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Tax Competition and Tax Harmonisation in an Urban Context

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Abstract

It is a standard prediction in the literature on tax competition that mobility of factors between jurisdictions causes local governments to choose too low tax rates and to under-provide public goods. This paper shows circumstances when the prediction may be false. The prediction may be false when workers live in one jurisdiction and commute to work in another. We show that in an urban setting land developers will make inefficient choices of both tax rates and public expenditures. Whether these are too high or too low from a social point of view is ambiguous. The only unambiguous prediction is that the non-cooperative payroll tax is inefficiently low. In our framework, the locational inefficiency is twofold, both residents and workers are inefficiently allocated across communities in equilibrium. We also show that tax harmonisation and/or voluntary inter-community transfers are not effective in restoring efficiency.

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1. INTRODUCTION

There are two types of inefficiencies associated with free migration of factors in a federation. The first one is the inefficiency of labour allocation. This occurs as individuals do not take into account the fiscal externality they create in migrating [Flatters, Henderson and Mieszkowski (1974), Boadway and Flatters (1982)].

The second inefficiency is that of government behaviour. In trying to attract consumers or capital from other jurisdictions, a benevolent local government sets too low a tax rate which results in underprovision of public goods [Zodrow and Mieszkowski (1986), Mintz and Tulkens (1986), Kanbur and Keen (1993)]. At the same time, competing local governments are biased towards the overprovision of public inputs (infrastructure) and underprovision of public goods [Keen and Marchand (1997)]. If, on the other hand, local governments are modelled as revenue maximisers (Leviathans) the resulting non-cooperative equilibrium predicts excessively high tax rates [Mintz and Tulkens (1996), Edwards and Keen (1986)].

These inefficiencies arise as a result of the coordination failure among local governments. Several solutions have been proposed in order to restore efficiency. A system of *interregional transfers* (equalization payments) of private goods can be implemented to restore the efficiency of labour allocation across regions [Flatters, Henderson and Mieszkowski (1974), Boadway and Flatters (1982)]. In order to induce local governments to behave efficiently some sort of *tax coordination* is necessary. The effect of tax harmonisation is not clearcut. In a symmetrical model of capital tax competition it is the case that tax harmonisation towards a common level increases welfare [Zodrow and Mieszkowski (1986)]. In a two-region asymmetrical model, however, while tax harmonisation can be detrimental for one of the competitors, the imposition of a minimum tax rate benefits both competitors [Kanbur and Keen (1993)]. The effect on the citizen's welfare of a tax coordination is less clear when local governments are assumed to be revenue maximisers [Edwards and Keen (1996)]. Alternatively, the fiscal externality problem can be eliminated using *corrective* *subsidies* [Wildasin (1989)]. The proposed solutions are to be implemented by a national government created for this purpose. There exists, however, the opposite view that there is no role for a national government: competing local governments have incentives to make interregional transfers in order to purchase a preferred population size eliminating thus the inefficiency of tax competition [Myers (1990)].

In what follows we examine the tax competition problem between fiscal jurisdictions in a metropolitan area. Our goal is to determine how the predictions of the standard tax competition models are changed when some of the assumptions of the model are being modified. In particular, we separate individuals' choice of residence from their choice of workplace. Individuals inelastically supply one unit of labour but this may be in a different community than their community of residence, i.e., individuals are allowed to commute to their workplace in our model. This is a realistic feature in an urban setting as we often see individuals commute to their work place in communities different from the one in which they reside, in response to wage differentials. For example the US Census data for 1980 and 1990 shows that almost 8% of the working population commutes to work *to* or *outside* a metropolitan area.[1] This figure increases to about 10% in 1990. Although not available, this gives us an idea of the extent of commuting *within* a metropolitan area.

Place of Work – MSA Level

Workers	1980	1990
Living in an MSA	76.8%	79.5%
Worked in MSA of residence	71.4%	72%
Worked outside MSA of residence	5.4%	7.6%
Not living in an MSA	23.2%	20.5%
Worked in an MSA	2.3%	2.5%
Worked outside any MSA	18%	20.9%

Source: 1980, 1990 US Census of Population.

[1] The US Census defines a metropolitan area as a Metropolitan Statistical Area (MSA).

The analysis is not restricted to the urban context as it can also be applied to the case of cross-border working in a federal state. We also assume the local authority to be a profit-maximiser community developer as it is usually assumed in an urban setting [Henderson (1981), Wildasin (1986), Brueckner (1983)].

The analysis shows that allowing workers to commute to their workplace is not without implications. Our results contradict the standard prediction in the literature that tax competition among jurisdictions causes governments to choose tax rates that are too low and to underprovide public goods. We show that in an urban setting land developers will make inefficient choices of both (property and payroll) taxes rates and public goods and inputs. Whether these are too high or too low from a social point of view is ambiguous. The only unambiguous prediction is that the non-cooperative payroll tax is inefficiently low. In our framework, the locational inefficiency is twofold, both residents and workers are inefficiently allocated across communities in equilibrium. We also show that tax harmonisation and/or voluntary inter-community transfers are not effective in restoring efficiency.

The paper is organised as follows. Section 2 analyses the effects of tax competition in a metropolitan area. The community developers engage in competition for both residents and workers by choosing property and payroll tax rates and the amount of public goods and public inputs to supply in their community. In Section 2.1 we allow workers to commute to their workplace in a community different from that where they reside. In Sections 2.2 and 2.3, we examine the implications of commuting. In order to do this, in Section 2.2 we constrain workers to work in their community of residence and then we contrast the equilibrium obtained with the one in Section 2.1. Section 3 investigates the effectiveness of tax harmonisation and/or inter-community transfers as instruments for eliminating the inefficiencies and Section 4 concludes.

2. TAX COMPETITION

The metropolitan area is assumed to consist of two communities or fiscal jurisdictions indexed by $i = 1, 2$. The fixed amount of land in each community is owned by community developers. There are four goods in each community: a private good (numeraire), housing, infrastructure and a public good. We thus distinguish between the public inputs benefitting the local producers (infrastructure) and public goods benefitting the residents of each community. We assume that individuals in both communities have identical preferences over the numeraire, housing and public good. We introduce asymmetry between the two communities by assuming that the numeraire is produced using labour and infrastructure with different technologies in the two communities. Individuals inelastically supply one unit of homogeneous labour either in their community of residence or the neighbouring community.[2] A commuting cost is incurred by any individual who has to travel to work in the neighbouring community. Housing is produced in each community using numeraire and land. We also assume that the marginal rates of transformation between the numeraire and the public good and public input respectively are 1. Each community developer sets property and payroll taxes to finance public spending on public goods and inputs in the community he controls. Individuals are free to choose their residence community and, in addition to this, the community where they wish to supply labour so as to maximise their utility. The two developers compete with each other for both residents and workers. The more residents and workers the community developer succeeds in attracting the higher the tax revenue and rents he can obtain. On the other hand, a bigger community size makes it more costly to the developer to supply the public good. The developer has to weigh these costs and benefits when setting the property and payroll tax rates.

We assume that decisions are taken in two consecutive stages. In stage one, each developer chooses the property and payroll tax rates and levels of public goods and infrastructure taking the choices of the other developer as given (Nash game). In the second

[2] For an analysis where the labour-leisure is distorted by the use of a property tax see Wilson (1991).

stage, individuals choose a community of residence and a community of work, deciding whether they wish to commute to their work place. The numeraire and housing are also produced at this stage.

