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Source versus Residence. A comparison from a New Economic Geography perspective

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Source versus Residence
A comparison from a New Economic Geography perspective

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Abstract

Recently, issues of international taxation have also been analysed from a New Economic Geography perspective. These discussions show that agglomerative forces play a non negligible role. In the paper, we introduce explicitly taxation into a Footloose Capital Model and compare implications of taxation according to the residence principle and the source principle from a New Economic Geography perspective. We confirm that agglomerative effects change the results substantially compared to the standard analysis and that the two taxation principles have different implications for industry agglomeration.

JEL: H2 - Taxation, Subsidies, and Revenue
R1 - General Regional Economics
R12 - Size and Spatial Distributions of Regional Economic Activity
F12 - Models of Trade with Imperfect Competition and Scale Economies

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Source versus Residence
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By Pasquale Commedatore and Ingrid Kubin[1]

1. Introduction

One of the central questions in capital income taxation, when capital is internationally mobile, is whether to tax according to the residence or to the source principle. The political discussion mainly focuses on which of the two principles is more likely to avoid tax evasion; the standard economic analysis concerns the efficiency of international capital and savings allocation generated by the two principles. Taxation based upon the residence principle generates an efficient allocation of capital (referred to as capital export neutrality) but no efficient allocation of savings (referred to as capital import neutrality); taxation based upon the source principle produces the opposite efficiency result. Taking differences in the tax rates as given, the comparison boils down to the question which of the two principles generates a lower welfare loss.

[1] The paper benefits from previous joint work with Martin Currie and from valuable discussions with him. While working on this paper, Ingrid Kubin enjoyed the kind hospitality of the School of Economics at Nottingham University. Contributions from participants in two Workshops at this School are gratefully acknowledged. The usual caveat applies.

Recently, issues of international taxation have also been analysed from a New Economic Geography perspective. These discussions show that adding agglomerative forces can change the results considerably. In the following paper, we address the comparison between the residence and the source principle from this perspective and argue that the two taxation principles have substantially different implications for industry agglomeration.

In the models of the New Economic Geography, countries or regions are separated by transport costs and agglomeration is brought about by factor mobility due to differences in regional economic incentives. Because of decreasing average costs in production, factor rewards are the higher, the higher the local demand is. A high share in total expenditure thus leads to an even higher share in industrial capital. This indicates obvious points at which public policy, i.e. taxation and public expenditures can affect this mechanism:

Factor mobility motivated by differences in net factor income is directly affected by tax policy. Most studies of public policy within the New Economic Geography take this aspect on board (e.g. the literature on tax competition: Baldwin and Krugman, 2004 and Borck and Pflüger, 2006, among the others). The provision of public goods, which enter into private consumption, can also impact upon the migration decision (see for this aspect Baldwin et al., 2003).

Moreover, public policy is also a central factor determining both the level and the composition of local demand. Income taxes change the disposable income and thus private expenditures; public expenditures are typically different from the private ones as far as their regional and sectoral structure is concerned. Trionfetti (1997) and Brülhart and Trionfetti (2004) study the former aspect. The latter is at the core of Commendatore and Kubin (2006) where it is explored whether sectoral differences in public policy may lead to industry agglomeration.[2] It is also included in the following analysis.

Public expenditures for infrastructure may reduce transport costs (see Martin and Rogers, 1995; Martin, 1999).

Finally, public expenditure can also affect factor rewards in a region via its effect upon productivity. This aspect has been also studied to some extent in the New Economic Geography models (Brakman et al., 2007; Commendatore, Kubin and Petraglia, 2007).

The present paper focuses on a comparison of the residence and the source principle; this has several implications for the model structure: First, we need a model in which the residence country of capital owners may be different from the country in which the capital income originates. This leads us to adopting a special variant of the Footloose Capital Model[3]. In this model, physical capital is mobile, but individuals, i.e. capital owners and workers, are immobile. Therefore, depending upon the taxation system, the mobility decision may depend upon taxation, but it does not depend upon the provision of public commodities (that enter into consumption). Second, in order to insulate the effects of differences in capital income taxation we assume that the countries' tax rates are different for capital income, but that these countries do not tax labour income. Third, we want to take agglomerative effects via public expenditures on board: We allow for differences between the structures of private and public expenditures, but do not consider its possible effects upon transport costs or productivity.

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[2] This is a companion paper to the present one which has an explicit emphasis on the dynamic pattern of agglomerative processes.

[3] See Commendatore et al (2007) for an exploration of the Footloose Capital Model without taxation; and Currie and Kubin (2006) for a more general exploration of the implications of specifying models of the new Economic Geography in discrete time.

The paper is structured as follows: In section 2 we introduce the assumption of our model; section 3 presents the full model structure and introduces taxation according to the Residence Principle. Section 4 analyses the model with taxation according to the Source Principle. Section 5 compares the different cases analysed and draws some implications for tax policy.

2. Assumptions

The Footloose Capital model involves two countries or regions, $r = 1,2$. There are L consumers, who are immobile between regions and equally distributed between the regions. Each of the consumers provides one unit of labour per period and own one unit of (physical) capital. A key feature of the Footloose Capital model is that physical capital is mobile between regions but capital owners are completely immobile and they spend all their earnings in the region in which they live.

A representative consumer has the following utility function:

$$U = Up + Ug = \left(C_A\right)^{1-\mu}\left(C_M\right)^{\mu} + Ug\left(C_G\right). \tag{1}$$

Up denotes the private utility component derived from private expenditures and Ug the public utility component derived from public expenditures. We specify both components as linear separable, therefore private commodities demands are not affected by the level of the public good provision. The private utility component depends in the usual form on quantity consumed of a homogeneous agricultural good, C_A, and on a quantity index C_M that is a CES function of the varieties of manufactured goods. The constant elasticity of substitution between the manufactured varieties is denoted by $\sigma > 1$; the lower σ, the greater the consumers' taste for variety. The exponents of the agricultural good and of the manufacturing composite in the common utility function – $(1-\mu)$ and μ, respectively – indicate the invariant shares of disposable income devoted to the agricultural good and to manufactures; therefore $0<\mu<1$. We do not specify explicitly the utility derived from public expenditures, it depends on the quantity consumed of a publicly provided good, C_G (with a positive first and a negative second derivative).

In the literature on tax competition it is typically assumed that each government provides publicly a private good (see e.g. Zodrow, 2003, who explicitly points to this fact); therefore, in total $\frac{L}{2}C_G$ units have to be produced in each region; the respective production function is:

(2) $$\frac{L}{2}C_G = \left(C_{AG}\right)^{1-\nu}\left(C_{MG}\right)^{\nu}.$$

C_{AG} denotes the quantity of the agricultural good and C_{MG} the quantity index of the manufactured goods – again based on a substitution elasticity of σ – used in providing $\frac{L}{2}C_G$. This specification implies that the share of governmental revenue devoted to the agricultural commodity and to the manufacturing composite – $(1-\nu)$ and ν, respectively, with $0\le\nu\le 1$ – may differ from the private shares; the elasticity of substitution between the manufactured varieties, however, is assumed to be the same for the private and the public sector. Public expenditures are financed by capital income taxes, the budget is always balanced.

The agricultural commodity is produced with labour as the sole input, one unit of labour yields one unit of the agricultural product. We assume that neither region has enough labour to satisfy the total demand of both regions for the agricultural good. Thus, both regions always produce the agricultural commodity – the so-called non-full-specialization condition. Transportation of the agricultural product between regions is costless.

Manufacturing involves increasing returns: each manufacturer requires a fixed input of 1 unit of capital to operate and has a constant marginal labour requirement β. Transport costs for manufactures take an iceberg form: if 1 unit is shipped between the regions, $1/T$ arrives where $T \geq 1$. 'Trade freeness' is defined as $\phi \equiv T^{1-\sigma}$ where $0 < \phi \leq 1$, with $\phi = 1$ representing no trade cost and with trade cost becoming prohibitive as $\phi \to 0$. The manufacturing sectors involve Dixit-Stiglitz monopolistic competition. Given the consumers' preference for variety, a firm would always produce a variety different from the varieties produced by other firms. Thus the number of varieties is always the same as the number of firms. Furthermore, since 1 unit of capital is required for each manufacturing firm, the total number of firms / varieties, *n*, is always equal to the total supply of capital:

(3) $$n = K$$

The number of varieties produced in period *t* in region *r* is:

(4) $$n_{1,t} = \lambda_t n = \lambda_t K \qquad n_{2,t} = \left(1-\lambda_t\right) n = \left(1-\lambda_t\right) K$$

where $0 \leq \lambda_t \leq 1$ denotes the share of physical capital used in region 1 in period *t*.

As with most economic geography models, the primary focus of the Footloose Capital model is the spatial location of manufacturing industry, governed here by the endogenous regional allocation of capital, λ_t.

In what follows, we complete the model by characterizing the short-run general equilibrium in period *t* contingent on λ_t, by specifying explicitly the capital migration process, and by analysing the long-run equilibrium given as fixed point of the capital mobility dynamics. We consider two different cases depending on the principle of capital taxation: we assume in Section 3 that taxes are collected according to the residence principle. In Section 4, we analyse the case of taxation according to the source principle, which turns out to be considerably more complex.

3. Full Model with Taxation according to the Residence Principle

3.1. Short-run General Equilibrium

With the instantaneous establishment of equilibrium in the agricultural market and no transport costs, the agricultural price is the same in both regions. Since competition results in zero agricultural profits, the equilibrium nominal wage of workers in period t is equal to the agricultural product price and is therefore always the same in both regions. We take this wage / agricultural price as the *numeraire*. Since manufacturers in both regions face that same wage in every period, all set the same mill price p, using the Dixit-Stiglitz pricing rule. Given that the wage is 1, the local price of every variety is:

$$p = \frac{\beta\sigma}{\sigma - 1} \tag{5}$$

The effective price paid by consumers for one unit of a variety produced in the other region is pT .

Short-run general equilibrium in period t requires that each manufacturer meets the demand for its variety.[4] For a variety produced in region r:

[4] As a result of Walras' Law, equilibrium in all product markets implies equilibrium in the regional labour markets.

(6) $$q_{r,t} = d_{r,t}$$

where $q_{r,t}$ is the output of each manufacturer in region *r* and $d_{r,t}$ is the demand for that manufacturer's variety. From equ. (5), the short-run equilibrium profit per variety in region *r* is:

(7) $$\pi_{r,t} = pq_{r,t} - \beta q_{r,t} = \frac{pq_{r,t}}{\sigma} = \left[\frac{\beta}{\sigma - 1}\right] q_{r,t}$$

This profit per variety constitutes the regional rental per unit of capital.

