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# POLITICAL SUPPORT FOR TAX DECENTRALISATION

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**Abstract**

This paper presents a spatial model of a city with two unequally productive jurisdictions. City residents bear a commuting cost to work in either of the two jurisdictions. In each jurisdiction, a fixed public budget must be financed with a wage tax and a head-tax. We compare the first best optimum to tax decentralisation equilibria. From the total welfare viewpoint, tax competition is always inefficient. Inefficiency may be higher under utilitarian governments or majoritarian ones. If local governments are utilitarian, the more productive jurisdiction is better off at the first best than with tax competition, while the other is worst off. If they are majoritarian, both jurisdictions will under some conditions prefer the tax decentralisation to the first best.
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## 1 Introduction

The combination of decision-making decentralisation and increased mobility creates inter-regional spillovers at all levels: not only among countries, as within each country among its regions, municipalities and jurisdictions. These spillovers may come from different sources, e.g., amenities in one region affect residents' welfare and firm productivity in the other, sales taxes in one region affect consumption patterns in the other. This paper focuses on taxes as the origin of spillovers.

As observed by Fisher (1996) in his study of local taxation in the U.S. "Many individuals live in one city, work in another, and do most of their shopping at stores or a shopping mall in still another locality."(p.6) This quote pretty much defines the spatial scope of our analysis. Indeed, we are interested in spillovers arising from situations in which an individual's residence place does not coincide with his workplace and each of them is under the jurisdiction of a different tax authority. These may either be different jurisdictions in one metropolitan area, neighbouring cities, counties or even, in border areas, different states. In all these cases it is conceivable that an individual might live in a place and work in the other, i.e., commute everyday to his workplace. In what follows, we adopt the term jurisdiction to refer to these different possible local tax authorities and we call city the spatial unit that encompasses them.

As the quote above by Fisher (1996) suggests, inter-jurisdictional commuting is far from being an exception in the daily life of many individuals. Moreover, the improvement of transportation technologies has contributed to increase the prevalence of commuters in modern economies. For instance, in Britain, average commuting distance has gone up by 50% between 1975 and 1995 (The Economist, 1998). In Hong-Kong, people commute an average of 38 minutes (one-way), but the standard deviation equals 23 minutes (data for the year 2000, Tse and Chan (2003)). In the US, as much as 21% of all workers in 1990 crossed county lines to go to work every day. The corresponding figure was 10% in 1960 (Renkow, 2003). The number of commuters from rural counties to adjacent urban counties in North Carolina has gone up from 33,633 (around 12% of the rural counties' workforce) in 1960 to 160,400 (almost 30% of the rural counties' work force) in 1990. Also, the area over which commuters into urban counties chose to reside has increased substantially over the period. (Renkow and Hoover, 2000).

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Using data from all US metropolitan areas, Glaeser et al. (2000) computed the total number of commuters from the suburbs to the city: they found 6,6 millions in 1960 and 15,2 in 1990. The number of commuters from the city to the suburbs has also increased from 2 to 6 million people. Not surprisingly, inter-jurisdictional commuting is much higher when one considers smaller spatial jurisdictions: in Pennsylvania, 20% of workers commute inter-counties while more than 75% commute among municipalities (data for 1990, Shields and Swenson (2000)). Van Ommeren et al. (1999) use a comprehensive sample of Dutch male workers, of which about 60% work in a different municipality than the one where they reside. Average commuting distance is 20 km. Cameron and Muellbauer (1998) split Great Britain into 10 regions, and still obtain commuting patterns out of such a large scale spatial division. For instance, 6,3% (7,8%) of the employed residents of East Midlands out-commuted in 1981 (1991). On average, 2,2% of every regions' employed residents are commuters.

The study of local taxation spillovers is very important as the existence of local governments at different levels is a widespread phenomenon. In the United States, there were 86,750 local governments in 1992, counting 50 states, 39,000 counties, municipalities and townships and 47,700 special purpose governments like school districts. Even these latter do have taxing power in some cases. Their expenditures financed from own sources (i.e., excluding central government grants) represent 10% of the US GDP, a bit less than one half of the federal government figure (Fisher, 1996). As regards the European Union, we have for instance, 605 local governments in Belgium (of which 589 municipalities), 36,889 in France (36,763 municipalities) and 8,222 in Italy (8,100 municipalities). Sub-national expenditure represents about one third of total public expenditure (average for a sample of 8 European countries)(OECD, 2002). Of course the existence of such numerous local authorities is only interesting to the extent that their autonomy in setting tax and expenditure levels is considerable. Both in the EU and the US local governments seem to enjoy considerable freedom in establishing local tax bases and/or rates. E.g., a survey of six EU countries (Belgium, Denmark, Netherlands, Spain, Sweden and UK) reports local governments to choose tax rates (on centrally set tax bases) on almost all of their taxes (setting aside Spanish local governments and Belgian communities, we have an average of 90% tax rate control). In Belgium, Spain and Sweden there exist tax bases that are set at the local level. The autonomy is even higher in the US and it is also a necessary condition for the diversity of local tax and expenditure arrangements being the rule rather than the exception. As Fisher (1996) puts it: "this diversity is the essence of a federal, as opposed to a unitary, system of government".

This paper treats the case of a city formed by two jurisdictions. Residents of the city must decide whether to work in their own jurisdiction (i.e., where they live) or in the other. The plausibility of policentric cities (i.e. with more than one employment center) has been established both theoretically (see e.g. chapter 6 in Fujita and Thisse (2002) for endogenous city shapes displaying more than one employment center) and empirically. Jun and Ha (2002) show how the city of Seoul has evolved from essentially monocentric in the early 80's to essentially tri-centric in the mid 90's. The same evolution toward policentric structures is widely observed in the US (see Bogart and Ferry (1999), who study the Cleveland metropolitan area, and the references therein regarding Chicago, Dallas, Ohio, Los Angeles and San Francisco). Garreau (1991) clearly argues that employment centers apart from the central business district (which he labels edge-cities) are a widespread phenomenon.

In choosing their workplace, people trade off the relative advantages (e.g. wage and working conditions) of a given job with the cost they bear in order to get there daily (i.e. the travel cost in all its aspects: distance, time and money). There is an extensive body of empirical evidence showing this basic trade-off. So et al. (2001) estimate the elasticity between the number of commuters from non-metropolitan to metropolitan De Moines area and commuting time to be around -1,8. The elasticity between the number of in-commuters and metropolitan wages is estimated by the same authors at 0,75. In his study of commuting of female workers in The Netherlands, Rouwendal (1999) estimates that a worker is willing to accept an increase in the two-way commuting distance by 1 km against an increase in around 1 Dutch guilder of daily wage. In Renkow and Hoover (2000)'s analysis of North Carolina, the elasticity of out-commuting (measured as a percentage of local population) with respect to wage in the destination urban county is 0,13 and the elasticity with respect to distance (in miles) is -1. In our model, these two aspects of inter-jurisdictional commuting are present. On the one hand, one of the jurisdictions is more productive than the other and thus able to pay higher wages.[1] On the other hand, individuals pay a constant per-mile commuting cost and it is more costly for them to work further from

[1]For evidence of different wage rates prevailing in different employment centers of the Boston and Minneapolis metropolitan areas, controlling for workers characteristics, see Thimothy and Wheaton (2001). Wages can vary up to 15% among the 24 employment centres in Boston and up to 18% among the 15 in Minneapolis. Interestingly, wages in some non-central employment centres can be almost as high as in the central business district

their home, that is, in the jurisdiction where they do not reside.

As said above, this paper tackles inter-jurisdictional tax spillovers. Each jurisdiction sets a head tax, to be paid by all its residents and a wage tax, to be paid by all the individuals working in the jurisdiction. Equivalently, this wage tax may be paid by the firm employing the worker. One may wonder about the practical relevance of the source-based wage taxation. There are many examples of such taxes. On the one hand, several OECD countries have payroll taxes at the state or local level: Australia, Austria, France and Greece (OECD, 1992). It is also the case in Mexico (Amieva-Huerta, 1997). In the US, wages are taxed at the source in different localities in the states of Alabama, Kentucky, New Jersey, Ohio, Oregon, also in the city of Philadelphia and in New York city – where it has been abandoned by state imposition in 2000 but the discussion to bring it back has gone on (Fisher (1996), Braid (1996), Haughwout et al. (2003)).[2] In Korea, income taxation at the local level is source based (Chu and Norregaard, 1997). Depending on the stage of production at which they apply, some value added taxes fall on the production factors at a given locality, labour included.[3] This happens in the US, in Hawaii, Michigan and Washington (Fisher, 1996) and also in Italy (OECD, 2002). In Japan, a new VAT with such characteristics is to be introduced soon.[4]

In our model, tax receipts are used to finance a fixed local budget which finances a public good (or a publicly provided private good) that benefits the residents of the jurisdiction. We have in mind local services linked to residency, like rubbish collection, education or leisure facilities used by residents in weekends (like parks or swimming-pools). This tax structure, combined with inter-jurisdictional commuting, creates room for tax exporting, i.e., non-residents bearing a part of the tax burden of the local public good. Tax exporting seems to play an important role at the local level: several empirical studies have shown that exportability of a given tax burden partially explains its adoption by local governments (Fisher, 1996).

We study of welfare implications of tax competition. A common result in the literature is that tax competition is Pareto inferior to centralised tax decisions. That is due to the inter-jurisdictional spillover (or externality) it creates. However, when asymmetries exist among jurisdictions, some

[2] See also *Budget options for New York City*, http://www.nyc.gov/html/records/pdf/finan/631options2003.pdf

[3] A VAT applied at the retail level, i.e., a sales tax is of no interest to us. The interesting case is when it is to be paid by the firm producing the good, as a percentage of either its gross sales or its value added (i.e. gross sales minus purchases of intermediate goods).

[4] I thank Motohiro Sato for suggesting me this example.

of them may gain from tax competition, despite its being globally welfare worsening. Both Bucovetsky (1991) and Wilson (1991) have shown that less populated regions are an example of such welfare gainers. If jurisdictions had some (not too expensive) way to make transfers between them, they both could attain a higher welfare by setting taxes cooperatively. This being the case and given that tax competition games are in general repeated, we should expect cooperation to be often observed. At the international level, there are some examples of (at least partial) tax cooperation but there are definitely many examples of absence of such coordination. At smaller scales (like the one of interest to us, a metropolitan area) where centralisation used to prevail, we might expect the decentralisation never to arise. At least one lower-tier government, anticipating that it will loose from the process, should not approve of a move towards decentralisation. Nevertheless, decisions are becoming more and more decentralised. The best measure we have of such a phenomenon is probably the increasing role played by local governments. For instance, in the United States, between the early 50's and the early 90's, state and local government spending has had higher growth rates than the overall size of the economy, population or price levels (Fisher, 1996). The same pattern is observed in most EU countries, where sub-national taxes represent increasing percentages of sub-national expenditures. In a survey of 8 countries, the figure has decreased in only two, but has increased sharply in most of them. For instance in Belgium, it has been up from 26% in 1980 to 78.5% in 1998, in Denmark, from 38.7% to 51.2% and in Sweden from 57% to 74.5% (OECD, 2002).

Our paper highlights one possible mechanism explaining why tax decentralisation is so widely observed: if local governments are majoritarian, they may approve tax decentralisation even though social welfare decreases with it. Our analysis also highlights the fact that the choice of the local government objective function is not innocuous. Depending on wether local governments are majoritarian or utility maximising planners, their attitudes towards tax decentralisation may vary sharply. The key issue is that when decision making is majoritarian there is an individual who becomes the decisive voter. *We show that this individual might benefit from tax decentralisation. Put otherwise, there is a majority in each jurisdiction preferring the inefficient tax competition equilibrium to the first best.* This result is obtained through a welfare analysis of tax competition in a setting enriched and characterised by two types of asymmetry: on the one hand, jurisdictions are asymmetric and, on the other, each jurisdiction's residents are heterogeneous.

