Industrial Agglomeration and Capital Taxation¤

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Abstract

Models with imperfect competition and intra-industry trade have become widely accepted as appropriate frameworks within which to analyze the impact of trade liberalization on industrial agglomeration. This paper makes one modi…cation to the standard model; it allows for taxation of internationally mobile capital. Making this change fundamentally alters the main lesson from the tax literature that a country which faces perfectly internationally mobile capital should not use source-based taxes on capital income. In particular, it is shown that a country which hosts an agglomeration may actually increase its welfare level per capita by levying a source-tax on capital income even if capital can move costlessly between countries. It is thereby able to exploit the locational inertia created by agglomeration forces.

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1 Introduction

A main lesson from the literature on capital taxation in an open economy is that in a situation with internationally mobile capital a country should not use source-based taxes on capital income. This result is valid if labor is in …xed supply and there are no pure pro…ts (e.g. Gordon, 1986, Frenkel, Razin and Sadka, 1991, and Bucovetsky and Wilson, 1991). The reason is that internationally mobile capital escapes any burden of taxation if foreign-source income cannot be taxed for compliance reasons.[1] Yet, in a world where economic activity is not evenly spread out across space but "lumped" into industrial agglomerations, tax policies developed for a smooth world might need rethinking. In this paper we argue that in the presence of agglomerations, one of the assumptions underlying the well known result of zero source tax on capital income, no longer holds. We show that even though capital is perfectly internationally mobile, it need not necessarily be perfectly elastic in supply, in which case the zero source tax does not remain an optimal policy. It is shown that through a positive source tax a government may be able to exploit the locational inertia created by agglomeration forces. Thus, a country that hosts an industrial cluster can, in fact, increase national welfare by levying a source tax on capital income.

To bring forward the implications of industrial agglomeration for the design of optimal tax policy, we set up a simple model that follows the line of work that is usually referred to as the "new economic geography". The model is based on an interaction between economies of scale, market size, positive market linkages, trade costs, and national tax policies. It allows for analysis not only of how the presence of industrial agglomerations may a¤ect optimal tax policy, but also of the impact of capital taxation on the localisation of industries and clusters. A further di¤erence between this paper and the previous tax literature is the realistic interaction between trade and capital mobility, which is modelled within a two country - two industry - setting. The literature on tax policy and capital mobility

[1] If labor supply is variable and agents di¤er in their shares of capital and labor income, it is optimal to levy a source based tax on capital as well as a tax on labor income (Bjerksund and Schjelderup, 1998). The reason is that the incidence of the wage tax is partly shifted to capital owners.

has hitherto completely ignored the interaction of capital taxation, markets size and trade costs as parameters that may influence the optimal design of capital taxation.[2] Yet there is mounting empirical evidence that these parameters play a major part in firms' investment decisions. Cantwell (1994) and Deveraux and Griffith (1996), for example, demonstrate that market size is one of the main determinants for foreign direct investments, while Hartman (1985) and Slemrod (1990) find that there is a statistically significant and positive relationship between market size and the effective marginal tax on capital. In addition, there is amble evidence that politicians give concessions to industrial clusters out of fear for that these concentrations will otherwise vanish.[3]

The chosen framework allows us to examine what will happen to the relative competitiveness of an industry in the two countries (for a given level of trade costs) and thus to production and trade, if we introduce changes in capital taxation. We elaborate on the persistence of industry structures and trade patterns when taxes on capital are allowed to differ between countries. In addition, by changing the level of trade costs we investigate the interaction between capital taxation and the degree of economic integration. The rapid integration of western economies and, in particular, the creation of the internal market of the European Union (EU) is hoped to improve efficiency and welfare.

Politicians and economists still worry about some possibly less desirable consequences of tighter economic integration. Trade economists typically fear that tighter economic integration may increase concentration tendencies and reduce the competitiveness of industry located at the periphery thereby possibly lowering income and welfare in rural areas (e.g. Krugman and Venables, 1990, 1995 and Krugman, 1991). In the public finance literature the debate has been over economic consequences of differences in Europe's fiscal systems. The removal of trade barriers may exacerbate distortions from non-harmonized national tax systems and lead to capital flight

[2] One exception is Haufler and Wooton (1997). In their study market size is the sole determinant for location decisions.

