

DISCUSSION PAPER SERIES

No. 9499

HOW TO MAKE THE METROPOLITAN AREA WORK? NEITHER BIG GOVERNMENT, NOR LAISSEZ-FAIRE

Carl Gagné, Stéphane Riou and Jacques-
François Thisse

*INTERNATIONAL TRADE AND
REGIONAL ECONOMICS and PUBLIC
POLICY*



Centre for Economic Policy Research

www.cepr.org

Available online at:

www.cepr.org/pubs/dps/DP9499.asp

HOW TO MAKE THE METROPOLITAN AREA WORK? NEITHER BIG GOVERNMENT, NOR LAISSEZ-FAIRE

Carl Gagné, INRA, UMR1302, SMART Rennes and CREATE, Laval University
Stéphane Riou, UMR CNRS GATE Lyon Saint-Etienne, Université de Saint-
Etienne

Jacques-François Thisse, CORE, Université Catholique de Louvain, Higher
School of Economics and CEPR

Discussion Paper No. 9499
June 2013

Centre for Economic Policy Research
77 Bastwick Street, London EC1V 3PZ, UK
Tel: (44 20) 7183 8801, Fax: (44 20) 7183 8820
Email: cepr@cepr.org, Website: www.cepr.org

This Discussion Paper is issued under the auspices of the Centre's research programme in **INTERNATIONAL TRADE AND REGIONAL ECONOMICS and PUBLIC POLICY**. Any opinions expressed here are those of the author(s) and not those of the Centre for Economic Policy Research. Research disseminated by CEPR may include views on policy, but the Centre itself takes no institutional policy positions.

The Centre for Economic Policy Research was established in 1983 as an educational charity, to promote independent analysis and public discussion of open economies and the relations among them. It is pluralist and non-partisan, bringing economic research to bear on the analysis of medium- and long-run policy questions.

These Discussion Papers often represent preliminary or incomplete work, circulated to encourage discussion and comment. Citation and use of such a paper should take account of its provisional character.

Copyright: Carl Gagné, Stéphane Riou and Jacques-François Thisse

June 2013

ABSTRACT

How to make the metropolitan area work? Neither big government,
nor laissez-faire*

We study how political boundaries and fiscal competition interact with the labor and land markets to determine the economic structure and performance of metropolitan areas. Contrary to general belief, institutional fragmentation need not be welfare-decreasing, and commuting from the suburbs to the central city is not wasteful. Thus, the institutional and economic limits of the central city do not coincide at the social optimum. Under tax competition, the central business district is too small. The dispersion of jobs is increased when suburbanite workers consume the public services supplied by the central city. This indicates the need for some metropolitan governance.

JEL Classification: H41, H71 and R12

Keywords: administrative boundary, economic boundary, fiscal competition, local labor markets, metropolitan area and suburbanization

Carl Gagné
Unité Structures et Marchés
Agricoles, Ressources et Territoires
INRA
Rue Adolphe Bobierre, CS 61103
35011 Rennes cedex
FRANCE

Email: gaigne@enesad.inra.fr

Stéphane Riou
UMR CNRS GATE Lyon Saint-
Etienne, 6 rue basse des rives 42023
Saint-Etienne
FRANCE

Email: stephane.riou@univ-st-etienne.fr

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=159511

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=160696

Jacques-François Thisse
CORE
Université catholique de Louvain
34, Voie du Roman Pays
B-1348 Louvain-la-Neuve
BELGIUM

Email: jacques.thisse@uclouvain.be

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=104425

*We thank Marcus Berliant, Ralph Braid, Jon Hamilton, Robert Inman, Suzanne Kok, Claudio Perroni, and participants to the Regional Science and Urban Economics Workshop of the Paris School of Economics and Public Policies and Spatial Economics Workshop of GATE Lyon-Saint-Etienne for their comments and suggestions.

Submitted 20 May 2013

1 Introduction

According to Alain Juppé, a former prime minister of France and mayor of the city of Bordeaux, “governments are too small to deal with the big problems and too big to deal with the small problems” within today’s administrative limits. Bruce Katz, a vice president at the Brookings Institution, went one step further when he said that “metro governance is almost uniformly characterized by fragmentation and balkanization, by cultures of competition rather than one of collaboration.” Empirical works confirm the idea that the institutional structure of a metropolitan area has a significant impact on both the efficiency of its local public services and on the welfare of its residents by influencing the distribution of jobs and the level of housing and commuting costs (Glaeser and Kahn, 2001; Cheshire and Magrini, 2009). Given that large metropolitan areas also produce a sizable and growing share of the wealth of nations,¹ it is surprising that a sound economic analysis of metropolitan areas is still lacking.