**Related literature**

A number of papers have tackled tax choices at the local level. Braid (2000) analyses a city with commuters. He focus on the choice of tax instruments when jurisdictions may dispose of wage, capital and head taxes. Since jurisdictions are symmetric, the wage tax is not used as long as the head tax is available. In other papers, like Braid (1997), the wage tax is used under some circumstances, even in the presence of a head tax. His model is different from ours in that there is a fixed factor (land), commuting is costless and jurisdictions are symmetric. Each individual owns land in other than his own jurisdiction therefore a property tax is used for tax exporting. If the property tax is not available, the wage tax is used as a means to export taxes in a less effective way. Braid (1996) is similar to Braid (1997) except that there is no tax exporting, therefore wages are not taxed if it is possible to use residence taxation. In other tax competition setting, capital taxation, papers like Bucovetsky (1991) and Wilson (1991) as much as DePater and Myers (1994) and Peralta and van Ypersele (2002) have analysed the consequences of asymmetries among regions. With utilitarian local governments, the two latter have obtained that when regions are not price-takers on the world market, the importing region taxes while the exporting region subsidises capital. In our setting, thanks to the combination of imperfect mobility of labour (due to commuting costs) and price taking behaviour on the world capital market, the exporting jurisdiction does not tax (nor subsidise) labour. A "small region advantage" has been identified by Bucovetsky (1991) and Wilson (1991). They show that at the tax competition equilibrium the less populated region is better-off than the more populated one. This latter faces a less elastic capital supply and therefore charges a higher tax rate than the small region, which has more invested capital and higher production. In our setting, jurisdictions have the same population and it is the more productive one that enjoys an advantage. Decentralisation gives it the power to export its tax burden through taxing the foreign production factor it imports. Another feature of our analysis is its political aspect. A number of previous contributions have related tax competition and political issues. The two first are more related to our analysis in that they also show that (partially or fully) centralising tax decisions may worsen the median voter's welfare. In a model of capital tax competition where international evasion is possible, Fuest and Huber (2001) explain the lack of tax coordination through a majority support for tax decentralisation (middle income voters being capital owners but not wealthy enough as to avoid taxation through capital flight). Grazzini and van Ypersele (2003) show that a partial coordination policy (imposition of a minimum tax on capital) need not improve the median voter's welfare. Besley and Smart

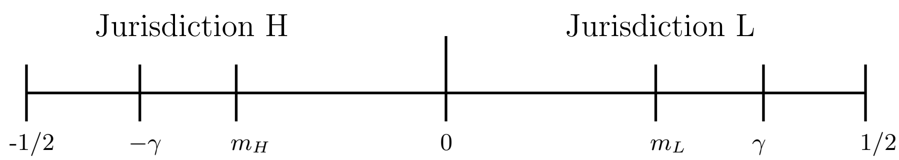
(2003) study the effect of tax competition on voters' welfare on a political agency model and show that increased tax competition need not worsen it. Kessler et al. (2002) study redistributive taxation in a model where both capital and labour are mobile and a capital tax is decided democratically. They show that it may happen that the median voter is better off when both factors are mobile than when only one is. Our results are also somewhat related to the literature on secession. In their paper about the number (and size) of nations, Alesina and Spolaore (1997) obtain that when each country has a majoritarian government, the world will split into a too large number of countries (as compared to the first best situation). Haimanko et al. (2001) show that a country can be efficient and yet prone to secession threats on behalf of some of its regions. As in the present contribution, majoritarian decision making yields over-decentralisation because the decisive voter does not internalize other individuals' utility loss. This is also the case in Cremer et al. (1985), where they show that majority voting for the location of public facilities in space yields a larger than the optimal number of facilities.

## 2 The Model

We consider a linear duocentric city composed of two jurisdictions, as shown in Figure 1.[5] Without loss of generality, we normalise the two extreme points of the segment to $-1/2$ and $1/2$, respectively. The city is inhabited by a continuum of individuals indexed by $x$, distributed according to a symmetric density function $n(x)$ with distribution function $N(x)$. For simplicity, we normalise the total number of city residents to 1. Given the symmetry of $n(x)$, each jurisdiction has the same number of inhabitants which we denote $\bar{N}$, with $\bar{N} = 1/2$. $m_H$ and $m_L$ refer to the median inhabitants of jurisdiction H and jurisdiction L. Each jurisdiction has an employment centre, denoted respectively $-\gamma$ and $\gamma$. The employment centre is located outwards from the median resident: to the left in jurisdiction H and to the right in jurisdiction L. The fact that the employment centre does not coincide with the median location of the jurisdiction opens the possibility for a majority of

[5]A duocentric city can be the endogenous result of a model of city formation. Fujita and Thisse (2002, chapter 6) provide such a model, where information externalities push firms to locate close together and commuting costs born by workers (and the corresponding wage increase) as well as scarcity of land (and its high price) are the dispersion forces. A whole range of intermediate values of the commuting cost and of the distance-decay effect of the information externality yield duocentric cities, as long as this latter effect is non-linear.

Figure 1: The City




the residents of one jurisdiction to commute to the other. Given the generality of $n(x)$, this assumption is not incompatible with the employment centre being located at the geographical centre of the jurisdiction, i.e., $\gamma = 1/4$.

The local government of each jurisdiction must finance a fixed public budget, $G_i$. It does so by collecting an ad-valorem source tax on wage ($\tau_i$), to be payed by all workers in jurisdiction $i$ and a head tax $T_i$ to be payed by all its residents.[6] In what follows, $\tau$ and $T$ refer to the vectors of local wage and residence taxes, i.e. $\tau = (\tau_H, \tau_L)$ and $T = (T_H, T_L)$. The local government of jurisdiction $i$ faces the following budget constraint:

$$G_i = \alpha_i N_i \tau_i + \bar{N} T_i$$

where $N_i$ is the number of workers in the jurisdiction.

In each jurisdiction, an homogeneous good is produced according to a linear technology, which is more productive in jurisdiction $H$ than in jurisdiction $L$. Denoting $Y_i$ the production in jurisdiction $i$, we have:

$$Y_i = \alpha_i N_i$$

with $\alpha_H \geq \alpha_L \geq 0$ and $N_i > 0$. This assumption is used for the sake of keeping computations simple enough and it is not essential. None of our results would change if instead we had a constant returns to scale technology combining labour and capital. Since jurisdictions are small and thus price-takers in the world capital market, capital supply is perfectly elastic. Therefore, it remains untaxed at equilibrium so that the gross wage is uniquely determined by the world capital price.[7] Our assumption therefore brings two important simplifications to the model - one factor instead of two, two tax instruments instead of three - without changing the analysis.

[6] Thanks to the availability of the lump-sum tax $T_i$ our analysis would be unchanged if we endogeneized the public budget, either as a pure public good or as a publicly provided private good. Then, $G_i$ would be determined by the Samuelson rule.

[7] Computations for the model with capital are available upon request.

Place of residence is given. Individuals are however free to choose their workplace. By paying a constant per-mile commuting cost of $c$, an individual may work either in $-\gamma$ or in $\gamma$. Note that in this model all individuals commute: some to their own jurisdiction's employment center and some to the other one. We shall refer to the former type as *commuters* and to the latter as *ij-commuters*, a shorthand for inter-jurisdictional commuters.

Individuals derive utility both from private consumption and from the local public budget. We assume that the public budget is used to provide services to the residents. Each individual provides one unit of labour in the $j$ labour market and has its wage taxed at the source. The individual has an amount $W$ of revenue from other sources, e.g., capital revenue in a more general setting with capital. We assume $W$ is big enough such that each individual can always pay his tax bill. We let $\omega_j = \alpha_j(1-\tau_j)$ denote the net wage of the individual working in $j$.[8] The utility enjoyed by individual $x$, a $i$ resident working in $j$ is quasi-linear and given by:

$$U_{ij}(x;\tau) = \omega_j - T_i + W - c\left|x - EC_j\right| + v(G_i) \qquad i,j = H,L$$

where $EC_j$ is the employment centre in $j$ and $G_i$ the public budget in $i$. $v(G)$ is an increasing concave function. We use $v_i'$ as shorthand for $dv/dG_i$ (analogously for $v_i''$). The total monetary travelling cost born by the individual is $c\left|x - EC_j\right|$.

Individuals decide where to work according to where their utility level is higher: the $i$ resident $x$ works in $i$ if and only if $U_{ii}(x;\tau) - U_{ij}(x;\tau) \geq 0$, otherwise he works in $j$. We denote the marginal ij-commuter by $\hat{x}$.[9] Utility differences are as follows:

$$U_{iH}(x;\tau) - U_{iL}(x;\tau) = \begin{cases} \omega_H - \omega_L - c(x+\gamma) + c(\gamma - x), & i = H, L, \quad -\gamma < x < \gamma \\ \omega_H - \omega_L - c(x+\gamma) + c(x-\gamma), & i = L, \qquad x \geq \gamma \\ \omega_H - \omega_L - c(-x-\gamma) + c(x+\gamma), & i = H, \qquad x \leq -\gamma \end{cases} \tag{1}$$

If $x \geq \gamma$ , (1) reduces to

$$\omega_H - \omega_L - 2c\gamma$$

and if $x \leq -\gamma$

$$\omega_H - \omega_L + 2c\gamma$$

[8] In some countries, the local tax base is income net of central (or federal) government taxes. Our model may easily encompass such a setting. It suffices to replace $\alpha_j$ in by $\alpha_j - t$, $t$ being the central government wage tax.

[9] Given that we have a continuum of individuals, the marginal ij-commuter may work in either of the jurisdictions without changing the results.

Both expressions are independent from $x$, therefore if one individual to the right of $\gamma$ commutes, then all of them do. The same is true for individuals to the left of $-\gamma$. If this happens, one of the jurisdictions has no workers at all, while the other has all of them. In order to avoid such non-interesting cases, we assume a discontinuity in the production function at $N_i = 0$: the marginal productivity of labour is arbitrarily high when labour is close to zero. This is the equivalent of assuming Inada conditions on a more general model with capital. Then there is a very high wage in the jurisdiction where there are no workers and this cannot be an equilibrium as then all individuals want to work there.

We are left with the case $-\gamma < x < \gamma$ when (1) reduces to

$$\omega_H - \omega_L - 2cx$$

From which we obtain the marginal ij-commuter:

$$\hat{x}\left(\tau_H, \tau_L\right) = \frac{\omega_H - \omega_L}{2c} = \frac{\alpha_H(1-\tau_H) - \alpha_L(1-\tau_L)}{2c}$$

To sum up, all $x < \hat{x}$ work in H and all $x > \hat{x}$ work in L if and only if $-\gamma < \hat{x} < \gamma$. The marginal inter-jurisdictional commuter $\hat{x}$ defines a *commuting equilibrium*. Labour employed in each jurisdiction is given by:

$$\begin{aligned} N_H &= N(\hat{x}) \\ N_L &= 1 - N(\hat{x}) \end{aligned}$$

### 2.1 Taxation effects

In our model, governments move first in deciding tax levels. Local governments in jurisdictions H and L simultaneously decide the wage and the residence tax. Given the tax choices of the first stage, individuals decide where to work in the second stage. In the end, production and consumption take place. We solve the model by backwards induction. Each government, when setting tax rates, anticipates how they influence, on the one hand, the workforce in the jurisdiction and, on the other, the local budget constraint.

Given the assumption of a fixed local budget, the government's decision is unidimensional. Once $\tau_i$ is decided, $T_i$ adjusts to satisfy the fixed budget requirement, that is

$$T_i = \frac{G_i}{\bar{N}} - \frac{N_i}{\bar{N}}\alpha_i\tau_i \tag{2}$$

The wage tax is distortive. Through its effect on net wages, it affects the marginal ij-commuter and thus the number of workers in each jurisdiction.

Not surprisingly, the marginal ij-commuter moves leftwards in response to an increase in $\tau_H$ and rightwards if $\tau_L$ increases. We have:

$$\begin{aligned}\frac{d\hat{x}}{d\tau_H} &= -\frac{\alpha_H}{2c} < 0 \\ \frac{d\hat{x}}{d\tau_L} &= \frac{\alpha_L}{2c} > 0\end{aligned}$$

The number of workers in each jurisdiction changes accordingly:

$$\begin{aligned}\frac{dN_H}{d\tau_H} &= -\frac{dN_L}{d\tau_H} = -\frac{\alpha_H}{2c}n(\hat{x}) \\ \frac{dN_L}{d\tau_L} &= -\frac{dN_H}{d\tau_L} = -\frac{\alpha_L}{2c}n(\hat{x})\end{aligned}$$

And so does the residence tax:

$$\frac{dT_i}{d\tau_i} = -\alpha_i\frac{N_i}{\bar{N}} - \frac{1}{\bar{N}}\alpha_i\tau_i\frac{dN_i}{d\tau_i} = -\alpha_i\frac{N_i}{\bar{N}} + \frac{1}{\bar{N}}\alpha_i\tau_i\frac{\alpha_i}{2c}n(\hat{x})$$

The first term is the direct positive effect: workers pay the increased tax rate and therefore the government collects more funds. The second term is an indirect effect: the increase in the tax decreases the number of workers. If the wage is taxed, this decreases the funds available to the government; if instead it is subsidised, we have an increase in available funds.