[3] The shipping industry, for example, is facing close to zero rates of effective taxation for exactly these reasons (OECD 1997).

to low-tax countries as well as changes in the patterns of international trade (e.g. Sinn, 1990). Although both the trade and the public …nance literature have been concerned with the e¤ects of economic integration, very little work has been undertaken to combine the two strands of the literature, and is as such also a scope of the present analysis.[4]

The paper is organized as follows. In section 2 we describe our basic model. Section 3 examines on the one hand how tax policy design is a¤ected by the presence of agglomerations, and on the other hand how changes in national tax policy and capital mobility a¤ect localization decisions. Section 4 o¤ers 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 di¤er between sectors but not across countries, and the agricultural sector is assumed relatively intensive in the use of labor. Labor is immobile between countries while capital is assumed internationally mobile. Each country may levy taxes on wage and capital income, but since a tax on labor income within this setting is lump sum in nature, it will not be subject to discussion: The representative resident in country i receives income from labor and capital and has preferences over agriculture and manufacturing given by the utility function $U = C_A^{1-\circ} C_M^{\circ}$; $0 < \circ < 1$; where C_A is consumption of the agricultural good and C_M is consumption of a manufactures aggregate. The shape of the utility function implies that manufactures receive a share $\circ$ of expenditure.

[4] One notable exception is Hau‡er and Wooton (1997) who analyze tax competition between two countries of unequal size trying to attract a foreign-owned monopolist in a world with positive trade costs. In their paper it is shown that the large country "wins" the competition for foreign direct investments in the sense that it attracts the foreign …rm and increases its per capita welfare level.

Agriculture can be costlessly traded internationally, is perfectly competitive, and employs labor only.[5] By choice of scale unit labor requirement is one, and we select the A-good as numeraire. We consequently have

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

where $w_i = 1$ if country i produces agriculture.

The production technology in the manufacturing sector requires labor, capital, and a composite of intermediate goods. Following Krugman and Venables (1995) we make the simplifying assumption that the composite intermediate good is the same as the composite consumption good, and de…ne $C_M \equiv \left[\sum_k c_k^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$ with $\sigma > 1$: In line with Dixit and Stiglitz (1977) we assume monopolistic competition between intermediate good producers, and thus both the elasticity of substitution and the perceived elasticity of demand are equal to σ. All producers have access to the same technology, so prices from …rms in a given country will not di¤er. Since …rms use the constant markup $\frac{\sigma}{\sigma-1}$ over marginal costs (MC_i), the f.o.b. price from country i is given by

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

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

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

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

where n_i and n_j are the number of varieties produced on countries i and j.

[5] Letting agriculture not just be relatively intensive in the use of labour, but focusing on the extreme case where it only uses labour, simpli…es the analysis signi…cantly. The qualitative results are, however, not a¤ected.

Let x_i denote aggregate output from a representative …rm located in country i: Labor, capital and intermediates are combined with a Cobb-Douglas technology. Each …rm produces its output using ® units as a …xed cost and ¯ per unit output thereafter, and a representative …rm's total cost function is therefore

$$TC_i = w_i^{1-\mu-\gamma} r_i^{\mu} q_i^{\gamma} (\beta + \bar{\beta} x_i); \quad \mu \in [0;1] \text{ and } \gamma \in [0;1]; \tag{4}$$

where q_i is the price of the intermediates aggregate (Z_i).

To simplify (but without loss of generality), we set $\bar{\beta} = \frac{(\sigma-1)}{\sigma}$ and $\beta = \frac{1}{\sigma}$: There is free entry in the manufacturing sector, and the zero pro…t condition in combination with (4) and (2) imply that

$$x_i = \frac{\beta(\sigma-1)}{\bar{\beta}} = 1 \tag{5}$$

if it is pro…table 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 $L_i = L_{Mi} + L_{Ai}$: From (4) - using Shephard's lemma - we …nd

$$L_{Mi} = (1-\mu-\gamma) w_i^{-(\mu+\gamma)} r_i^{\mu} q_i^{\gamma} n_i: \tag{6}$$

Residents can invest at home and abroad, and taxation of interest income follows the principle of source taxation.[6]

Let K_{ii} and K_{ij} denote the part of country i's capital which is allocated domestically and abroad, respectively, so that $K_i = K_{ii} + K_{ij}$: We assume that an investor

[6] In principle most countries tax interest income of residents at the home tax rate, regardless of geographic source, but allow a full credit for foreign taxes paid against the domestic tax liability provided the foreign tax payments do not exceed the domestic tax liability. If the foreign tax liability exceeds the domestic tax liability, foreign-source income is exempted from taxation in the country of residence. There is, however, strong empirical evidence that governments for compliance reasons …nd it di¢cult to tax foreign interest income (see Razin and Sadka, 1991). For this reason interest income earned abroad either becomes untaxed or if taxed, then only subject to the foreign tax rate. In practice, taxation of interest income therefore corresponds to the source principle of taxation.