Consumers and government (as input demanders) face regional manufacturing price indices given by:

(8) $$\begin{aligned} G_{1,t} &= \left[n_{1,t} p^{1-\sigma} + n_{2,t} p^{1-\sigma} T^{1-\sigma}\right]^{\frac{1}{1-\sigma}} = \left[\lambda_t + (1-\lambda_t)\phi\right]^{\frac{1}{1-\sigma}} K^{\frac{1}{1-\sigma}} p \\ G_{2,t} &= \left[n_{1,t} p^{1-\sigma} T^{1-\sigma} + n_{2,t} p^{1-\sigma}\right]^{\frac{1}{1-\sigma}} = \left[\lambda_t \phi + (1-\lambda_t)\right]^{\frac{1}{1-\sigma}} K^{\frac{1}{1-\sigma}} p \end{aligned}$$

Consumption and public input demand per variety in each region is:

(9) $$\begin{aligned} d_{1,t} &= \left[M_{1,t} G_{1,t}^{\sigma-1} + M_{2,t} G_{2,t}^{\sigma-1} \phi\right] p^{-\sigma} \\ d_{2,t} &= \left[M_{1,t} G_{1,t}^{\sigma-1} \phi + M_{2,t} G_{2,t}^{\sigma-1}\right] p^{-\sigma} \end{aligned}.$$

$M_{r,t}$ denotes private and public expenditures for manufactured goods in region *r*; M_t defines the world expenditures for manufactures $M_t = M_{1,t} + M_{2,t}$ and $s_{E,t} = \frac{M_{1,t}}{M_t}$ its regional split. From equ. (6), (8) and (9)

(10)
$$q_{1,t}=d_{1,t}=\left[\frac{s_{E,t}}{\lambda_t+(1-\lambda_t)\phi}+\frac{(1-s_{E,t})\phi}{\lambda_t\phi+(1-\lambda_t)}\right]\frac{M_t}{\sigma}\frac{1}{K}\frac{\sigma-1}{\beta}$$
$$q_{2,t}=d_{2,t}=\left[\frac{s_{E,t}\phi}{\lambda_t+(1-\lambda_t)\phi}+\frac{1-s_{E,t}}{\lambda_t\phi+(1-\lambda_t)}\right]\frac{M_t}{\sigma}\frac{1}{K}\frac{\sigma-1}{\beta}$$

Therefore – see equ. (7) – short-run equilibrium profit per variety in region *r* is:

(11)
$$\pi_{1,t}=\left[\frac{s_{E,t}}{\lambda_t+(1-\lambda_t)\phi}+\frac{(1-s_{E,t})\phi}{\lambda_t\phi+(1-\lambda_t)}\right]\frac{M_t}{\sigma}\frac{1}{K}$$
$$\pi_{2,t}=\left[\frac{s_{E,t}\phi}{\lambda_t+(1-\lambda_t)\phi}+\frac{1-s_{E,t}}{\lambda_t\phi+(1-\lambda_t)}\right]\frac{M_t}{\sigma}\frac{1}{K}$$

For future reference, note that regional and world profit incomes, $\Pi_{r,t}$ and Π_t repectively, are given by

(12)
$$\Pi_{1,t}=\lambda_t K\pi_{1,t}\qquad \Pi_{2,t}=(1-\lambda_t)K\pi_{2,t}\qquad \Pi_t=\Pi_{1,t}+\Pi_{2,t}=\frac{M_t}{\sigma}$$

(for the latter use equ. (11)) and world income Y_t by

(13)
$$Y_t=L+\frac{1}{\sigma}M_t.$$

Crucial for the subsequent dynamic analysis is the relative profitability of capital $R(\lambda_t)$ given by:

(14)
$$R(\lambda_t)=\frac{\pi_{1,t}}{\pi_{2,t}}=\frac{s_{E,t}\left[\lambda_t\phi+(1-\lambda_t)\right]+(1-s_{E,t})\phi\left[\lambda_t+(1-\lambda_t)\phi\right]}{s_{E,t}\phi\left[\lambda_t\phi+(1-\lambda_t)\right]+(1-s_{E,t})\left[\lambda_t+(1-\lambda_t)\phi\right]}.$$

Two effects determine how relative profitability changes with the allocation of capital. First, for a constant $s_{E,t}$ the relative profitability of capital depends upon the allocation of capital λ_t only via the competition effect: A higher λ_t increases the competition in region 1 and therefore reduces relative profitability, i.e. $\left.\frac{\partial R(\lambda_t)}{\partial \lambda_t}\right|_{s_E=const} < 0$. Second, if $s_{E,t}$ changes with the allocation of capital, a demand effect impacts upon profitability as well: A higher share in expenditure increases the relative profitability, i.e. $\frac{\partial R(sE)}{\partial sE} > 0$. Whether a demand effect occurs depends upon the principle according to which capital taxes are collected; the competition effect is active under both systems.

Turning now to the specifities of taxation according to the residence principle, note that the tax burden on capital owners living in region *r* is identical to the tax revenues for government *r*, denoted by $TR_{r,t}$:

(15) $$TR_{r,t} = \tau_r \frac{\Pi_t}{2}$$

$0 \leq \tau_r \leq 1$ denotes the regional tax rate on profit incomes. If it is different between the regions, tax revenues and tax burdens differ as well. Regional expenditures for manufactured goods are therefore given as

(16) $$M_{r,t} = \mu\left(\frac{L}{2} + \frac{\Pi_t}{2} - TR_{r,t}\right) + \nu TR_{r,t}$$

Public policy affects expenditures for manufactured goods in as far private and public expenditure shares differ; i.e. $\mu \neq \nu$. Those effects differ between regions, if local tax rates are different; i.e. $\tau_1 \neq \tau_2$.

Observing equ. (12) and (15), world expenditures for manufactures are

(17) $$M_t = \mu\left(L + \Pi_t\right) + \left(\nu - \mu\right)\left(TR_{1,t} + TR_{2,t}\right) = \mu\left(L + \frac{M_t}{\sigma}\right) + \left(\nu - \mu\right)\frac{\tau_1 + \tau_2}{2}\frac{M_t}{\sigma}.$$

Therefore,

(18) $$M_t = \overline{M} = \frac{\mu}{\sigma - \mu + \frac{\tau_1 + \tau_2}{2}\left(\mu - \nu\right)}\sigma L.$$

Its regional split is

(19) $$s_{E,t} = \overline{s_E} = \frac{1}{2}\left(1 + \frac{\nu - \mu}{\sigma}\frac{\tau_1 - \tau_2}{2}\right).$$

With the residence principle, world income (see equ. (13)), total expenditures for manufactures and its regional split are constant, i.e. independent of the regional allocation of capital. $\overline{s_E}$, the expenditure share for manufactured goods in Region 1, will be one of our central parameters. It summarizes the effects of public expenditure and tax policy. If both regions have the same tax rate, i.e. if $\tau_1 = \tau_2$, or if public expenditure behaviour is not different from the private one, i.e. if $\mu = \nu$, then $\overline{s_E} = \frac{1}{2}$ as in the symmetric Footloose Capital Model without a public sector. If regional tax policy differs, i.e. $\tau_1 \neq \tau_2$, and if this difference matters for expenditure behaviour, i.e. if $\mu \neq \nu$, then $\overline{s_E} \neq 0.5$. Equ. (19) shows that the higher tax region ends up with the higher expenditure share for manufactured goods, if governments spend more for manufactured goods than private consumers do; i.e. if $\nu > \mu$.

Finally, equ. (11), (18) and (19) determine short-run equilibrium regional profits per variety; the relative profitability of capital $R\left(\lambda_t\right)$ is given by:

(20) $$R(\lambda_t) = \frac{\overline{s_E}\left[\lambda_t\phi+(1-\lambda_t)\right]+\left(1-\overline{s_E}\right)\phi\left[\lambda_t+(1-\lambda_t)\phi\right]}{\overline{s_E}\phi\left[\lambda_t\phi+(1-\lambda_t)\right]+\left(1-\overline{s_E}\right)\left[\lambda_t+(1-\lambda_t)\phi\right]}.$$

Since the share of expenditures for manufactures $\overline{s_E}$ is independent of the capital allocation, no demand effect occurs and the competition effect implies a negative slope of $R(\lambda_t)$, i.e. $\frac{\partial R(\lambda_t)}{\partial \lambda_t} < 0$. Relative profitability depends upon public policy parameters since $\overline{s_E}$ depends (positively) upon $(\nu-\mu)(\tau_1-\tau_2)$. Any parameter change that increases $\overline{s_E}$, increases relative profitability, i.e. $\frac{\partial R}{\partial \overline{s_E}} > 0$. If, for example, $\tau_1 < \tau_2$ and the manufactures share in public expenditures ν increases, the share of expenditures for manufactures in region 1, $\overline{s_E}$, declines and relative profitability is reduced (for $\tau_1 > \tau_2$ the opposite holds true).

3.2. Capital Movements and the Complete Dynamical Model

In a Footloose Capital model, the representative capitalist does not move herself, but allocates the physical capital she owns between the regions. In doing so, she is interested in her *real net* income (we assume that she takes the level of the publicly provided good at home as given). Since all income is taxed and spent in the home region of the capitalist, the relevant tax rate and price index for calculating *real net* income are the ones at home, irrespective of the regional capital allocation. Therefore, in this case location choices based on *real net* income and on *nominal gross* income are equivalent.