The purpose of this paper is to study how the institutional design of the metropolitan area affects its economic structure and performance. To this end, we develop a new model with one central city and several suburban jurisdictions, in which the labor and land markets interact with the tax competition between asymmetric jurisdictions to shape the economic structure of the metropolitan area. The standard approach in the literature on jurisdiction formation is to focus on the trade-off between the crowding effect of public services, which increases with jurisdiction size, and the unit cost of public services, which decreases with population size. We contend that the problem may be tackled from a different, but equally important, angle by recognizing that workplaces and residences do not necessarily belong to the same jurisdiction. In practice, the central city attracts a large number of workers who live in adjacent but independent areas, thus giving rise to a substantial amount of “cross-border” commuting. So workers face a second trade-off. They can earn a high wage in centrally located firms and bear high commuting costs. Or, they can receive lower pay in firms located in secondary business centers and pay less for commuting. By combining these two trade-offs within a unifying framework, we distinguish between the *administrative* and *economic* limits of the central city, a distinction that has not attracted much attention in the literature (see, for example, Scotchmer, 2002; and Epple and Nechyba, 2004).

Policy-makers stress the need for coordinating the actions of local governments. To seriously assess the desirability and scope of such a move, we need to understand how local governments interact with the urban labor and land markets. Since jurisdictions compete for tax revenue to finance the public services provided to their residents, the institutional fragmentation of the

¹For example, the estimated GDP of the metropolitan area of Tokyo or New York in 2006 is similar to those of Canada or Spain

metropolitan area affects the location of firms and consumers. It is well documented empirically that a geographical concentration of firms raises the productivity of those firms through various mechanisms, generically nicknamed “agglomeration economies” (Rosenthal and Strange, 2004; Glaeser and Gottlieb, 2009). Despite this, another major trend is the decentralization of jobs in secondary employment centers because land and labor are cheaper there (Glaeser and Kahn, 2004). In addition, the location of households also depends on the prices of land in different places. Finally, since workers are free to commute within the whole metropolitan area, the distribution of jobs is endogenous and determined together with the location of firms.

To carry out our study, we develop a full-fledged general equilibrium model in which consumers and firms are free to choose their location within the metropolitan area, while local governments act strategically. Our model, unlike those in the existing literature, encompasses the effects mentioned above by combining building blocks borrowed from local public finance and urban economics. Another distinctive feature of our model is that the central city has better access to the metropolitan labor pool. As a result, the jurisdictions are asymmetric in a way that differs from the standard modeling approaches used in tax competition literature. In addition, the structure of the metropolitan area can be mono- or polycentric, depending on the parameters of the economy. For our purposes, a polycentric metropolitan area is more relevant, with only a share of jobs in the metropolitan area located in the central city (Glaeser and Kahn, 2001). Another feature is that our model can account for very different job distribution configurations. For example, the employment level in the central business district (CBD) may be higher or lower than that in the suburban business district (SBD), while the employment ratio between the CBD and a SBD is endogenous. Because the monocentric city model is still the dominant one in urban economics, we also study the monocentric configuration as a limiting case.

Lastly, the framework we propose is versatile enough to study how a particular institutional context interacts with market forces to determine the morphology and economic performance of the metropolitan area. In the same vein, due to its simplicity, our model can be used as a building block in analyses addressing broader sets of issues.

Our main findings may be organized in three distinct, but complementary, categories.

1. We study the first-best outcome, which we use later on as a benchmark (Section 3). The planner, who aims to maximize welfare within the whole metropolitan area, determine the economic and administrative sizes of jurisdictions by choosing where consumers live and work. When the number of potential jurisdictions is fixed, it is never desirable to amalgamate the suburban jurisdictions with the central one. Moreover, the economic boundary of the central city always encompasses its administrative boundary: firms and jobs are more agglomerated than public services. This implies that *the administrative and economic boundaries of the central*

city never coincide, a result that clashes with the general belief that these boundaries should be the same (OECD, 2006). These boundaries do not coincide because the planner chooses the size of a jurisdiction that permits the best provision of public services, whereas the optimal size of central and secondary business centers depends on the interplay between commuting and agglomeration economies. In addition, whether the optimal metropolitan area is mono- or polycentric depends on several parameters. When commuting costs are low, agglomeration economies are strong, or the total population is small, all jobs are located in the central business district. Otherwise, the suburban jurisdictions host firms and jobs.