2.1. Tax Competition With Commuting

Individuals

There are $\overline{N}$ individuals in the metropolitan area. Individuals are assumed to be identical in their tastes for the private good x_i, housing consumption h_i, and public goods g_i, where the subscript denotes the community of residence. We assume that the utility function takes the quasi-linear form given by

$$u(x_i, h_i, g_i) = x_i + v(h_i) + b(g_i), \tag{1}$$

for an individual for whom the work and residence communities coincide and

$$u(x_i, h_i, g_i) - \delta = x_i + v(h_i) + b(g_i) - \delta \tag{2}$$

if the two communities differ. Thus, any individual who chooses to reside in a community other than his work community incurs a commuting cost of δ, $\delta > 0$. The price of housing net of tax is denoted by p_i. Housing is taxed at rate t_i, so $p_i^* = p_i + t_i$ is the gross price of housing as incurred by the individuals. Workers pay a payroll tax of τ_j if they decide to work in community j, $j = 1, 2$. Individuals then choose their demands for the private good and housing so as to maximise their utility subject to the budget constraint

$$x_i + p_i^* h_i = w_j - \tau_j, \tag{λ}$$

where w_j is the going wage rate in community j, $j = 1, 2$.

Production

The numeraire good is produced in each community i using labour ℓ_i and infrastructure G_i according to the production function $F^i(\ell_i, G_i)$, with $F^i_{\ell\ell} < 0$, $F^i_{GG} < 0$ and

$F^i_{G\ell} > 0$, where the subscripts refer to the partial derivatives with respect to each argument, while the superscript i refers to the community where the numeraire is produced. Perfect competition in the labour market implies that the wage rate in each community is equal to the marginal product of labour, i.e., $w_i = F^i_\ell(\ell_i, G_i)$. The numeraire goes to four different uses: private consumption x_i, public goods g_i, infrastructure G_i, and as input in the housing technology z_i. Housing is produced in each community using the numeraire z_i and (fixed) land as inputs in the production function H, with $H' > 0 > H''$. We drop the fixed argument in the production function for notational convenience. The housing producer chooses the amount of numeraire to employ in order to maximise profits

$$\max_{z_i} \quad p_i H(z_i) - z_i. \tag{3}$$

The maximised value of the objective gives the profit function $\pi(p_i)$ of the housing producers in community i, with $\pi' > 0$ and $\pi'' > 0$. We denote the housing supply function derived from the profit maximisation problem by $S(p_i)$, with $S' > 0$. The resulting rents in the housing market are assumed to be kept by the housing producer.

We proceed now to determine the equilibrium of this two-stage game by starting as usual at the second stage of the game. We first determine the choice of residence and work communities for an individual at stage two, taking as given the developer's choice of public policy. We then turn to the first stage to see how the equilibrium mix of tax rates and public goods and inputs is determined as a solution to the Nash game between the two community developers.

Stage 2: Choice of residence and work communities

We can divide this stage into two sub-stages. In the first sub-stage, individuals take public policy choices, t_i, τ_i, g_i, G_i, and prices, p_i, w_j $(i, j = 1, 2)$, as given and determine their housing and numeraire demands. The first-order conditions for the individual optimisation problem require that the marginal rate of substitution between the numeraire and the housing consumption be equal to the gross price of housing

$$v'(h_i) = p_i^*. \tag{4}$$

Solving Eq. (4), we obtain the individual demand for housing, $h(p_i^*)$, where $h' < 0$, and the indirect utility function

$$V(w_j - \tau_j, p_i^*, g_i) \equiv w_j - \tau_j - p_i^* h(p_i^*) + v(h(p_i^*)) + b(g_i) \quad \text{for} \quad j = i \tag{5}$$

and

$$V(w_j - \tau_j, p_i^*, g_i) - \delta \equiv w_j - \tau_j - p_i^* h(p_i^*) + v(h(p_i^*)) + b(g_i) - \delta \quad \text{for} \quad j \neq i. \tag{6}$$

The difference between Eq. (5) and (6) is given by δ. An individual choosing to commute to his work place is forced to pay a fixed commuting cost of δ.

At the second sub-stage, individuals choose their work and residence communities simultaneously.[3] Our working assumption is that community 2 has a better technology which implies that wages are higher there than those in community 1. We can check at the end that this is indeed the case (see the Appendix for a proof when the numeraire production function is quadratic). At this stage, an individual faces four choices: (reside in 1, work in 1), (reside in 1, work in 2), (reside in 2, work in 2), and (reside in 2, work in 1). Given the higher wage in community 2, there will be individuals working in community 2 who choose to reside in community 1 and commute to their work place provided that the mix of tax rates and public goods in community 1 compensates them for the travelling cost. Note that we cannot have commuting happening both ways, that is, there are no individuals who live in community 2 and work in community 1 given the higher wages in community 2 and the commuting cost they have to incur. There are two conditions that have to be satisfied in equilibrium. The first one,

$$V(w_2 - \tau_2, p_1^*, g_1) - \delta = V(w_2 - \tau_2, p_2^*, g_2), \tag{7}$$

[3] The analysis is not changed if individuals choose their work and residence communities sequentially.

requires that an individual who works in community 2 be indifferent between residing in either community.[4] The second condition requires that there are no individuals residing and working in community 1 that would be happier residing and working in community 2,

$$V(w_1 - \tau_1, p_1^*, g_1) = V(w_2 - \tau_2, p_2^*, g_2). \tag{8}$$

Eq. (8) says that in equilibrium free mobility of residents and workers must guarantee that individuals obtain the same utility level irrespective of their residence and work communities. For the assumed quasi-linear utility function, the equilibrium conditions described by Eqs (7) and (8) reduce to

$$w_1 - \tau_1 = w_2 - \tau_2 - \delta, \tag{9}$$

i.e., the higher wage rate in community 2 just compensates commuters for their transportation cost δ. One can easily determine the equilibrium number of workers in each community by re-writing Eq. (9) as

$$F_\ell^1(\ell_1, G_1) - \tau_1 = F_\ell^2(\ell_2, G_2) - \tau_2 - \delta, \tag{10}$$

where $\ell_1 + \ell_2 = \overline{N}$. Eq. (10) then gives the equilibrium numbers of workers in each community as functions of the public policy according to

$$\ell_i = \ell_i(\tau_1, G_1, \tau_2, G_2), \tag{11}$$

with

$$\frac{\partial \ell_i}{\partial \tau_j} \begin{cases} < 0 & \text{for} \quad i = j \\ > 0 & \text{for} \quad i \neq j \end{cases}, \qquad \frac{\partial \ell_i}{\partial G_j} \begin{cases} > 0 & \text{for} \quad i = j \\ < 0 & \text{for} \quad i \neq j \end{cases}. \tag{12}$$

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[4] Stability of the resident migration equilibrium requires that

$$\frac{d}{dN_2}\left[V(w_2, p_2^*, g_2) - V(w_2, p_1^*, g_1) + \delta\right] < 0,$$

hold. This would be satisfied if the metropolitan area is overpopulated (see Boadway and Flatters (1982) and Atkinson and Stiglitz (1980)).

We denote by N_i the equilibrium number of residents in community i, $(i = 1, 2)$ where $N_1 + N_2 = \overline{N}$. Equilibrium in the housing market requires that demand and supply of housing be equalised, i.e.,

$$N_i h(p_i^*) = S(p_i), \tag{13}$$

for $i = 1, 2$. Recalling that $p_i^* = p_i + t_i$, we can use Eq. (13) to obtain the price of housing in each community as a function of the number of community residents and tax rate levels

$$p_i = p_i(N_i, t_i), \quad \text{with} \quad \frac{\partial p_i}{\partial N_i} > 0 \quad \text{and} \quad \frac{\partial p_i}{\partial t_i} > 0, \tag{14}$$

for $i = 1, 2$. We can now determine the equilibrium number of community residents by feeding Eq. (14) back into the equilibrium condition Eq. (7). This exercise yields

$$N_i = N_i(t_1, g_1, t_2, g_2) \tag{15}$$

with

$$\frac{\partial N_i}{\partial t_j} \begin{cases} < 0 & \text{for} \quad i = j \\ > 0 & \text{for} \quad i \neq j \end{cases}, \qquad \frac{\partial N_i}{\partial g_j} \begin{cases} > 0 & \text{for} \quad i = j \\ < 0 & \text{for} \quad i \neq j \end{cases}. \tag{16}$$

An increase in the public goods or a decrease in the tax rate in one of the communities induces an in-migration of individuals into the community. A change in the public policy in the sense of decreasing the level of public goods provided or increasing the tax rate results in an out-migration of residents.