who undertakes foreign direct investments incurs a definite loss of resources of ζ_K per unit capital exported.[7] Denoting t_i^r the tax rate on capital income in country i; arbitrage between the home country and the foreign country implies that

$$\begin{aligned} (1 - t_h^r)\, r_h &= \left(1 - t_f^r\right) \frac{r_f}{\zeta_K}; \qquad K_{hf} > 0; K_{fh} = 0; \\ \text{or} \qquad (1 - t_h^r) \frac{r_h}{\zeta_K} &= \left(1 - t_f^r\right) r_f; \qquad K_{hf} = 0; K_{fh} > 0: \end{aligned} \tag{7}$$

From (7) it is clear that two-way investment flows will never occur if trade in capital is costly ($\zeta_K > 1$); so $K_{hf} > 0$ implies $K_{fh} = 0$ and vice versa. Without loss of generality we shall focus on the case where country f exports and country h imports capital. Equilibrium in the world capital market requires that the demand for capital world-wide equals supply,

$$n_h \mu w_h^{1-\mu} r_h^{\mu-1} q_h + n_f \mu w_f^{1-\mu} r_f^{\mu-1} q_f = K_h + K_{ff} + \frac{K_{fh}}{\zeta_K}. \tag{8}$$

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

$$Y_h = w_h L_h + r_h K_h + t_h^r r_h \frac{K_{fh}}{\zeta_K}; \quad Y_f = w_f L_f + r_f K_{ff} + (1 - t_h^r)\, r_h \frac{K_{fh}}{\zeta_K} \tag{9}$$

Taxes on labor income is de facto pure lump sum, since labor supply is fixed and internationally immobile. Capital taxes, however, affect the flow of capital between the two countries and are therefore distortionary.

From the description of preferences and technology we can write the total value of expenditure on differentiated goods in each country as

$$E_i = \alpha Y_i + \beta p_i n_i, \quad i = h; f. \tag{10}$$

[7] Wasteful transaction costs are common in the international macroeconomic literature and also used in public finance problems (e.g. Giavazzi and Giovannini, 1989 and Huber, 1997). There is moreover a substantial trade literature that analyses the effect of trade barriers on factor movements (see for instance Mundell, 1957, and Norman and Venables, 1995).

The …rst term on the right-hand sides of (10) is residents' expenditure on manufactures while the last term is intermediate demand. Using Shepard's lemma on (3) we can now write that domestic and foreign demand for a good produced in country i equals

$$x_{ii} = p_i^{-\sigma} q_i^{\sigma-1} E_i; \qquad x_{ij} = p_i^{-\sigma} q_j^{\sigma-1} \tau^{1-\sigma} E_j; \qquad i \neq j: \tag{11}$$

In equilibrium the supply of each variant must equal demand. Using (5) and (11), the equilibrium takes the form

$$1 = p_i^{-\sigma} \left[q_i^{\sigma-1} E_i + \tau^{1-\sigma} q_j^{\sigma-1} E_j \right]; \qquad i \neq j: \tag{12}$$

Balanced trade occurs when

$$n_h p_h x_{hf} - n_f p_f x_{fh} = (1 - t_h^r) r_h \frac{K_{fh}}{\tau K} - [w_h L_{Ah} - (1 - \alpha) Y_h]: \tag{13}$$

Equilibrium is now characterized by the equations (1), (2), (3), 7 (8), (10), (12), (13), which can be solved to give equilibrium values on w_i, q_i; p_i, r_i, E_i, n_i and $K_{ij;}$ $i \neq j$; $i = h; f$. In the next sections we investigate how changes in national capital taxes as well as a reduction in transaction costs a¤ect spatial agglomeration.

3 Equilibrium Analysis

There will always be international wage equalization in this model if demand for the agriculture good is so large that it must be produced in both countries. The pure existence of an asymmetric equilibrium suggests that this outcome is somewhat arti…cial, and the result would disappear if we had assumed that there is decreasing returns to scale in reproducible resources (labor) in the agricultural sector. Since a model extension along the latter lines would make the algebra substantially more complex, we shall instead assume that α is so large that one country is able to produce world-wide demand for the A¡good. In that way we allow wages to di¤er internationally in a simple model set-up. The case with enforced wage equalization will be brie‡y discussed later in this section.