2. We then study the decentralized outcome when the number of jurisdictions and their administrative boundaries are exogenous (Section 4). There are three types of players: a large number of consumers (formally, a continuum), a large number of firms (formally, a continuum), and a finite number of local governments. Consumers choose a residence and a workplace. Firms choose a location and the wages paid to their employees. Jurisdictions supply a local public good. To finance this good, local governments choose non-cooperatively a property tax levied on their residents and a business tax paid by the firms located in their jurisdiction. Tax competition yields a very contrasted pattern: the central city levies a higher business tax than suburban governments.² This is because consumers working in the central business district (CBD) need not reside in the central city, which incentivizes its government to practice *tax exporting*. This result shows the importance of working with a setting in which the commuting pattern is fully endogenous.

We also show that, under corporate tax competition, *when the population size of the central city is optimal, the CBD is too small, whereas the central city is too large when the size of the CBD is optimal*. Therefore, redrawing the border of the central city is not the remedy to correct the misallocation of capital within the metropolitan area. This tension stems from the fact that the distribution of jobs is governed by a system of forces that overlaps imperfectly with that taken into account by the local governments. As a consequence, there is no reason to expect the two types of boundaries to coincide. Even though we have only one type of public good supplied by different jurisdictions, our analysis calls for an economic governance at the level of the entire metropolitan area of issues not addressed by local governments. The purpose of this metropolitan area government is to provide integrated management of agglomeration economies by coordinating business tax rates across the whole range of jurisdictions.³ This is

²Hoyt (1992) developed a setting in which the central city's government influences the land rent in suburban jurisdictions, whereas the tax policy of the government of a suburban jurisdiction has no impact on the central city's land rent because its population share is negligible. Like us, Hoyt showed that the property tax is higher in the central city. However, unlike us, he treated households' residential locations and workplaces as exogenous.

³Even though we do not discuss transportation policies, the role played by commuting in our analysis suggests that transportation issues should also be addressed at the metropolitan level.

in accordance with Inman (2009) who argues in favor of the creation of business improvement districts.

3. Once it is recognized that suburbanites commuting to the CBD may consume the public services supplied by the central city, the tax gap widens because the central city sets an even higher tax rate to reduce the congestion costs borne by its residents, whereas suburban jurisdictions now subsidize firms to restore their attractiveness (Section 5). As a result, firms located in the CBD (SBDs) pay a lower (higher) wage to their employees. All in all, *central city's residents are hurt twice by the suburbanites' free-riding behavior: they end up with both a lower quality of public services and lower wages.* This concurs with Katz for whom the culture of competition that prevails in many metropolitan areas is damaging to the central city. Observe that spillovers do not generate the misallocation of firms and jobs within the metropolitan area; they exacerbate it.

Our analysis suggests that neither the amalgamation nor the decentralization among competing jurisdictions is the best way to govern large metropolitan areas. Combining a multi-jurisdictional political system with an economic government of the metropolitan area or a deep inter-jurisdictional cooperation seems to be a more efficient way to solve the various distortions inherent to the working of a metropolitan economy. To some extent, such a recommendation has been implemented in several European countries under the concrete form of fiscal coordination (OECD, 2006). In the United States, the tax-base sharing program implemented in Minneapolis-Saint Paul has decreased incentives for local governments to compete for a larger tax base (Inman, 2009).

A last comment is in order. The legal environment in which metropolitan areas operate vastly differs across countries. The model presented in this paper is context-free in that it focuses on (some of) the fundamental characteristics common to most metropolitan areas and disregards specific and idiosyncratic issues that are important in some countries but not in others.

Related literature. Ever since Tiebout (1956), it is widely acknowledged that a wide portfolio of local jurisdictions allows consumers to live in the locale supplying the tax/service package that fits best their preferences. However, once it is recognized that the provision of public services is often governed by increasing returns, political fragmentation may generate a substantial waste of resources. Indeed, decentralization implies that similar public goods are supplied in a large number of jurisdictions, and thus the fixed cost associated with the construction of public facilities is paid many times. This trade-off has been studied independently by Cremer et al. (1985) and Alesina and Spolaore (1997) in different, but related, contexts. These authors reach the same conclusion: there are too many jurisdictions and, therefore, excessive public expenditures. Though relevant when consumers are immobile, this framework is not

suitable for studying metropolitan areas where consumers choose both where to live and where to work, the importance of which is recognized in recent empirical works. For example, Rhode and Strumpf (2003) showed that Tiebout mechanisms are not a dominant factor in the long-run residential choices within the Boston Metropolitan Area, even though this metropolitan area is often presented as the archetype of the Tiebout model. By contrast, the interaction between land and labor markets is central to urban labor economics. However, this strand of literature does not account for tax competition and its effect on the economic structure of large cities (Zenou, 2009).

