile capital is able to escape any burden of taxation of the source type, as taxes will instead be born by internationally immobile factors of production. This result, recognized as an open economy version of Diamond and Mirrlees' (1971) production efficiency theorem, is achieved because capital effectively is perfectly elastic in supply. An additional, but implicit, assumption underlying the result is that economic activity is evenly spread out across space. The latter assumption, although seemingly innocent, is non-trivial since empirical studies show that economic activities indeed are unevenly distributed across space.[1]

The second strand of the literature is also cast in a perfectly competitive setting, but analyses tax competition when capital is imperfectly mobile due to capital controls. Giovannini (1991) and Razin and Sadka (1991) find that if governments can impose quantitative restrictions on mobile capital (at no cost), it is optimal to restrict international capital movements since this allows the country to impose a welfare-increasing tax on domestic capital income. Bjerksund and Schjelderup (1999) show that this result is valid even if redistributive considerations enter the social welfare function. Huber (1997) assumes that capital controls act like transactions costs on capital that raise the costs of international asset trade. This type of capital control yields different results and capital taxes may be positive or zero depending on the revenue needs of the government.

The third set of papers studies tax competition over capital under imperfect competition. In this literature countries differ either by size, exogenous wage level, or other cost components. The main lesson from these studies is that taxes in general

[1]See Porter (1990); Pyke, Becatttini and Sengenberger (1990); Krugman (1991).

are non-zero in the tax competition equilibrium, and that countries may subsidize capital if there are positive externalities from attracting capital [see e.g. Black and Hoyt (1989), Haaparanta (1996), and Haufler and Wooton (1999), and Fuest and Huber (1999)].

In this paper, we investigate how spatial agglomeration of economic activity affects the outcome of capital tax competition. The model presented differs fundamentally from earlier contributions in several respects. First, it provides a full fledged model where capital, goods, and firms are internationally mobile. Second, there is no difference *per se* between countries either in endowments, size, technology, or any other country specific variable that may predetermine how taxes are set in the Nash equilibrium. Third, the outcome of tax competition depends on the *interaction* between two 'forces of agglomeration'; trade cost and pecuniary externalities, not previously brought together in a capital tax competition framework.[2]

We find that in the presence of agglomeration forces, previous tax policy recommendations need rethinking.[3] The analysis shows that if industrial agglomeration is concentrated in one single country, a government may - through a positive source tax - be able to exploit the locational "rents" created by agglomeration forces and thereby increase national welfare. An implication of this result is that increased economic integration, defined as a reduction in trade costs, may actually allow a country to raise its tax without losing capital or its industrial base. In contrast, if industry is evenly spread across countries, the analysis finds that taxes in the Nash equilibrium will entail equal subsidies to capital.

To bring forward how tax competition over capital is affected by industrial agglomeration, we set up a simple model that follows the line of work that is usually referred to as the new economic geography.[4] The existing literature uses a two country-two sector model, with labor as the only factor of production. In this framework part of the workforce may be mobile internationally, and migration of

[2]Trade costs have been introduced in a capital tax competition framework by Haufler and Wooton (1999).

[3]It is well documented that taxes affect the concentration of industries. See Hartman (1985), Boskin and Gale (1987) and Slemrod (1990).

[4]See e.g. Krugman (1991) and Krugman and Venables (1995).

mobile workers implies the movement of factors of production as well as purchasing power. We alter this model by using capital and labor as input factors, where only the former is mobile internationally. Capital exports from one country to another country implies factor movement, but not migration of purchasing power, since we assume that income from capital is consumed in the owner's country of residence. This modification to the standard model has two advantages. First, by introducing capital as a factor of production in a new geography framework, increased realism is achieved since labor is acknowledged to be less mobile than capital in an international context. Second, the use of capital allows for an analysis of capital tax competition directly related to the existing literature on tax competition in public finance.

In section 2 we describe our basic model. Section 3 examines how taxes on capital are set in the competitive equilibrium. Two alternative settings are analyzed; one where industry is concentrated in a single location; one where countries are identical and industry is evenly spread across space. Section 4 contrasts the results of the analysis to those obtained in related literature, while Section 5 offers some concluding remarks.

2 The Model

There are two countries, called country h (home) and f (foreign). Each country may contain two sectors, agriculture and manufacturing. Country i is endowed with L_i units of labor and K_i units of capital. We denote w_i as the wage rate, and r_i as the rental rate of capital. Factor intensities differ between sectors but not across countries, and for simplicity the agricultural sector is assumed to employ labor only.[5] Labor is immobile between countries, while there is free international movement of capital. Each country may levy taxes on wage and capital income, and the tax on labor income is lump sum in nature, since labor is in fixed supply. The representative resident in country i receives income from labor and capital. Preferences are given by

[5]Focusing on the case where agriculture only uses labour as an input makes the analysis more tractable, but does not affect the results in any qualitative way.

the utility function $u = C_A^{1-\gamma} C_M^{\gamma}$, $0 < \gamma < 1$, where C_A and C_M denote consumption of the goods from the agriculture and manufacturing sector, respectively, and γ is the expenditure share on manufacturing.

Agriculture can be costlessly traded internationally and is perfectly competitive. By choice of scale unit labor requirement is one, and we select the A-good as numeraire, so that the price of the agricultural good, p_A, equals unity. We consequently have

$$w_i \geq 1, \tag{1}$$

where the wage level $w_i = 1$ if country i produces agriculture. In the continuation, the analysis will concentrate on the case where both countries produce agriculture.[6]

The manufacturing good M consists of a number of differentiated goods, and its consumption is defined by the CES function $C_M \equiv \left[\sum_k c_k^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$ with $\sigma > 1$. Each producer operates under increasing returns to scale at the level of the plant, and in line with Dixit and Stiglitz (1977) we assume that there is monopolistic competition between manufacturers. Thus, both the perceived elasticity of demand and the elasticity of substitution between any pair of differentiated goods are equal to σ.

All producers have access to the same technology, so prices do not differ between firms in a given country. Since firms use the constant markup $\frac{\sigma}{\sigma-1}$ over marginal costs (MC_i), the *f.o.b.* price from country $i = h, f$, is given by

$$p_i = \frac{\sigma}{\sigma - 1} MC_i. \tag{2}$$

Manufactured goods are tradeable, but we assume Samuelson iceberg type trade costs such that only $\frac{1}{\tau}$ of each unit shipped actually reaches its destination. This

[6]Wages may differ if demand for the traditional good is sufficiently small to only warrant production in one country. Differences in wages will, however, not affect the main result that a country hosting an agglomeration may benefit from a positive source tax on capital.

means that the *c.i.f.* price is τ times higher than the *f.o.b.* price of an imported good. "Trade costs" should be thought of as a synthetic measure of a wide range of trade barriers and are intrinsically wasteful.