Note that the quasi-linearity assumption is important in obtaining expressions (11) and (15). This assumption implies that changes in the property taxes and public goods in either community have no effect on the equilibrium number of workers. Workers commute only in response to changes in the payroll taxes and public inputs levels. Also, changes to the payroll taxes and public inputs levels have no effect on the equilibrium number of residents. This is affected only by changes in the property tax rates and public good levels.

Stage 1: Developer's problem

We now turn to the first stage decisions. We assume that each community is controlled by a developer who collects and keeps all the rents resulting from the production of the numeraire. Beside taxing away all the rents, the developer obtains revenue from the property tax, t_i, and payroll tax, τ_i. The public good, g_i, and the public input, G_i, are provided by the community developer using the numeraire as the only input. We assume that the public good is congested and it is produced at a cost $g_i c(N_i)$, $c' > 0$. Each community resident enjoys the same quality and quantity of public goods, however, the marginal cost to the developer of supplying one unit of public goods, $c(N_i)$, is assumed to be increasing in the community size, N_i. There are, thus, higher administrative costs associated with bigger communities. At stage one, the developer chooses the levels of public goods, infrastructure, property and payroll tax rates to maximise his payoff,[5]

$$\max_{t_i, g_i, \tau_i, G_i} t_i S(p_i) + \tau_i \ell_i + R_i - g_i c(N_i) - G_i, \tag{17}$$

where $R_i = F^i(\ell_i, G_i) - F^i_\ell(\ell_i, G_i)\ell_i$ are the rents from the production of the numeraire that are fully taxed away by the developer. We denote the profit function resulting from this maximisation problem by Π_i, where $\Pi_i' > 0$, $i = 1, 2$. The two community developers compete for both residents and workers by offering a policy mix completely described by $(t_i,\ \tau_i,\ g_i,\ G_i)$. The two developers engage in Nash competition, that is, each making his choices taking the choices of his competitor as given. The community i developer takes into account the effect of his choice of t_i, τ_i, g_i and G_i on the location of residents and workers across communities, described by Eqs (11), (14), and (15). The maximisation problem for community i developer gives the levels of the tax rates, public goods and infrastructure in this community as the solutions to the following first-order conditions[6]

$$S(p_i) + t_i \frac{\partial S}{\partial p_i}\frac{\partial p_i}{\partial t_i} + \left[t_i \frac{\partial S}{\partial p_i}\frac{\partial p_i}{\partial N_i} - g_i c'(N_i)\right]\frac{\partial N_i}{\partial t_i} = 0, \tag{t$_\mathrm{i}$}$$

$$\left[t_i \frac{\partial S}{\partial p_i}\frac{\partial p_i}{\partial N_i} - g_i c'(N_i)\right]\frac{\partial N_i}{\partial g_i} - c(N_i) = 0, \tag{g$_\mathrm{i}$}$$

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5 We do not have to impose a resource constraint on the developer since this constraint can be shown to hold.

6 As opposed to Henderson (1985) in our case there is fiscal exploitation by the community developer, in the sense that the budget does not balance in equilibrium. When the developer is constrained in his choices by holding the utility of his residents constant (Henderson case) the no fiscal exploitation (i.e., budget balance) result obtains in equilibrium.

$$\ell_i + \tau_i \frac{\partial \ell_i}{\partial \tau_i} - F^i_{\ell\ell} \frac{\partial \ell_i}{\partial \tau_i} \ell_i = 0, \qquad (\tau_i)$$

$$\tau_i \frac{\partial \ell_i}{\partial G_i} + F^i_G - F^i_{\ell\ell} \frac{\partial \ell_i}{\partial G_i} \ell_i - 1 - F^i_{\ell G} \ell_i = 0. \qquad (G_i).$$

The first two terms in Eq. (t_i) give the direct effect of the choice of property tax rate on the tax base. A higher tax rate in community i is passed onto the housing producers and translates into a higher price of housing. This, in turn, results in a higher supply of housing and, therefore, a higher tax base for developer i. This is offset by the effect of increased taxation on the migration of residents. Higher taxes drive the residents out of the community, forcing the housing producers to lower their prices. This works to lower community i's tax revenue. On the other hand, out-migration lowers the congestion costs of supplying the public good. The developer will chose a tax rate so that the two effects offset each other in equilibrium. Eq. (g_i) describes the equilibrium choice of public goods g_i. A higher level of public goods in community i attracts more residents to this community. This results in an increased price of housing and a higher tax base at the same time with a lower congestion cost, which benefits the developer. In equilibrium, the benefit from in-migration has to equal the cost borne by the developer of providing an additional unit of public good. Eq. (ℓ_i) describes the effects of the choice of the payroll tax τ_i on developer's profits. At first, an increase in the payroll tax increases the developer's tax revenue. This is, however, followed by an out-migration of workers resulting in a lower tax base. The out-migration of workers has a negative impact on the rents the developer is able to extract, as a consequence of increased wages. The effects of changes in the community i infrastructure become apparent in Eq. (G_i). A higher G_i has a positive direct effect on the payroll tax base, $\tau_i \frac{\partial \ell_i}{\partial G_i}$, and the rents the developer is able to collect, F^i_G. At the same time, increased infrastructure attracts more workers to this community and benefits the community developer through the positive effect on rents. In addition to this, the community developer bears the direct cost of producing G_i. The first three terms in Eq. (G_i)represent the direct net benefit of expanding G_i. As ℓ_i and G_i are assumed to be complements, an increase in G_i also induces increased labour productivity. This imposes a loss in rents for the developer. The equilibrium choice of G_i must balance all these effects.

The following lemma gives sufficient conditions for both the property tax rate and public expenditures to be positive.

Lemma *If* $\varepsilon_{S,p_i} = \frac{\partial S}{\partial p_i}\frac{p_i}{S} < 1$ *holds, both the optimal tax rate* (t_i) *and public goods expenditures* (g_i) *are positive.*

Proof See the Appendix. ■

The condition in Lemma 1 requires that the supply of housing function be relatively inelastic with respect to its own price. An inelastic supply curve means that the developer can increase the tax rate and shift the resulting tax burden onto housing producers. The less elastic the housing supply (i.e., the lower ε_{S,p_i}) the easier the increased tax burden is reflected into the producer price of housing (i.e., the higher ε_{p_i,t_i}).[7] On the other hand, an inelastic supply of housing makes the producer price of housing very sensitive to the migration of residents (i.e., ε_{p_i,N_i} is high).[8] A very elastic producer price with respect to migration makes the developer's policy of increasing the tax rate less desirable since this will drive away potential new residents. Thus, a relatively flat housing supply function has two effects which are reflected in Eq. (A7) in the Appendix. The first one is to facilitate

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[7] This is formally expressed by the following equality

$$\varepsilon_{p,t} = \frac{\frac{t}{p+t}\varepsilon_{h,p^*}}{\varepsilon_{S,p} + \frac{p}{p+t}\varepsilon_{h,p^*}},$$

where $\varepsilon_{h,p^*} = \frac{\partial h}{\partial p^*}\frac{p^*}{h}$ and $\varepsilon_{S,p} = -\frac{\partial S}{\partial p}\frac{p}{S}$ are the price elasticities of the demand for housing and supply of housing respectively.