Only a handful of papers have studied the economic organization of a metropolitan area. Hoyt (1991) and Noiset and Oakland (1995) did not account for the fact that jobs may be located outside the central city, while Braid (2002) disregarded tax competition. When consumers are mobile, they live and work within the same jurisdiction in equilibrium (Braid, 1996; Epple and Zelenitz, 1981). Perroni and Scharf (2001) studied the effects of capital tax competition when the number of jurisdictions is endogenous and individuals are immobile. Braid (2010) focussed on the distances between jurisdictions that choose to offer, or not to offer, a local public good that may be consumed by non-residents. He did not study, however, the interactions between the provision of public goods and the labor and land markets.

The model is presented in the next section, whereas Section 3 describes the socially optimal metropolitan area. In Section 4, we study the decentralized outcome, which we compare to the optimum. We also determine the second-best outcome in which a planner chooses the optimal administrative boundary of jurisdictions while local governments, firms and residents pursue their own interest. In Section 5, we check the robustness of our main findings when agglomeration economies vary with the distribution of firms, suburbanites working in the CBD consume the public services provided by the central city, and the central city supplies a broader array of public services than the suburban jurisdictions. Section 6 concludes with some policy recommendations.

2 The Model

The metropolitan economy is endowed with L consumers/workers who are free to choose their residential location and workplace. There are three consumption goods: (i) land, which is used as a proxy for housing, (ii) a public good provided by jurisdictions, and (iii) a homogeneous good, the numéraire, produced by profit-maximizing firms whose locations are endogenous. The metropolitan area does not trade with the rest of the world. Note, however, that our findings could be extended to deal with a metropolitan area trading the numéraire against goods produced in other cities; likewise, firms could produce differentiated goods under monopolistic

competition.

2.1 Jurisdictions and the provision of public goods

The metropolitan area is formed by $m + 1$ jurisdictions. It has a *star-shaped* morphology, which means that the $m \geq 2$ suburban jurisdictions are connected only to the central jurisdiction that has a direct access to all suburbanites. Formally, the metropolitan area is described by m one-dimensional half-lines sharing the same initial point $x = 0$. Distances and locations are expressed by the same variable measured from $x = 0$.

The central jurisdiction ($i = 0$) hosts the central business district (CBD) of the metropolitan area at $x = 0$, while each suburban jurisdiction ($i = 1, \dots, m$) may, or may not, accommodate a secondary business district (SBD) located at x_i^s along the i th ray. Our model does not explain why the CBD is formed. Doing this would require introducing various types of agglomeration economies that would make the formal analysis much more complex. We have nothing new to add to what is known in this domain (Duranton and Puga, 2004). However, the internal economic structure of the metropolitan area is endogenous. In particular, the CBD and SBD sizes are variable and determined at the equilibrium. Figure 1 provides a bird-eye view of the metropolitan area.

Figure 1 about here

Consumers use a lot having the same fixed size. The units of land is chosen for this parameter to be normalized to one. The assumption of a fixed lot size does not allow replicating the well-documented fact that the population density is higher in the central city than in the suburbs. It is widely used, however, in models involving an urban economics building block because it captures the basic trade-off between long/short commutes and low/high land rents. The central city shares the boundary b_i with the i th suburban jurisdiction. Let B_i be the outer limit of the i th suburban jurisdiction, the value of which is determined by the residential choices made by consumers. As a result, the central city population (ℓ_0) and the suburban jurisdiction i population (ℓ_i) are, respectively, given by

$$\ell_0 = \sum_{i=1}^m b_i \quad \ell_i = B_i - b_i$$

with $\ell_0 + \sum_i \ell_i = L$. In practice, the central city population is often larger than the population of a suburban population, i.e. $\ell_0 > \ell_i$.