### 2.2 The case of a uniform distribution of residents

In order to simplify our exposition we shall focus on the special case of a uniform distribution of residents. Our results carry over (with minor qualifications) to the case of a general distribution function, satisfying some technical conditions. This general case is analysed in the Appendix, where it can also be checked that the uniform distribution used here respects the conditions derived to prove existence and uniqueness.

Therefore, in what follows, we shall concentrate on a city where a constant density of individuals resides at each point so that

$$\begin{aligned}n(x) &= 1 \\ N(x) &= x + 1/2\end{aligned}$$

Median residents then coincide with the geographical center of the jurisdiction, i.e., $m_H = -1/4$ and $m_L = 1/4$.

## 3 First Best

In this section we compute the utilitarian first best, which makes sense here given the quasi-linearity of utility functions. A city-level benevolent planner chooses a uniform wage tax so as to maximise the overall sum of utilities. The budget constraint is given by:

$$G_H + G_L = \tau \left( \alpha_H N_H \left( \tau \right) + \alpha_L N_L \left( \tau \right) \right) + 2\bar{N}T \tag{3}$$

As there are no externalities involved in the choice of the workplace, the commuting equilibrium is optimal, i.e., the benevolent planner would allocate individuals between the two employment centres in the same way as the market. Hence, in what follows, we take commuting decisions as given, i.e.

$$N_H(\tau) = 1 - N_L(\tau) = \frac{\alpha_H - \alpha_L}{2c}(1-\tau) + \frac{1}{2}$$

We begin by computing total commuting costs, denoted $C_i$ for jurisdiction $i$. Note that it can never be optimal to have workers commuting from H to L, since they would pay a cost to work in the less productive jurisdiction. Therefore, all H residents commute to $-\gamma$ and we have:

$$C_H = c\left[\int_{-1/2}^{-\gamma} \left(-x-\gamma\right) dx + \int_{-\gamma}^{0} \left(x+\gamma\right) dx\right] = c\left(\frac{1}{8} + \gamma^2 - \frac{\gamma}{2}\right)$$

As for L, residents to the right of $\hat{x}$ commute to $\gamma$ whereas those to the left commute to $-\gamma$, yielding:

$$\begin{aligned} C_L &= c\left[\int_{0}^{\hat{x}} \left(x+\gamma\right) dx + \int_{\hat{x}}^{\gamma} \left(\gamma - x\right) dx + \int_{\gamma}^{1/2} \left(x-\gamma\right) dx\right] \\ &= C_H + 2c\int_{0}^{\hat{x}} x dx = c\left(\frac{1}{8} + \gamma^2 - \frac{\gamma}{2} + \hat{x}^2\right) \end{aligned}$$

L residents bear a commuting cost $2c\int_0^{\hat{x}} xdx$ higher than the one they would pay were they to all work at the employment centre of their own jurisdiction. Indeed, for each of the $x$ individuals working at $-\gamma$, the additional travel distance is until $-x$ (i.e. $2x$), since further from that point it is the equivalent of what he would pay to commute to $\gamma$.

Denoting total utility in H by $U_H(\tau)$ we have:

$$U_H(\tau) = \bar{N}\left(\omega_H + v\left(G_H\right) - T\right) - C_H \tag{4}$$

As for $U_L(\tau)$:

$$\begin{aligned} U_L(\tau) &= N_L(\omega_L + v(G_L) - T) + (\bar{N} - N_L)(\omega_H + v(G_L) - T) - C_L \quad (5) \\ &= \bar{N}(\omega_L + v(G_L) - T) - C_H + (\bar{N} - N_L)(\omega_H - \omega_L) - 2c\int_0^{\hat{x}} x dx \end{aligned}$$

with $T$ given by (3). The last two terms represent the gain to L of having some commuters as opposed to having none. Their sum is positive as the wage differential more than pays for the travel costs to all but the marginal ij-commuter.

The first best consists in choosing $\tau$ so as to maximise

$$U_H(\tau) + U_L(\tau)$$

Not surprisingly distortive taxation is not used:

$$\tau^o = 0$$

where the $o$ superscript is used for the first best.[10]

Therefore the optimal marginal ij-commuter $\hat{x}^o$ is given by:

$$\hat{x}^o = \frac{\alpha_H - \alpha_L}{2c} \geq 0$$

As long as $\alpha_H > \alpha_L$, it is optimal to have some commuting in equilibrium, more so (i) the lower is $c$, (ii) the higher is the productivity difference.

This is a commuting equilibrium if and only if $\hat{x}^o \leq \gamma$. We will use this assumption throughout the paper. Besides imposing a sufficiently peripheral employment centre or a maximum productivity advantage of H, it may be seen as imposing a minimum travel cost.

# 4 Tax Competition

In this section, we devolve fiscal power to each of the jurisdictions. We will solve for a Nash equilibrium in tax rates under both utilitarian and democratically elected local governments. We then proceed to welfare comparisons between the different types of tax competition equilibrium and the first best. We show that jurisdiction H is always a net gainer from tax competition, whereas jurisdiction L is always a looser. However, the median

[10] We show in the Appendix that the second order conditions for a maximum are satisfied.

voter of jurisdiction L does gain with tax competition, if the regional asymmetry is not too big. Therefore if local governments are majoritarian there may be a consensus towards tax decentralisation even though it is harmful for one of the regions and wasteful from a global point of view.

We look for equilibria with ij-commuting from L to H, i.e., $\hat{x} > 0$. We show later that none of the decision rules adopted for jurisdictions can produce an equilibrium with $\hat{x} < 0$.

## 4.1 Utilitarian Governments

We begin by looking at the tax competition equilibrium when local decisions are taken by an utilitarian jurisdiction-level government. In H, there is a benevolent utility maximiser planner who chooses $\tau_H$ so as to maximise $U_H(\tau)$ as given by (4). Analogously, in L the local planner maximises $U_L(\tau)$ as given by (5), through its choice of $\tau_L$. We derive Nash equilibrium tax rates $\tau^U$ of this game to which we refer to as *utilitarian tax equilibrium.* Associated with the utilitarian tax equilibrium there is a commuting equilibrium in the second stage of the game.

As usual in models with factor mobility at equilibrium, we obtain that tax exporting leads jurisdiction H to tax its work force. However, contrary to the usual result for the jurisdiction exporting the production factor, L will not use its labour tax at the Nash equilibrium of this game. That is what the following proposition tells us:

**Proposition 1** *If each jurisdiction is run by a benevolent planner, then a unique tax equilibrium exists. Jurisdiction L does not tax nor subsidise wages, while jurisdiction H taxes wages. Inter-jurisdictional commuting is reduced as compared to the first best.*

**Proof** Special case of Proposition 1' in the Appendix.□

In what concerns H, we may decompose the effect of the wage tax into three sub-components. The first relates to the net income of individuals: the pocket wage received by H residents decreases. The two others concern the residence tax: on the one hand, it decreases thanks to the higher wage tax and on the other hand there are less workers in the jurisdiction, meaning a lower $T_H$ if the $\tau_H$ is positive and a higher one if $\tau_H$ is negative (i.e., a wage subsidy).

The sum of the two first effects is given by:

$$-\alpha_H \left(\bar{N} - N_H\right)$$

which is positive if and only if H imports labour, i.e., if ij-commuters go from L to H in equilibrium. Indeed, if there are some non-residents paying the wage tax, the positive impact on the government budget constraint more than compensates for the wage loss of residents.

If we now add up the third effect, we get:

$$-\alpha_H \left(\bar{N} - N_H\right) - \frac{\alpha_H^2}{2c}\tau_H \tag{6}$$

hence the reaction function is given by the implicit relationship:

$$\tau_H^U = 2c\frac{N_H\left(\tau_H^U, \tau_L^U\right) - \bar{N}}{\alpha_H} = \frac{2c\hat{x}\left(\tau_H^U, \tau_L^U\right)}{\alpha_H} \geq 0$$

where the $U$ superscript is used to refer to the utilitarian local governments' choice. Were H to subsidise labour, the marginal effect of the wage tax (6) would be positive and, therefore, H would go on increasing the tax until it eventually turned positive. By taxing labour, a part of the public budget is born by non-residents, thereby benefiting the residents whose utility the planner is maximising. The result that jurisdiction H taxes its labour force is usual in tax competition games where a region imports some production factor.

We now look at L. A standard result in models where some production factor is exported is the exporting region subsidising it. That does not happen in our setting, however. Besides the three effects it has for H, the wage tax has two additional ones on L's utility, referring to the two last terms in (5). Firstly, there is an increase in ij-commuting since $\omega_L$ decreases: this entails a positive part since this marginal ij-commuter gains a higher net wage at H but also a negative one since he must bear higher commuting costs. Secondly, the non-marginal ij-commuters, who work in H anyway independently of the tax increase, now do it for a higher wage difference: this is a positive effect. Since the marginal ij-commuter exactly offsets his wage gain with the commuting costs he bears to work at $-\gamma$, the first effect is nil.[11] Therefore we must add a positive term, namely, the increased wage advantage of the non-marginal commuters:

$$-\frac{d\omega_L}{d\tau_L}\left(\bar{N} - N_L\right) > 0$$

to the three effects discussed for H to get the first order condition:

$$\frac{d\omega_L}{d\tau_L}\left(\left(\bar{N} - N_L\right) - \left(\bar{N} - N_L\right)\right) = 0$$

[11] See the Appendix for analytical expressions.

We thus obtain that the decrease in $w_L$ has no effect whatsoever on utility and therefore the jurisdiction has no incentive to use the wage tax: $\tau_L^U = 0$.

This outcome is not surprising in that exactly the same workers contributing to the budget constraint are getting a wage loss. In H, the same happens with the important difference that only a fraction of the people getting the wage loss actually counts for the planner, therefore the overall effect is positive.

Earlier contributions to the literature (e.g. DePater and Myers (1994) and Peralta and van Ypersele(2002)) obtain the exporting region subsidising the production factor, provided that it can manipulate the terms of trade. This is not the case here. L has no instrument to manipulate the pocket wage earned by its residents who work in H ($\omega_H$). In fact, the combination of imperfect mobility of labour and fixed gross wages (remember this is the consequence of price-taking in world capital markets in a framework with capital), create segmented labour markets.

Given that wages are taxed in the importing jurisdiction, it becomes less beneficial for people to work there and therefore ij-commuting is under-optimal at the utilitarian tax competition equilibrium, namely, it is reduced by half. To see this, note that

$$\hat{x}^U = \frac{\alpha_H \left(1 - \frac{2c\hat{x}^U}{\alpha_H}\right) - \alpha_L}{2c} = \hat{x}^o - \hat{x}^U$$

yielding $\hat{x}^U = \hat{x}^o/2$. It is then possible to solve for the equilibrium tax of H: $\tau_H = (\alpha_H - \alpha_L)/(2\alpha_H) < 1$.

We now look at the issue of the welfare effects of decentralisation. As the following proposition shows, H benefits from tax competition whereas L looses from it, when compared to the first best.

**Proposition 2** *When tax decisions are decentralised to utilitarian local governments, welfare increases in jurisdiction H, but decreases in jurisdiction L. Furthermore, total welfare in the city decreases.*

**Proof** Special case of Proposition 2' in the Appendix.□

H residents have a welfare gain because they can export taxes. They are able to finance the public budget partly from taxing the other jurisdiction's residents, which is not the case in the first best.