As a point of departure we shall assume that $w_h > w_f$ and that country h is completely specialized in production of manufacturing goods and country f in production of the agricultural good. Evidently this cannot be an equilibrium if production of manufacturing goods in f o¤ers pure pro…ts. In the appendix it is shown that both countries produce M-goods unless

$$x_f^{\alpha} = \left(\frac{1 - t_h^r}{1 - t_f^r}\sqrt{\phi_K}\right)^{\mu\gamma} w_h^{\gamma(1-\mu-\gamma')}\phi^{1-\gamma-\gamma'}\left[1 + \frac{E_f}{E_f + E_h}\left(\phi^{2(\gamma-1)} - 1\right)\right]^{\gamma'/\gamma} < 1: \quad (14)$$

It is convenient to assume that $t_h^r = t_f^r$ in order to get an intuitive feeling for the relationship between x_f^{α} and ϕ: Note …rst that international location is irrelevant if there is completely free trade, in which case we necessarily must have $x_f^{\alpha} > x_h = 1$ if $w_h > w_f$: An outcome with international wage di¤erences and complete specialization consequently cannot be an equilibrium at $\phi = 1{:}0$: Neither can it be an equilibrium in the neighborhood of $\phi = 1{:}0$; since x_f^{α} is a continuous function of ϕ: What if ϕ increases from a "high value"? Then x_f^{α} must also increase, and a possible specialized equilibrium eventually break down, since the countries approaches autarky. For some medium levels of trade costs, however, a completely specialized equilibrium with $w_h > w_f$ may exist if some of the industry output also is used as inputs ($\gamma' > 0$). The reason is that country h then o¤ers both a relatively large market for manufacturing goods (demand linkage) and inexpensive intermediate goods to the industry (cost linkage); $q_h < q_f$: These cost and demand linkages (so called positive market linkages) may dominate over the fact that $w_h > w_f$: We should thus expect x_f^{α} to be a U-shaped function of ϕ, and this is con…rmed by the simulations in the next section.[8]

In the next two subsections we shall investigate how changes in national tax rates $t_h^r; t_f^r$ and capital mobility (ϕ_K) a¤ect the sustainability of a manufacturing agglomeration located in h, national industrial structures and welfare. At the same time we moreover elaborate on optimal tax policy in the presence of industrial agglomerations. Note that entrepreneurs in the manufacturing sector generally are

[8] This is a quite common result in economic geography models, and was …rst shown by Krugman and Venables (1995). See also Ottaviano and Puga (1997) for a survey.

challenged on two fronts; they must compete for market shares with possible foreign …rms in the same industry and with (potential) domestic agriculture production for labor. These general equilibrium e¤ects makes it necessary to rely on simulations.

3.1 Tax Policy

The international location of economic activity depends in general on relative market sizes, market linkages, trade costs, national tax policies, and the degree of capital mobility.[9]

It is easy to show that increased capital taxation in f reinforces the manufacturing agglomeration in h and reduces the pro…tability of producing manufacturing goods in f; so that we have $\frac{@x_f^{\alpha}}{@t_f^r} < 0$: The reason for this rather obvious result is that the potential net return on capital investments decreases when capital taxes increase. We shall refer to this e¤ect as the rate of return e¤ect.

The impact on agglomeration in h from an increase in t_h^r is less transparent, and it can be shown that $\frac{@x_f^{\alpha}}{@t_h^r}$ has an ambiguous sign because there are two opposing e¤ects that must be considered. The …rst is the rate of return e¤ect which - as indicated above - now will weaken agglomeration in h. The second e¤ect is the income e¤ect. Since country h is a net-importer of capital, an increase in t_h^r tends to raise tax revenue and thus national income in h. The increase in national income in turn raises demand in h and therefore the pro…tability of manufacturing in h. Which e¤ect that dominates, the rate of return or the income e¤ect, depends on the relative magnitude of the two e¤ects. Yet, for a more or less realistic choice of parameter values, the former is found to dominate, implying that an increase in the home country's tax rate weakens the forces for agglomerations.

More important than the ambiguity of the sign of $\frac{@x_f^{\alpha}}{@t_h^r}$ is the fact that it may be optimal for country h to increase capital taxation even if $\frac{@x_f^{\alpha}}{@t_h^r} > 0$: This is illustrated in …gure 1, which shows x_f^{α} as a function of ¿ for three di¤erent tax constellations. For the middle curve capital taxes are zero in both countries $\left(t_h^r = 0{:}0;\ t_f^r = 0{:}0\right)$,

[9] The assumption of imperfect capital mobility has been supported by empirical studies. See Feldstein and Horioka (1980), and Dooley, Frankel and Mathieson (1987).