We assume that public expenditures in a jurisdiction are exogenous; they generate a gross utility equal to $G > 0$. We will see in subsection 5.1 what our main findings become when the central city provides a wider range of public services than the suburban jurisdictions. Moreover, we consider a *congestible* public good (e.g. hospitals or recreational facilities). Specifically, the

net utility of this good is equal to $G - \alpha \ell_i$, where $\alpha > 0$ is a constant and ℓ_i the number of users. This modeling strategy captures indirectly the idea that a larger population must incur a higher cost to sustain a given utility level associated with the consumption of local public services. Only the local residents use the public good supplied by their jurisdictions. In subsection 5.1, we allow the cross-border commuters to consume the central city's public good. Note that we could assume that the public service is provided by a facility located at the center of the jurisdiction. In this case, consumers have to bear the travel cost to the public facility, which increases with the distance between their location and the facility location. Evidently, the average distance rises with the population size, and thus the average utility of the public good also decreases with the jurisdiction's population, as supposed here.

To finance the public good, the i th jurisdiction uses two instruments, that is, a *property* tax t_i levied on the land rent prevailing in the jurisdiction and a *business* tax T_i paid by the firms located therein.⁴ Since G is exogenous, we do not address the issue of over- or under-provision of public good, which is generally associated with tax competition.

When a suburban jurisdiction accommodates an SBD, we call it an *edge city* to differentiate it from the central city. In this case, the metropolitan area is *polycentric*; otherwise, it is *monocentric*. The most interesting case to study involves edge cities since job decentralization appears to be a powerful trend in many metropolitan areas.

2.2 Workers and land rents

Each consumer bears a unit commuting cost given by $\tau > 0$. Therefore, commuting costs are equal τx or $\tau |x - x_i^s|$ according to the location of her employment center. Each jurisdiction owns its land and the aggregate land rent is evenly redistributed among the residents.⁵

As will be seen below, a commuting pattern such that $y_i < b_i$ is never an equilibrium or a solution chosen by the planner. Consequently, only the following three patterns may emerge: (i) when $b_i < y_i < B_i$ for $i = 1, \dots, m$, there are one CBD and m SBDs; (ii) when $b_i < y_i = B_i$ for $i = 1, \dots, m$, there are no SBDs but $m + 1$ jurisdictions; and (iii) when $b_i = y_i = B_i$ for $i = 1, \dots, m$, there is a single city and a single jurisdiction. Because of cross-border commuting, land is used on both sides of the boundary between the central and suburban jurisdictions. As a result, there is not vacant land within the metropolitan area.

⁴Our results hold true if consumers pay a head tax instead of a property tax as assumed here.

⁵Instead one could think of using the aggregate land rent to finance the local public good. The Henry George Theorem holds when each jurisdiction reaches its optimal size. This condition can hardly be satisfied here because the total population size and the number of jurisdictions are given. Furthermore, the land rent capitalizes several effects in our setting.

When a consumer lives and works in the central city, her indirect utility is given by

$$V_0(x) = w_0 - (1 + t_0)R_0(x) - \tau x + G - \alpha \ell_0 + \frac{ALR_0}{\ell_0} \quad (1)$$

where $R_0(x)$ is the land rent at a distance x from the CBD, while w_0 is the wage paid by the firms located in CBD, t_0 the property tax levied by the central city's government, while

$$ALR_0 = \sum_{i=1}^m \int_0^{b_i} R_0(x) dx$$

is the aggregate land rent in the central city. When a consumer lives in the suburban jurisdiction $i = 1, \dots, m$ and works in the central city, her indirect utility becomes

$$V_i^0(x) = w_0 - (1 + t_i)R_i(x) - \tau x + G - \alpha \ell_i + \frac{ALR_i}{\ell_i} \quad (2)$$

where $R_i(x)$ and t_i are, respectively, the land rent and property tax in the suburban city i , while

$$ALR_i = \int_{b_i}^{B_i} R_i(x) dx.$$

Last, when a consumer lives and works in the jurisdiction $i = 1, \dots, m$, her indirect utility is

$$V_i^i(x) = w_i - (1 + t_i)R_i(x) - \tau |x - x_i^s| + G - \alpha \ell_i + \frac{ALR_i}{\ell_i} \quad (3)$$

where w_i is the wage rate paid in the corresponding SBD.

We define the *economic boundary* of the central city as the limit of the area that includes all the individuals working in the CBD. It is given by the location y of the worker who is indifferent between working in the CBD or in a SBD:

$$V_i^0(y) = V_i^i(y)$$

which shows that y is endogenous.