Taking the dual of C_M we find that the true price index for the manufacturing good is

$$q_i = \left[n_i p_i^{1-\sigma} + n_j (p_j \tau)^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \qquad i \neq j, \tag{3}$$

where n_i and n_j are the number of varieties produced in countries i and j. Accordingly, the consumer price index can be expressed as

$$P_i = p_A^{1-\gamma} q_i^{\gamma}, \qquad i = h, f. \tag{4}$$

The production technology for differentiated goods requires a composite of intermediate goods, labor, and capital. As in Krugman and Venables (1995) we make the simplifying assumption that the composite good has the same form as the consumer good C_M.[7] Thus, a representative firm i (in either country) produces its output x_i using α units of input as fixed costs and β per unit of output thereafter, and has a total cost function given by

$$TC_i = w_i^{1-\theta-\eta} r_i^{\theta} q_i^{\eta} (\alpha + \beta x_i), \;\; \theta \in \langle 0, 1\rangle \;\text{ and } \eta \in [0, 1\rangle \,, \tag{5}$$

where r_i is the rental price for capital. In (5) the parameters η, θ, and $(1 - \theta - \eta)$ are the shares of total costs that go to the purchase of intermediates, capital, and labor, respectively. Notice that for $\eta > 0$ we have vertical industry linkages in the sense that the manufacturing sector uses a share of its own output as input. Vertical industry linkages will give rise to location specific external economies of scale if there are positive trade costs. The reason is that an increase in the size of the domestic manufacturing base n_i will reduce the price of the composite good, q_i, and thus firms' total costs, TC_i.[8] The cost reduction in this case is increasing in η.

[7]The main advantage of this simplification is that p_i from equation (2) then will apply both for consumer demand and industry demand.

[8]Vertical industry linkages are standard features of new geography models. See Venables (1996) for a more general case of vertical industry linkages in which intermediate and final goods are distinct.

Due to free entry there are zero pure profits (i.e., $p_i x_i - TC_i = 0$). Using the zero profit condition in combination with (5) and (2) we have that $x_i = \alpha(\sigma - 1)/\beta$ in equilibrium. To simplify, but without loss of generality, we set $\beta = (\sigma - 1)/\sigma$ and $\alpha = 1/\sigma$, so that

$$x_i = 1, \qquad i = h, f, \tag{6}$$

if it is profitable to produce intermediate goods in country i.

The supply of labor (L_i) must - in equilibrium - be equal to the demand in manufacturing (L_{Mi}) and agriculture (L_{Ai}) so $L_i = L_{Mi} + L_{Ai}$. Using Shephard's lemma on equation (5) we have

$$L_{Mi} = (1 - \theta - \eta) w_i^{-(\theta+\eta)} r_i^{\theta} q_i^{\eta} n_i. \tag{7}$$

Since residents can invest both at home and abroad it is important to specify the international tax system. In principle, most countries tax interest income of residents at the home tax rate, regardless of geographic source, but allow foreign taxes paid to be credited against the domestic tax liability falling on foreign income. Most countries limit the use of the tax credit so that if the foreign tax liability exceeds that of the home country, only the foreign rate applies and the source principle of taxation is effectively in operation. Furthermore, there is strong empirical evidence that governments for compliance reasons find it difficult to tax foreign interest income (see Razin and Sadka, 1991). For this reason interest income earned abroad is either untaxed or, if taxed, then only subject to the foreign rate. In practice, taxation of interest income therefore corresponds closely to the source principle of taxation (see Tanzi and Bovenberg, 1990 and Keen, 1993), and this assumption will also be made in the analysis that follows.

Let K_{ii} and K_{ij} be the part of country i's capital which is allocated domestically and abroad, respectively, so that $K_i = K_{ii} + K_{ij}$. Denoting by t_i the tax rate on capital income in country i, arbitrage between the home country and the foreign

country implies that

$$(1 - t_h)\, r_h = (1 - t_f)\, r_f. \tag{8}$$

Whenever the two countries trade capital in equilibrium, then by convention country h is the importer. Equilibrium in the world capital market requires that the demand for capital world-wide equals supply. Again using Shepard's lemma on equation (5), we have

$$n_h \theta w_h^{1-\theta-\eta} r_h^{\theta-1} q_h^{\eta} + n_f \theta w_f^{1-\theta-\eta} r_f^{\theta-1} q_f^{\eta} = K_h + K_{ff} + K_{fh}. \tag{9}$$

Abstracting from questions related to optimal size of the public sector, we assume that the entire tax revenue is redistributed back to domestic consumers. Disposable consumer income thus equals

$$Y_h = w_h L_h + r_h K_h + t_h r_h K_{fh}, \quad Y_f = w_f L_f + r_f K_{ff} + (1 - t_h)\, r_h K_{fh}. \tag{10}$$

From the utility function it follows that the consumer will spend a share γ of income Y_i on manufactured goods. Similarly, from equation (5) we know that a share η of a manufacturing firm's total costs is spent on intermediates. Since $x_i = 1$, the zero profit condition in the manufacturing sector implies that $TC_i = p_i x_i = p_i$. We can therefore express the total value of expenditure on differentiated goods, E_i, as

$$E_i = \gamma Y_i + \eta p_i n_i \qquad i = h, f. \tag{11}$$

The first term on the right hand side of (11) is the residents' expenditure on manufactures, while the last term is the sector's demand for its own output. In order to derive the share of total expenditure E_i that is spent on each single variety of the manufacturing good, we use Shepard's lemma on (3). Domestic and foreign demand for a variety of the manufactured good produced in country i can then be written as

$$x_{ii} = p_i^{-\sigma} q_i^{\sigma-1} E_i, \qquad x_{ij} = p_i^{-\sigma} q_j^{\sigma-1} \tau^{1-\sigma} E_j, \qquad i \neq j. \tag{12}$$

In equilibrium the supply of each variant must equal demand. Using (6) and (12), the equilibrium takes the form

$$1 = p_i^{-\sigma} \left[q_i^{\sigma-1} E_i + \tau^{1-\sigma} q_j^{\sigma-1} E_j \right], \qquad i \neq j. \tag{13}$$

Balanced trade occurs when

$$n_h p_h x_{hf} - n_f p_f x_{fh} = (1 - t_h) r_h K_{fh} - \left[w_h L_{Ah} - (1 - \gamma) Y_h \right]. \tag{14}$$

Equilibrium is now characterized by the equations (1), (2), (3), (8), (9), (11), (13), and (14), which can be solved to give equilibrium values on w_i, q_i, p_i, r_i, E_i, n_i and K_{ij}, $i \neq j$, $i = h, f$.