The concrete specification of the dynamic process follows ideas from the replicator dynamics widely used in evolutionary economics and evolutionary game theory (see e.g., Weibull, 1997; see Fujita et al., 2000, p. 77, who pointed to this fact). Taking into account the constraint $0 \le \lambda_{t+1} \le 1$, the piecewise smooth one-dimensional map whereby λ_{t+1} is determined by λ_t is:

(21)
$$\lambda_{t+1} = Z(\lambda_t) = \begin{cases} 0 & if \quad F(\lambda_t) < 0 \\ F(\lambda_t) & if \quad 0 \le F(\lambda_t) \le 1 \\ 1 & if \quad F(\lambda_t) > 1 \end{cases}$$

where λ_t is in [0,1] implies that λ_{t+1} is in [0,1] and where

(22)
$$\frac{F(\lambda_t) - \lambda_t}{\lambda_t} = \gamma E_t = \gamma \frac{\pi_{1,t} - \left(\lambda_t \pi_{1,t} + (1-\lambda_t)\pi_{2,t}\right)}{\lambda_t \pi_{1,t} + (1-\lambda_t)\pi_{2,t}}.$$

We refer to $\gamma > 0$ as the 'speed' with which the representative capitalist alters the share of capital in region 1 in response to economic incentives E_t, in particular to a comparison of the rate of profit in region 1 with the average rate of profit, given by $\left(\lambda_t \pi_{1,t} + (1-\lambda_t)\pi_{2,t}\right)$. It can be transformed into a law of motion depending upon the ratio in regional profitability, $R(\lambda_t)$:[5]

(23)
$$F(\lambda_t) = \lambda_t + \gamma \lambda_t (1-\lambda_t) \frac{R(\lambda_t) - 1}{\lambda_t R(\lambda_t) + (1-\lambda_t)}.$$

Fixed points for the dynamical system, which correspond to points of rest or long-run equilibria, are defined by $Z(\lambda) = \lambda$. Core-periphery equilibria, i.e. $\lambda_0^{CP} = 0$ or $\lambda_1^{CP} = 1$, are boundary fixed points of the dynamic system. A central question of the New Economic

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[5] Note that – from an analytic perspective – this specification is a good approximation to the discrete-time counterpart of the process assumed by Puga (1998) in his core-periphery model.

Geography concerns critical values for trade freeness (or for any other parameter) at which agglomeration in either region is sustainable. The so-called sustain points give conditions under which "the advantages created by such a concentration, should it somehow come into existence, [are] sufficient to maintain it" (Fujita et al., 2000, p. 9). Sustain points therefore specify conditions at which the boundary equilibria λ_i^{CP} (where i = 0, 1) become (at least locally) stable. These critical values are defined by $F'\left(\lambda_i^{CP}\right)=1$, with the latter indicating the derivative of the first return map equ. (22). The latter condition can be reduced to $R\left(\lambda_i^{CP}\right)=1$ and solved for

(24) $$\phi^{S(0)}=\frac{\overline{s_E}}{1-\overline{s_E}} \qquad \phi^{S(1)}=\frac{1-\overline{s_E}}{\overline{s_E}},$$

where $\phi^{S(i)}$ indicates the sustain point for λ_i^{CP}. For $\overline{s_E}=0.5$ it holds that $\phi^{S(0)}=\phi^{S(1)}=1$; for $\overline{s_E}>0.5$ this condition changes to $\phi^{S(1)}<1<\phi^{S(0)}$ (and for $\overline{s_E}<0.5$ it holds that $\phi^{S(0)}<1<\phi^{S(1)}$).

In addition to the boundary fixed points, an interior fixed point is given by

(25) $$\lambda_R^*=\frac{1}{2}+\frac{1+\phi}{1-\phi}\left(\overline{s_E}-\frac{1}{2}\right)=\frac{1}{2}\left(1+\frac{1+\phi}{1-\phi}\frac{\nu-\mu}{\sigma}\frac{\tau_1-\tau_2}{2}\right).$$

A second central question of the New Economic Geography concerns critical values for the trade freeness (or for any other parameter) at which an (interior) equilibrium without spatial concentration "breaks up". This so-called break point gives conditions under which "small differences among locations [will] snowball into larger differences over time, so that the symmetry between identical locations will spontaneously break" (Fujita et al., 2000, p. 9). I.e. it gives conditions under which an interior fixed point λ_R^* becomes (at least locally) unstable and the dynamics is attracted to one of the boundary equilibria. Analytically, the break point is defined by $F'\left(\lambda_R^*\right)=1$. In our model, the break point arises when the interior fixed point coincides with one of the boundary fixed points and it is equal to the corresponding sustain point.[6]

Figure 1, drawn for $\overline{s_E} > 0.5$, summarizes the fixed points and their stability properties: For highly open economies, i.e. for $\phi^{S(1)} < \phi < 1$ agglomeration in region 1 is the only stable outcome. For $0 < \phi < \phi^{S(1)}$ both core-periphery solutions are unstable, and the interior fixed point is stable (provided that the adjustment speed is sufficiently low, see Commendatore and Kubin, 2006). As equ. (19) and (25) show, for $\nu > \mu$ it is the high tax region that ends up with the higher share in capital. In this case, the high tax region succeeds in obtaining a higher share in manufacturing expenditures that translates in an even higher share in capital. This so-called home market (magnification) effect is the stronger, the freer trade is.

[6] In a companion paper, Commendatoire and Kubin (2006), we analyse the dynamic properties of the model in greater detail.

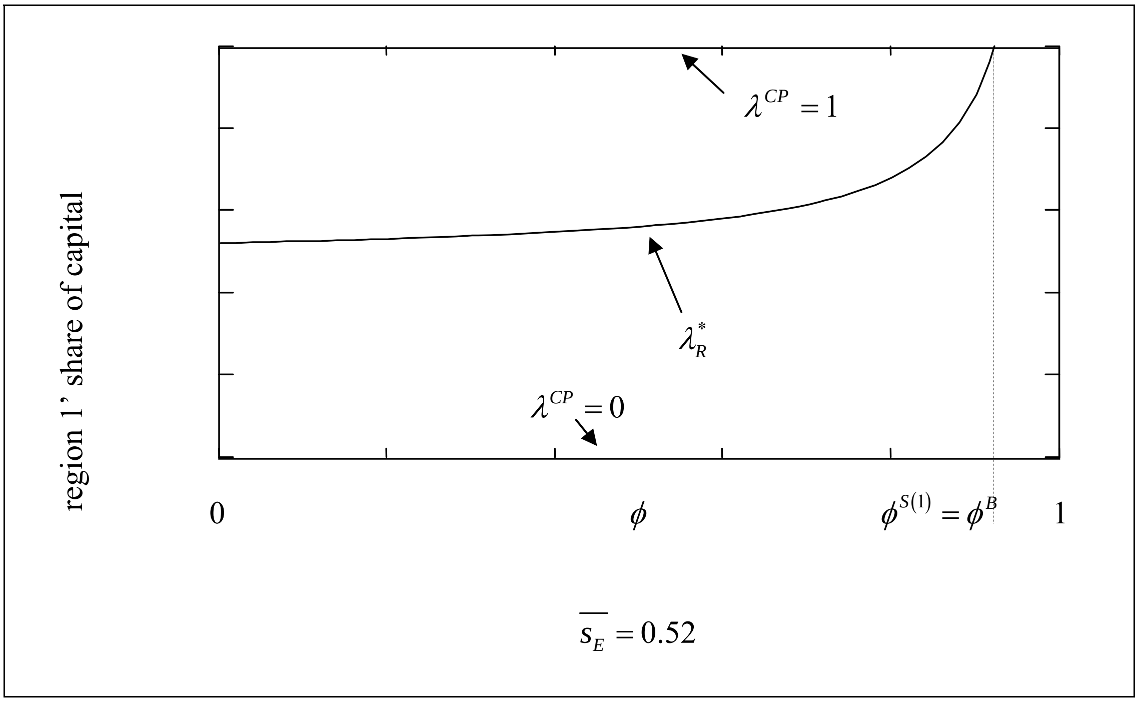

Figure 1: Region 1' share of capital with taxation according to the residence principle

4. Taxation according to the source principle

4.1. Short-run General Equilibrium

Turning now to the analysis of taxation according to the source principle, first note that equ. (1) to (14) still apply. However, if capital income taxes are collected according to the source principle, regional tax revenues are given as

(26) $$TR_{1,t} = \tau_1 \lambda_t K \pi_{1,t} \qquad TR_{2,t} = \tau_2 \left(1-\lambda_t\right) K \pi_{2,t}$$

and regional expenditures for manufactures as

(27) $$M_{r,t} \quad = \mu\left(\frac{L}{2}+\frac{\Pi_t}{2}-\frac{TR_{1,t}+TR_{2,t}}{2}\right)+\nu TR_{r,t}\,.$$

Tax burdens are identical between regions; changes in the tax rates affect private spending in both regions in an identical way. However, regional tax burdens are no longer identical to regional tax revenues. Therefore, if regional tax revenues are different and at least some of these revenues is spent for manufactured goods ($\nu > 0$)[7], regional expenditures are also different. Taxation according to the source principle relocates expenditures for manufacturers to the region with the higher tax revenue. Regional tax revenues do not only depend upon the tax rates, but also on the allocation of capital between the regions (λ_t), which determines the tax base.

World expenditures for manufactured goods are given as

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[7] Note that the crucial point is whether the share in public expenditure devoted to manufactured goods is positive and not whether it is greater than the private share.

$$M_t = \mu\left(L + \Pi_t\right) + \left(\nu - \mu\right)\left(TR_{1,t} + TR_{2,t}\right) =$$

(28)

$$= \mu\left(L + \lambda_t K \pi_{1,t} + \left(1 - \lambda_t\right) K \pi_{2,t}\right) + \left(\nu - \mu\right)\left(\lambda_t K \pi_{1,t} \tau_1 + \left(1 - \lambda_t\right) K \pi_{2,t} \tau_2\right).$$

Note that they are no longer constant but depend upon the allocation of capital. The regional split of expenditures for manufacturers is:

$$s_{E,t} = \frac{1}{2} + \frac{1}{2}\nu\left(\frac{TR_{1,t} - TR_{2,t}}{M_t}\right) \qquad 1 - s_{E,t} = \frac{1}{2} - \frac{1}{2}\nu\left(\frac{TR_{1,t} - TR_{2,t}}{M_t}\right)$$

(29) $$s_{E,t} M_t = \frac{1}{2} M_t + \frac{1}{2}\nu K\left(\lambda_t \pi_{1,t} \tau_1 - \left(1 - \lambda_t\right) \pi_{2,t} \tau_2\right)$$

$$\left(1 - s_{E,t}\right) M_t = \frac{1}{2} M_t - \frac{1}{2}\nu K\left(\lambda_t \pi_{1,t} \tau_1 - \left(1 - \lambda_t\right) \pi_{2,t} \tau_2\right)$$

The region with the higher tax revenue gets the higher share in expenditures (if at least some of the tax revenue is spent for manufactured goods).