As regards L, commuters at first best (to the right of $\hat{x}^o$) are indifferent between the first best and the utilitarian tax equilibrium: they get the same net wage and pay the same head-tax. All the other L residents loose with decentralisation. The ij-commuters at both equilibria (to the left of $\hat{x}^U$) because they get a lower net wage at H and the ones between $\hat{x}^U$ and $\hat{x}^o$ because they work at the more efficient jurisdiction at the first best and do not at the utilitarian tax equilibrium, thereby getting a lower wage. Of course they also bear lower commuting costs, but they ij-commute at the first best only because the wage difference pays for the higher commuting costs.

Other types of asymmetric tax competition models (like Bucovetsky (1991), Wilson (1991)) do obtain that, under some conditions, some regions gain from tax competition despite its overall inefficiency. We obtain a similar result here, though with a different type of asymmetry: *the jurisdiction with a productive advantage imports labour, though less at the tax equilibrium equilibrium than at the first best. Nevertheless, it can tax it with decentralisation, thus alleviating its residents from a part of the tax burden of the public budget.*

### 4.2 Majority voting

We now suppose that there is a majoritarian government in each jurisdiction that decides tax levels. The majority election outcome corresponds to the preferred policy of the median resident.

Before proceeding with the analysis, three important remarks are in order. The first pertains to the application of the median voter theorem in our setting. As it will become clear, the wage tax choice is independent of the precise location of a given individual inside his jurisdiction: it only depends on where he works. Therefore, in each jurisdiction, all the ij-commuters have the same preferred tax level and all the non ij-commuters also share a given preferred tax level. The majority group is by definition the one to which the median voter belongs. This brings us to the second remark. The nature of tax competition depends on whether the L median voter commutes to work at $\gamma$ or rather at $-\gamma$. In this latter case, he is an ij-commuter and his choice of his own jurisdiction's wage tax does not affect the pocket wage he receives in the other jurisdiction. Finally, note that the median voter, if working in H, chooses the tax that maximises his utility in that situation; similarly, he chooses the utility maximising tax in case he works in L. But the outcome of the tax competition game will depend on which of the situations he prefers, i.e., if the maximum utility he may attain by working in H is higher or lower than the one he attains by working in L.

We will solve for an equilibrium which we call *majoritarian tax equilibrium.* Let the superscript $mLL$ denote the Nash equilibrium tax choices when $m_L$ works in L and analogously for $mLH$. We use the term tax configurations to refer to $\tau^{mLL}$ and $\tau^{mLH}$. Then $\tau^{mLL}$ is a majoritarian tax equilibrium if the two following conditions are satisfied:

**C1:** $U_{LL}(m_L; \tau^{mLL}) > U_{LH}(m_L; \tau^{mLL})$, that is, given $\tau_L^{mLL}$ and $\tau_H^{mLL}$,$m_L$ prefers to work in L;

**C2:** $U_{LL}(m_L; \tau^{mLL}) > U_{LH}(m_L; \tau^{mLH})$, that is, a rephrasing of the third remark above.

Analogous conditions must be respected for $\tau^{mLH}$ to be the majoritarian tax equilibrium.

In order to simplify the exposition, we begin by putting aside C2. Suppose that $m_L$ is myopic, in the sense that when considering where to work he does not take into account that the set of equilibrium tax rates changes if he changes workplace. We have the two following lemmas:

**Lemma 1** *If each jurisdiction is run by a majoritarian government and $m_L$ works in H then a unique Nash equilibrium in tax rates exists. At the equilibrium tax rates, $m_L$ prefers to work in H if and only if he works in H at the first best (i.e. $\hat{x}^o > m_L$). Wages are taxed both in H and in L. Moreover, ij-commuting is reduced as compared to the its first best value.*

**Proof** Special case of Lemma 1' in the Appendix.□

**Lemma 2** *If each jurisdiction is run by a majoritarian government and $m_L$ works in L then a unique Nash equilibrium in tax rates exists. At the equilibrium tax rates, $m_L$ always prefers to work in L. Wages are taxed in H and subsidised in L. Moreover, ij-commuting is reduced as compared to its first best value.*

**Proof** Special case of Lemma 2' in the Appendix.□

The median voter in H taxes labour to spread the public budget funding over to other H workers, be them residents of H or of L. The same expression as in the case in which the local planner decides tax levels is obtained here for H's reaction function:

$$\tau_H^{mLi} = 2c\frac{\hat{x}(\tau_H^{mLi}, \tau_L^{mLi})}{\alpha_H} \geq 0, \text{ for } i = H, L$$

As regards $m_L$, when he does not work in L his pocket wage is unaffected by his choice of $\tau_L$ and he is only concerned by its effect on the residence tax. The median voter just chooses the level of the wage tax that maximises government revenue from this tax. In so doing, he decreases his own contribution to the public budget, equal to $T_L$. Not surprisingly, a positive level of $\tau_L$ does the job:

$$\tau_L^{mLH} = 2c\frac{N_L(\tau_H^{mLH}, \tau_L^{mLH})}{\alpha_L} = 2c\frac{1/2 - \hat{x}(\tau_H^{mLH}, \tau_L^{mLH})}{\alpha_L} \geq 0$$

On the other hand, when he works in L his pocket wage does vary with the wage tax he sets. We then have the same three effects as the ones discussed for the local planner at H. The sum of the first two effects amounts to:

$$-\frac{d\omega_L}{d\tau_L}\left(-1 + \frac{N_L}{\bar{N}}\right)$$

where the first term is the decrease in the pocket wage and the second term is the decrease in the residence tax. As L exports labour, only $N_L < \bar{N}$ workers pay wage taxes and therefore the positive impact of the wage tax is outweighed by the negative one. It is therefore not optimal for $m_L$ to tax labour (put otherwise, the third effect must be positive at the optimum) and we have:

$$\tau_L^{mLL} = 2c\frac{N_L(\tau_H^{mLL}, \tau_L^{mLL}) - \bar{N}}{\alpha_L} = -2c\frac{\hat{x}(\tau_H^{mLL}, \tau_L^{mLL})}{\alpha_L} \leq 0$$

Given the linearity of reaction functions, it is straightforward to solve for equilibrium taxes:

$$\tau_H^{mLH} = \frac{c + (\alpha_H - \alpha_L)}{3\alpha_H}, \qquad \tau_L^{mLH} = \frac{2c - (\alpha_H - \alpha_L)}{3\alpha_L}$$
$$\tau_H^{mLL} = \frac{\alpha_H - \alpha_L}{3\alpha_H}, \qquad \tau_L^{mLL} = -\frac{\alpha_H - \alpha_L}{3\alpha_L}$$

The marginal ij-commuter is given by:

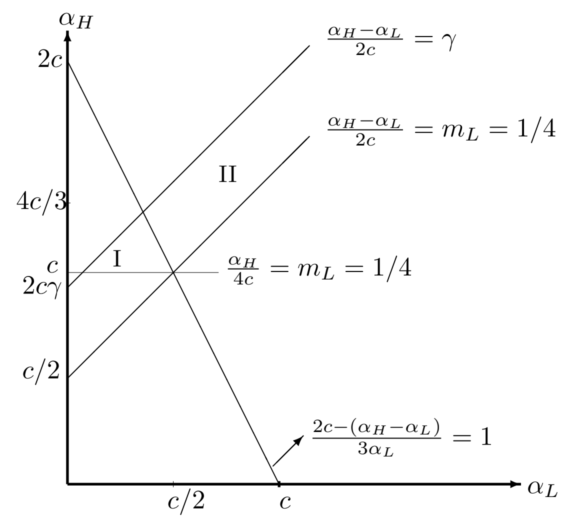
$$\hat{x}^{mLL} = \frac{\hat{x}^o}{3}$$

in case $m_L$ works in L and

$$\hat{x}^{mLH} = \frac{\hat{x}^o}{3} + \frac{1}{6}$$

when $m_L$ works in H.

Figure 2: Tax configurations




Configurations $mLL$ and $U$ exist everywhere below $\frac{\alpha_H-\alpha_L}{2c} = \gamma$

Region I: configuration $mLH$ exists with $\tau_H^{mLH} = 1$

Region II: configuration $mLH$ exists with $\tau_L^{mLH} < 1$

We now check condition C1 for the existence of a majoritarian tax equilibrium. As regards $\hat{x}^{mLL}$, we have to check that $U_{LL}\left(m_L;\tau^{mLL}\right) > U_{LH}\left(m_L;\tau^{mLL}\right)$ or, what amounts to the same, $\hat{x}^{mLL} < m_L$, which happens if $\hat{x}^o < 3/4$, therefore, it is always true (remember the city ends at $x = 1/2$). Analogously, we must have $\hat{x}^{mLH} > m_L$ which is true if $\hat{x}^o > 1/4$, that is, if $m_L$ commutes at the first best. Inter-jurisdictional commuting is reduced as compared to the first best: $\hat{x}^{mLH} < \hat{x}^o$ when $\hat{x}^o > 1/4$.

As regards equilibrium tax rates, we have to make sure that they are not higher than 1. That is trivially the case for $\tau_i^{mLL}$. As for the $mLH$ tax configuration, note that $\hat{x}^o > 1/4 \Leftrightarrow \alpha_H - \alpha_L > c/2$ or $c < 2(\alpha_H - \alpha_L)$ from which we obtain that $\tau_H^{mLH} < 1$. Regarding $\tau_L^{mLH}$, it is greater than unity when $2c - \alpha_H + \alpha_L > 3\alpha_L$. In that case, $\tau_L^{mLH} = 1$ and $\hat{x}^{mLH} = \alpha_H(1 - \tau_H)/2c$. Going back to H's reaction function we obtain $\tau_H = 1/2$. Therefore $\hat{x}^{mLH} = \alpha_H/4c$ and this can only be an equilibrium if $\alpha_H/4c > m_L$, or $\alpha_H > c$. Figure 2 shows the parameter regions where each type of possible tax configuration exists.

We now let $m_L$ decide his workplace, taking into account the fact that he may change the prevailing taxes accordingly, i.e., we tackle condition C2 for the existence of a majoritarian tax equilibrium. In what follows, we will often use $U_{LL}^{mLL}$ as shorthand for $U_{LL}(m_L;\tau^{mLL})$ and analogously for $U_{LH}^{mLH}$.

**Proposition 3** *If local governments are majoritarian, then there is a unique tax equilibrium. Wages are taxed at H and subsidised at L. Moreover, ij-commuting decreases as compared to its first best value.*

**Proof** From Proposition 3' in the Appendix, note that the case $\hat{x}^o > m_L + (2n(m_L))^{-1} = 3/4$ is impossible. We either have $\hat{x}^o < m_L$ and equilibrium is $U_{LL}^{mLL}$ or $\hat{x}^o > m_L$ and then we must compute $U_{LL}^{mLL} - U_{LH}^{mLH}$ which simple algebra shows to be equal to

$$\frac{2c}{18}\left(\frac{7}{2} - 4\hat{x}^o\right) > 0$$

when $\tau_L^{mLH} < 1$ and

$$\frac{9c(c-\alpha_H) + (2\alpha_H + \alpha_L)(\alpha_H + 2\alpha_L)}{18c}$$

when $\tau_L^{mLH} = 1$, which is also positive for any $\alpha_H \in [c, 4c/3]$. $\square$

Therefore, in the majoritarian tax equilibrium, $m_L$ works in his own jurisdiction.[12] When $\hat{x}^o < m_L$ that is the only possible outcome since C1 is not respected when $m_L$ works in H. When $\hat{x}^o > m_L$, i.e., $m_L$ prefers to work in the more productive jurisdiction in the absence of distortive taxation, then he chooses to work in the less productive one in the tax competition equilibrium. This is true irrespective of the gross wage difference $\alpha_H - \alpha_L$. By working in L instead of H, $m_L$ has a clear gain: while his wage is taxed at H, it is subsidised at L. But this advantage comes at a cost. On the one hand, since he ij-commutes at the first best, his gross wage net of commuting costs is lower. On the other hand, the head tax is higher when $m_L$ works in L. In fact, in addition to the public budget, it must cover the subsidy that is paid to all L workers; on the contrary, when $m_L$ works in H, there is a wage tax at L, which partly covers the public budget, decreasing the head tax. We obtain that the positive effect outweighs the two negative ones and $m_L$ will rather work in his own jurisdiction. Put otherwise, the distortion caused by both taxes in net wages is very high.