[8] This relationship is expressed as

$$\varepsilon_{p,N} = \frac{1}{\varepsilon_{S,p} - \frac{p}{p+t}\varepsilon_{h,p^*}},$$

with the same notation as before.

the community developer to choose a higher tax rate by shifting the increased burden of taxation onto the housing producers. The other effect, working in the opposite direction, constrains the developer from choosing too high a tax rate by the adverse effect it has on in-migration of residents through the increased price of housing. When this second effect is important the developer resorts to increased public spending in trying to make the community more attractive to potential migrants.

Efficiency

To study the efficiency of the public policy and that of the migration of residents and workers (from the point of view of the metropolitan area as a whole), we define the following *measure of efficiency*

$$\begin{aligned}\Phi = \quad & \ell_1 V(w_1 - \tau_1, p_1^*, g_1) + (N_1 - \ell_1)\left[V(w_2 - \tau_2, p_1^*, g_1) - \delta\right] + N_2 V(w_2 - \tau_2, p_2^*, g_2) \\ & + \pi(p_1) + \pi(p_2) + \Pi_1 + \Pi_2,\end{aligned}$$

where $V(w_1 - \tau_1, p_1^*, g_1) = w_1 - \tau_1 - p_1^* h(p_1^*) + v(h(p_1^*)) + b(g_1)$ is the utility enjoyed by the community 1 residents working in their own community, $V(w_2 - \tau_2, p_1^*, g_1) - \delta = w_2 - \tau_2 - p_1^* h(p_1^*) + v(h(p_1^*)) + b(g_1) - \delta$ is the utility of community 1 residents commuting to work in community 2, and $V(w_2 - \tau_2, p_2^*, g_2) = w_2 - \tau_2 - p_2^* h(p_2^*) + v(h(p_2^*)) + b(g_2)$ is the utility of community 2 residents. The terms $\pi(p_i)$, $i = 1, 2$, represent the profits obtained by the housing producers and Π_i, $i = 1, 2$, the profits of the community developer in each community.

In what follows we are going to make use of the following definition.

Definition Community i, $i = 1, 2$, is said to be *overpopulated* from its developer point of view if

$$\frac{d\Pi_i}{dN_i} = t_i \frac{\partial S}{\partial p_i} \frac{\partial p_i}{\partial N_i} - g_i c'(N_i) \leq 0 \tag{18}$$

that is, resident migration out of community i increases developer i's profits. Community i, $i = 1, 2$, is said to be *underpopulated* from its developer point of view if the reverse inequality holds.

Propositions 1, 2, 3, and 4 below assess the efficiency properties of the public policy.

Proposition 1 *The public good, g_i, is inefficiently provided in the non-cooperative equilibrium. If community j $(j \neq i)$ is overpopulated from the point of view of its developer, then developer i underprovides the public good g_i.*

Proof This can be seen by differentiating the efficiency measure Φ with respect to g_i taking into account the effect this policy instrument has on p_i, N_i, and ℓ_i, $i = 1, 2$. Evaluating at the equilibrium gives the following expression:

$$\frac{d\Phi}{dg_i} = N_i b'(g_i) - \left[t_j \frac{\partial S(p_j)}{\partial p_j} \frac{\partial p_j}{\partial N_j} - g_j c'(N_j) \right] \frac{\partial N_i}{\partial g_i}, \tag{19}$$

with $i \neq j$. The first term in Eq. (19) represents the direct effect of increasing community i's public goods level on efficiency. The second term is the fiscal externality effect. When choosing the level of public goods developer i ignores the effect this has on the developer j's payoff. A marginal increase in the community i's public goods attracts more residents to this community. If community j is overpopulated then the increase in g_i reduces community j's population and in turn increases developer j's payoff. Thus, efficiency could be increased if developer i took into account the effects of his choice of g_i on community i's residents reflected in the term $N_i b'(g_i)$ and developer j's payoff $\left[t_j \frac{\partial S(p_j)}{\partial p_j} \frac{\partial p_j}{\partial N_j} - g_j c'(N_j) \right]$. ■

Proposition 2 *The property tax rate, t_i, $i = 1, 2$ is inefficiently set in the non-cooperative equilibrium. If community j $(j \neq i)$ is overpopulated from the point of view of its developer, then developer i chooses an inefficiently high tax rate.*

Proof This can be seen by differentiating the efficiency measure Φ with respect to t_i $(i = 1, 2)$, and evaluating at the equilibrium to obtain

$$\frac{d\Phi}{dt_i} = -S(p_i) - \left[t_j \frac{\partial S}{\partial p_j} \frac{\partial p_j}{\partial N_j} - g_j c'(N_j) \right] \frac{\partial N_i}{\partial t_i}, \tag{20}$$

with $i \neq j$. The inefficiency of the choice of t_i comes from two sources. Firstly, the community developer does not take into account the direct effect of his choice of t_i on the profits of the housing producers. As t_i increases, the housing producers in community i increase their supply of housing which in turn increases their profits. Secondly, developer i ignores the fiscal externality imposed on the neighbouring community by his choice of t_i. Increasing the tax rate in community i induces a migration of residents out of this community. If community j is already overpopulated as perceived by its own developer, then the increase in t_i imposes a negative externality on community j's developer. This is reflected in the negative sign of the term in the square brackets in the above equation. Thus, if one of the communities is overpopulated from its own developer point of view, the other community developer will choose an inefficiently high tax rate. More generally, if both communities are overpopulated from their respective developers viewpoint, both developers will choose too high a tax rate compared to the efficient one. The sign of the expression above cannot be determined for the overpopulated community when the neighbouring community is underpopulated.■

Proposition 3 *The non-cooperative payroll tax, τ_i, $i = 1, 2$ is inefficiently low.*

Proof This result follows from direct differentiation of Φ with respect to τ_i and evaluation at the equilibrium to obtain

$$\frac{d\Phi}{d\tau_i} = \tau_j \frac{\partial \ell_j}{\partial \tau_i} = \frac{\ell_i \tau_j}{\tau_i - F^i_{\ell\ell} \ell_i} > 0. \tag{21}$$

When developer i changes the payroll tax rate in the community he controls he fails to internalise the effect this has on his competitor's payroll tax revenue. A change in the sense of increasing community i's payroll tax works to induce an out-migration of workers from community i and into community j. This in turn, increases developer j's tax base and, therefore, his payroll tax revenue. As developer i fails to take this effect into account, the resulting payroll tax, τ_i, is too low in the non-cooperative equilibrium from the point of view of the whole metropolitan area. ■

Proposition 4 *In the non-cooperative equilibrium, the public input, G_i, $i = 1, 2$ is inefficiently high.*

Proof Differentiating the efficiency measure, Φ, with respect to G_i and evaluating it at the equilibrium levels of tax rates and public expenditures gives

$$\frac{d\Phi}{dG_i} = \tau_j \frac{\partial \ell_j}{\partial G_i} - F^j_{ll} \frac{\partial \ell_j}{\partial G_i} \ell_j < 0. \tag{22}$$

When developer i decides to increase the level of public inputs, G_i, this has a negative effect on the payroll tax base of his competitor, j, as an increase in G_i attracts more workers to community i. At the same time, an outflow of workers from community j decreases developer j's rents. As developer i does not take these effects into account when choosing his most preferred level of public inputs, his choice is inefficiently high from the point of view of the whole metropolitan area. ■

Propositions 1 and 4 help us compare our results with those in Keen and Marchand (1997). In their case, that of local governments competing for mobile capital, public goods are underprovided and public inputs are overprovided. The reason for this is that capital and public inputs are assumed to be complements, and thus increasing the level of public inputs attracts more capital from abroad. This in turn increases the welfare of residents and government's revenue. In our case, the composition of public spending may or may not be biased toward public inputs. Although the developers have incentives to overprovide the public inputs in order to attract more workers and thus increase their rents, we cannot say for sure that public goods are underprovided. This does happen however when the neighbouring community is overpopulated.