To see how the model works notice that scale economies in manufacturing will lead a firm to locate its production in only one country, from which it exports. The migration of one single firm in manufacturing affects industry profits in the receiving country through three channels. First, the presence of one more firm will increase competition in the product and labor markets thus tending to reduce profits and mitigate concentration tendencies. The decline in profits, however, will be counteracted by two location specific external economies of scale effects. The first effect pertains to the fact that a new entrant will reduce costs of existing firms since they save trade costs on their purchase of intermediates from the new entrant. In addition, entrance of a new firm also means that domestic demand for intermediates in the receiving country increases. These cost and demand linkages are self-reinforcing, and may dominate over the market competition effect and give rise to agglomeration of manufacturing.

Notice that the agglomeration effect vanishes in the absence of trade costs ($\tau = 1.0$), because firms cannot save transport costs by locating close to other firms. In this case geographical location is irrelevant. Neither can we have agglomeration

for high levels of trade costs. High trade costs mean that countries are effectively sheltered from import competition and thus become self-sufficient. We shall consequently see that the agglomeration forces are strongest for low and intermediate levels of trade costs, in which case it may be possible for a country to levy positive capital taxes and still host an agglomeration.

In the next section we will focus on tax competition between the two countries.

3 Tax Competition

To simplify the analysis and focus on the role of taxes for firms' localization decision, we assume that the two countries have the same factor endowments and production technology. There are two possible starting points for the analysis of tax competition; capital and firms may either - ex ante - be concentrated in one single location (concentration), or they may be evenly spread between the two countries (dispersion). We shall investigate how taxes on capital are set under both assumptions.

The Nash equilibrium is characterized by simultaneous moves, where each country chooses capital taxes so as to maximize the utility of its residents. For reasons of tractability, the cases of concentration and diversification are treated separately. Due to the substantial system of equations that characterize the general equilibrium, the outcome of capital tax competition is found through numerical simulations.

3.1 Concentration

We now examine the case where all of manufacturing is concentrated in country h, while both countries produce the agriculture good. The question we address is for what range of trade costs (τ) and size of industry linkages (η) is industrial agglomeration a sustainable equilibrium when countries engage in tax competition.

When manufacturing is concentrated in h, the utility of the representative consumer in country h and f, respectively, is equal to[9]

$$u_h = k\left[(1-\theta\gamma-\eta)+(1+t_h)\theta\gamma\right]. \tag{15}$$

[9]The derivation of (15) and (16) is given in Appendix A2.

$$u_f = k\left[\frac{(1-\theta\gamma-\eta)+(1-t_h)\theta\gamma}{\tau^\gamma}\right], \tag{16}$$

where $k > 0$ is some constant. The utility of the representative consumer in f differs from that in h for two reasons. First, consumer goods are more expensive in f since consumers must incur transport costs on all their purchases of manufacturing goods, thus, $P_f/P_h = \tau^\gamma > 1$ (see eq. (4)). The second reason is that differences in national tax policy will lead to a net transfer of income between nations, making consumer income in the two countries differ. This effect is reflected by the second term in the numerators of (15) and (16).

Since the countries are intrinsically symmetric, the gain to country h from hosting the agglomeration is exhibited by the inequality $u_h > u_f$, which - by use of (15) and (16) - can be expressed in terms of the tax rate in country h as

$$t_h \geq t_h^{low} \equiv -\frac{(\tau^\gamma - 1)(1-\eta)}{(\tau^\gamma + 1)\theta\gamma}. \tag{17}$$

Equation (17) defines the lowest tax rate, t_h^{low}, that country h is willing to levy to keep the agglomeration in h. We see from (17) that consumers will subsidize capital $\left(t_h^{low} < 0\right)$ in order to save trade costs on consumer purchases, and that higher trade costs will lead to an increase in the subsidy $\left(dt_h^{low}/d\tau < 0\right)$. Intuitively, one would perhaps expect η to have the same qualitative effect on t_h^{low} as τ. However, from (17) it follows that

$$\frac{dt_h^{low}}{d\eta} > 0, \tag{18}$$

since an increase in η means that a larger share of differentiated goods is used as inputs for production rather than directly for consumption.

Equation (17) is only a necessary condition for the existence of an asymmetric Nash-equilibrium. In addition, it must also be true that country f cannot increase its welfare by setting t_f so low that it attracts the agglomeration. Let t_f^{crit} be the tax rate in country f that just makes it profitable for manufacturing to produce in f. It follows immediately from this definition that an increase in t_f^{crit} means that

manufacturing firms have become more tax elastic. We can express t_f^{crit} as[10]

$$t_f^{crit} = 1 - (1 - t_h) \left[\frac{2\tau^{\sigma(1+\eta)-1}}{2 + (1 - \eta - t_h\theta\gamma)\left(\tau^{2(\sigma-1)} - 1\right)} \right]^{\frac{1}{\sigma\theta}}. \tag{19}$$

Notice from (19) that $t_f^{crit}(t_h)$ imposes an upper bound on the tax rate that country h can levy if it is to prevent the whole cluster from relocating to f. Defining this upper bound as t_h^{high}, it can be written as[11]

$$t_h \leq t_h^{high} \equiv -\frac{(\tau^\gamma - 1)(1 - \eta)}{\theta\gamma} - \tau^\gamma t_f^{crit}. \tag{20}$$

From (20) it is clear that $t_h^{high} = t_h^{high}\left(t_f^{crit}(\eta), \eta\right)$, and we can derive that

$$\frac{\partial t_h^{high}}{\partial \eta} > 0, \qquad \frac{\partial t_h^{high}}{\partial t_f^{crit}} < 0. \tag{21}$$

The first of these derivatives mirrors that an increase in η reduces the share of differentiated goods consumed directly, and thus country $f's$ desire to attract the agglomeration. The other derivative says that country h must lower its tax rate if firms in the agglomeration become more tax elastic (i.e. t_f^{crit} increases).

In can be shown from (18) that

$$\frac{\partial t_f^{crit}}{\partial \eta} < 0, \tag{22}$$

since the higher is η, the less attractive it will be to locate away from the cluster.[12] From (21) and (22) we can conclude that

$$\frac{dt_h^{high}}{d\eta} > 0, \tag{23}$$

which provides the valuable insight that the taxing potential of country h is strengthened by stronger vertical industry linkages.

To sum up, equations (17) and (20) are derived by maximizing the utility of the representative consumer in country h given the tax rate in the foreign country. If the host country levies a too high tax rate this may induce industry to migrate, while

[10]The derivation has been relegated to Appendix A3.