Given the regional allocation of capital λ_t, equ. (11), (28) and (29) allow to determine

(30) $$s_{E,t} = \frac{\sigma + \frac{\nu}{\lambda_t \phi + \left(1 - \lambda_t\right)}\left(\lambda_t \tau_1 \phi - \left(1 - \lambda_t\right) \tau_2\right)}{2\sigma - \nu \lambda_t \tau_1 \left(\frac{1}{\lambda_t + \left(1 - \lambda_t\right)\phi} - \frac{\phi}{\lambda_t \phi + \left(1 - \lambda_t\right)}\right) - \nu\left(1 - \lambda_t\right)\tau_2 \left(\frac{1}{\lambda_t \phi + \left(1 - \lambda_t\right)} - \frac{\phi}{\lambda_t + \left(1 - \lambda_t\right)\phi}\right)},$$

(31) $$M_t = L\mu \frac{\sigma}{\sigma - \mu + \left(\mu - \nu\right) C\left(\lambda_t\right)}.$$

$C\left(\lambda_t\right)$ is a complicated expression which collects all terms depending upon tax policy and upon the regional allocation of capital. Note that the region 1's share of expenditure is no longer constant, but depends upon the capital allocation, i.e. $s_{E,t} = s_E\left(\lambda_t\right)$. Finally, equ. (11) and (30) determine short-run equilibrium regional profits and their ratio:

(32) $$R(\lambda_t)=\frac{\left(1+\phi^2\right)\left(1-\lambda_t\right)+2\phi\lambda_t-\frac{\nu}{\sigma}\tau_2\left(1-\phi^2\right)\left(1-\lambda_t\right)}{\left(1+\phi^2\right)\lambda_t+2\phi\left(1-\lambda_t\right)-\frac{\nu}{\sigma}\tau_1\left(1-\phi^2\right)\lambda_t}.$$

For $\nu=0$ or for $\tau_1=\tau_2=0$ the analysis is equivalent to that of the symmetric Footloose Capital model without a public sector.

Only if government spending does not change the sectoral split of total expenditures, i.e. if $\nu=\mu$, total expenditures on manufacturers (and total income) are constant and esp. independent of tax policy and of regional allocation of capital. Equ. (31) and (13) reduce to

(33) $$M_t=\overline{M}=L\mu\frac{\sigma}{\sigma-\mu}$$

(34) $$Y_t=\overline{Y}=L+\frac{1}{\sigma}\overline{M}=L\frac{\sigma}{\sigma-\mu}$$

The regional split of expenditures on manufactures, however, is still affected by tax policy and by the regional allocation of capital, since taxation according to the source principle shifts expenditures regionally, as shown in equ. (30) (which does not simplify). The same holds true for regional profits.

If public expenditures are only used for the agricultural good, i.e. if $\nu=0$, the regional split of expenditures for manufactures is constant and equal to one half (see equ. (29) or (30)); the level of total expenditures on manufactures, however, still depends upon the allocation of capital, i.e. on λ_t (see equ. (31)). Note that this change affects both regional profits in an identical way (see equ. (11)).

Turning to the analysis of the relative profitability $R(\lambda_t)$ as defined in equ. (14), note that in addition to the competition effect a demand effect occurs as well. $s_{E,t}$ is no longer constant; equ. (29) shows that it depends upon the difference in tax revenues, which in turn depends upon the allocation of capital λ_t:

$$(35) \qquad \frac{TR_{1,t} - TR_{2,t}}{M_t}(\lambda_t = 0) < 0 \qquad \frac{TR_{1,t} - TR_{2,t}}{M_t}(\lambda_t = 1) > 0 \qquad \frac{\partial}{\partial \lambda_t}\left(\frac{TR_{1,t} - TR_{2,t}}{M_t}\right) > 0.$$

For low values of λ_t tax revenues in region 1 are lower than in region 2 and the expenditure share of region 1 $s_{E,t}$ is less than one half, and vice versa. For some intermediate allocation of capital, $\tilde{\lambda}$, tax revenues are equal in both regions and $s_{E,t} = \frac{1}{2}$.[8]

Increasing λ_t shifts the tax bases and therefore tax revenue and (public) demand to region 1 and its share in expenditures increases as well; this demand effect leads to an increase of relative profitability. As in the standard core-periphery-model, the relative strength of the competition and the demand effect depend upon the openness of the economy: For low values of ϕ the competition effect dominates the demand effect, it follows $\frac{\partial R(\lambda_t)}{\partial \lambda_t} < 0$. Vice versa for high values of ϕ.

How does the expenditure policy, i.e. ν affect relative profitability? A higher ν enhances the demand relocation effect of tax policies. For low values of λ_t, i.e. $\lambda_t < \tilde{\lambda}$, tax revenue in

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[8] $\tilde{\lambda}$ is implicitly defined by $(1-\phi)^2(\tau_1 - \tau_2)\tilde{\lambda}(1-\tilde{\lambda}) + 2\phi\left(\tau_1\tilde{\lambda} - \tau_2(1-\tilde{\lambda})\right) = 0$. It only depends upon the parameters ϕ, τ_1 and τ_2. For $0 \le \tau_1 < \tau_2$ $0.5 < \tilde{\lambda} \le 1$ and $0 \le \tilde{\lambda} < 0.5$ for $0 \le \tau_2 < \tau_1$. No simple explicit solution for $\tilde{\lambda}$ is obtainable.

region 1 is lower than in region 2; therefore, region 1 loses in profitability if a higher share of tax revenues is spent for manufacturers. For high values of λ_t, i.e. $\lambda_t > \tilde{\lambda}$, the opposite holds true. Therefore, increasing ν turns the $R(\lambda_t)$ schedule anti-clockwise pivoting around $\tilde{\lambda}$. Figure 2 summarizes the properties of the $R(\lambda_t)$ schedule.

4.2. Capital Movement and the Complete Dynamical Model

In contrast to the previous case, with taxation according to the source principle, it is the ratio of *net* nominal profits that is the relevant economic incentive for capital reallocation:

(36)
$$E_t = \frac{(1-\tau_1)\pi_{1,t} - \left(\lambda_t(1-\tau_1)\pi_{1,t} + (1-\lambda_t)(1-\tau_2)\pi_{2,t}\right)}{\lambda_t(1-\tau_1)\pi_{1,t} + (1-\lambda_t)(1-\tau_2)\pi_{2,t}} =$$
$$= \frac{\Delta T \cdot R(\lambda_t) - 1}{\lambda_t \Delta T \cdot R(\lambda_t) + (1-\lambda_t)} \Delta T \cdot R(\lambda_t)$$

$$\text{with} \quad \Delta T = \frac{1-\tau_1}{1-\tau_2}.$$

We introduce ΔT since we would like to disentangle the effects of tax policy *via* its impact upon the mobility decision from its effect *via* its impact on spending behaviour. By setting $\Delta T = 1$ we shall insulate the latter effect.

The central dynamic equation now is

(37)
$$\lambda_{t+1} = Z(\lambda_t) = \begin{cases} 0 & if \quad F(\lambda_t) < 0 \\ F(\lambda_t) & if \quad 0 \le F(\lambda_t) \le 1 \\ 1 & if \quad F(\lambda_t) > 1 \end{cases} \qquad \text{with}$$

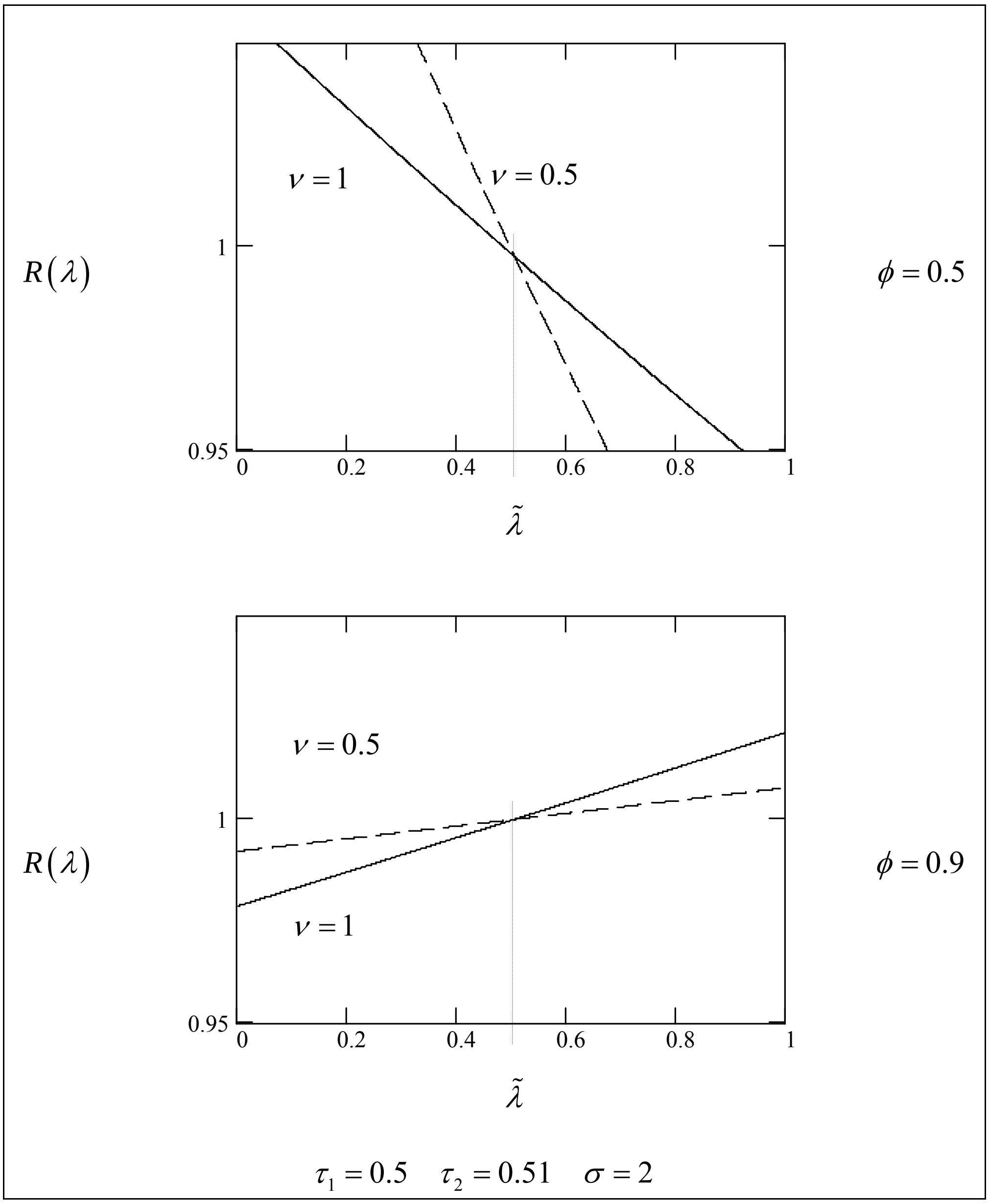

Figure 2: Relative profitability with taxation according to the source principle

(38) $$F(\lambda_t)=\lambda_t+\gamma\lambda_t(1-\lambda_t)\frac{\Delta T\cdot R(\lambda_t)-1}{\lambda_t\Delta T\cdot R(\lambda_t)+(1-\lambda_t)}\Delta T\cdot R(\lambda_t).$$

In the following we assume that region one is the region with the lower tax rate and we again start with the two boundary fixed point capital allocations, $\lambda_0^{CP}=0$ and $\lambda_1^{CP}=1$. They change (local) stability at the sustain points defined by $F'(\lambda_i^{CP})=1$, which indicates the derivative of the first return map (38), or equivalently by $R(\lambda_i^{CP})=\frac{1-\tau_2}{1-\tau_1}$. For $\lambda_1^{CP}=1$ this condition solves for:

(39) $$\phi^{S(1)}=\frac{1}{1+\frac{\nu}{\sigma}\tau_1}\left[\frac{1-\tau_1}{1-\tau_2}-\sqrt{\left(\frac{\nu}{\sigma}\tau_1\right)^2+\left(\frac{1-\tau_1}{1-\tau_2}\right)^2-1}\right]$$

with $0<\phi^{S(1)}<1$.