Tax competition in inefficient: overall welfare is lower under the majoritarian tax competition than at the first best. The welfare loss in L more than compensates for the gain in H.[13] The inefficiency is due to the shrunk ij-commuting.

[12]Under a generic density function, it may be the case that the $mLH$ tax configuration is the majoritarian tax equilibrium

[13]See Lemmas 3' and 4' in the Appendix.

This model displays not only asymmetry between jurisdictions as citizens of each jurisdiction are also asymmetric among them. The median voter of jurisdiction H will always prefer tax decentralisation. An interesting result of our analysis is that the median voter of the loosing jurisdiction may under some circumstances attain a higher utility in the majoritarian tax equilibrium, as compared to the first best. Majority elected governments may then unanimously approve decentralisation even if this latter is an obvious loss to one of the jurisdictions (and a loss to the city as a whole). There can be a majority of city residents (all the H residents plus more than one half of L residents) that are better off at an inefficient equilibrium than at the first best.

**Proposition 4** *If local governments are majoritarian, then they prefer tax decentralisation to the first best when inter-jurisdictional commuting at the first best is not too large. Moreover, under the majoritarian tax equilibrium, welfare in the city is lower than at the first best. Jurisdiction H is a net gainer from decentralisation whereas jurisdiction L is a net loser.*

**Proof** Special case of Proposition 4' (first part of proposition) and Lemmas 3' and 4' (second part) in the Appendix. We compute here the actual threshold of $\hat{x}^o$ below which tax decentralisation is preferred to the first best. From Proposition 3', it is always the case that $U_{LL}^{mLL} > U_{LL}^o$ (when $\hat{x}^o < m_L$). For $\hat{x}^o > m_L$ we have to compute

$$U_{LL}^{mLL} - U_{LH}^o = \frac{-9c^2 + 18c(\alpha_H - \alpha_L) - 2(\alpha_H - \alpha_L)^2}{18c}$$

which is negative for $(\alpha_H - \alpha_L)/2c > (9 - 3\sqrt{7})/4 \simeq 0,27$ □

The welfare improvement is not just a result of decentralisation. Rather, it depends on the *type of decentralisation* at hand. While $m_H$ improves his welfare even with the utilitarian tax equilibrium, the same is not true of $m_L$, who always prefers the first best to a utilitarian government. Remember that $\tau_L^U = 0$, therefore $T_L^U = T_L^o$. When $m_L$ works in L at both the first best and the utilitarian tax equilibrium he is indifferent between both. If he ij-commutes under both equilibria, then he looses with decentralisation since he now pays a wage tax at H. Finally, if he works in H under the first best but not at the utilitarian tax equilibrium, then $U_{LL}\left(m_L;\tau^U\right) = U_{LL}\left(m_L;\tau^o\right) < U_{LH}\left(m_L;\tau^o\right)$ and again he is worse off when local planners set tax rates.

The fact that $m_L$ improves his situation by becoming the decisive voter, as opposed to the context in which the planner decides, is not surprising.

The median voter can do at least as well as the planner by mimicking its decision. The interesting result is that $m_L$ improves his situation to the point of preferring the inefficient tax competition equilibrium to the first best situation.

The median voter of H is better off under tax competition because he manages to pay less head tax, since a positive wage tax is born by all workers at H. Regarding $m_L$, he works in L and gets a wage subsidy, creating a deficit in government revenue and paying a higher head tax in order to cover the public budget. As there are less workers getting the subsidy than residents paying the head tax, the head tax increase is less than the subsidy. Hence, all L residents who work in L gain with tax decentralisation. Ij-commuters partly fund, through the head tax, the subsidy that the majority of their fellow residents get by working in L. Therefore, when $m_L$ works in his own jurisdiction anyway, he always gains with tax decentralisation. However, if he ij-commutes at the first best, he gets a lower gross wage at the majoritarian tax equilibrium. If this gross wage difference is very high, $m_L$ looses with tax competition.

### 4.3 Inter-jurisdictional commuting and tax competition inefficiency

In all types of tax competition equilibria we analyse the amount of ij-commuting is less than optimal. As usual in tax competition models, strategic use of local distortive taxation hampers factor mobility. It is interesting to notice however that this inefficiency is somewhat constrained in that commuting will always go in the good way. That is, tax competition is never so bad as to cause commuters to go from the more to the less productive jurisdiction. Nor with utilitarian neither with majoritarian local governments can we have $\hat{x} < 0$ at equilibrium. The following proposition addresses this issue.

**Proposition 5** *There exists no tax equilibrium such that jurisdiction H residents work in jurisdiction L.*

**Proof** Special case of Proposition 5' in the Appendix.□

The intuition for this result is simple: since the jurisdiction with in-commuters wants to tax wages under any form of local government, if this jurisdiction is also the less productive one then it cannot be attractive to ij-commuters.

We now compare the inefficiency resulting from the three possible tax configurations. The fact that less people work in more productive jobs is a social cost: the more ij-commuting departs from its first best value, the more inefficient is tax competition.[14] We have $\hat{x}^{mLH} > \hat{x}^{U} > \hat{x}^{mLL}$. This ranking corresponds to the weight ij-commuters have on the objective function. In the case where the median voter decides and he works in H, the ij-commuters' point of view is the only one taken into account. When he does not, this point of view is not taken into account at all. The local planner, in turn, weighs both the inter-jurisdictional and intra-jurisdictional commuters' utilities and gets to an intermediate situation. Given that under a majoritarian tax equilibrium the median voter will never ij-commute, the utilitarian tax equilibrium is less distortive. This leads us to the following somewhat paradoxical conclusion: majoritarian support for tax competition, when it exists, always comes from the more distortive form of local government. *It is precisely when tax competition is more costly for the city residents as a whole that it is preferred to the first best by a majority of those citizens.*

# 5 Extensions and Conclusion

## 5.1 Possible extensions

Our results are robust to changing the assumptions in a number of directions. For one thing, as previously discussed, introducing capital would not change the results, nor qualitatively neither quantitatively. The results also hold under different assumptions about the distribution of residents, as shown in the Appendix. Also, given that a lump-sum tax is available, the public budget can be made endogenous without changing any of our results.

As regards the type of local taxation we consider, its important feature is twofold: as regards H, it must be exportable to non-resident workers, and as regards L, it must allow discrimination of the fiscal burden between intra-jurisdictional and inter-jurisdictional commuters. Indeed, H imposes a wage tax on L residents who ij-commute, thereby alleviating the fiscal charge of the residence tax. The majority of L residents, who work in L, offer themselves a wage subsidy to be payed by a higher residence tax born by all L residents, including those who work in H. Any local tax rate featuring the two characteristics is likely to yield results which are similar in taste, i.e., for some parameter constellations we would expect to have a majority in each of the jurisdictions preferring the inefficient situation to the first best. Local wage tax is just the fiscal instrument that best fits the two properties.

[14] For the analytical result, see the Appendix (Lemma 4').

Any tax falling on local firms (value added, firm or property) is partly born by production factors and falls into this category. One may also think that some pricing schemes of local amenities would yield this type of result (e.g. amenities used by local workers in L partially subsidised by revenues from the residence tax, or amenities used by ij-commuters in H priced above their cost).

Another important assumption of our analysis is that residence is given. As we know from previous literature, mixing residence choice with majority voting equilibria is quite problematic when it comes to equilibrium existence. Caplin and Nalebuff (1997) are able to derive some general conditions for equilibrium existence, supposing, however, that individuals do not anticipate whether they become pivotal when joining a club.

In our setting, moreover, introducing residence choice is likely not to change our results a great deal. There is increasing evidence that individuals choose residence based on other factors than closeness to work place (see e.g. Rouwendal and Meijer, (2001) and Glaeser et al. (2000)). If we accept this hypothesis, then individuals live where they do because amenities or housing characteristics have led them to do so and the workplace decision is essentially independent from the resident location. If, on the other hand, the usual rent gradient holds in our setting, then living in L is less expensive than living in H and there would still be inter-jurisdictional commuters living in L and working in H. We should not expect people to move residence to relocate closer to a job belonging to the same region, i.e., neighbouring jurisdictions. This has been shown theoretically by Zax (1994), who supposes (realistically) that changing residence and changing job are both costly and when cheap commuting is an alternative (i.e. when the job is close to the residence) we should have "residential locations often unaccompanied by workplace relocations, and vice-versa". Empirical studies confirm this hypothesis, i.e. Zax (1991) shows that after relocation of a company in the Detroit metropolitan area, most employees who quit did not move residence and the other way around. After controlling for a number of relevant individual covariates, the estimated value of the correlation coefficient between quits and moves is negative and significant. Related empirical evidence shows that commuting is very much used as a substitute for migration. Renkow and Hoover (2000) show that out-commuting from non-urban counties to urban counties depends positively on recent migration to non-urban counties. So et al. (2001) obtain an elasticity of in-commuting to wages higher that the one relating immigration to wages. Both So et al. (2001) and Cameron and Muellbauer (1998) show that increasing housing prices increases in-commuting. So et al (2001) conclude: "Nonmetropolitan residents trade-off lower housing costs for lower wages in the local labour market. Those that opt to commute to urban markets trade-off higher wages for the disamenity of commuting time".

## 5.2 Conclusion

This paper studies tax competition when the place of residence of individuals does not necessarily coincide with their workplace and they pay taxes in both of them. Tax decentralisation is inefficient in that it decreases total welfare as compared to the first best: one of the jurisdictions gains from it but the other one's loss more than compensates for that gain. Hence, if local governments are utilitarian, one of them will prefer the first best to the utilitarian tax equilibrium. However, if local governments are majoritarian, they may unanimously approve tax decentralisation, i.e., a majority of voters in each jurisdiction may be better off under the majoritarian tax equilibrium than at the first best. Majoritarian local governments will also differ from utilitarian ones in their tax choices. While the more productive jurisdiction taxes wages anyway, the less productive one will not use the distortive tax under an utilitarian government, whereas it may either tax it or subsidise it under a majoritarian one.

We show that inter-jurisdictional commuting never attains its first best value under tax competition: it is always lower. The strategic use of the wage tax by local governments distorts net wages and hence commuting decisions. However, this distortion is never so high as to invert the sense of ij-commuting: people always ij-commute from the less to the more productive jurisdiction, only to a less extent than at the first best. The more ij-commuting decreases, the higher the welfare loss of tax competition. The local government form that will prefer tax competition to the first best is precisely the one whose tax choices are more costly from the overall welfare viewpoint.

The main contribution of our paper is to give one reason for the growing decentralisation of decision making. In so doing, it calls our attention to a number of important features. On the one hand, the choice of the regional objective function is not innocuous in the analysis of tax competition. On the other hand, the model pinpoints the importance of allowing for asymmetry along different axis: both inter-jurisdictional as intra-jurisdictional. Then, we may have loosing and winning jurisdictions as much as loosing and winning citizens within each jurisdiction. Hence, the welfare effects of tax competition are not trivial. All our results hold even for the case of a very slight inter-jurisdictional asymmetry, i.e. $\alpha_H = \alpha_L + \epsilon$. If instead we let

$\alpha_H = \alpha_L$, then our results change in that the wage tax will never be used and tax competition will not be wasteful nor will it affect median voter's welfare. Therefore, in the analysis of tax competition issues, the symmetry assumption is a restrictive one.

# Appendices

## A1 : General density function: reaction functions and second order conditions

In this Appendix we treat the case of a non-uniform symmetric density function. In order to do so, we assume the strategy set to be $\tau_i \in [\underline{\tau}_i, 1]$ and we introduce the following assumption:

**Assumption 1**

$$\max\left\{\frac{n'(x)}{n(x)^2}(N(x)-1), \frac{n'(x)}{n(x)^2}(N(x)-1/2)\right\} < 1 \quad \textit{and} \quad n(x)>0,$$
$$\forall x \in \left[0, \frac{\alpha_H - \alpha_L}{2c}\right]$$

The assumption is trivially verified by the uniform density since $n'(x) = 0$ in that case. Piece-wise linear densities also respect it with suitably chosen parameters. In particular, a triangular or inverted triangular as much as a bi-modal (i.e. a triangular density for H residents and a symmetric one for L ones) do the job.