[11]See Appendix A4 for the derivation.

[12]Qualitatively, the driving force behind this result is the same as in the case of $dt_h^{low}/d\eta$.

a too low tax rate may make it too costly to retain the industry agglomeration. Specifically, equations (17) and (20) give sufficient and necessary conditions in the Nash-game in the sense that country h is willing and able to retain the agglomeration as long as t_h lies within the interval $t_h^{low} \leq t_h \leq t_h^{high}$.[13] Below we show that, for any range of parameter values that supports a sustainable industrial concentration, there will exist a unique Nash-equilibrium with $t_h = t_h^{high}$. Of special importance are the size of the linkage effect (η) and the level of trade costs (τ), and in the next sections we investigate how t_h is determined under various assumptions concerning the size of η and τ.

3.1.1 Tax competition and vertical industry linkages (η)

We can use Figure 1 to illustrate the lower $\left(t_h^{low}\right)$ and upper (t_h^{high}) bounds for taxation in country h as a function of η. From (18) and (23) we know that t_h^{low} and t_h^{high} are increasing functions of η and this is exhibited by Figure 1. Recall that t_h^{low} defines the lowest tax rate that country h is willing to levy to keep the agglomeration, while t_h^{high} denotes the highest tax rate that country h can levy without losing the agglomeration. Hence, if $t_h^{low} > t_h^{high}$ the subsidies consumers in h are willing to pay are too small to keep the agglomeration in h. From Figure 1 we see that this situation arises for $\eta < \widehat{\eta}$ where an equilibrium with agglomeration does not exist. For stronger vertical linkages $(\eta > \widehat{\eta})$, however, we have $t_h^{low} < t_h^{high}$ which means that the forces of agglomeration are sufficiently strong to make it worthwhile for country h to host the cluster. In particular, the shaded area in Figure 1 is characterized by $u_h > u_f$ and $t_h^{low} \leq t_h \leq t_h^{high}$. Evidently, country h prefers to tax capital owners in country f as hard as possible and can do so by taxing away the locational rent that accrues to manufacturing. Thus, the Nash-equilibrium with agglomeration is described by $t_h = t_h^{high}$ for $\eta > \widehat{\eta}$. It is worth noting that for $\eta > 0.45$, country h maximizes its welfare if it levies a *positive source-tax* on capital in the Nash-equilibrium.

[13] For a formal proof in this type of setting see Wooton and Ludema (1998).

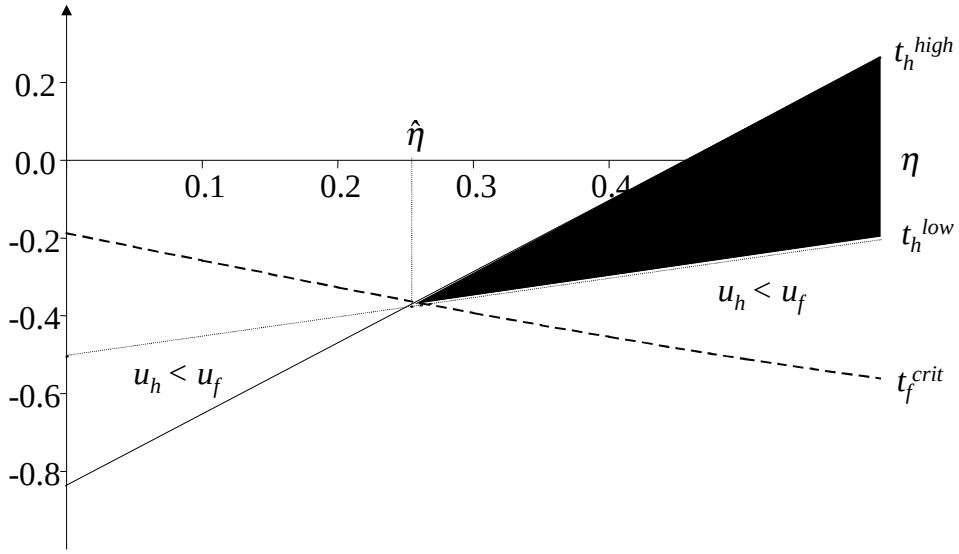

Figure 1: Industry linkages and taxation: $\tau = 1.5$.

3.1.2 Tax competition and trade costs (τ)

We now turn to examine the importance of trade costs for tax policy. Since location does not matter in the absence of trade costs, one would perhaps expect that the more firms can save on transport costs by locating closer to other firms, the greater is the scope for taxation by the hosting government. This logic, however, is flawed. Figure 2 shows that country h can only raise its tax rate - and retain the agglomeration - for levels of trade costs in the interval $\tau \in (1, \tilde{\tau})$. Country h must actually reduce its tax rate for trade costs higher than $\tilde{\tau}$ if it is to keep the agglomeration.

This result arises due to two counteracting effects. The first is the incentive to save on transport costs. Ceteris paribus, it indicates that as τ increases, so does the scope for taxing the pecuniary externality that arise in the agglomeration. The second effect pertains to the profitability of setting up production in country f. Higher trade costs reduce the profitability of exporting from country h and increase the import shelter for potential firms in country f. For sufficiently high levels of trade costs it therefore becomes profitable to produce manufacturing goods in both countries. Furthermore, beyond a certain high level of trade costs the import sheltering effect dominates the transport saving incentive, and necessitates a subsidy

from h to retain the agglomeration.[14]