For $\lambda_0^{CP}=0$ the sustain points are given by

(40) $$\phi_{1,2}^{S(0)}=\frac{1}{1+\frac{\nu}{\sigma}\tau_2}\left[\frac{1-\tau_2}{1-\tau_1}\mp\sqrt{\left(\frac{\nu}{\sigma}\tau_2\right)^2+\left(\frac{1-\tau_2}{1-\tau_1}\right)^2-1}\right]$$

where $\phi_{1,2}^{S(0)}$ are distinct and real for $\left(\frac{\nu}{\sigma}\tau_2\right)^2+\left(\frac{1-\tau_2}{1-\tau_1}\right)^2>1$ and $0<\phi_1^{S(0)}<\phi_2^{S(0)}<1$ holds.

In addition, an interior fixed point is defined by $\frac{1-\tau_1}{1-\tau_2}R(\lambda_S^*)=1$, which solves for (observing equ. (14) and (30)):

(41) $$\lambda_S^* = \frac{1}{2} + \frac{1}{2}\frac{(\tau_1 - \tau_2)\left(\frac{1+\phi}{1-\phi}\right)\left(\frac{\nu}{\sigma} - \left(\frac{1+\phi}{1-\phi}\right)\right)}{2 - \tau_1 - \tau_2 + (2\tau_1\tau_2 - \tau_1 - \tau_2)\frac{\nu}{\sigma}\left(\frac{1+\phi}{1-\phi}\right)}$$

which can also be written as:

(42) $$\lambda_S^* = \frac{1}{2}\frac{\left(2\frac{\phi}{(1-\phi)^2} + 1 - \tau_2\frac{1+\phi}{1-\phi}\frac{\nu}{\sigma}\right)(\Delta T - 1) + 1 - \tau_2\frac{1+\phi}{1-\phi}\frac{\nu}{\sigma}}{\left(1 - \tau_2\frac{1+\phi}{1-\phi}\frac{\nu}{\sigma}\right)\frac{\Delta T - 1}{2} + 1 - \frac{\tau_1 + \tau_2}{2}\frac{1+\phi}{1-\phi}\frac{\nu}{\sigma}}.$$

Note that for $\tau_1 = \tau_2$ the fixed point $\lambda_S^* = \frac{1}{2}$ corresponds to that in the symmetric Footloose Capital model without a public sector. At break points, the interior fixed point changes stability. Analytically, the break point ϕ^B is defined by $F'(\lambda_S^*) = 1$ or, equivalently by $R'(\lambda_S^*) = 0$. In our model, the break point and the sustain point for $\lambda_1^{CP} = 1$ coincide, $\phi^B = \phi^{S(1)}$. Assuming sufficiently low values for the adjustment speed, the interior fixed point is stable for $0 < \phi < \phi^B$ (see Commendatore and Kubin, 2006). The interior fixed point changes again also stability at $\phi = \phi_i^{S(0)}$. It is (locally) unstable for $\phi_1^{S(0)} < \phi < \phi_2^{S(0)}$.

Figure 3, plotted for $\tau_1 < \tau_2$, is the equivalent to the standard (broken) tomahawk diagram. The upper panel shows the fixed points as depending upon ϕ.

In our numeric example $\phi^B = \phi^{S(1)} < \phi_1^{S(0)} < \phi_2^{S(0)}$, which delimits various ranges for the trade freeness ϕ:

For $\phi_2^{S(0)} < \phi$ and for $\phi^{S(1)} < \phi < \phi_1^{S(0)}$, no interior fixed point exists within the interval (0,1). The boundary fixed point $\lambda_0^{CP} = 0$ is (locally) unstable, and $\lambda_1^{CP} = 1$ is (locally) stable.

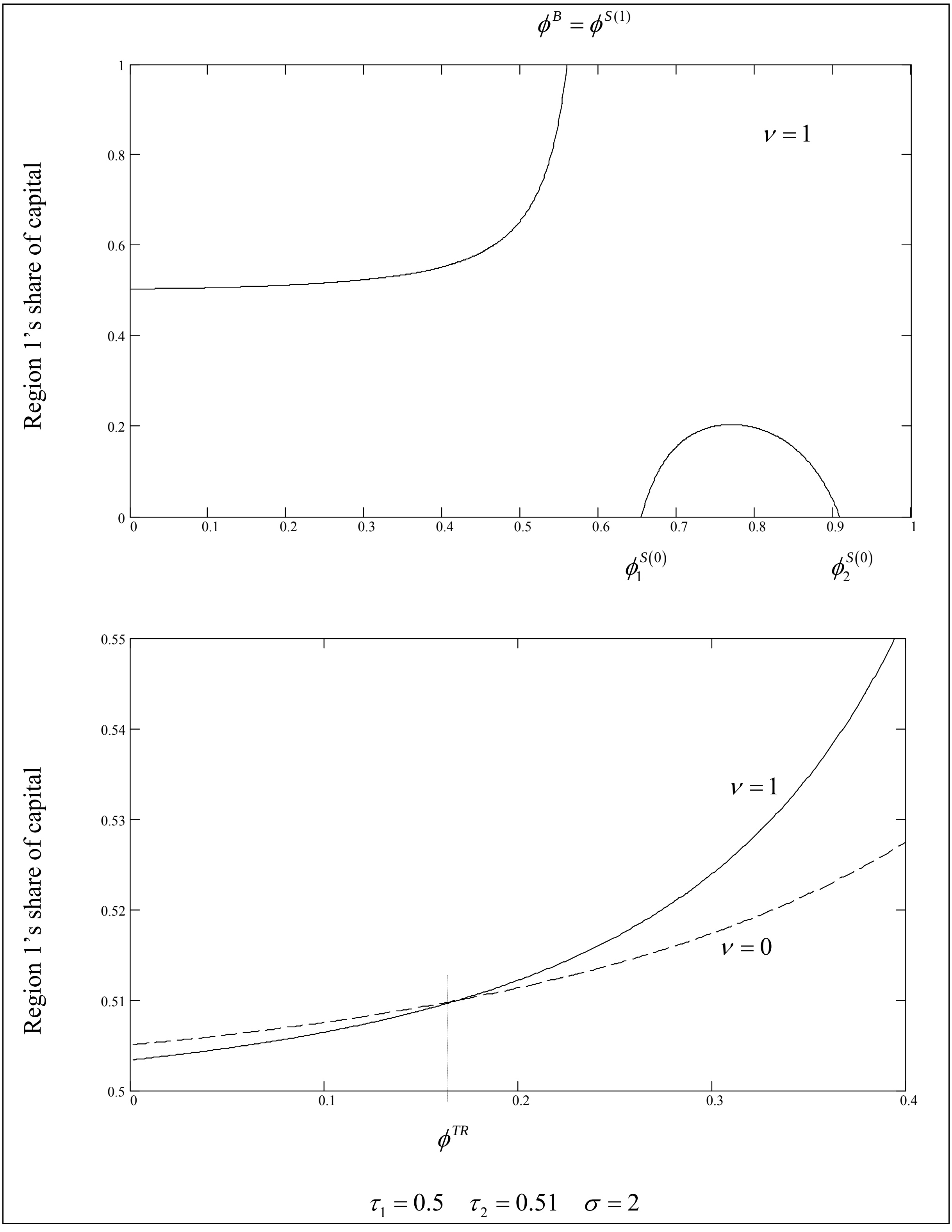

Figure 3: Region 1' share of capital with taxation according to the source principle

For $\phi_1^{S(0)} < \phi < \phi_2^{S(0)}$, both boundary fixed point are (locally) stable. In addition, a (locally) unstable interior fixed point exists, which delimits the basin of attraction for the two boundary fixed points.

For $0 < \phi < \phi^B$, an interior fixed point exists, which is (locally) stable provided the adjustment speed γ is low enough. Both boundary fixed points are (locally) unstable.

5. Comparison of the results

5.1. Public Policy and Industry Agglomeration

The previous sections have shown that in a New Economic Geography perspective public policy, i.e. taxation and public expenditures, changes industry location in particular *via* its effect upon the expenditure structure. In this section, we would like to compare these results in two dimensions:

First, we would like to compare the results derived in a New Economic Geography model with the standard analysis, in which the effect *via* expenditure structure is absent; second we would like to compare the implications of the two taxation principles within the New Economic Geography perspective (for an overview see Table 1).

What are the differences of our New Economic Geography perspective with respect to the standard analysis of taxation according to the residence principle? In the standard literature, taxation according to the residence principle does not affect the international capital allocation, its efficiency is maintained (a result called also capital export neutrality); however, intertemporal savings decisions are distorted. In contrast, models of the New

Economic Geography abstract from any intertemporal decisions and thus also from any intertemporal efficiency loss, but reveal possible implications of public policy for equilibrium capital (industry) location (see equ. (25)):

(43) $$\lambda_R^* > 0.5 \quad \text{if} \quad (\nu - \mu)(\tau_1 - \tau_2) > 0$$

(44) $$\frac{\partial \lambda_R^*}{\partial \nu} > 0 \quad \text{if} \quad \tau_1 > \tau_2 \qquad \text{and} \qquad \frac{\partial \lambda_R^*}{\partial \tau_1} > 0 \quad \text{if} \quad \nu > \mu .$$

Thus, changes in industry (capital) location and agglomerative effects occur even with taxation under the residence principle; this result modifies and extends the standard analysis of taxation principles.