Proposition 5 *The non-cooperative equilibrium with commuting results in an inefficient allocation of residents over the metropolitan area.*

Proof Differentiating Φ with respect to N_i and evaluating at the equilibrium yields

$$\begin{aligned} \frac{d\Phi}{dN_i} &= \left[t_i \frac{\partial S}{\partial p_i} \frac{\partial p_i}{\partial N_i} - t_j \frac{\partial S}{\partial p_j} \frac{\partial p_j}{\partial N_j} \right] + [-g_i c'(N_i) + g_j c'(N_j)] \\ &= A \left[\frac{c(N_i)}{b(g_i)} - \frac{c(N_j)}{b(g_j)} \right], \end{aligned} \tag{23}$$

for $i \neq j$. Free mobility of residents gives rise to two types of externalities. Firstly, there is a redistributive effect associated with free mobility. When residents migrate out of one community this has a negative effect on the tax base of this community and a positive effect on the tax base of the community of destination. Secondly, migration out of community i and into community j eases the congestion cost borne by the developer i and imposes an additional congestion cost on developer j. The overall sign of this expression cannot in general be established. If, however, community i is underpopulated and j is overpopulated from their developers' point of view, overall efficiency could be increased if more individuals would migrate to community i. That is, if community i is underpopulated and j is overpopulated from their developers' point of view the two communities are also underpopulated and overpopulated respectively from the point of view of the metropolitan area as a whole. ■

Proposition 6 *If the payroll taxes in the two communities are different,* $\tau_i \neq \tau_j$*, for* $i \neq j$*, the non-cooperative equilibrium allocation of workers is inefficient.*

Proof Evaluating the derivative of the efficiency measure Φ with respect to ℓ_i at the equilibrium gives

$$\frac{d\Phi}{d\ell_i} = \tau_i - \tau_j, \tag{24}$$

for $i, j = 1, 2,\ i \neq j$. Thus, the allocation of workers is inefficient as long as the two communities choose different payroll takes, $\tau_i \neq \tau_j$. An inflow of workers into community i and out of community j increases the tax base of community i's developer and reduces that of his competitor. Unless these two effects cancel out in equilibrium, the non-cooperative allocation of workers over the metropolitan area is inefficient. ■

Our results stated in Propositions 1-4 show that taxes and public spending might not always be inefficiently low as most of the tax competition literature predicts. While this is indeed true for the payroll tax rate and public inputs levels, the standard prediction might not apply to the property tax rate and public goods levels. If at least one of the communities is overpopulated, the property tax rate is going to be inefficiently high and the public goods level too low in the neighbouring community. Moreover, if both communities are overpopulated, then the property tax rates are going to be too high and public goods levels too low in both communities.

2.2. Tax Competition Without Commuting

When workers are constrained to work in their residential community (for instance by very high transportation costs) the equilibrium allocation of residents-*cum*-workers is characterised by

$$V(w_1 - \tau_1, p_1^*, g_1) = V(w_2 - \tau_2, p_2^*, g_2), \tag{25}$$

which is the same as Eq. (8) in the equilibrium with commuting. The above equilibrium condition along with Eq. (14) determine the equilibrium allocation of individuals across communities as a function of the public policy in the two communities according to the following expression

$$N_i = N_i(t_1, g_1, \tau_1, G_1, t_2, g_2, \tau_2, G_2), \tag{26}$$

where

$$\frac{\partial N_i}{\partial t_j} \begin{cases} < 0 & \text{for} \quad i = j \\ > 0 & \text{for} \quad i \neq j \end{cases}, \qquad \frac{\partial N_i}{\partial g_j} \begin{cases} > 0 & \text{for} \quad i = j \\ < 0 & \text{for} \quad i \neq j \end{cases}, \tag{27}$$

$$\frac{\partial N_i}{\partial \tau_j} \begin{cases} < 0 & \text{for} \quad i = j \\ > 0 & \text{for} \quad i \neq j \end{cases}, \qquad \frac{\partial N_i}{\partial G_j} \begin{cases} > 0 & \text{for} \quad i = j \\ < 0 & \text{for} \quad i \neq j \end{cases}. \tag{28}$$

The developer i's optimisation problem then becomes

$$\max_{t_i, g_i, \tau_i, G_i} t_i S(p_i) + \tau_i N_i + R_i - g_i c(N_i) - G_i,$$

with $R_i = F^i(N_i, G_i) - F_N^i(N_i, G_i)N_i$, for $i = 1, 2$. The optimal choices of t_i, g_i, τ_i and G_i are then characterised by the following first-order conditions:

$$S(p_i) + t_i \frac{\partial S}{\partial p_i}\frac{\partial p_i}{\partial t_i} + \left[t_i \frac{\partial S}{\partial p_i}\frac{\partial p_i}{\partial N_i} - g_i c'(N_i)\right]\frac{\partial N_i}{\partial t_i} + \tau_i \frac{\partial N_i}{\partial t_i} - F_{NN}^i \frac{\partial N_i}{\partial t_i} N_i = 0, \tag{29}$$

$$\left[t_i \frac{\partial S}{\partial p_i}\frac{\partial p_i}{\partial N_i} - g_i c'(N_i)\right]\frac{\partial N_i}{\partial g_i} - c(N_i) + \tau_i \frac{\partial N_i}{\partial g_i} - F_{NN}^i \frac{\partial N_i}{\partial g_i} N_i = 0, \tag{30}$$

$$\left[t_i \frac{\partial S}{\partial p_i}\frac{\partial p_i}{\partial N_i} - g_i c'(N_i)\right]\frac{\partial N_i}{\partial \tau_i} + N_i + \tau_i \frac{\partial N_i}{\partial \tau_i} - F_{NN}^i \frac{\partial N_i}{\partial \tau_i} N_i = 0, \tag{31}$$

$$\left[t_i \frac{\partial S}{\partial p_i}\frac{\partial p_i}{\partial N_i} - g_i c'(N_i)\right]\frac{\partial N_i}{\partial G_i} + \tau_i \frac{\partial N_i}{\partial G_i} + F_G^i - F_{NN}^i N_i \frac{\partial N_i}{\partial G_i} - F_{NG}^i N_i - 1 = 0. \qquad (32)$$

The equations describing the equilibrium choices of t_i, g_i look similar to the ones obtained in the case when workers are allowed to commute to their workplace. The necessary conditions that have to be satisfied by t_i and g_i in the no commuting case differ from the ones derived earlier only through the effects these choices have on rents and payroll tax revenue. In the case with commuting the choice of the property tax rate and public goods level does not have any effect on the rents the developer can collect. However, when the residents are forced to work in their community of residence (i.e., the commuting cost is too high) the developer can collect rents only from his own residents. The developer cannot impose too high a tax rate because in addition to out-migration this also reduces his rents. In the no commuting case the developer is also restricted in his choice of t_i by the effect this has on his payroll tax revenues. The out-migration caused by an increased property tax works to reduce these revenues as now an out-migration of residents also means an out-migration of workers.