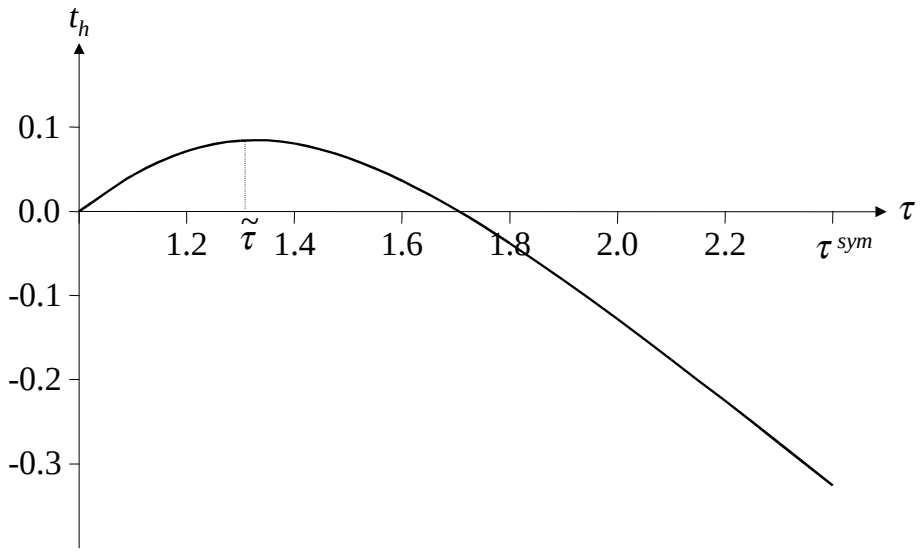

Figure 2: Nash taxes compatible with agglomeration in h; $\eta = 0.5$

Figure 3 shows that welfare in country h increases in the interval $\tau \in (1, \tilde{\tau})$. The reason is that the cost saving incentive dominates in this interval. Hence, as trade costs increase, so does the profitability of being in the cluster and the locational rent that country h may tax away. For higher trade costs, i.e., $\tau > \tilde{\tau}$, the import sheltering effect dominates. In this case country h must reduce its source-tax to abate the increased incentive to relocate.

Given the political relevance of tighter economic integration and globalization, it is interesting to see how welfare in the two countries is affected by *trade liberalization* ($d\tau < 0$). Figure 3 illustrates that trade liberalization unambiguously increases welfare in country f. The explanation is that trade liberalization leads to a reduction in the consumer price of differentiated goods in country f. In contrast, country h will only gain from trade liberalization if trade costs lie within the interval $\tau \in (\tilde{\tau}, \tau^{sym})$.[15] In this interval the profitability of relocating to f (import sheltering effect) is diminished by trade liberalization, and allows country h to increase its tax. Notice that country h would prefer not to liberalize trade below $\tau = \tilde{\tau}$. At this level

[14]If trade costs are very high the asymmetric equilibrium may not exist. See Appendix A5.

[15]It can be shown that for trade costs above τ^{sym} multiple equilibria with and without agglomeration may exist.

the taxable rent in the agglomeration reaches its peak value. Figure 3, therefore, may explain why incentives to engage in trade liberalization efforts differ among countries.

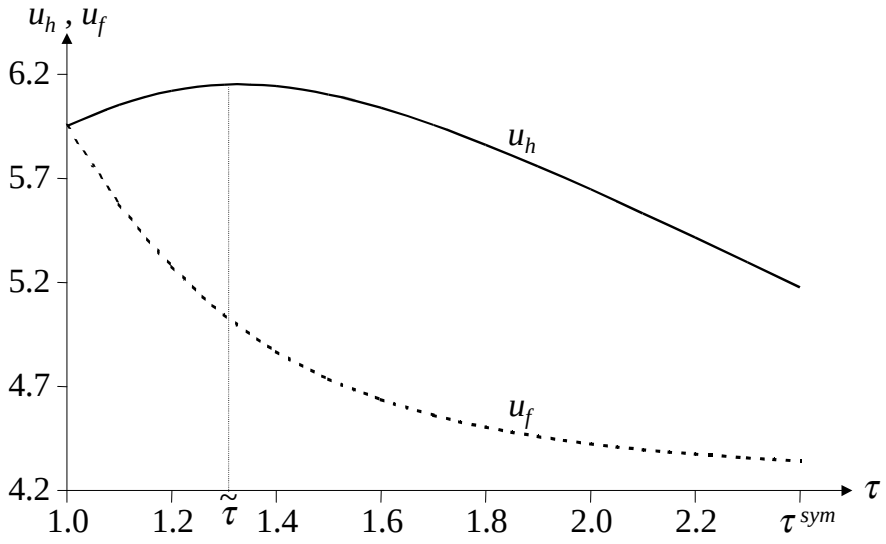

Figure 3: Welfare and trade costs; $\eta = 0.5$

3.2 Dispersion

We now turn to examine the case where parameter values do not support asymmetric equilibria, and where the only stable equilibrium is one where manufacturing is evenly distributed between the two countries. Recall from the discussion in Section 3.1 that an equilibrium with industrial agglomeration only existed if trade costs were below a certain critical level and industry linkages were sufficiently strong.[16] Hence, our point of departure here is a situation with rather high trade costs and relatively weak industry linkages.

The objective of the government is to maximize the welfare of its residents, and the indirect utility function can be written as

$$V_i^* = \max_{t_i} \frac{Y_i(t_i; t_j, ..)}{L_i P_i(t_i; t_j, ..)}. \tag{24}$$

[16]Note that due to the interaction of trade costs and industry linkages, the critical level of trade costs depends on how strong the industry linkages are (and vice versa).

Equation (24) must be solved simultaneously with (1), (2), (3), (8), (9), (11), (13), and (14), that characterises the equilibrium. This gives us 15 equations in 15 unknowns, and the analytical solution is too complex to be informative. We shall therefore use numerical simulations to illustrate the outcome.

In order to understand the forces at work in the symmetric equilibrium, notice that each country can attract capital and firms by setting a tax rate below that of the other country. There are costs and benefits of such a policy. The benefits are lower prices on differentiated goods because fewer varieties now have to be imported. The costs of a subsidy pertain to the transfer of income to foreigners and a fall in the domestic interest rate (due to capital inflow and decreasing returns to scale in capital). If the subsidy is not too high, the benefit exceeds the cost. This means that, up to a certain point, it is welfare increasing for each country to bid down its tax rate and attract capital and firm.

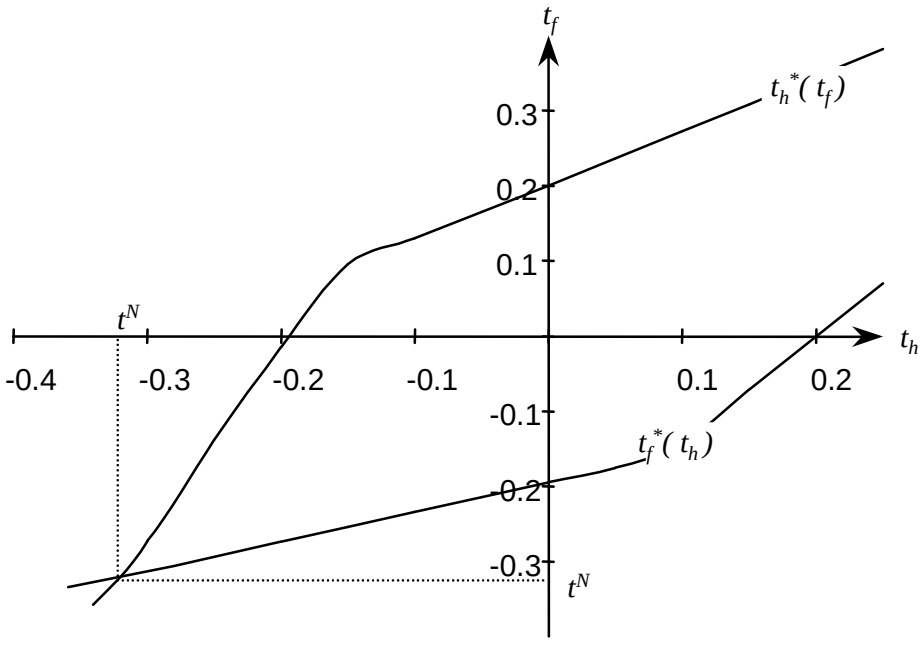

Figure 4. Symmetric Nash equilibrium

In Figure 4 the resulting Nash equilibrium is drawn. The curves $t_h^*(t_f)$ and $t_f^*(t_h)$ depict the optimal tax rate in country h and f, respectively, for given tax rates in the other country. Since the two countries are intrinsically identical, they will choose