### A1.1 : $U_{HH}(m_H;\tau)$, $U_{LL}(m_L;\tau)$ and $U_H(\tau)$

Maximisation of $U_{HH}(m_H;\tau)$ is formally equivalent to $U_{LL}(m_L;\tau)$ and also (up to a multiplicative constant) to $U_H(\tau)$. We derive reaction functions and check quasi-concavity of $U_{LL}(m_L;\tau)$, which to simplify we refer to as $U_{LL}$. The maximisation problem is:

$$\max_{\tau_L} U_{LL}(m_L;\tau) = \alpha_L(1-\tau_L) + v(G_L) - \frac{G_L - \alpha_L \tau_L N_L}{\bar{N}}$$

Reaction functions are obtained from the first order condition:

$$\frac{dU_{LL}}{d\tau_L} = \alpha_L\left(-1 + \frac{N_L}{\bar{N}}\right) - \alpha_L^2 \tau_L \frac{n(\hat{x})}{\bar{N}2c} = 0 \tag{7}$$

$$\Leftrightarrow \tau_L = 2c\frac{N_L - \bar{N}}{\alpha_L n(\hat{x})} = 2c\frac{1/2 - N(\hat{x})}{\alpha_L n(\hat{x})} \tag{8}$$

Regarding H we have an analogous reaction function:

$$\tau_H = 2c\frac{N_H - \bar{N}}{\alpha_H n\left(\hat{x}\right)} = 2c\frac{N(\hat{x}) - 1/2}{\alpha_H n\left(\hat{x}\right)} \tag{9}$$

The second order derivative is

$$\frac{d^2 U_{LL}}{d\tau_L^2} = -\frac{\alpha_L^2}{4c^2\bar{N}}\left(4cn(\hat{x}) + \alpha_L \tau_L n'(\hat{x})\right) \tag{10}$$

We now prove quasi-concavity by showing that *(i)* (7) is positive at $\underline{\tau}_L$ and negative at $\tau_L = 1$ and *(ii)* for all $\tau_L$ such that (7) $= 0$ we have that (10) $< 0$ (i.e. (7) changes sign only once). To have *(i)*, we may suitably chose $\underline{\tau}_L$ such that (7) $> 0$ with $\tau_L = \underline{\tau}_L$. Since $\bar{N} - N_L$ is at most equal to $1/2$, it suffices to let $\underline{\tau}_L < -\frac{c}{\min_x\{n(x)\}\alpha_L}$. When $\tau_L = 1$ we have that $\hat{x} = \alpha_H(1-\tau_H)/2c > 0$ therefore $\bar{N} - N_L > 0$ and (7) $< 0$. Evaluating (10) with $\tau_L$ given by (8) we obtain:

$$\frac{\alpha_L^2 n(\hat{x})}{c}\left(-2 + \left(N(\hat{x}) - 1\right)\frac{n'(\hat{x})}{n(\hat{x})}\right)$$

which is negative under Assumption 1.

### A1.2 : $U_{LH}(m_L;\tau)$

The problem of the $m_L$ individual working in H is:

$$\max_{\tau_L} U_{LH}(m_L;\tau) = \alpha_H(1-\tau_H) + v(G_L) - \frac{G_L - \alpha_L \tau_L N_L}{\bar{N}}$$

with the first order condition

$$\frac{dU_{LL}}{d\tau_L} = \frac{1}{\bar{N}}\left(\alpha_L N_L - \alpha_L^2 \tau_L \frac{n\left(\hat{x}\right)}{2c}\right) = 0 \tag{11}$$

$$\Leftrightarrow \tau_L = 2c\frac{N_L}{\alpha_L n\left(\hat{x}\right)} = 2c\frac{1 - N(\hat{x})}{\alpha_L n\left(\hat{x}\right)} \tag{12}$$

If $2cN_L - n(\hat{x})\alpha_L$ (i.e. (11) with $\tau_L = 1$) is negative, it suffices to take $\underline{\tau}_L < 0$. Since $N_L$ is non-negative, we then have that (11) evaluated at $\underline{\tau}_L$ is positive. The second derivative is the same as in the $U_{LL}$ case. Evaluated at the best reply, it gives

$$-\frac{\alpha_L^2}{2c\bar{N}} n(\hat{x})\left(2 - \left(N(\hat{x}) - 1\right)\frac{n'(\hat{x})}{n(\hat{x})}\right)$$

which is negative under Assumption 1. When $2cN_L - n(\hat{x})\alpha_L > 0$, $U_{LH}$ is increasing for all $\tau_L \leq 1$ and the best reply is $\tau_L = 1$.

## A1.3 : $U_L(\tau)$

We now look at the maximisation problem of the local planner in jurisdiction L:

$$\max_{\tau_L} U_L(\tau) = \bar{N}\left(\alpha_L\left(1-\tau_L\right) + v(G_L) - \frac{G_L - \alpha_L \tau_L N_L}{\bar{N}}\right) - C_H$$
$$+ \left(\bar{N} - N_L\right)\left(\alpha_H\left(1-\tau_H\right) - \alpha_L\left(1-\tau_L\right)\right) - 2c\int_0^{\hat{x}} xn\left(x\right)dx \quad (13)$$

the first order condition is:

$$\frac{dU_L}{d\tau_L} = \bar{N}\left(-\alpha_L + \frac{1}{\bar{N}}\left(\alpha_L N_L - \alpha_L^2 \tau_L \frac{n\left(\hat{x}\right)}{2c}\right)\right) + \alpha_L\left(\bar{N} - N_L\right) = 0 \quad (14)$$
$$\Leftrightarrow \tau_L = 0 \quad (15)$$

We now check quasi-concavity. Clearly, (14) is positive for negative $\tau_L$ and negative for $\tau_L = 1$. The second order derivative is:

$$\frac{d^2 U_L}{d\tau_L^2} = -\alpha_L^2\left(2cn(\hat{x}) + \alpha_L \tau_L n'(\hat{x})\right)$$

which is negative at $\tau_L = 0$.

## A1.4 : $U_L(\tau) + U_H(\tau)$

The first best is given by maximising

$$U(\tau) = U_H(\tau) + U_L(\tau)$$

as given by (4) and (13) and respecting the budget constraint (3). The FOC is:

$$\frac{dU}{d\tau} = -\frac{(\alpha_H - \alpha_L)^2 \tau n(\hat{x})}{2c} = 0$$

The second derivative is negative when $\tau = 0$:

$$\frac{d^2 U}{d\tau^2} = -\frac{(\alpha_H - \alpha_L)^2}{4c^2}\left(-2cn(\hat{x}) + (\alpha_H - \alpha_L)\tau n'(\hat{x})\right)$$

## A2 : Tax Competition

### A2.1 : Utilitarian Governments

**Proposition 1'** *If each jurisdiction is run by a benevolent planner, then a unique tax equilibrium exists. Jurisdiction L does not tax nor subsidise wages, while jurisdiction H taxes wages. Ij-commuting is reduced as compared to the first best.*

**Proof**

*(i)*Tax choice: see (9) and (15). *(ii)*Existence. Under Assumption 1, payoffs are quasi-concave in own taxes. They are also continuous as long as $\hat{x} > 0$. Moreover, the strategy set is compact and convex. Therefore an equilibrium exists. *(iii)*Uniqueness. Recall $\tau_L^U = 0$ and H's reaction function is given by (9). We only need to show that there is a unique $\tau_H^U$ which is a best reply to $\tau_L^U = 0$. Note that under Assumption 1,

$$\frac{d\tau_H^U}{d\hat{x}^U} = \frac{2c}{\alpha_H} \frac{n(x)^2 - n(x)'(N(x) - 1/2)}{n(x)^2} > 0$$

$\tau_H^U$ being a monotonic function of $\hat{x}$ , it is uniquely determined by $\hat{x}$. Therefore, if we prove that there is a unique $\hat{x}^U$ that comes out of the reaction functions, we are done. We do so below. *(iv)* We now show that the marginal ij-commuter exists, is unique and moreover $0 < \hat{x}^U < \hat{x}^o$.

$$\hat{x}^U = \frac{\alpha_H \left(1 - \tau_H^U\right) - \alpha_L}{2c} = \hat{x}^o - \frac{N\left(\hat{x}^U\right) - 1/2}{n\left(\hat{x}^U\right)} \tag{16}$$

It is clear that $\hat{x}^U > 0$ as otherwise $N\left(\hat{x}^U\right) - 1/2 < 0$ and $\hat{x}^U > \hat{x}^o$, a contradiction. Hence, $N\left(\hat{x}^U\right) - 1/2 > 0$ and $\hat{x}^U < \hat{x}^o$. Now call

$$\beta(x) = \hat{x}^o - \frac{N(x) - 1/2}{n(x)}$$

Under Assumption 1 $\beta(x)$ is continuous and decreasing and $\beta(0) = \hat{x}^o > 0$ and $\beta(\hat{x}^o) < \hat{x}^o$, therefore $x = \beta(x)$ has a unique fixed point on $[0, \hat{x}^o]$.[15] *(v)* We finally show that equilibrium tax rates belong to the strategy space. $\tau_L^U$ is trivial; given that $\hat{x}^U$ exists and is non-negative we have $\alpha_H \left(1 - \tau_H^U\right) \geq \alpha_L \geq 0$ implying $1 - \tau_H^U \geq 0$. As by Assumption 1 $\tau_H^U$ is increasing in $\hat{x}$, we have that $\tau_H^U > 0$ for $\hat{x} > 0$.□

[15] Note that to get existence we only need that $n(x) \neq 0$ and to get uniqueness we actually need $\beta'(x) < 0$ for $x = \hat{x}^U$ and not on the whole domain $[0, \hat{x}^o]$.

**Proposition 2'** *When tax decisions are decentralised to utilitarian local governments, welfare increases in jurisdiction H, but decreases in jurisdiction L. Furthermore, total welfare in the city decreases.*

**Proof** From (2), we have for $i = H, L$

$$T_i^U = T_i^o - \alpha_i \tau_i \frac{N_i}{\bar{N}}$$

Now:

$$\begin{aligned} U_H^o(\tau^o) &= \bar{N}(\alpha_H + v(G_H) - T_H^o) - C_H \\ U_H^U(\tau^U) &= \bar{N}\left(\alpha_H - 2c\frac{N_H^U - \bar{N}}{n(\hat{x}^U)} + v(G_H) - T_H^U\right) - C_H \end{aligned}$$

yielding

$$U_H^o - U_H^U = -2c\frac{\left(N_H^U - \bar{N}\right)^2}{n(\hat{x}^U)} < 0$$

Regarding L, note that:

$$\left(\bar{N} - N_L\right)(\alpha_H(1-\tau_H) - \alpha_L(1-\tau_L)) = 2c\hat{x}\left(\bar{N} - 1 + N(\hat{x})\right) = 2c\hat{x}\left(N(\hat{x}) - \bar{N}\right)$$

therefore we may write utilities as:

$$\begin{aligned} U_L^o(\tau^o) &= \bar{N}(\alpha_L + v(G_L) - T_L^o) \\ &\quad + 2c\left(\hat{x}^o\left(N(\hat{x}^o) - \bar{N}\right) - \int_0^{\hat{x}^o} xn(x)dx\right) - C_H \\ U_L^U\left(\tau^U\right) &= \bar{N}(\alpha_L + v(G_L) - T_L^o) \\ &\quad + 2c\left(\hat{x}^U\left(N\left(\hat{x}^U\right) - \bar{N}\right) - \int_0^{\hat{x}^U} xn(x)dx\right) - C_H \end{aligned}$$

Using the fact that

$$\int xn(x)dx = xN(x) - \int N(x)dx \tag{17}$$

we obtain after manipulation:

$$U_L^o(\tau^o, T^o) - U_L^U\left(\tau^U, T^U\right) = 2c\left(\int_{\hat{x}^U}^{\hat{x}^o} N(x)\,dx - \bar{N}\left(\hat{x}^o - \hat{x}^U\right)\right)$$

$N(x)$ being an increasing function:

$$\int_{\hat{x}^U}^{\hat{x}^o} N(x)\,dx > N(\hat{x}^U)\left(\hat{x}^o - \hat{x}^U\right) > \bar{N}\left(\hat{x}^o - \hat{x}^U\right)$$

hence $U_L^o(\tau^o, T^o) > U_L^U\left(\tau^U, T^U\right)$. Moreover, using (16), the social cost of tax competition amounts to:

$$U_L^o + U_H^o - U_L^U - U_H^U = 2c\left(\int_{\hat{x}^U}^{\hat{x}^o} N(x)\,dx - N\left(\hat{x}^U\right)\left(\hat{x}^o - \hat{x}^U\right)\right) > 0\Box$$

## A2.2 : Majority Voting

Recall conditions C1 and C2 in Section 4.2.