	Direct effect upon mobility decision		Indirect effect *via* the expenditure structure	
Standard analysis	Residence: no	Source: yes	no	
New Economic Geography	Residence: no	Source: yes	Residence: yes specific	Source: yes specific

Table 1: Dimensions of comparison

Turning to taxation according to the source principle, note that in the standard analysis it is associated with capital import neutrality (i.e. an efficient allocation of savings since intertemporal decisions are not affected by this taxing principle), but not with capital export neutrality since the international allocation of capital is affected *via* the impact of taxation upon the capital mobility. In the models of the New Economic Geography this mechanism is also present; however, there is a second effect on industry location, namely the effect *via* the expenditure structure.

In order to insulate the first effect – and to allow a comparison with the standard analysis – we assume that public expenditures are not used for manufacturers, i.e $\nu = 0$; it follows that the regional split of expenditures for manufactures is constant and equal to one half (see equ. (30)) and this comes as close as possible to the standard case. Equilibrium capital allocation is given by (see equ. (41):

(45) $$\lambda_S^*\left(\nu = 0\right) = \frac{1}{2}\left[1 - \frac{\tau_1 - \tau_2}{2 - \tau_1 - \tau_2}\left(\frac{1+\phi}{1-\phi}\right)^2\right].$$

Note that this is exactly the case treated in Baldwin et al. (2003). Tax policy affects equilibrium capital allocation *via* its direct effect upon capital mobility; the region with the lower tax rate attracts the higher share in capital – results very similar to the standard case. However, trade freeness – a parameter which plays no role in the standard analysis – determines the sensitivity of capital movements with respect to differences in tax rates: a higher trade freeness increases the sensitivity.

The second effect, which arises from the regional shift in expenditures for manufactures induced by a tax policy according to the source principle, is given by (see equ. (41)):

$$\lambda_S^*(\nu>0)-\lambda_S^*(\nu=0)=$$

(46)
$$=\frac{\tau_1-\tau_2}{2-\tau_1-\tau_2}\left(\frac{1+\phi}{1-\phi}\right)^2 2\frac{\nu}{\sigma}\left(\frac{(1-\tau_1)(1-\tau_2)(1+\phi^2)+2(\tau_1\tau_2-1)\phi}{(2-\tau_1-\tau_2)(1-\phi^2)-\left[\tau_1(1-\tau_2)+\tau_2(1-\tau_1)\right](1+\phi)^2\frac{\nu}{\sigma}}\right).$$

A priori, the sign of this effect is not clear: Public expenditures for manufactured goods $(\nu>0)$ increases the expenditure share for the high tax revenue region (see equ. (29)). However, this could be the region with the higher tax rate, but also the region with the lower tax rate, since a lower tax rate can be offset by a sufficiently high tax base, i.e. by a sufficiently high share in capital. As Figure 3, illustrates, the low tax rate region attracts the higher a share in capital the freer trade is. It can be shown that there exists a lower threshold ϕ^{TR}: Tax revenue at the fixed point capital allocation is higher in the low tax rate region than in the high tax rate region if

(47)
$$\phi>\frac{1-\tau_1\tau_2}{(1-\tau_1)(1-\tau_2)}-\sqrt{\left(\frac{1-\tau_1\tau_2}{(1-\tau_1)(1-\tau_2)}\right)^2-1}=\phi^{TR}.$$

Therefore, for $\phi^{TR}<\phi$ both effects work in favour of the low tax rate region. For $\phi<\phi^{TR}$ the region with the high tax rate has the higher tax revenue and can partly offset the loss of industrial capital due to the direct effect of a high tax rate. The lower panel in Figure 3 (which is an enlargement of the upper panel) illustrates this case: Region 2 has the higher tax rate; the dashed line shows region 1's capital share if tax revenues are not spent for the manufactured commodity (i.e. for $\nu=0$); the solid line illustrates the opposite extreme spending pattern: all tax revenue is spent for the manufactured commodity (i.e. $\nu=1$), a behaviour which favours the region with the higher tax revenue. For $\phi^{TR}<\phi$ this is region 1, its share of capital is in that case higher for $\nu=1$ than for $\nu=0$. The opposite holds true for $\phi < \phi^{TR}$: Now it is region 2 that disposes of the higher tax revenue and its share in capital is higher (and the share of region 1 is lower) for the higher value of ν. Therefore, the agglomerative effects modify the effects *via* the direct impact of tax policy upon the mobility decision (which is also present in a standard analysis of tax principles).

A second comparison involves the effects of taxation according to the residence and source principle within the New Economic Geography perspective. With both principles, public policy affects industry location; however, only with taxation according to the source principle has in addition a direct impact upon capital mobility. Therefore, it is convenient to start the analysis by assuming $\Delta T = 1$, i.e. to abstract from direct effects of taxation upon capital mobility, which allows to focus on possible differences of the effects *via* its impact upon (public and private) expenditures.

In that case the fixed point as given in equ. (42) reduces to

(48)
$$\lambda_S^*(\Delta T = 1) = \frac{1}{2} \frac{1 - \tau_2 \frac{1+\phi}{1-\phi} \frac{\nu}{\sigma}}{1 - \frac{\tau_1 + \tau_2}{2} \frac{1+\phi}{1-\phi} \frac{\nu}{\sigma}}.$$

For $\tau_1 < \tau_2$ the interior fixed point is stable for $0 < \phi < \phi^B$; in that parameter range $\frac{\partial \lambda_S^*(\Delta T = 1)}{\partial \tau_1} > 0$; and $\lambda_S^*(\Delta T = 1) < \frac{1}{2}$ for $\tau_1 < \tau_2$; i.e. without considering the direct effect upon mobility, with the source principle it is the high tax region, which ends up with the higher share in capital, provided that tax revenue is spent at all for manufactured goods (i.e. provided that $\nu > 0$). In contrast, with the residence principle, the high tax region gets the higher share in capital only if $\nu > \mu$ (see equ. (43)).

However, taken into account the direct effect on mobility as well, the following properties can be shown:

(49) $$\lambda_S^* > \frac{1}{2} \quad \text{for} \quad \tau_1 < \tau_2 \quad \text{and} \quad \frac{\partial \lambda_S^*}{\partial \tau_1} < 0\,;$$

i.e. with the source principle the low tax region ends up with the higher share of capital, the direct effect upon mobility dominates the effect *via* the expenditure structure, the latter only attenuates the direct effect without overturning it.

5.2. Welfare Analysis and Implications for Tax Competition

In the previous section we have seen that the New Economic Geography perspective adds agglomeration effects to the standard analysis of public policy. In this section we investigate the welfare implications. It is convenient to use the indirect utility function $U_r\left(\tau_1,\tau_2\right)$ of one representative agent in region r:

(50) $$U_r\left(\tau_1,\tau_2\right) = Up_r + Ug_r\left(C_{G,r}\right) \quad \text{with} \quad r = 1,2$$

$$Up_r = a \cdot NetIncome_r\left(\tau_1,\tau_2\right) \cdot G_r\left(\tau_1,\tau_2\right)^{-\mu} \qquad C_{G,r} = \frac{2}{L} bTR_r\left(\tau_1,\tau_2\right) G_r\left(\tau_1,\tau_2\right)^{-\nu},$$

$$\text{with} \quad a = \mu^{\mu}\left(1-\mu\right)^{1-\mu} \quad \text{and} \quad b = \nu^{\nu}\left(1-\nu\right)^{1-\nu}.$$

Therefore, welfare implications of tax policy depend upon three factors: First, how tax policy affects net income (per person); second, how tax policy affects tax revenues; and third, how tax policy affects the price index *via* its effect upon industry location and thus upon the number of locally produced variants. Note that tax policy in one region affects utility in the other region through all three channels; these fiscal externalities suggest that non co-operatively set tax rates may not be welfare maximizing and policy coordination may attain better results.

Since the seminal work of Zodrow and Mieszkowski (1986) one of the main concerns with capital income taxation is that with rising international capital mobility countries increasingly compete for the internationally mobile tax base and set inefficiently low tax rates. In the standard analysis, tax coordination is a way out of this "race to the bottom"; another way is taxation according to the residence principle instead of the source principle. It is remarkable that in the New Economic Geography perspective issues of tax competition also occur with taxation according to the residence principle. Therefore, we concentrate our following analysis on this case.[9]

With taxation according to the residence principle see equ. (12), (15) and (18) net income per person and tax revenue are:

(51) $$NetIncome_r(\tau_1,\tau_2)=1+\frac{\Pi(\tau_1,\tau_2)}{L}(1-\tau_r) \quad \text{and} \quad TR_r(\tau_1,\tau_2)=\tau_r\frac{\Pi(\tau_1,\tau_2)}{2}$$

$$\text{with} \quad \frac{\Pi(\tau_1,\tau_2)}{L}=\frac{\mu}{\sigma-\mu-\frac{\tau_1+\tau_2}{2}(\nu-\mu)}.$$

At the (interior) fixed point capital allocation λ_R^* – see equ. (25) – the price indices are given by:

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[9] With taxation according to the source principle fiscal externalities and issues of tax competition occur in the standard as well as in the New Economic Geography perspective. However, from the discussion in the previous section follows that the effects would be different in the two perspectives. Given its high analytic complexity we do not pursue this case.

(52) $$G_1(\tau_1,\tau_2)=(1+\phi)^{\frac{1}{1-\sigma}}\overline{s_E}^{\frac{1}{1-\sigma}}K^{\frac{1}{1-\sigma}}p=p(1+\phi)^{\frac{1}{1-\sigma}}\left(\frac{K}{2}\right)^{\frac{1}{1-\sigma}}\left(1+\frac{\nu-\mu}{\sigma}\frac{\tau_1-\tau_2}{2}\right)^{\frac{1}{1-\sigma}}$$

$$G_2(\tau_1,\tau_2)=(1+\phi)^{\frac{1}{1-\sigma}}\left(1-\overline{s_E}\right)^{\frac{1}{1-\sigma}}K^{\frac{1}{1-\sigma}}p=p(1+\phi)^{\frac{1}{1-\sigma}}\left(\frac{K}{2}\right)^{\frac{1}{1-\sigma}}\left(1-\frac{\nu-\mu}{\sigma}\frac{\tau_1-\tau_2}{2}\right)^{\frac{1}{1-\sigma}}.$$

First, we analyse the welfare implications of varying the own tax rate (while keeping the other one constant). The following results can be shown analytically:

(53) $$\frac{\partial}{\partial\tau_r}\Pi(\tau_1,\tau_2)>0 \qquad if \qquad \nu>\mu,$$

An increase in the tax rate increases world (gross) profit income, if the share for manufacturing is higher in public expenditures than in private expenditures. However, it can be shown that an increase in the own tax rate always decreases net income, irrespective of the expenditure structure, and that the tax revenue of the country that increases the tax rate increases as well:

(54) $$\frac{\partial}{\partial\tau_r}\left(1+\frac{\Pi(\tau_1,\tau_2)}{L}(1-\tau_r)\right)<0 \qquad \frac{\partial}{\partial\tau_r}\left(\frac{\Pi(\tau_1,\tau_2)}{2}\tau_r\right)>0.$$

For assessing the utility effects of these income changes, the effect upon the price index has to be taken into consideration as well, which depends upon the expenditure structure:

(55) $$\frac{\partial}{\partial\tau_r}G_i(\tau_1,\tau_2)<0 \qquad if \qquad \nu>\mu.$$

Combining income and price index effects leads to the following implications for utility:

First case: $\nu < \mu$

In that case, increasing the tax rate reduces net income and the number of locally produced varieties as well (the price index increases) – the private utility component decreases. Tax revenue increases; however, the quantity of the publicly provided good (and thus the public utility component) may increase or decline (because of the countervailing increase in the price index). Therefore, a positive tax rate can only be welfare maximising if the quantity of the publicly provided good increases and if it has sufficiently strong welfare effects to counterbalance the decline in the private utility component.