while $\overset{n}{t}{}_h^r = 0{:}2;\ t_f^r = 0{:}0\overset{o}{}$ and $\overset{n}{t}{}_h^r = 0{:}0;\ t_f^r = 0{:}2\overset{o}{}$ for the upper and lower curve; respectively.[10] Consider now the middle curve and the parameter values $t_h^r = t_f^r = 0{:}0$; and $¿ = 1{:}3$; yielding $x_f^¤ ¼ 0;7$. Since tax revenues from foreign capital owners are increasing in t_h^r as long as $x_f^¤$ stays below 1.0, it is clear from the middle curve that country h could gain from increasing its capital tax rate. This is illustrated by considering the upper curve where country h levies a 20% tax on capital without losing any …rms. The upper …gure actually tells us that there is no reason why the home country should set t_h^r lower than some twenty percent when $¿ = 1{:}3$.[11]

FIGURE 1: Sustainability of an industrial agglomeration.

Positive market linkages generate cost and demand advantages which may dominate over the disadvantage incurred by a relatively higher wage rate in country h, making the …rms located in h more competitive than any potential …rm in f. Thus, the stronger the linkages within the industry (measured by ´); the stronger the forces for agglomeration and, consequently, the deeper the U-curves. In the presence of such linkages and positive trade costs, the proximity to other …rms is essential for the competitiveness of a manufacturer - a fact that may be exploited by the government of a host country by levying relatively high taxes. The U-shape of $x_f^¤(¿)$ makes it clear, however, that country h's ability to tax foreign capitalists depends

[10] See appendix for other parameter values.

[11] Though international tax agreements may prevent countries from direct capital subsidies, there are usually no upward limits on the allowed tax rates.

crucially on the level of trade costs (i.e., the degree of economic integration). In particular, the import competition facing a potential entrepreneur in f is low when trade costs are high. He is consequently able to charge relatively high prices from domestic consumers, with a correspondingly high value on the marginal product of capital. This increases the tax elasticity of the cluster, which is also happens for low levels of trade costs, since …rms then are sensitive to di¤erences in wage costs and tax rates between the home and foreign country. Indeed, …gure 1 shows that the cluster will dissolve when trade costs fall below the critical level ¿ < 1:15 unless h has lower capital taxation than f (c.f. middle curve where ¿ < 1:15 yields $x_f^¤ > 1$). To understand this result recall that the model allows for positive market linkages (´ > 0); and within the chosen framework of imperfect competition such linkages generate pecuniary externalities . Pecuniary externalities may encourage industrial agglomeration, but only as long as there are trade costs, since geographical distance does not matter per se for pecuniary externalities (unlike what often is assumed for technological externalities, see, e.g., Grossman and Helpman, 1991, Bayoumi, Coe and Helpman, 1996, and Ja¤e, Trajtenberg and Henderson, 1993).[12] When trade costs fall below a certain level, cost di¤erences encouraging the spread of industry come to dominate.

Country size or, more precisely, local purchasing power is also important for the host country's taxing ability (due to the scale advantages in the manufacturing sector). Country size in this model may be measured in terms of factor endowments, and is re‡ected through consumers' expenditures on manufactured products ($E_h; E_f$): A small country is placed at a disadvantage relative to the larger country due to its inferior market access. From (14) it can be derived that the smaller the country where manufacturing is concentrated, the more sensitive is an industrial cluster to changes. Decreasing size of the host country means that the U is pulled upwards $\frac{dx_f^¤}{dE_h} > 0$. Thus, if a small country is hosting the agglomeration, relatively small changes in tax policy may destabilize the asymmetric equilibrium. This result is qualitatively in line with Hau‡er and Wooton (1997). The policy variables

[12] The cluster would have remained all down to ¿ = 1:0 if $t_f^r = t_h^r$ and we had chosen parameter values such that we always have wage equalization, c.f. the discussion above.

in their model are trade costs and lump sum taxes, and they …nd that the small country levies lower taxes in the locational equilibrium than does the large country.

Eventually, production technology also has implications for the consequences of tax reforms: the higher the share of capital in the production cost of the manufacturing good, the more severe the e¤ects of changes in tax policy. It can be derived from equation (14) that the more capital intensive is manufacturing, the more crucial is the rental rate of capital - and thereby the tax rate of capital - for a …rm's location decision.

Summarising our …ndings, it appears that the stronger the forces for agglomeration, the higher the tax on capital income that the home government can levy without fearing the vanishing of the industrial agglomeration. The forces for agglomeration are stronger the larger the size of the home market, the smaller the foreign market, the more signi…cant the intra-industry linkages, and are most dominant for intermediate levels of trade costs. This can alternatively be illustrated in a diagram where we let $x_f^¤$ be drawn as a function of the tax rate in the home country, for given values of all other parameters. The optimal tax rate from a home country point of view, is the maximum tax rate that can be charged without the industrial agglomeration dissolving, and is given by $t_h^r = 0{:}48$ for which $x_f^¤ = 1$: For stronger (weaker) forces for agglomeration the $x_f^¤$ curve shifts to the right (left), implying that the optimal and maximum tax rate increases (decreases).