When commuting between communities is not allowed, the developers' choices of payroll taxes and public inputs also affect the property tax base and the congestion costs. This is so, because now workers are also residents of the community. So, on the one hand, a higher payroll tax rate induces out-migration of individuals, reducing the developer's property tax base. On the other hand, out-migration reduces the congestion cost for the developer. Depending on which of these effect dominates in equilibrium, the payroll tax rate is higher or lower in the no commuting case compared to the case without commuting. The same argument, applies to the public inputs level. The choice of public inputs not only affects migration of workers but also migration of residents as these two groups of individuals now coincide. Again, the equilibrium level of public inputs can be lower or higher than in the case when commuting is allowed.

Evaluating Eqs. (29), (30), (31), and (32) at the equilibrium values of t_i and g_i obtained in the case with commuting allow us to state the following result.

Proposition 7

1. *The optimal tax rate t_i is higher in the case with commuting than in the case with no commuting.*

2. *The optimal level of public goods provision g_i is lower in the case with commuting than in the case with no commuting.*

The intuition for this result is the following. As we saw earlier when labour is immobile the community developer is constrained in raising the tax rate too high by the effect this has on the rents he is able to extract. Choosing too high a tax rate induces an out-migration of residents which in turn has a negative effect on rents. In the equilibrium without commuting the developer does not face such a constraint. In the latter case, the developer can raise the tax rate without reducing his rents as these no longer depend on the equilibrium number of residents. Similarly, starting from the equilibrium with commuting values of t_i and g_i, developer i has an incentive to increase g_i as this attracts more workers into the community and allows the developer to extract more rents.

Efficiency

In order to examine efficiency properties of the equilibrium without commuting we now introduce an efficiency measure analogous to the one defined in the previous section

$$\begin{aligned}\Phi =& N_1 V(w_1 - \tau_1, p_1^*, g_1) + N_2 V(w_2 - \tau_2, p_2^*, g_2) \\ &+ \pi(p_1) + \pi(p_2) + \Pi_1 + \Pi_2,\end{aligned}$$

where $V(w_i - \tau_i, p_i^*, g_i) = F_N^i(N_i, G_i) - p_i^* h(p_i^*) + v(h(p_i^*)) + b(g_i)$, $i = 1, 2$, $\pi(p_i)$, $i = 1, 2$ are the profits of the housing producer in community i, and $\Pi_i = \max\{t_i S(p_i) + \tau_i N_i + R_i - g_i c(N_i) - G_i\}$, $i = 1, 2$ is developer i's payoff. Differentiating Φ with respect to t_i, g_i, τ_i, and G_i and evaluating at the Nash equilibrium values of these variables gives the following expressions

$$\frac{d\Phi}{dt_i} = -S(p_i) - \left[t_j \frac{\partial S}{\partial p_j}\frac{\partial p_j}{\partial N_j} - g_j c'(N_j)\right]\frac{\partial N_i}{\partial t_i} - \tau_j \frac{\partial N_i}{\partial t_i} + F_{NN}^i \frac{\partial N_i}{\partial t_i} N_i, \qquad (33)$$

$$\frac{d\Phi}{dg_i} = N_i b'(g_i) - \left[t_j \frac{\partial S}{\partial p_j}\frac{\partial p_j}{\partial N_j} - g_j c'(N_j)\right]\frac{\partial N_i}{\partial g_i} - \tau_j \frac{\partial N_i}{\partial g_i} + F^i_{NN}\frac{\partial N_i}{\partial g_i}N_i, \quad (34)$$

$$\frac{d\Phi}{d\tau_i} = -\left[t_j \frac{\partial S}{\partial p_j}\frac{\partial p_j}{\partial N_j} - g_j c'(N_j)\right]\frac{\partial N_i}{\partial \tau_i} + \tau_j \frac{\partial N_j}{\partial \tau_i} + F^i_{NN}\frac{\partial N_i}{\partial \tau_i}N_i, \quad (35)$$

$$\frac{d\Phi}{dG_i} = -\left[t_j \frac{\partial S}{\partial p_j}\frac{\partial p_j}{\partial N_j} - g_j c'(N_j)\right]\frac{\partial N_i}{\partial G_i} + \tau_j \frac{\partial N_j}{\partial G_i} + F^i_{NN}\frac{\partial N_i}{\partial G_i}N_i. \quad (36)$$

We can see from the above equations that public policy is inefficient with the efficiency criterion we defined. The reason is that each developer, acting independently, does not take into account the effects of his choices on his competitor's payoff, the utility of his residents, and the profits of the housing producer in his community.

Comparing Eqs (33), (34) with the efficiency conditions we obtained in the case with commuting, Eqs (19) and (20), yields the following result.

Proposition 8 *The efficient property tax rate, t_i, is higher in the no commuting case than in the commuting case. The efficient level of public goods, g_i, is lower in the no commuting case than in the commuting case.*

Whether the efficient payroll tax rate and the efficient public inputs level is higher or lower in the no commuting case as opposed to the case with commuting depends is ambiguous. There is one instance in which we can, however, make an unambiguous prediction. If community j is underpopulated from its developer point of view, the efficient payroll tax rate in community i is higher in the no commuting case. Thus, if community j is underpopulated, efficiency could be increased if more individuals migrate into this community. A lower payroll tax rate in community i would serve this purpose. Also, if community j is underpopulated from its developer point of view, the efficient public inputs level is lower in the no commuting case. When community j is underpopulated a lower level of public inputs in community i induces more residents to migrate to community j, increasing overall efficiency.

The next proposition is the analogue of Proposition 5 in the previous section.

Proposition 9 *The allocation of residents-cum-workers is inefficient from the point of view of the metropolitan area as a whole.*

Proof Differentiating the efficiency measure, Φ, and evaluating at the equilibrium gives us the following expression

$$\frac{d\Phi}{dN_i} = \left[t_i \frac{\partial S}{\partial p_i}\frac{\partial p_i}{\partial N_i} - g_i c'(N_i) + \tau_i\right] - \left[t_j \frac{\partial S}{\partial p_j}\frac{\partial p_j}{\partial N_j} - g_j c'(N_j) + \tau_j\right]$$
$$= [c(N_i) - c(N_j)] + \frac{1}{A}\left[F^i_{NN} N_i b'(g_i) - F^j_{NN} N_j b'(g_j)\right],$$

which tells us that community i is either underpopulated or overpopulated from the social standpoint.■

The above discussion sheds light on why allowing individuals to commute to their work place in the tax competition models is important. Firstly, efficiency requires the property tax rate be lower in the case when commuting is allowed. That is, if the Nash property tax was inefficiently low, departures from the efficient property tax is less severe in the commuting case than in the no commuting one. Secondly, the efficient level of public goods is higher in the commuting case. Thus, if the Nash public goods level was inefficiently low, the inefficiency is more severe in the commuting case. Thirdly, in the no commuting case we can no longer unambiguously predict whether the payroll tax rate and the public inputs level is inefficiently low or high, as we did in the commuting case. Fourthly, while the inefficiency of worker allocation can be easily eliminated by harmonising the payroll tax rate in the commuting case, this is no longer the case when commuting is not allowed. This is so because workers now coincide with residents and payroll tax harmonisation does not induce residents to locate efficiently.

3. TAX HARMONISATION AND INTER-COMMUNITY TRANSFERS

In this section we examine the possibility of eliminating the inefficiencies resulting in the non-cooperative equilibrium with the use of two 'decentralised' instruments, tax harmonisation and inter-community transfers. There are two questions we are trying to answer in this section. The first question is whether the two developers can agree between themselves to harmonise the tax rates and/or to make voluntary inter-community transfers. If so, the second question is whether these two instruments also solve the inefficiency issue. We are emphasising the fact that we are looking at the 'decentralised' solution, that is, a situation where the two developers consent to harmonise their taxes and/or to make inter-community transfers without any external intervention such as that of a central government.