Second case: $\nu > \mu$

In that case, increasing the tax rate still reduces net income; however, it increases the number of locally produced varieties and thus the price index decreases. Therefore, even without any welfare effect of the publicly provided good, a positive tax rate can be utility maximising if the effect on the private utility component *via* the price index is strong enough – i.e. if $(\nu - \mu)$ is high enough and/or if the preference for product variety is high enough (if σ is close enough to its lower boundary value of 1) to offset the negative utility effect of a lower net income. Tax revenue increases as does the quantity of the publicly provided good (given the decrease in the price index). Therefore, the public utility component increases as well.

To sum up: A positive tax rate can be welfare maximising even without any utility derived from the publicly provided good because public policy affects industrial location and thus the price index. This mechanism is genuine to the New Economic Geography perspective and, whenever convenient, we shall focus our subsequent analysis on it.

Next, we turn to an analysis of fiscal external effects and to the related question of tax competition. Tax policy in one region affects the utility in the other region because it affects total expenditure for manufacturers and thus total profit income $\frac{\partial \Pi(\tau_1,\tau_2)}{\partial \tau_r} > 0$ for $\nu > \mu$ (see equ. (53)); net income and tax revenue in the other region change accordingly:

(56) $$\frac{\partial}{\partial \tau_r}\left(1+\frac{\Pi(\tau_1,\tau_2)}{L}(1-\tau_s)\right) > 0 \qquad \frac{\partial}{\partial \tau_r}\left(\frac{\Pi(\tau_1,\tau_2)}{2}\tau_s\right) > 0$$

with $r,s = 1,2$ and $r \neq s$.

In addition, public policy in one region affects the price index in the other region by influencing the regional distribution of industrial capital and thus the number of locally produced variants. It can be shown that:

(57) $$\frac{\partial}{\partial \tau_r} G_s(\tau_1,\tau_2) > 0 \qquad if \qquad \nu > \mu .$$

The effects on the utility components in the other country are ambiguous, since the income (tax revenue) effect and the price index effect work in opposite direction; numerical explorations indicate that the private utility component in the other region increases if $\nu < \mu$ (and *vice versa*). Table 2 summarizes this utility analysis.[10]

[10] With the source principle, increasing the tax rate in one region reduces the share of industrial capital and increases the price index in this region (and *vice versa* in the other region). Therefore, also with the source principle an external effect *via* agglomeration exists. However, the effects upon net incomes and tax revenues are ambiguous and no clear picture emerges.

<table>
<tr><td></td><td colspan="3">$\nu < \mu$</td><td colspan="3">$\nu > \mu$</td></tr>
<tr><td></td><td colspan="3">$WorldProfitIncome \downarrow$</td><td colspan="3">$WorldProfitIncome \uparrow$</td></tr>
<tr><td></td><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td rowspan="3">Effects in Region 1</td><td>$NetIncome_1 \downarrow$</td><td rowspan="2">$Up_1 \downarrow$</td><td></td><td>$NetIncome_1 \downarrow$</td><td rowspan="2">Up_1 ?</td><td></td></tr>
<tr><td>$PriceIndex_1 \uparrow$</td><td rowspan="2">Ug_1 ?</td><td>$PriceIndex_1 \downarrow$</td><td rowspan="2">$Ug_1 \uparrow$</td></tr>
<tr><td>$TR_1 \uparrow$</td><td></td><td>$TR_1 \uparrow$</td><td></td></tr>
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<tr><td rowspan="3">Effects in Region 2</td><td>$NetIncome_2 \downarrow$</td><td rowspan="2">$Up_2 \uparrow$</td><td></td><td>$NetIncome_2 \uparrow$</td><td rowspan="2">$Up_2 \downarrow$</td><td></td></tr>
<tr><td>$PriceIndex_2 \downarrow$</td><td rowspan="2">Ug_2 ?</td><td>$PriceIndex_2 \uparrow$</td><td rowspan="2">Ug_2 ?</td></tr>
<tr><td>$TR_2 \downarrow$</td><td></td><td>$TR_2 \uparrow$</td><td></td></tr>
</table>

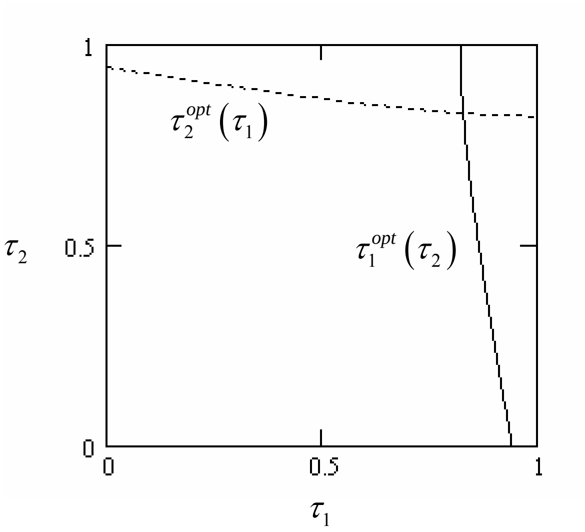
Table 2: Utility effects of an increase of the tax rate in region 1 τ_1

Because of these external effects, regional governments will change their own tax rate as reaction to a change in the tax rate of the other region opening up space for tax competition. Assuming benevolent governments, they set utility maximising tax rates and the reaction functions are given as:

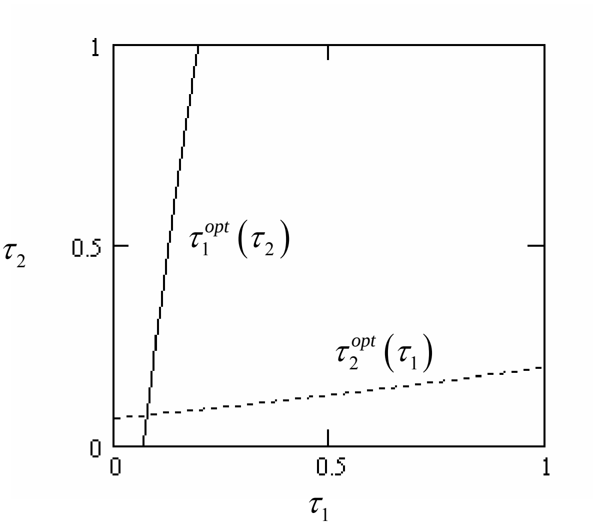
$$\tau_r^{opt}\left(\tau_s\right) = \text{Argmax}\left(U_r\left(\tau_1, \tau_2\right)\right). \tag{58}$$

No simple analytic results are possible. However, if we concentrate on the case in which no utility is derived from the publicly provided good, which allows us to highlight mechanisms specific to the New Economic Geography perspective, numerical explorations are ready available: The parameter space is simple; we focus on $0 \le \mu < \nu \le 1$, for the other parameters the following restrictions hold: $0 \le \tau_1, \tau_2 \le 1$ and $1 < \sigma$. Our experiments reveal the following properties (summarised in Figure 4):

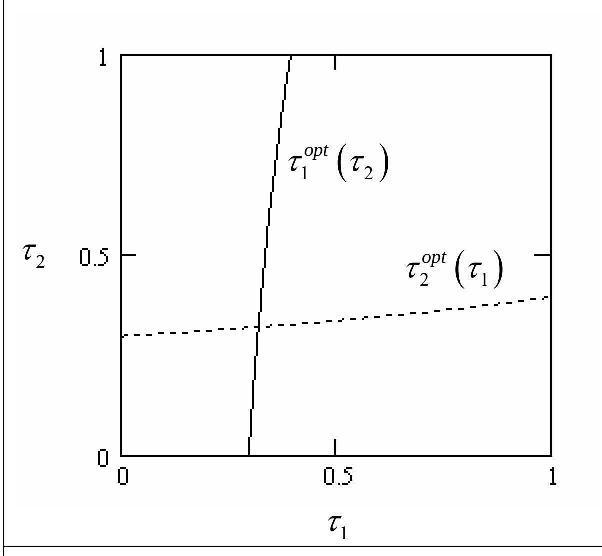
For high values of $(\nu - \mu)$ close to 1 and low values of σ (reflecting a high preference for product variety) the price index effect is strong. The utility functions are maximised at relatively high tax rates and the optimal tax rate in one country depends positively upon the tax rate in the other country, implying positively sloped reaction functions. Nash tax competition results in a comparatively high (common) tax rate (see Figure 4, panel a). For lower values of $(\nu - \mu)$ and higher values of σ the price index effect gets weaker; the optimal tax rates are lower and the reaction functions are negatively sloped (see Figure 4, panel b and c). Nash tax competition results in low common tax rates.