FIGURE 2: Optimal tax rate in the presence of an industrial agglomeration.

Figures 1 and 2 elucidate the important result that for a certain range of parameter values, despite being perfectly internationally mobile, capital may be perfectly inelastic in supply. For all parameter values that gives $x_f^{\alpha} < 1$, capital will be inelastic in supply to manufacturing activity taking place within the industrial cluster. It will not respond to any changes in tax rates or trade costs as long as these does not entail that the crictical $x_f^{\alpha} = 1$ is exceeded.

3.2 Capital mobility

Transaction costs on capital are intrinsically wasteful and reduce the rate of return by $1 - \frac{1}{\phi_K}$ percent for each exported capital unit, other things being equal. What happens if the transaction costs on capital are reduced? First, it raises the returns to exported capital, making exporting of capital more profitable and strengthens the agglomeration in h. Second, capital revenues in both countries are affected. As a first guess it is tempting to state that the capital exporting country (f) will be better off if ϕ_K is reduced, but that is not necessarily true. This is easily seen by looking at the change in the capital revenue for f when transaction costs are reduced ($-d\phi_K > 0$); by defining $R_f \equiv \frac{r_h K_{fh}}{\phi_K} = \frac{r_h K_f}{\phi_K}$ and differentiating w.r.t. ϕ_K we find

$$\frac{dR_f}{-d\phi_K} = \frac{r_h K_f}{\phi_K^2} - \frac{K_f}{\phi_K}\frac{dr_h}{d\phi_K}. \tag{15}$$

The first term on the right hand side of (15) shows the effect on f's capital income when we hold r_h fixed. This is the direct effect of reduced transaction costs and is obviously positive. Since there is decreasing returns to capital, and the effective capital stock increases when ϕ_K is reduced, we must, however, subtract the second term. The existence of two opposing terms means that in general R_f will not reach its maximum value at $\phi_K = 1$.[13] Whether one or the other effect dominates depends crucially on how transaction costs are modelled and on the production function in the manufacturing sector. In general one would expect the influence of the positive effect to be stronger the higher the substitutability between capital and the other

[13] Reduced transaction costs would always be beneficial for f if capital owners in f could coordinate their export decisions, in which case they would use their market power and withhold some of the capital (R_f is maximized for some $K_{fh} < K_f$).

factors of production. As for capital revenue in h, this will decrease due to the lower rate of return to capital.

A higher degree of capital mobility implies that the agglomeration in h, ceteris paribus, is weakened if $\frac{dR_f}{d\phi_K} > 0$, because local demand in f increases and local demand in h decreases, i.e. production in f becomes more profitable. However, there are also effects present that are not included in (15): If capital income in f increases, so do tax revenues in h: This strengthens agglomeration in h. Furthermore, an increased capital stock not only implies a reduced price on capital, but also allows for more varieties to be produced. Reduced price on capital and more varieties entail lower prices and price indices, and increased real income in both countries.

Hence, the total effect on agglomeration in h from a reduction in ϕ_K is ambiguous. With our specifications, however, the likely scenario is one where agglomeration in h is reinforced and welfare is increased in both countries. It should, however, be noted that agglomeration cannot be sustainable if ϕ_K is sufficiently increased. Therefore tighter restrictions on capital mobility may enforce the spread of economic activities internationally. Whether or not such a policy is welfare improving for country f depends in general on the level of trade costs as well as the characteristics of the production technology and the extent of pecuniary externalities (see Kind, Midelfart Knarvik and Schjelderup 1997).

3.3 Related literature

Our discussion of capital mobility and tax policy relates to various strands in the recent literature on the interaction between capital mobility and tax policy. A central result here is that a country which faces a perfectly internationally mobile capital should not use source-based taxes on capital income. This result hinges on the assumptions that the government can tax labor optimally, that labor is internationally immobile (its supply fixed), that there are no pure profits, that trade in goods between countries does not occur [Gordon (1986), Frenkel, Razin and Sadka (1991) and Bucovetsky and Wilson (1991)], and that when capital is perfectly internationally mobile, it is also perfectly elastic in supply. The intuition is that internationally

mobile capital escapes any tax burden if foreign source income cannot be taxed and the country is small. Thus, a source-based capital income tax is fully shifted to immobile factors. It is well understood that this result is a generalized open economy version of Diamond and Mirrlees' (1971) production e¢ciency theorem.