**Lemma 1'** *If each jurisdiction is run by a majoritarian government and $m_L$ works in H then a unique Nash equilibrium in tax rates exists and it satisfies condition 1 if and only if $\hat{x}^o > m_L$. Wages are taxed both in H and in L. Moreover, ij-commuting is reduced as compared to its first best value.*

**Proof** *(i)* Tax choices: see (9) and (12). *(ii)* Existence. Analogous to Proposition 1'. *(iii)* Uniqueness. Recall the reaction functions (9) and (12) and note that under Assumption 1,

$$\begin{aligned}\frac{d\tau_H^{mLH}}{d\hat{x}^{mLH}} &= \frac{2c}{\alpha_H}\frac{n(x)^2 - n(x)'(N(x) - 1/2)}{n(x)^2} > 0\\ \frac{d\tau_L^{mLH}}{d\hat{x}^{mLH}} &= \frac{2c}{\alpha_L}\frac{-n(x)^2 - n(x)'(1 - N(x))}{n(x)^2} < 0\end{aligned}$$

As in the proof of Proposition 1', we only need to show that there is a unique $\hat{x}^{mLH}$ that comes out of the reaction functions. *(iv)* We now show that the marginal ij-commuter exists if and only if $\hat{x} > m_L$, is unique and moreover $0 < \hat{x}^{mLH} < \hat{x}^o$.

$$\hat{x}^{mLH} = \frac{\alpha_H\left(1 - \tau_H^{mLH}\right) - \alpha_L\left(1 - \tau_L^{mLH}\right)}{2c} = \hat{x}^o - 2\frac{N\left(\hat{x}^{mLH}\right) - 3/4}{n\left(\hat{x}^{mLH}\right)}$$

It is clear that $\hat{x}^{mLH} > 0$ as otherwise $N\left(\hat{x}^{mLH}\right) - 3/4 < 0$ and $\hat{x}^{mLH} > \hat{x}^o$, a contradiction. For this to be an equilibrium, we need $\hat{x}^{mLH} > m_L$, or $N\left(\hat{x}^{mLL}\right) - 3/4 > 0$ therefore $\hat{x}^{mLH} < \hat{x}^o$. Now call

$$\beta(x) = \hat{x}^o - 2\frac{N(x) - 3/4}{n(x)}$$

Under Assumption 1 $\beta(x)$ is continuous and decreasing on $[0, \hat{x}^o]$. Two cases are possible:

(a) if $\hat{x}^o > m_L$ then $\beta(m_L) = \hat{x}^o > m_L$ and $\beta(\hat{x}^o) < \hat{x}^o$ and therefore $x = \beta(x)$ has a unique fixed point on $]m_L, \hat{x}^o[$.[16]

(b) if $\hat{x}^o < m_L$ then for all $x > m_L$ we have that $N(x) > 3/4$ therefore $\beta(x) < \hat{x}^o < m_L$ and these cannot be fixed points of $x = \beta(x)$.

*(v)* If $\tau_L^{mLH} < 1$ then the fact that $\hat{x}^{mLH} > 0$ implies that $\tau_H^{mLH} < 1$. Then a similar argument as the one in Proposition 1' shows that tax rates belong to the strategy space. We omit here the case $\tau_L^{mLH} = 1$.[17] *(vi)* We finally show that we may apply the median voter theorem. In what concerns H, it is straightforwardly so as all voters have the same bliss point. Regarding L, all L residents who commute to H have a bliss point $\tau_L^{mLH}$ and all the ones who do not have a bliss point $\tau_L^{mLL}$. If $m_L$ belongs to the set of commuters, $\tau_L^{mLH}$ gets at least one half of the votes whereas $\tau_L^{mLL}$ gets no more than one half. Any $\tau \neq \tau_L^{mLH}$ is trivially beaten by $\tau_L^{mLH}$.□

**Lemma 2'** *If each jurisdiction is run by a majoritarian governments and $m_L$ works in L, then a unique Nash equilibrium in tax rates exists and it respects condition 1 if and only if $\hat{x}^o < m_L + \frac{1}{2n(m_L)}$. Local public goods are optimally provided. Wages are taxed in H and subsidised in L. Moreover, ij-commuting is reduced as compared to its first best value.*

**Proof** *(i)* Tax choices: see (9) and (8). *(ii)* Existence. Analogous to Proposition 1'. *(iii)* Uniqueness. Recall the reaction functions (9) and (8) and note that under Assumption 1

$$\begin{aligned}
\frac{d\tau_H^{mLL}}{d\hat{x}^{mLL}} &= \frac{2c}{\alpha_H} \frac{n(x)^2 - n(x)'(N(x) - 1/2)}{n(x)^2} > 0 \\
\frac{d\tau_L^{mLL}}{d\hat{x}^{mLL}} &= \frac{2c}{\alpha_L} \frac{-n(x)^2 - n(x)'(1 - N(x))}{n(x)^2} < 0
\end{aligned}$$

As in the proof of Proposition 1', we only need to show that there is a unique $\hat{x}^{mLL}$ that comes out of the reaction functions. *(iv)* We now show that the

[16] Note that to get existence we only used the fact that $n(x) \neq 0$ and to get uniqueness you actually need that $\beta'(x) < 0$ for $x = \hat{x}^{mLH}$ only.

[17] In the main text of the paper, we treat that case for the uniform distribution.

marginal ij-commuter exists if and only if $\hat{x} < m_L + \frac{1}{2n(m_L)}$, is unique and moreover $0 < \hat{x}^{mLL} < \hat{x}^o$.

$$\hat{x}^{mLL} = \frac{\alpha_H\left(1-\tau_H^{mLL}\right) - \alpha_L\left(1-\tau_L^{mLL}\right)}{2c} = \hat{x}^o - 2\frac{N\left(\hat{x}^{mLL}\right) - 1/2}{n\left(\hat{x}^{mLL}\right)}$$

It is clear that $\hat{x}^{mLL} > 0$ as otherwise $N\left(\hat{x}^{mLL}\right) - 1/2 < 0$ and $\hat{x}^{mLL} > \hat{x}^o$, a contradiction. With any $\hat{x}^{mLL} > 0$, $N\left(\hat{x}^{mLL}\right) - 1/2 > 0$ and $\hat{x}^{mLL} < \hat{x}^o$. Now call

$$\beta(x) = \hat{x}^o - 2\frac{N(x) - 1/2}{n(x)}$$

Under Assumption 1 it is clear that $\beta(x)$ is continuous and decreasing on $[0, \hat{x}^o]$ and $\beta(0) = \hat{x}^o > 0$ and $\beta(\hat{x}^o) < \hat{x}^o$, therefore $x = \beta(x)$ has a unique fixed point on $[0, \hat{x}^o]$.[18] The only thing left to check is that $m_L$ does not commute: $\hat{x}^{mLL} < m_L$. If $\hat{x}^o < m_L$ then the fact that $\hat{x}^{mLL} \in [0, \hat{x}^o]$ implies that $\hat{x}^{mLL} < m_L$. If $\hat{x}^o > m_L$, then given that $\beta(x)$ is continuous and monotonically decreasing, $\beta(m_L) < m_L$ is necessary and sufficient to guarantee that $\hat{x}^{mLL} < m_L$.

$$\beta(m_L) = \hat{x}^o - 2\frac{3/4 - 1/2}{n(m_L)} = \hat{x}^o - \frac{1}{2n(m_L)}$$

which is smaller than $m_L$ if and only if $\hat{x}^o < m_L + \frac{1}{2n(m_L)}$. *(v)* A similar argument as the one in Proposition 1' shows that tax rates belong to the strategy space. *(vi)* A similar argument as the one in Lemma 1' shows that we may apply the median voter theorem.□

What remains to be determined is which will be the majoritarian tax equilibrium, $\tau^{mLL}$ or $\tau^{mLH}$? Given that $m_H$ will always work in H and have the same reaction function, it boils down to determine what $m_L$ prefers: to commute and tax $\tau_L^{mLH}$ or not commute and tax $\tau_L^{mLL}$, i.e., whether $U_{LH}(m_L;\tau^{mLH})$ is higher or lower than $U_{LL}(m_L;\tau^{mLL})$ (C2). We have the following Proposition:

**Proposition 3'** *When local governments are majoritarian, there is a unique tax equilibrium. If $\hat{x}^o < m_L$, the unique majoritarian tax equilibrium is $\tau^{mLL}$. If $\hat{x}^o > m_L + (2n(m_L))^{-1}$ the unique majoritarian tax equilibrium is $\tau^{mLH}$. For $m_L < \hat{x}^o < m_L + (2n(m_L))^{-1}$, there is a unique majoritarian tax equilibrium. It is $\tau^{mLL}$ if and only if $U_{LL}(m_L;\tau^{mLL}) > U_{LH}(m_L;\tau^{mLH})$ and $\tau^{mLH}$ otherwise.*

[18] Note that to get existence we only used the fact that $(x) \neq 0$ and to get uniqueness you actually need that $\beta'(x) < 0$ for $x = \hat{x}^{mLL}$ only.

**Proof** In what follows, we use $U_{ij}^{mLi}$ as shorthand for $U_{ij}(m_L;\tau^{mLi})$. We begin by the case $\hat{x}^o < m_L$. From Lemma 3, we know that $\hat{x}^{mLH} > m_L \Leftrightarrow U_{LH}^{mLH} > U_{LL}^{mLH}$ if and only if $\hat{x}^o > m_L$. Therefore with $\hat{x}^o < m_L$ we have $U_{LL}^{mLH} > U_{LH}^{mLH}$. Moreover, by definition of a Nash equilibrium, $U_{LL}^{mLL} > U_{LL}^{mLH}$. Therefore $U_{LL}^{mLL} > U_{LL}^{mLH} > U_{LH}^{mLH}$ for $\hat{x}^o < m_L$. We also have to show that $U_{LL}^{mLL} > U_{LH}^{mLL}$. To see this, note that $U_{LL}^{mLL} > U_{LH}^{mLH}$ as proven above and moreover $U_{LH}^{mLH} > U_{LH}^{mLL}$ by definition of a Nash equilibrium. We conclude that $\left(\tau^{mLL}\right)$ is the unique equilibrium for $\hat{x}^o < m_L$.

Take now $\hat{x}^o > m_L + 1/2n(m_L)$. First of all, from Lemma 4, we have that $U_{LH}^{mLL} > U_{LL}^{mLL}$ if and only if $\hat{x}^o > m_L + 1/2n(m_L)$. Moreover, $U_{LH}^{mLH} > U_{LH}^{mLL}$ by the definition of a Nash equilibrium and we obtain $U_{LH}^{mLH} > U_{LH}^{mLL} > U_{LL}^{mLL}$. We also have to show that $U_{LH}^{mLH} > U_{LL}^{mLH}$. By Lemma 3, this is true for $\hat{x}^o > m_L$. We conclude that $\left(\tau^{mLH}\right)$ is the unique equilibrium for $\hat{x}^o > m_L + \frac{1}{2n(m_L)}$.