the same subsidy in the symmetric equilibrium; $t_f^* = t_h^* = t^N < 0$ as long as there are non zero trade costs ($\tau > 1$).

Although general expressions for the reaction functions cannot easily be derived, the Nash equilibrium may still be characterized. By definition a small change in t_i does not change the equilibrium welfare level in country i, and equation (24) can thus be written as

$$\frac{dV_i^*}{dt_i} = 0 \Leftrightarrow \frac{dP_i}{P_i} - \frac{dY_i}{Y_i} = 0. \tag{25}$$

In order to interpret equation (25), suppose that country i levies a somewhat higher subsidy than does country j. In this case capital will flow from country j to country i ($dK_{ji} > 0$), making the number of manufacturing firms larger in country i than in country j ($n_i > n_j$). The change in tax (subsidy) impacts on national welfare through two channels. First, due to the increase in number of local manufacturing firms, fewer varieties have to be imported and, provided that there are positive trade costs, the consumer price index in country i falls. This effect is captured by the first term in (25) which can be expressed as $dP_i/P_i = \gamma dq_i/q_i < 0$. Second, an increase in the subsidy induces an income transfer to the foreign country, and a reduction in the (gross) returns to capital. As a consequence, nominal income in country i falls. The reduction in nominal income is captured by the second term in (25), which can written as $\left(-K_i dr_i - r_i t^N dK_{ji}\right)/(L_i + r_i K_i)$ using equation (10). The Nash equilibrium subsidy rate is thus defined by the equality $\gamma dq_i/q_i = (K_i dr_i + r_i t^N dK_{ji})/(L_i + r_i K_i)$.

In equilibrium, the welfare level in each country is, in fact, unaffected by tax competition. The reason is that capital does not move between the two countries, and that the consumer is both a capital owner and a worker at the same time. Hence, the subsidy is financed by a *de facto* lump sum tax on consumer income which - in the Nash equilibrium - is redistributed to the consumer in a lump sum fashion leaving consumer wealth unchanged. Obviously, this result hinges on the assumption that there is only one type of consumer in the model, deriving income from capital and wages. In a model with several types of consumers, capital owners

and wage earners, say, results would certainly differ due to the unequal endowments of factors.[17]

Notice that in the Nash-equilibrium, taxes are so low that if one country increased its subsidy, the cost of doing so would be higher than the benefit. The tax rates (subsidies) are therefore unique in the Nash equilibrium.

An interesting question is what happens to the equilibrium if trade costs are reduced? It can be shown that below a certain threshold level of trade costs, the symmetric equilibrium becomes unstable. Furthermore, the threshold level is a decreasing function of η. In the unstable equilibrium, it may be the case that both countries will - due to cost and demand linkages - set *positive* source taxes on capital (i.e., $t^N = t_h^*(t_f) = t_f^*(t_h) > 0$).

To understand why it may be optimal to switch to positive taxes on capital, suppose we have the tax constellation; $t_f = 0$ and $t_h > 0$. In this case, equations (8) and (10) tell us that disposable consumer income (Y_i) in country h is greater than in country f. But this implies that the demand for manufacturing goods is higher in country h. Free entry and the zero profit condition can then lead to *migration* of firms *from* f to h, so that country h hosts a larger number of intermediate goods producers. Since intermediate goods are used as inputs in the manufacturing sector ($\eta > 0$), the existence of trade costs means that the larger industry in h has a cost advantage. If the cost linkage effect is sufficiently strong, further relocation of firms from f to h can occur. Moreover, if the share of the manufacturing sector that is located in h increases, then, other things equal, we should expect to see even higher demand for intermediate goods from the manufacturing sector in h (demand linkage). This circular causation - which is present for relatively high values of η - can lead the entire manufacturing sector to become concentrated in h even if such concentration implies higher cost of capital and labor in h.[18]

[17] A reasonable conjecture is that wage earners would lose since they will be subject to the tax that finances the subsidy, while capital owners will be the winners of tax competition. This makes it clear that redistributive matters are of importance in models of tax competition and may affect policy decisions.

[18] See Krugman and Venables (1995) for a discussion of the interaction between demand linkages and cost linkages, and how they may generate international specialization.

The mechanism of the example above explains why each country may want to switch to positive capital tax rates if η is positive and trade costs are reduced.[19]

4 Discussion of results

Comparing the results in this paper with previous research our analysis is closest to the papers that study the outcome of tax competition under imperfect competition, but our results also relates to the literature on capital controls.

Our paper differs from the tax competition literature under imperfect competition in several respects. First, the analysis provides a full fledged model where capital, goods and firms are internationally mobile. Second, the driving forces of our results are endogenous, and not predetermined by assumptions of cross-country differences. Differences in country size, for example, determines the outcome of tax competition in Haufler and Wooton (1999) who study tax competition between two countries trying to attract a foreign-owned monopolist. The existence of trade costs and scale economies means that the firm will prefer to locate in the large market where it will be able to charge a higher producer price. The locational preference for the large country allows the taxing authority in this country to attract the firm at a lower cost than the small country. Fuest and Huber (1999) analyses the implications of unemployment for fiscal competition and tax coordination among small open economies. They show that when labor markets are non-competitive the undertaxation hypothesis may not hold in the tax equilibrium. Haaparanta (1996) investigates a subsidy game between two countries which seek to attract inward foreign direct investment in order to alleviate domestic unemployment. In this model differences in national wage levels provide countries with unequal incentives to subsidize capital to lower domestic unemployment. In Black and Hoyt (1989) regional differences in a non-labor cost component are the crucial component in a subsidy game between two regions which attempt to attract firms by realizing scale economies with respect

[19]For completeness, note that the symmetric equilibrium is stable when trade costs are high due to import sheltering effect. This effect, however, is weakened if trade is inexpensive, and the symmetric equilibrium can become unstable for sufficiently low levels of trade costs.

to the provision of public goods..