Our results obtained in section 3.1 were derived under the assumption of zero transaction costs on internationally mobile capital and are therefore comparable to this literature. Our …ndings, however, show that when one allows for pecuniary externalities and trade in goods the result of a zero source tax on capital is no longer valid (c.f. section 3.1). As a matter of fact, a country may bene…t from levying a source tax on capital income if it is the host of an industrial cluster. The reason is the inclusion of trade, trade costs and market linkages in our model. In particular, their inclusion means that manufacturers in the "cluster location" h are more competitive than their "rivals" in f, and can thus pay a higher price for each unit of capital without making losses. So 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, tax rates and other parameter values, it will in fact be inelastic in supply to an established industrial agglomeration. This is the main reason why previous results in the tax literature no longer are valid in this model.[14]

A di¤erent type of results have been obtained in the literature that examines the welfare impact of quantitative capital controls [Giovannini (1991), Razin and Sadka (1991), Huber (1997) and Bjerksund and Schjelderup (1998)]. These studies can be compared to the scenario in our model when $¿_K > 1$: Giovannini (1991) and Razin and Sadka (1991) …nd that if governments cannot tax foreign-source income, it is optimal from an e¢ciency point of view to impose quantitative restrictions on capital exports in combination with a positive source tax on capital. The reason is that reducing capital exports increases the capital income tax base and allows a welfare increasing reduction in the tax on capital income for a given level of public consumption.

[14] Note that our result also holds in the absence of market linkages, as long as there are di¤erences in market size. If h constitute the larger country where the complete monopolistic industry is localised, the country may still bene…t from levying a source tax on capital income.

Huber (1997) modifies the result by Giovannini (1991), Razin and Sadka (1991) by studying a specific type of capital controls which act like proportional transaction costs that increase the cost of international capital movements. Huber shows that the optimal policy for a capital exporting country depends on the revenue needs of the government. For relatively low levels of government expenditures, for example, the optimal policy entails a binding quota on capital exports but a zero source-tax on capital. This result is qualitatively similar to Gordon (1986) (see above), and hinges on the governments ability to tax the rent accruing to the inelastic factor labor at a rate of 100%. If these rents cannot be fully taxed, a zero source-based capital income tax is no longer necessarily optimal (see Giovannini (1991)). Bjerksund and Schjelderup (1998) consider restrictions on capital exports if agents differ in their shares of capital and labor income and labor supply is variable. Their analysis shows that irrespective of distributional preferences, free capital mobility is never optimal if capital is taxed according to the source principle of taxation. In addition, it is always optimal for a government to levy a positive source-tax on capital income. These results are obtained for any government objective, because the incidence of the wage tax is partly shifted to capital owners.

Our analysis supports this literature in the sense that it may be optimal from a social standing point to restrict the free mobility of capital. However, the reasons for this differ from the other studies. As discussed in section 3.2, tighter restrictions on capital mobility may enforce the spread of economic activities internationally. This may be optimal from a national point of view depending on the level of trade costs as well as the characteristics of the production technology and the extent of pecuniary externalities. Our analysis, therefore, provides additional reasons for why capital mobility may not be optimal from a single country's point of view.

4 Concluding Remarks

Models with imperfect competition and intra-industry trade have become widely accepted as appropriate frameworks within which to analyze the impact of trade liberalization on industrial agglomeration. The research outlined in this paper is

novel in the sense that it makes one modi…cation to the standard model; it allows for capital taxation of internationally mobile capital. Making this change fundamentally changes previous results and recommendations from the tax literature on capital taxation and capital mobility (i.e., countries should not levy source taxes on capital, see Gordon 1986, Frenkel, Razin and Sadka 1991 and Huber 1997). In particular, one of the main lessons from the analysis is that a country which hosts agglomeration of manufacturing may actually increase its welfare level per capita by levying a tax on capital income. This results carries through if a tax increase leads to an expansion in demand in the host country that is su¢ciently high to compensate capital owners for the direct loss in capital income following the tax change.

The fact that levying a source tax on capital may be welfare increasing was shown to depend on the level of trade costs and the existence of positive market linkages. This means that including trade into the framework of capital taxation is important partly because the existence of both trade costs and linkages are well documented, and partly because these factors seem to matter for the design of policy.

5 Appendix

In this section we give the parameterized values of …gure 1 as well as the derivation of equation (14).