We are starting with the tax harmonisation issue. If the two developers agreed to harmonise both the payroll and property tax rate, the common rates would solve the following maximisation problem

$$\max_{t,\tau} \quad \Pi_1 + \Pi_2, \tag{37}$$

i.e., the common rates would maximise the joint profit of the two developers. Let us first note that there is no common level of the payroll tax to which the two developers would agree to harmonise.[9] The intuition behind this observation is the following. By agreeing to harmonise the payroll taxes to a common rate, the two developers do in fact give up their ability to use the payroll tax as an instrument for attracting workers into their community. With a common payroll tax rate the number of workers in each community depends only on the level of infrastructure spending in the two communities,[10] $\ell_i = \ell_i(G_1, G_2)$. The common payroll tax becomes irrelevant for the migration of workers across communities. Since the developers cannot agree to a common payroll tax rate it follows that workers are still inefficiently allocated across communities according to Eq. (23).

The next question is whether harmonising the property tax rates would be beneficial. If the developers agree to harmonise, the common property tax rate, t^*, solves the first-order condition

$$S(p_1) + t^* \frac{\partial S}{\partial p_1} \frac{\partial p_1}{\partial t^*} + \left[t^* \frac{\partial S}{\partial p_1} - g_1 c'(N_1) \right] \frac{\partial N_1}{\partial t^*} + \tag{38}$$

[9] Formally, the first-order condition for the common payroll tax rate is $\ell_1 + \ell_2 = 0$.

[10] This is due to the assumed quasi-linear utility function.

$$S(p_2) + t^* \frac{\partial S}{\partial p_2} \frac{\partial p_2}{\partial t^*} + \left[t^* \frac{\partial S}{\partial p_2} - g_2 c'(N_2) \right] \frac{\partial N_2}{\partial t^*} = 0.$$

It is straightforward to show that the harmonised property tax is not efficient. The reason is that the two developers are ignoring the effect of their choice on the housing producers in the two communities.

There is also a commitment problem associated with tax harmonisation. If the two developers cannot credibly commit to harmonise the property tax rate so as to maximise their joint profit, each one of them has incentives to defect, since cooperation gives a lower payoff.

We now turn to look at the usefulness of inter-community transfers in dealing with the locational inefficiency and the inefficiency of the developers' behaviour. In this case, the developers choose the levels of property and payroll tax rates, expenditures on public goods, g_i, public inputs, G_i, and inter-community transfers, T_{ij}, to maximise their profits. We take T_{ij} to denote the voluntary transfer from community i to community j $(i, j = 1, 2)$. We assume that developer i equally distributes the transfer T_{ji} received from developer j to the residents in his community. The equilibrium number of community i residents, N_i, now depends not only on t_i, τ_i, g_i, and G_i, but also on the voluntary transfers T_{ij}, $i, j = 1, 2$, $i \neq j$. Then developer i's problem $(i = 1, 2)$ becomes

$$\max_{t_i, \tau_i, g_i, G_i, T_{ij}} \quad t_i S(p_i) + \tau_i \ell_i + R_i - g_i c(N_i) - G_i - T_{ij} + T_{ji}. \tag{39}$$

The policy variables t_i, τ_i, g_i, G_i must satisfy the same first-order conditions as before. The only new condition is the one for the inter-community transfers T_{ij}

$$\left[t_i \frac{\partial S}{\partial p_i} \frac{\partial p_i}{\partial N_i} - g_i c'(N_i) \right] \frac{\partial N_i}{\partial T_{ij}} = 1, \tag{40}$$

for $i, j = 1, 2$, $i \neq j$.

Proposition 10 *The system of voluntary inter-community transfers, $\{T_{ij}\}_{i,j=1,2,i\neq j}$, restores the efficiency of resident location if and only if the two communities have the same number of residents in equilibrium, $N_i = N_j$, $i, j = 1, 2$, $i \neq j$.*

Proof In the Appendix.■

From Eqs. (23) and (37) that the allocation of residents is efficient if and only if a change in the voluntary transfers produce a proportional change in the number of residents in the two communities, i.e., $\frac{\partial N_i}{\partial T_{ij}} = \frac{\partial N_j}{\partial T_{ji}}$. As it is shown in the Appendix, this condition is satisfied only for $N_i = N_j$. Since we cannot have the same number of residents with asymmetrical communities, we can conclude that, in general, the allocation of residents is inefficient and the developers cannot use inter-community transfers to buy the desired number of residents in their community. This contradicts the result in Myers (1990) where benevolent governments are constrained in their choices by the budget balance requirement.

4. CONCLUSIONS

There are two main ingredients in our model, commuting and profit-maximising community developers. As the analysis in Section 2 shows, separating the choice of residence decision from the choice of workplace decision aggravates the locational inefficiency problem present in the standard tax competition models. Two types of inefficiency are present in the Nash equilibrium. The first inefficiency is that of the behaviour of the community developers. In choosing their preferred tax rates and public goods and inputs each developer ignores the effect his choices have on his own residents and the other developer. The second inefficiency is a locational one: both residents and workers are allocated inefficiently across communities. The equilibrium allocation of residents is inefficient as migration from one community to the other has a negative effect on the tax base of the community of origin and a positive effect on that of the community of destination. At the same time, migration eases the congestion cost of the developer of the origin community and imposes an additional congestion cost on the developer of the destination community. The allocation of workers is inefficient due to different payroll tax rates chosen by the developers of the two communities.

Section 3 has looked at the possibility of using 'decentralised' solutions to restore efficiency. The proposed solutions are tax harmonisation and voluntary inter-community transfers. It is shown that neither of the two proposals can restore efficiency. First of all, there is no rate to which the two developers would agree to harmonise their payroll taxes. If they agreed to harmonise the payroll taxes, the two developers would in fact give up their ability to use the payroll tax rate as an instrument to attract labour into their communities. Thus, the necessary and sufficient condition for workers to locate efficiently, that of equal payroll taxes, cannot be achieved.

In our framework, voluntary inter-community transfers cannot restore the efficiency of resident location. This contradicts the result in Myers (1990) that benevolent local governments, acting in the interest of their residents, use inter-community transfers to buy the desired number of residents in their community. We can re-obtain this result in our model with commuting by taking community developers to be benevolent. Benevolent community developers are constrained in their choices by the budget balance constraint, which is not the case with profit-maximising developers where fiscal exploitation of residents is possible.

Since community developers cannot agree to a 'decentralised' solution, the task of restoring efficiency can be assigned to a central institution – central/federal government. Alternatively, the two (or more) communities could be amalgamated into one big community.

In our analysis we have used the simplifying assumption of quasi-linear utility. Although useful in obtaining expressions that can be readily interpreted, this assumption is no doubt restrictive. We believe that most of our results would carry through to the case of a general utility function less the result which states that there is no level to which the two developers would agree to harmonise the payroll tax. With a general utility function the equilibrium number of residents would no longer be independent of the payroll tax rates, therefore, the developers would choose that level of the payroll tax that would give them the optimum mix of residents and workers in their community. Furthermore, a more general utility function is needed if one is to construct a model with commuting happening both ways which is a more realistic situation.[11]

The possibility that community developers have other objectives beside that of maximising profits has been ignored. It is quite realistic that developers also care about staying in office and it would be interesting to have a model that accounts for this as well.

[11] With a quasi-linear utility function and commuting both ways we have two equilibrium conditions $w_1 - \tau_1 = w_2 - \tau_2 - \delta$ and $w_2 - \tau_2 = w_1 - \tau_1 - \delta$ that have to be satisfied simultaneously. This can happen only if the commuting cost δ is zero. If commuting is not costless we need a more general utility function.