In contrast to these studies, the single reason for the subsidy game in the *symmetric* equilibrium in our analysis is a positive externality of *equal size* to both countries.[20] Similar to previous studies, however, is the result that the positive externality puts a downward pressure on capital tax rates. This is not the case in the *concentrated* equilibrium, where the externality allows the hosting country not only to increase its tax rate above that of the other country, but to levy a positive source tax on capital.

A second difference from earlier literature pertains to the issue of who "wins" the competition for mobile capital. Bucovetsky (1991) and Wilson (1991) find that small countries win the competition for capital in the sense that they attract a more than proportional share of mobile capital and achieves a higher per-capital utility than large countries. Haufler and Wooton (1999) show that if there are economies of scale in production, the existence of trade costs will give the firm an incentive to locate in the large country. Hence, the large country is able to attract the firm at a lower cost and thus has the higher per-capita utility in equilibrium.

The present paper shows that the country which host an agglomeration will win the competition for capital. The reason is that manufacturers in the "cluster location" h are more competitive than their potential "rivals" in f, and can thus pay a higher price for each unit of capital without making losses. This means that even if capital can move costlessly between countries, the supply of capital will not be perfectly tax elastic. In fact, for a range of trade costs and tax rates capital will be inelastic in supply. The host country can exploit this by levying a source-tax on capital above that of the other country. The "higher" level of taxation will increase welfare in the hosting country - and will - for reasonable parameter values - entail a positive source-tax on capital.

[20]The result in the symmetric case is related to the standard result in public finance that taxes are set too low in the Nash-equilibrium [see Zodrow and Mieszkowski, (1986)]. The standard result is obtained by allowing tax revenue to finance a public consumption good. It can easily be shown that allowing for a public consumption good in our framework would reproduce the result that the public good is underprovided in the Nash equilibrium.

The fact that the supply of capital will not be perfectly tax elastic when industry is agglomerated also ties this paper to the literature on capital controls. In this literature the government can impose quantitative restrictions on the mobility of capital (as in Giovannini (1991) and Razin and Sadka (1991)), or impose transaction costs on capital (as in Huber (1997)). In either case, the tax elasticity of capital is reduced, and this allows the government to levy a positive source tax on capital depending on its revenue needs.

5 Concluding Remarks

Previous models on tax competition between countries have assumed that economic activity is evenly spread out across space. Empirical studies, however, suggest that economic activity is lumped together in 'clusters', and that trade is not frictionless. The research outlined in this paper is novel in the sense that it makes two modifications to the standard model of new economic geography; first, it introduces capital as a factor of production (rather than only labor as in the standard set up) and, second, it allows for taxation of internationally mobile capital. Given these modifications, two alternative settings for tax competition have been analyzed. In the first scenario, capital and firms were assumed to be concentrated in one single location. It was then shown that the host country could gain from setting its source-tax on capital above that of the other country. In particular, the hosting country could - under reasonable assumptions - increase its welfare per capita by levying a positive source-tax on capital, since capital effectively became immobile due to pecuniary externalities arising in the agglomeration. In the second scenario capital and firms were evenly spread across the two countries. The equilibrium outcome in this case was that both countries provided a subsidy of equal size to capital.

The analysis in this paper could be extended in various directions. An obvious extension would be to include several industries that varies in their degree of internal and external linkages. This holds the potential of eliminating the extreme result that the whole manufacturing sector becomes located in one country. A second interesting extension would be to include a time dimension in the model, and explicitly consider

the time inconsistency problem that may constitute an important aspect of any sustainable tax policy (see Kydland and Prescott, 1977). This extension would obviously affect our results since the analysis has implicitly assumed that countries - when trying to attract capital and firms - have made a credible promise over future beneficial capital taxation.

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Appendix

A1 Parameter values

We have used $K_h = K_f = 1$, $L_h = L_f = 1$, $\theta = 0.4$, $\sigma = 4$, $\gamma = 0.5$ in all the simulations. In Figure 1 we have $\eta = 0.1$ and $\tau = 1.5$, while $\eta = 0.5$ and $\tau = 1.5$ in Figure 2 and Figure 3. In Figure 4 η is equal to 0.5.

A2 Deduction of equations (15) and (16)

Capital costs constitute a share θ of the total manufacturing costs (c.f. (5)), and with complete agglomeration in h we thus have

$$r_h \left(K_h + K_f\right) = \theta \left(E_h + E_f\right). \tag{26}$$

Total expenditure on manufacturing goods is equal to $E_h + E_f = n_h p_h$ when $n_f = 0$. With $w_h = w_f = 1$ it thus follows from equations (10) and (11) that $E_h = \gamma(w_h L_h + r_h K_h + t_h r_h K_f) + \eta(E_h + E_f)$ and $E_f = \gamma\left[w_f L_f + (1 - t_h) r_h K_f\right]$. Let $K \equiv K_h + K_f$ and $L \equiv L_h + L_f$. Using the above expressions for E_h and E_f together with (26) it can be shown that the interest rate in h equals

$$r_h = \left(\frac{\theta\gamma}{1 - \theta\gamma - \eta}\right)\frac{L}{K}, \tag{27}$$

while expenditures for manufacturing goods can be expressed as[21]

$$E_h = \gamma \left[L_h + \frac{L}{K} \left(\frac{\theta\gamma}{1-\theta\gamma-\eta} \right) (K_h + t_h K_f) \right] + \left(\frac{\eta\gamma}{1-\theta\gamma-\eta} \right) L, \tag{28}$$

and

$$E_f = \gamma \left[L_f + \frac{L}{K} \left(\frac{\theta\gamma}{1-\theta\gamma-\eta} \right) (1-t_h) K_f \right]. \tag{29}$$

Using Shepard's lemma on equation (5) we find that capital demand from each of the n_h firms is equal to $\theta r_h^{\theta-1} q_h^{\eta}$. Equilibrium on the capital market thus requires

$$n_h = \frac{K}{\theta r_h^{\theta-1} q_h^{\eta}}. \tag{30}$$

The price index for differentiated goods in country h is equal to $q_h = (n_h p_h^{1-\sigma})^{\frac{1}{1-\sigma}}$ from equation (3). By using that $p_h = r_h^{\theta} q_h^{\eta}$ from equations (2) and (5), we have

$$q_h = n_h^{\frac{1}{(1-\sigma)(1-\eta)}} r_h^{\frac{\theta}{1-\eta}}. \tag{31}$$