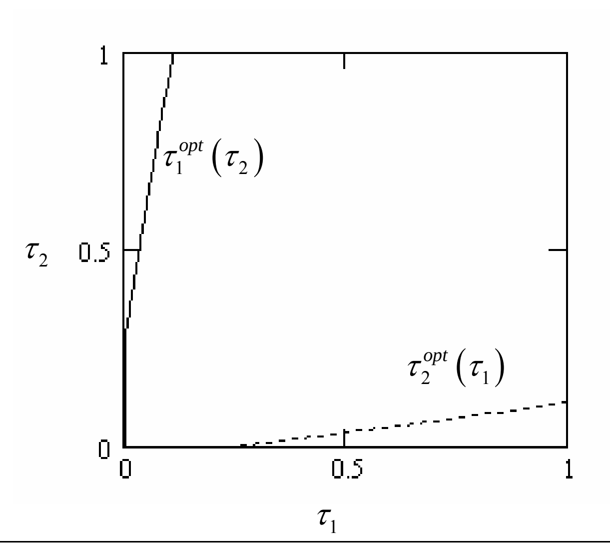
Panel a: $1 = \nu > \mu = 0.4 \qquad \sigma = 1.1$



Panel b: $1 = \nu > \mu = 0.4 \qquad \sigma = 1.4$



Panel c: $1 = \nu > \mu = 0.8 \qquad \sigma = 1.1$



Panel d: $1 = \nu > \mu = 0.45 \qquad \sigma = 1.4$

Figure 4: Reactions functions and Nash tax competition

Finally, for very low values of $(\nu-\mu)$ and high values of σ the price index effect is weak and utility functions are decreasing in the own tax rates. Nash tax competition results in the boundary solution of $\tau_1=\tau_2=0$ (see Figure 4, panel d).

Given the above discussed external effects, competitively set tax rates are not welfare maximising and tax coordination can be welfare improving. With tax coordination, both regional tax rates are chosen simultaneously in order to maximize the joint private utility $Up_{1+2}(\tau_1,\tau_2)$ – leaving again the utility derived from the publicly provided good out of consideration. It is given as (using equ. (50), (51) and (52)):

$$Up_{1+2}(\tau_1,\tau_2)=Up_1(\tau_1,\tau_2)+Up_2(\tau_1,\tau_2)=\left(1+\frac{\nu-\mu}{\sigma}\frac{\tau_1-\tau_2}{2}\right)^{\frac{\mu}{\sigma-1}}+\left(1-\frac{\nu-\mu}{\sigma}\frac{\tau_1-\tau_2}{2}\right)^{\frac{\mu}{\sigma-1}}+$$

$$+\frac{\mu}{\sigma-\mu-\frac{\tau_1+\tau_2}{2}(\nu-\mu)}\left((1-\tau_1)\left(1+\frac{\nu-\mu}{\sigma}\frac{\tau_1-\tau_2}{2}\right)^{\frac{\mu}{\sigma-1}}+(1-\tau_2)\left(1-\frac{\nu-\mu}{\sigma}\frac{\tau_1-\tau_2}{2}\right)^{\frac{\mu}{\sigma-1}}\right)$$

where a constant $ap(1+\phi)^{\frac{1}{1-\sigma}}\left(\frac{K}{2}\right)^{\frac{1}{1-\sigma}}$ is disregarded. Various effects determine the joint utility:

The first two terms correspond to the utility effect upon labour income – only the effect *via* the price index (i.e. *via* the number of locally produced varieties) matters. The third term corresponds to the effect upon the two profit incomes – in addition to the price index effects, tax policy also changes the level of gross profits and of course also directly the level of net profit income.

Focusing on the case of $\nu > \mu$, a high *sum* of the regional profit rates increases gross profit income; however, tax rates equal to one are not utility maximizing because of the direct impact of the individual tax rates on net profit income. In contrast, the price index effect depends upon the *difference* of regional tax rates. Note that $(\bullet)^{\frac{\mu}{\sigma-1}}$ can be concave or convex in $(\tau_1 - \tau_2)$ depending upon $\frac{\mu}{\sigma-1} < 1$ or $\frac{\mu}{\sigma-1} > 1$. Therefore – apart from the borderline case of $\sigma = 1 + \mu$ – even the effects upon labour income (which work only through the effect on the price index) do not cancel each other: For $\nu > \mu$, an increase in the local tax rate increases profits in the region under consideration and industrial capital is relocated to that region. The number of locally produced variants increases and the price index is reduced. The utility derived from labour income increases in the region under consideration. In the other region, the opposite holds true. If $\sigma < 1 + \mu$ the utility loss derived from labour income in the latter region is smaller than the utility gain in the former region. Therefore, parameter constellations exist for which a positive sum of tax rates and a high difference of tax rates is utility maximizing, i.e. $\tau_1 = \tau_{as}^{co} > 0$ and $\tau_2 = 0$, or $\tau_1 = 0$ and $\tau_2 = \tau_{as}^{co} > 0$.

However, it can be shown analytically that by imposing equality of regional tax rates – which eliminates any effect of tax policy on industry location and thus on the price index – a zero tax rate in both regions is maximizing the joint utility; competitively set positive regional tax rates are too high and tax coordination is welfare improving.

Figure 5, which is based on the same parameter values as Figure 4, panel a, depicts such a case: The top panel represents the joint private utility as depending upon the two tax rates. In the bottom left panel the solid line corresponds to $Up_{1+2}(\tau_1, \tau_2 = 0)$, i.e. it indicates the joint private utility as depending upon the tax rate in region 1 if the tax rate in region to is kept constant and equal to zero. The dotted line is $Up_{1+2}(\tau_1 = \tau_2)$; i.e. it gives the joint private utility under the assumption of equal tax rates in both regions. If asymmetries in the regional tax rates are possible, the pair $(\tau_1 = \tau_{as}^{co}, \tau_2 = 0)$ or the pair $(\tau_1 = 0, \tau_2 = \tau_{as}^{co})$ maximizes the joint utility. Imposing equality of regional tax rates $Up_{1+2}(\tau_1 = \tau_2)$, the pair $(\tau_1 = \tau_2 = 0)$ is maximizing the joint utility (but the utility level is lower than in the asymmetric cases).

For an easier comparison, the bottom right panel in Figure 5 represents the two reaction functions with tax competition (as given in Figure 4, panel a). An equal and positive tax rate is chosen; the associated utility level is lower than in either of the tax coordination cases, as can be read off the dotted utility function in the left panel.

6. Conclusions

In the previous analysis we compared the source and the residence principle of international capital income taxation from a New Economic Geography perspective, which adds agglomerative forces to the picture. We used the analytically simplest model, the footloose capital model, which we extended to account for a public sector; our study focused on the case in which tax revenues are spent for the public provision of goods and in which public policy may change the expenditure structure (between manufacturing and agriculture) and may thus change the pattern of industry location. These agglomerative effects turned out to be different with taxation according to the residence and according to the source principle. With taxation according to the residence principle the high tax region may end up with the higher share in industry, provided that the public sector spends more for manufactures than the private sector. Instead, with taxation according to the source principle, it is always the low tax region that gets the higher share in industrial capital. By changing industry location public policy in one region exerts an external effect on the other region that is specific to the New Economic Geography perspective and that leads to issues of tax competition. It is remarkable that these effects also occur with taxation according to the residence principle; we argue that tax rates set in a non-cooperative Nash game may be too high compared to the cooperatively chosen ones – in the New Economic Geography perspective tax competition may lead to a “race to the top”.

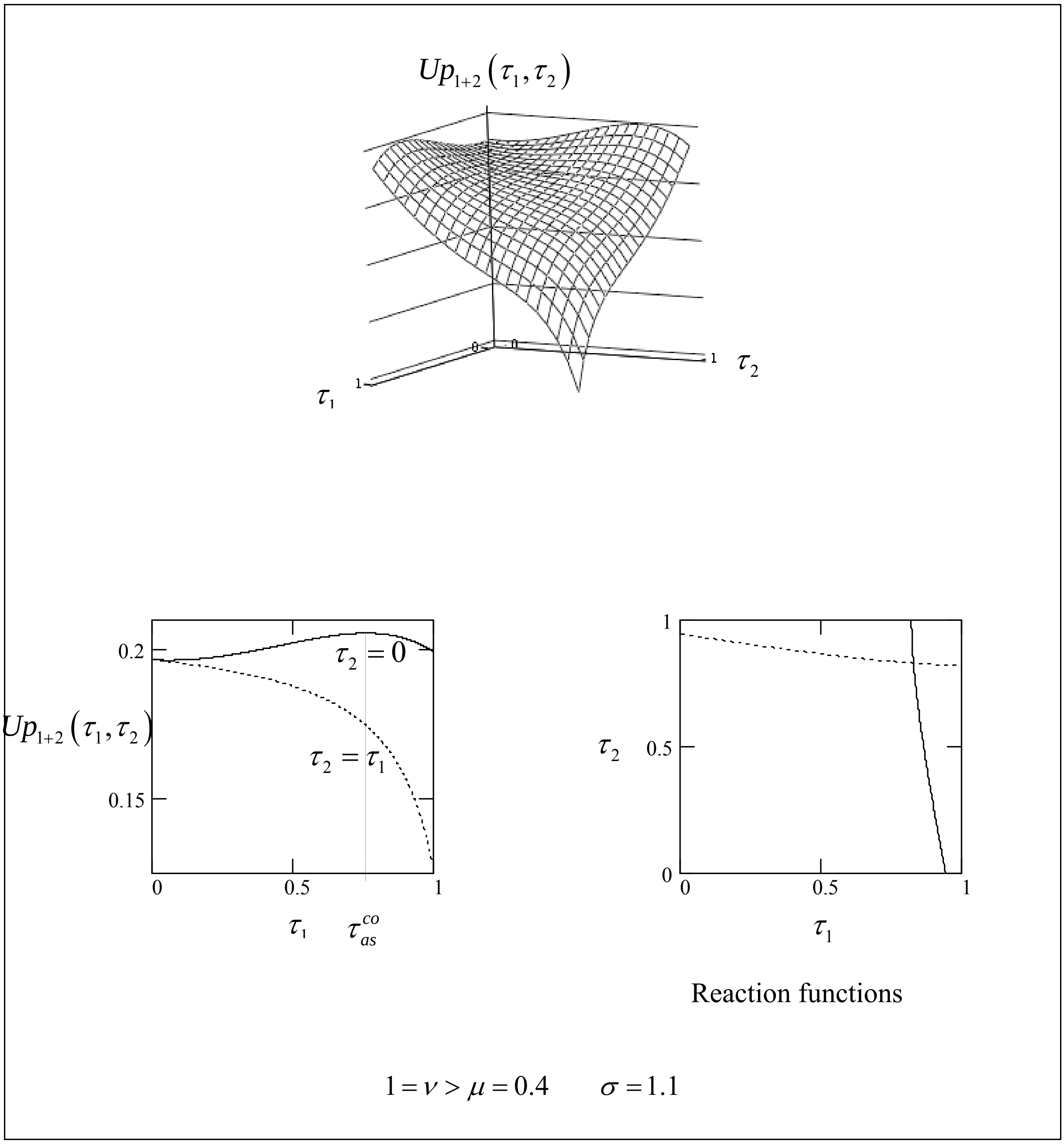


Figure 5: Tax coordination

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