APPENDIX

A. Proof of Lemma 1

Using the residence choice equilibrium condition Eq. (8) we denote

$$\Delta \equiv [-p_1^* h(p_1^*) + v(h(p_1^*)) + b(g_1) - c] - [-p_2^* h(p_2^*) + v(h(p_2^*)) + b(g_2)] = 0. \qquad (A1)$$

Differentiating Eq. (A1) with respect to N_i, t_i and g_i and using the envelope theorem we obtain

$$\Delta_{N_1} = -\Delta_{N_2} = -\left[\frac{p_1 S(p_1)}{N_1^2}\varepsilon_{p_1,N_1} + \frac{p_2 S(p_2)}{N_2^2}\varepsilon_{p_2,N_2}\right] \equiv -A, \qquad (A2)$$

$$\Delta_{t_1} = -\frac{S(p_1)}{N_1}\left[-\frac{p_1}{t_1}\varepsilon_{p_1,t_1} + 1\right], \qquad (A3)$$

$$\Delta_{t_2} = \frac{S(p_2)}{N_2}\left[-\frac{p_2}{t_2}\varepsilon_{p_2,t_2} + 1\right],$$

and

$$\Delta_{g_i} = b'(g_i). \qquad (A4)$$

We can now determine the effects of the public policy on the resident migration as

$$\frac{dN_i}{dt_i} = -\frac{\Delta_{t_i}}{\Delta_{N_i}} = \frac{S(p_i)}{N_i}\frac{1 - \frac{p_i}{t_i}\varepsilon_{p_i,t_i}}{A}, \qquad (A5)$$

and

$$\frac{dN_i}{dg_i} = -\frac{\Delta_{g_i}}{\Delta_{N_i}} = \frac{b'(g_i)}{A}. \qquad (A6)$$

The first-order conditions for the community i developer can be easily derived as

$$S(p_i) + t_i \frac{\partial S}{\partial p_i}\frac{\partial p_i}{\partial N_i}\frac{\partial N_i}{\partial t_i} + t_i \frac{\partial S}{\partial p_i}\frac{\partial p_i}{\partial t_i} = 0, \qquad (\mathrm{t_i})$$

$$t_i \frac{\partial S}{\partial p_i}\frac{\partial p_i}{\partial N_i}\frac{\partial N_i}{\partial g_i} - 1 = 0, \qquad (\mathrm{g_i})$$

and

$$-F^i_{\ell\ell}\frac{\partial \ell_i}{\partial G_i}\ell_i + F^i_G - F^i_{\ell G} - 1 = 0. \qquad (\mathrm{G_i})$$

Eqs (t_i) and (g_i) can be re-written in elasticity form as

$$[1-\varepsilon_{S,p_i}\varepsilon_{p_i,t_i}]S(p_i)+\frac{t_iS(p_i)}{N_i}\varepsilon_{S,p_i}\varepsilon_{p_i,N_i}\frac{\partial N_i}{\partial t_i}=0, \tag{A7}$$

$$\frac{t_iS(p_i)}{N_i}\varepsilon_{S,p_i}\varepsilon_{p_i,N_i}\frac{\partial N_i}{\partial g_i}-1=0. \tag{A8}$$

From Eq. (A5) we can see that in a stable equilibrium $1-\frac{p_i}{t_i}\varepsilon_{p_i,t_i}$ must be negative which means that excessive tax burden in immediately transferred onto the housing producers. It can be proved that ε_{p_i,t_i} and ε_{S,p_i} are inversely related through

$$\varepsilon_{p_i,t_i}=\frac{\frac{t_i}{p_i+t_i}\varepsilon_{h,p_i^*}}{\varepsilon_{S,p_i}+\frac{p_i}{p_i+t_i}\varepsilon_{h,p_i^*}}, \tag{A9}$$

where $\varepsilon_{h,p_i}=-\frac{\partial h}{\partial p_i^*}\frac{p_i^*}{h}$ is the price elasticity of the demand for housing. Thus, Eq. (A9) shows that a relatively inelastic supply of housing function guarantees that both $1-\frac{p_i}{t_i}\varepsilon_{p_i,t_i}<0$ and $1-\varepsilon_{S,p_i}\varepsilon_{p_i,t_i}<0$ hold. That is to say that the requirement in Lemma is a sufficient condition for a positive tax rate to obtain.

B. Proof that $w_2 > w_1$ in equilibrium

Let us assume that the numeraire production function is quadratic of the form $F_i(\ell_i, G_i)=a_i-b_i\frac{\ell_i^2}{2}+d_iG_i$, a_i, b_i, $d_i>0$, $i=1,2$. In this case, the equilibrium equation (10) becomes $a_1-b_1\ell_1-\tau_1=a_2-b_2\ell_2-\tau_2-c$. Given that all workers are employed in one or the other of the communities, $\ell_1+\ell_2=\overline{N}$, we can obtain the number of workers in each community as function of the public policy

$$\ell_1=\frac{1}{b_1+b_2}[a_1-a_2-\tau_1+\tau_2+\delta+b_2\overline{N}], \tag{B1}$$

and

$$\ell_2=\frac{1}{b_1+b_2}[a_2-a_1-\tau_2+\tau_1+\delta+b_1\overline{N}]. \tag{B2}$$

We can now determine the solutions ℓ_i to this problem using the first-order condition Eq. (τ_i)

$$\ell_1=\frac{a_1-a_2+\delta}{2(b_1+b_2)}+\frac{\overline{N}}{2}, \tag{B3}$$

$$\ell_2 = \frac{\overline{N}}{2} - \frac{a_1 - a_2 + \delta}{2(b_1 + b_2)}. \qquad (B4)$$

These two closed-form solutions along with the perfect labour market condition, $w_i = a_i - b_i \ell_i$, allow us to determine a condition under which the wage rate is higher in community 2

$$a_2 - a_1 > (b_2 - b_1)\frac{2(b_1 + b_2)}{b_1 + 3b_2}\left(\frac{\overline{N}}{2} - \delta\right). \qquad (B5)$$

If

(i) $\overline{N} > 2\delta$;

(ii) $a_2 > a_1$ and $b_1 > b_2$,

the equilibrium wage rate is higher in community 2 than in community 1. ■

C. Proof of Proposition 10

The equilibrium condition (7) now becomes

$$V(w_2 - \tau_2 + \frac{T_{21}}{N_1}, p_1^*, g_1) - \delta = V(w_2 - \tau_2 + \frac{T_{12}}{N_2}, p_2^*, g_2). \qquad (C1)$$

The price of housing function is again $p_i = p_i(N_i, t_i)$, while the equilibrium number of residents now depends on the transfers as well $N_i = N_i(t_1, g_1, t_2, g_2, T_{12}, T_{21})$. Implicit differentiation of Eq. (C1) with respect to T_{12} and T_{21} gives

$$\left[T_{21}\frac{1}{N_1^2} + T_{12}\frac{1}{N_2^2} + h(p_1^*)\frac{\partial p_1}{\partial N_1} + h(p_2^*)\frac{\partial p_2}{\partial N_2}\right]\frac{\partial N_1}{\partial T_{12}} = -\frac{1}{N_2}, \qquad (C2)$$

$$\left[T_{21}\frac{1}{N_1^2} + T_{12}\frac{1}{N_2^2} + h(p_1^*)\frac{\partial p_1}{\partial N_1} + h(p_2^*)\frac{\partial p_2}{\partial N_2}\right]\frac{\partial N_2}{\partial T_{21}} = -\frac{1}{N_1}. \qquad (C3)$$

From Eqs (C2) and (C3) we obtain that $\frac{\partial N_1}{\partial T_{12}} = \frac{\partial N_2}{\partial T_{21}}$ if and only if $N_1 = N_2$. ■

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