Solving (30) and (31) simultaneously, and inserting for r_h from equation (27), we find after a significant amount of algebra that

$$n_h = \left(\frac{K}{\theta} \right)^{\frac{1}{(1-\sigma)(1-\eta)+\eta}} \left(\frac{\gamma L}{1-\theta\gamma-\eta} \right)^{\frac{(1-\sigma)(1-\eta-\theta)}{(1-\sigma)(1-\eta)+\eta}}, \tag{32}$$

and

$$q_h = \left(\frac{K}{\theta} \right)^{\frac{\theta\sigma}{(1-\sigma)(1-\eta)+\eta}} \left(\frac{\gamma L}{1-\theta\gamma-\eta} \right)^{\frac{1-\theta\sigma}{(1-\sigma)(1-\eta)+\eta}}. \tag{33}$$

The welfare level per capita in country h is equal to $u_h = \frac{1}{L_h} \frac{\left(w_h L_h + r_h K_h + t_h r_h K_f \right)}{p_A^{1-\gamma} q_h^{\gamma}}$. Using $w_h = p_A = 1$ together with equations (27) and (33) we have

$$u_h = \left(\frac{1}{L_h} \right) \frac{(1-\theta\gamma-\eta) K L_h + \theta\gamma L (K_h + t_h K_f)}{N}$$

where $N \equiv (1-\theta\gamma-\eta) K \left[\left(\frac{K}{\theta} \right)^{\theta\sigma} \left(\frac{\gamma L}{1-\theta\gamma-\eta} \right)^{1-\theta\sigma} \right]^{\frac{\gamma}{(1-\sigma)(1-\eta)+\eta}}$. With $K_h = K_f$ and $L_h = L_f$ we arrive at equation (15) in the main text, where $k \equiv \frac{K}{N}$.

[21]We must of course require that (1-$\theta\gamma - \eta$)>0, otherwise the interest rate would be negative.

Equation (16) for the welfare level in country f is found in a similar way, by noting that $q_f = \tau q_h$ and $u_f = \frac{1}{L_f} \frac{\left(w_f L_f + (1-t_h) r_h K_f\right)}{p_A^{1-\gamma} q_f^{\gamma}}$ when $n_f = 0$.

A3 Deduction of equation (34)

By means of (3) and (12) we have that $x_f = \left(\frac{p_f}{p_h}\right)^{-\sigma} \frac{\tau^{\sigma-1} E_f + \tau^{1-\sigma} E_h}{p_h n_h}$. With all manufacturing agglomerated in country h equations (2) and (5) tell us that we have $p_f = r_f^{\theta} q_f^{\eta}$, $p_h = r_h^{\theta} q_h^{\eta}$, and $q_f = \tau q_h$. The no-arbitrage condition further implies that $\frac{r_f}{r_h} = \frac{1-t_h}{1-t_f}$, and therefore we can rewrite x_f as $x_f = \left(\frac{p_f}{p_h}\right)^{-\sigma} \frac{\tau^{\sigma-1} E_f + \tau^{1-\sigma} E_h}{p_h n_h} = \left(\frac{1-t_h}{1-t_f}\tau\right)^{-\theta\sigma} \frac{\tau^{\sigma-1} E_f + \tau^{1-\sigma} E_h}{p_h n_h}$. From equations (28) and (29) we thus have that manufacturing in f is profitable if,

$$x_f = \left(\frac{1-t_h}{1-t_f}\right)^{-\theta\sigma} \tau^{1-\sigma-\eta\sigma} \left(1 + \frac{(1-\theta\gamma-\eta) + (1-t_h)\,\theta\gamma}{2\left(\tau^{2(\sigma-1)} - 1\right)^{-1}}\right) \geq 1. \qquad (34)$$

Solving (34) for $x_f = 1$ leads to (19).

A4 The derivation of equation (20)

Suppose country f uses the tax rate $t_f = t_f^{crit}$ and becomes the new host of the agglomeration. In that case it follows from equation (15) that $u_f(t_f^{crit}) = k\left[(1-\theta\gamma-\eta) + (1+t_f^{crit})\theta\gamma\right]$. If the agglomeration stays in h, on the other hand, we know from equation (16) that $u_f(t_h) = k\left[\frac{(1-\theta\gamma-\eta)+(1-t_h)\theta\gamma}{\tau^{\gamma}}\right]$. Country h is therefore able to keep the agglomeration by choosing a tax rate t_h such that $u_f(t_h) \geq u_f(t_f^{crit})$. Solving this inequality we arrive at equation (20).

A5 Non-existence of agglomeration for high levels of trade costs

Suppose that it is profitable to produce differentiated goods in f for any given $t_h \leq 1.0$ when the level of trade costs is sufficiently high. In that case the asymmetric equilibrium must sooner or later break down if we increase τ. Does that happen? Equation (34) tells us that $\lim_{\tau\to\infty} x_f = \lim_{\tau\to\infty} \left(\frac{1-t_h}{1-t_f}\right)^{-\theta\sigma} \left\{\frac{2+[(1-\theta\gamma-\eta)+(1-t_h)\theta\gamma]\left(\tau^{2(\sigma-1)}-1\right)}{2\tau^{\sigma(1+\eta)-1}}\right\}$. By using L'Hopital's rule this can be simplified to $\lim_{\tau\to\infty} x_f = \lim_{\tau\to\infty} \left(\frac{1-t_h}{1-t_f}\right)^{-\theta\sigma}$ times $\left\{\frac{[(1-\theta\gamma-\eta)+(1-t_h)\theta\gamma]\tau^{2(\sigma-1)}}{2[\sigma(1+\eta)-1]\tau^{\sigma(1+\eta)-1}}\right\} \tau^{\sigma(1+\eta)-1}$. Since $(1-\theta\gamma-\eta) > 0$ we thus have $\lim_{\tau\to\infty} x_f = \infty$ if $\sigma > \frac{1}{1+\eta}$. If this inequality is satisfied, there must exist a critical level of trade costs beyond which $x_f > 1$ (so that the agglomeration breaks down).

It is easy to show that the degree of scale economies is an inverse function of σ, and approaches infinity as $\sigma \rightarrow 1$. Assuming $\sigma > \frac{1}{1+\eta}$ amounts to requiring that the scale economies are not are 'too large'. If σ were smaller than $\frac{1}{1+\eta}$, then, due to its small home market, country f would become more and more disadvantaged as τ increases. We would then end up in a situation where country h taxies away all capital income from country f ($t_h = 1.0$) for high levels of trade costs. We have ruled out this implausible case in our simulations, and thus assumed that $\sigma > \frac{1}{1+\eta}$.

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