5.1 Parameter values for …gure 1:

The derivation of …gure 1 is based on the following parameter values:

$L_h = 1$; $L_f = 2$; $K_h = 1$; $K_f = 2$; ¾ = 4:0; µ = 0:4; ´ = 0:4; ° = 0:9; and free mobility of capital, that is, ¿$_K$ = 1:0: The same parameter values are employed for …gure 2 where in addition $t_f = 0:2$.

5.2 The condition for a sustainable asymmetric equilibrium with industrial agglomeration:

From (3) we have that $q_f = \neg q_h = \neg n_h^{\frac{1}{1 \mathbin{i} \frac{3}{4}}} p_h$ if all manufacturing is located in country h (i.e., $n_f = 0$). Using (5) and (12) we …nd that the sales of a manufacturing …rm in h equals:

$$x_h = \frac{E_h + E_f}{p_h n_h} = 1: \tag{16}$$

Now consider an entrepreneur in f. Since the elasticity of substitution between any two intermediate goods equals ¾; he would expect to sell $\left(\frac{p_f}{p_h \neg}\right)^{\mathbin{i} \frac{3}{4}} \frac{E_f}{p_h n_h \neg}$ in f and $\neg \left(\frac{p_f \neg}{p_h}\right)^{\mathbin{i} \frac{3}{4}} \frac{E_f}{p_h n_h}$ in h (recall that only $\frac{1}{\neg}$ of each good actually reaches the export destination since we have assumed Samuelson iceberg costs). We thus …nd

$$x_f^{\alpha} = \left(\frac{p_f}{ph}\right)^{\mathbin{i} \frac{3}{4}} \frac{\neg^{\frac{3}{4} \mathbin{i} 1} E_f + \neg^{1 \mathbin{i} \frac{3}{4}} E_h}{p_h n_h}; \tag{17}$$

and that it is unpro…table to produce manufacturing goods in f if $x_f^{\alpha} < 1$: Equation (17) can alternatively be expressed as

$$x_f^{\alpha} = \left(\frac{1 \mathbin{i} t_h^r}{1 \mathbin{i} t_f^r \neg K}\right)^{\mathbin{i} \mu \frac{3}{4}} w_h^{\frac{3}{4}(1 \mathbin{i} \mu \mathbin{i} \acute{}) \neg^{1 \mathbin{i} \frac{3}{4} \mathbin{i} \acute{} \frac{3}{4}}} \left(1 + \frac{E_f}{E_f + E_h} \neg^{2(\frac{3}{4} \mathbin{i} 1)} \mathbin{i} 1\right)^{\frac{\acute{}}{\#}} \tag{18}$$

by using that $w_f = 1$; $p_f = r_f^{\mu} q_f^{\acute{}}$, $p_h = w_h^{1 \mathbin{i} \mu \mathbin{i} \acute{}} r_h^{\mu} q_h^{\acute{}}$ (c.f. equations (4) and (2)), $q_f = \neg q_h$; and the no-arbitrage condition $\frac{r_f}{r_h} = \frac{1 \mathbin{i} t_h^r}{\left(1 \mathbin{i} t_f^r\right) \neg K}$ from equation (7).

Finally, labor in h receives a share $(1 \mathbin{i} \mu \mathbin{i} \acute{})$ of expenditures on manufacturing goods (c.f. 3) if there is complete international specialization, so that we have

$$w_h L_h = (1 \mathbin{i} \mu \mathbin{i} \acute{}) (E_h + E_f); \tag{19}$$

or

$$w_h L_h = p_h n_h x_h = p_h n_h: \tag{20}$$

Solving the system of equations (10), (13), (18), (19), and (20) we obtain equilibrium values for the variables $w_h; r_h; E_h; E_f; E_h + E_f$, and can express x_f^{α} in terms of parameters only;

$$x_h^{\alpha} = \left(\frac{1 \mathbin{i} t_h^r}{1 \mathbin{i} t_f^r \neg K}\right)^{\mathbin{i} \mu \frac{3}{4}} \left(\frac{\circ (1 \mathbin{i} \mu \mathbin{i} \acute{}) L_f}{(1 \mathbin{i} \circ)(1 \mathbin{i} \acute{}) L_h}\right)^{\frac{3}{4}(1 \mathbin{i} \mu \mathbin{i} \acute{})} \neg^{\mathbin{i} \acute{} \frac{3}{4}} \tag{21}$$

$$\left[1 + \left(1 - \delta\right)\left(1 - \gamma\right) + \frac{\left(1 - t_h^r\right)\mu\frac{K_f}{K}}{\frac{K_f}{K} + K_h}\right]^{2(\sigma - 1)} - 1 < 1 :$$

It is now straightforward to differentiate x_f^* with respect to, e.g., t_h^r and t_f^r; and find the effects discussed in the main text.

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