For intermediate values $m_L < \hat{x}^o < m_L + \frac{1}{2n(m_L)}$ we know that $U_{LH}^{mLH} > U_{LL}^{mLH}$ by Lemma 3 and also that $U_{LL}^{mLL} > U_{LH}^{mLL}$ by Lemma 4. Therefore, an equilibrium exists. Either $U_{LH}^{mLH} > U_{LL}^{mLL}$ and the unique equilibrium is $\tau^{mLH}$ or $U_{LL}^{mLL} > U_{LH}^{mLH}$ and the unique equilibrium is $\tau^{mLL}$. $\square$

**Proposition 4'** *If local governments are majoritarian, then they prefer tax decentralisation to the first best when inter-jurisdictional commuting at the first best is not too large.*

**Proof** Following an analogous procedure as in Proposition 2', we obtain for $m_H$:

$$U_{HH}^{o}\left(m_H\right) - U_{HH}^{mLi}\left(m_{_H}\right) = -2c\frac{1}{\bar{N}}\frac{\left(N_H^{mLi} - \bar{N}\right)^2}{n(\hat{x}^{mLi})} < 0 \text{ for } i = H, L$$

As regards L we have, for $\hat{x}^o > m_L$, that at the decentralised equilibrium $m_L$ may either work in H or in L. Either he works in H and:

$$\begin{aligned} U_{LH}^{o}(m_L) &= \alpha_H + v(G_L) - T_L^o - (\gamma + m_L)\,c \\ U_{LH}^{mLH}\left(m_L\right) &= \alpha_H - 2c\frac{N(\hat{x}^{mLH}) - 1/2}{n(\hat{x}^{mLH})} + v(G_L) - T_L^{mLH} - (\gamma + m_L)\,c \end{aligned}$$

And using (2) and the fact that $N(\hat{x}^{mLH}) \in [3/4, 1]$:

$$U_{LH}^{o}(m_L) - U_{LH}^{mLH}(m_L) = \frac{2c}{n(\hat{x}^{mLH})}\left(-2N(\hat{x}^{mLH})^2 + 5N(\hat{x}^{mLH}) - \frac{3}{2}\right) > 0$$

Or he works in L and

$$U_{LL}^{mLL}\left(m_L\right)=\alpha_L+2c\frac{N(\hat{x}^{mLL})-1/2}{n(\hat{x}^{mLL})}+v(G_L)-T_L^{mLL}-\left(\gamma-m_L\right)c$$

We get

$$\begin{aligned}U_{LH}^{o}(m_L)-U_{LL}^{mLL}(m_L) &= 2c\left(\hat{x}^o-m_L\right)+\frac{2c}{n(\hat{x}^{mLL})}\left(-2N(\hat{x}^{mLL})^2\right.\\ &\quad \left.+2N(\hat{x}^{mLL})-\frac{1}{2}\right) \qquad (18)\end{aligned}$$

Where the second term is negative for $N(\hat{x}^{mLL})\in[1/2,3/4]$. Therefore, when $\hat{x}^o=m_L$, (18) $<0$ and when $\hat{x}^o=m_L+\left(2n(m_L)\right)^{-1}$ we have that $\hat{x}^{mLL}=mL$ and (18) $>0$. Moreover, it is possible to show that under Assumption 1 (18) increases monotonically in $\hat{x}^o$.[19] Call $\tilde{x}$ the value of $\hat{x}^o$ at which (18) $=0$. For $\hat{x}^o<\tilde{x}$ we have $U_{LL}^{mLL}>U_{LH}^{o}>U_{LH}^{mLH}$. For $\hat{x}^o<\tilde{x}$ we have both $U_{LL}^{mLL}<U_{LH}^{o}$ and $U_{LH}^{mLH}<U_{LH}^{o}$ and whatever the tax competition equilibrium utility is, it is lower than the first best one.

When $\hat{x}^o<m_L$ then $m_L$ is not a ij-commuter in the tax competition equilibrium and we have:

$$\begin{aligned}U_{LL}^{o}\left(m_L\right) &= \alpha_L+v\left(G_L\right)-T_L^o-c\left(\gamma-m_L\right)\\ U_{LL}^{mLL}\left(m_L\right) &= \alpha_L-2c\frac{N_L^{mLL}-\bar{N}}{n\left(\hat{x}^{mLL}\right)}+v\left(G_L\right)-T_L^{mLL}-c\left(\gamma-m_L\right)\end{aligned}$$

by using (2):

$$U_{LL}^{o}\left(m_L\right)-U_{LL}^{mLL}(m_L)=-\frac{1}{\bar{N}}2c\frac{\left(N_L^{mLL}-\bar{N}\right)^2}{n\left(\hat{x}^{mLL}\right)}<0\Box$$

**Lemma 3'** *When tax decisions are decentralised to majoritarian local governments, welfare increases in H, but decreases in L.*

**Proof** The welfare difference in H amounts to $\bar{N}$ times the welfare gain of $m_H$ and we have:

$$U_H^o-U_H^{mLi}=-2c\frac{\left(N_H^{mLi}-\bar{N}\right)^2}{n(\hat{x}^{mLi})}<0 \text{ for } i=H,L$$

[19] Assumption 1 guarantees both that $\frac{\partial\hat{x}^{mLL}}{\partial\hat{x}^o}>0$ and $\frac{\partial(14)}{\partial\hat{x}^{mLL}}>0$. Computations available upon request.

As for L we have the first best utility:

$$U_L^o = \bar{N}\left(\alpha_L + v\left(G_L\right) - T_L^o\right) - 2c\left(\hat{x}^o\bar{N} - \int_0^{\hat{x}^o} N(x)dx\right) - C_H$$

In case $m_L$ works in H:

$$\begin{aligned} U_L^{mLH} &= \bar{N}\left(\alpha_L - 2c\frac{N_L^{mLH}}{n(\hat{x}^{mLH})} + v\left(G_L\right) - T_L^o + \frac{N_L^{mLH}}{\bar{N}}\frac{N_L^{mLH}}{n^{mLH}}2c\right) \\ &\quad -2c\left(\hat{x}^{mLH}\bar{N} - \int_0^{\hat{x}^{mLH}} N(x)dx\right) - C_H \end{aligned}$$

where we use (2) and (17). We obtain

$$U_L^o - U_L^{mLH} = 2c\left(\frac{\bar{N}N_L^{mLH}}{n(\hat{x}^{mLH})} - \frac{\left(N_L^{mLH}\right)^2}{n(\hat{x}^{mLH})} - \left(\hat{x}^o - \hat{x}^{mLH}\right)\bar{N} + \int_{\hat{x}^{mLH}}^{\hat{x}^o} N(x)dx\right) > 0$$

since the sum of the two first terms is positive (as $\bar{N} > N_L^{mLH}$) and so is the sum of the two last ones (as $N(\hat{x})$ is an increasing function and $\hat{x}^{mLH} < \hat{x}^o$).
If $m_L$ works in L then:

$$\begin{aligned} U_L^{mLL} &= \bar{N}\left(\alpha_L - 2c\frac{N_L^{mLL} - \bar{N}}{n(\hat{x}^{mLL})} + v\left(G_L\right) - T_L^o + \frac{N_L^{mLL}}{\bar{N}}\frac{N_L^{mLL} - \bar{N}}{n(\hat{x}^{mLL})}2c\right) \\ &\quad -2c\left(\hat{x}^{mLL}\bar{N} - \int_0^{\hat{x}^{mLL}} N(x)dx\right) - C_H \end{aligned}$$

therefore:

$$\begin{aligned} U_L^o - U_L^{mLL} = 2c\Bigg(&\bar{N}\frac{N_L^{mLL} - \bar{N}}{n(\hat{x}^{mLL})} - \bar{N}\frac{N_L^{mLL}}{\bar{N}}(N_L^{mLL} - \bar{N}) - \bar{N}\left(\hat{x}^o - \hat{x}^{mLL}\right) + \\ &\int_{\hat{x}^{mLL}}^{\hat{x}^o} N\left(x\right)dx\Bigg) > 0 \quad (19) \end{aligned}$$

To see this, note that $N(\hat{x})$ is an increasing function, $\hat{x}^{mLL} < \hat{x}^o$ and moreover

$$\begin{aligned} &\bar{N}\frac{N_L^{mLL} - \bar{N}}{n(\hat{x}^{mLL})} - \bar{N}\frac{N_L^{mLL}}{\bar{N}}(N_L^{mLL} - \bar{N}) = -\frac{\left(N_L^{mLL} - \bar{N}\right)^2}{n(\hat{x}^{mLL})} = \\ &-\frac{N(x^{\hat{mLL}}) - 1/2}{n(\hat{x}^{mLL})}\left(N(x^{\hat{mLL}}) - 1/2\right) = -(N(x^{\hat{mLL}}) - \bar{N})\frac{(\hat{x}^o - \hat{x}^{mLL})}{2} \end{aligned}$$

and thus the absolute value of the sum of the three first terms in (19) is smaller than

$$\left(\hat{x}^o - \hat{x}^{mLL}\right)(N(\hat{x}^{mLL}) - \bar{N}) + \bar{N}\left(\hat{x}^o - \hat{x}^{mLL}\right) = N(\hat{x}^{mLL})\left(\hat{x}^o - \hat{x}^{mLL}\right)\square$$

### A2.3 : Impossibility to have equilibria with $\hat{x} < 0$

**Proposition 5'** *There exists no tax equilibrium such that residents in jurisdiction H work in jurisdiction L.*

**Proof** With $\hat{x} < 0$, the objective functions of the planners and of the median voters change and to guarantee existence we would have to impose something of the kind of Assumption 1. Either it is not respected and an $\hat{x} < 0$ equilibrium does not exist or it is and then:

1. Can there be an U equilibrium with $\hat{x} < 0$? By analogy with previous computations, we know that $\tau_H^U = 0$ and $\tau_L^U > 0$ but then for sure $\omega_H^U > \omega_L^U$ and $\hat{x} > 0$.

2. Can there be an $mHH$ type of equilibrium with $\hat{x} < 0$? Again by analogy we obtain $\tau_H^{mHH} < 0$ and $\tau_L^{mHH} > 0$ and again $\omega_H^o > \omega_L^o$ hence $\hat{x} > 0$.

3. Can there be an $mHL$ type of equilibrium with $\hat{x} < 0$? We would obtain

$$\begin{aligned}\tau_H^{mHL} &= \frac{2c}{\alpha_H}\frac{N(\hat{x}^{mHL})}{n(\hat{x}^{mHL})} \\ \tau_L^{mHL} &= \frac{2c}{\alpha_L}\frac{1/2 - N(\hat{x}^{mHL})}{n(\hat{x}^{mHL})}\end{aligned}$$

   and

$$\hat{x}^{mHL} = \hat{x}^o - 2\frac{N(\hat{x}^{mHL}) - 1/4}{n(\hat{x}^{mHL})}$$

   and for $mH$ to be a ij-commuter we would need $N(\hat{x}^{mHL}) < 1/4$, implying $\hat{x}^{mHL} > \hat{x}^o > 0$, a contradiction.

Hence there can be no equilibrium with $\hat{x} < 0$.$\square$

**Lemma 4'** *When tax decisions are decentralised, total welfare in the city decreases as compared to the first best. The welfare loss is higher under the majoritarian local governments than under utilitarian local governments if the prevailing majoritarian tax equilibrium is ($\tau^{mLL}$). The reverse is true when the majoritarian tax equilibrium is ($\tau^{mLH}$).*

**Proof** We show that $\hat{x}^{mLH} > \hat{x}^U > \hat{x}^{mLL}$. Note that the three expressions

$$2\frac{N(x) - 1/2}{n(x)}, \frac{N(x) - 1/2}{n(x)} \text{ and } 2\frac{N(x) - 3/4}{n(x)}$$

are increasing under Assumption 1 on $[0, \hat{x}^o]$ and therefore each pair of them will cross at most once. The two first at $N(x) = 1/2$ and the two latter at $N(x) = 1$. At any $N(x) > 0$, we have $2\frac{N(x)-1/2}{n(x)} > \frac{N(x)-1/2}{n(x)}$ hence $\hat{x}^U > \hat{x}^{mLL}$ and at $N(x) < 1$ we have $2\frac{N(x)-3/4}{n(x)} < \frac{N(x)-1/2}{n(x)}$ hence $\hat{x}^{mLH} > \hat{x}^U$. Finally, we show that the global welfare loss is higher the lower is ij-commuting. Recalling Proposition 2' and Lemma 3', we can show that

$$U_L^o + U_H^o - U_L^{TC} - U_H^{TC} = \int_{\hat{x}^{TC}}^{\hat{x}^o} N(x)dx - N(\hat{x}^{TC})(\hat{x}^o - \hat{x}^{TC})$$

where $TC = U, mLH, mLL$ stands for tax competition equilibrium. Given that $N(x)$ is an increasing function, the above expression is decreasing in $\hat{x}^{TC}$.$\square$

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