Without loss of generality, we assume that the opportunity cost of land is zero. The land rent at each location in the central city is as follows. Given $V_0(x)$, the equilibrium land rent in the central city must solve $\partial V_0(x)/\partial x = 0$ or, equivalently, $(1 + t_0)R_0'(x) + \tau = 0$ whose solution is

$$R_0(x) = r_0 - \frac{\tau}{1 + t_0} x \quad (4)$$

where r_0 is a constant that will be determined in 4.1.2.

The land rent prevailing in the i th jurisdiction is given by

$$R_i(x) = \max \{ \Phi_i^0(x), \Phi_i^i(x), 0 \} \quad (5)$$

where $\Phi_i^0(x)$ ($\Phi_i^i(x)$) is the bid rent at x of a worker living in the i th jurisdiction and working in the central city (the edge city i). Given $V_i^0(x)$ and $V_i^i(x)$, the equilibrium land rent is such as $\partial V_i^0(x)/\partial x = \partial V_i^i(x)/\partial x = 0$. As a consequence, the bid rents are

$$\Phi_i^0(x) = r_i^0 - \frac{\tau}{1 + t_i} x \quad \Phi_i^i(x) = r_i^i - \frac{\tau}{1 + t_i} |x - x_i^s|$$

where both r_i^i and r_i^0 will be determined in subsection 4.1.2. Thus, in each jurisdiction, the slope and intercept of the land rent profile are endogenous.

Note that the land rent redistributed to consumers is jurisdiction-specific. Assuming that the total land rent within the metropolitan area is shared among all consumers is not consistent with the existence of independent and competing jurisdictions. In addition, our assumption allows ignoring the external effect stemming from the strategic manipulation of the metropolitan land rent by jurisdictions.

2.3 Firms and wages

Labor is the only production factor. Firms produce a homogeneous good, which is used as the numéraire. A firm requires a fixed amount of labor, and thus operates under increasing returns. We choose the unit of labor for the fixed requirement to be equal to 1. For simplicity, the marginal requirement is normalized to zero. By implication, the total number of firms established in the metropolitan area is finite and given by L . Firms can locate either in the CBD or in one of the edge cities where they form a SBD.

According to Baum-Snow (2012), agglomeration economies arise mainly within the central city, whereas Glaeser and Kahn (2004) argue that, due to the development of new information and communication technologies, their scope has spread within the metropolitan area. Hence, all firms located in a metropolitan area benefit from agglomeration economies, but they do so with different levels of intensity. Ideally, agglomeration economies should be modelled by assuming that the fixed requirement of labor needed to start a business decreases with the number of firms located in its vicinity. Following such an approach renders the analysis of the tax game intractable. This is why we consider a much simpler modelling strategy, that is, a firm locating in the CBD benefits from a more efficient environment that takes the concrete form of a cost drop E . We may then interpret E as follows: the stronger the agglomeration economies in the central city, the higher value of E . Admittedly, this specification is very ad hoc. Our line of defense is that it captures some of the main impacts of agglomeration economies, while keeping the formal analysis simple. In subsection 5.2, we consider a more general description of agglomeration economies and discuss what our main results become.

Let Π_0 (Π_i) be the profits earned by a firm set up in the central city (the edge city i). When a firm is located in the CBD, we have

$$\Pi_0 = I - (w_0 - E) - T_0 \tag{6}$$

where I denotes the firm's revenue, while $(w_0 - E)$ is the fixed production cost in the CBD. When a firm sets up in the i th edge city, its profit function becomes:

$$\Pi_i = I - w_i - T_i. \tag{7}$$

In each employment center, the equilibrium wages are determined by a bidding process in which firms compete for workers by offering them higher wages until no firm earn positive profits. As a result, a firm's revenue net of tax is equal to its wage bill. Setting (6) and (7) equal to zero and solving, respectively, for w_0 and w_i , we get

$$w_0 = I + E - T_0 \quad w_i = I - T_i. \quad (8)$$

Hence, business taxes alleviate residents' tax burden but they also reduce the wages earned by workers. When consumers work and live within the same jurisdiction, both effects are washed out. This is no longer true, however, when they work and live in different jurisdictions. As a consequence, the property tax paid in the jurisdiction where the consumer lives and the business tax paid in the jurisdiction where she works affect her utility level, whence her residence and workplace. By implication, both types of taxes affect the equilibrium pattern of activities.

Because the shipping costs of the consumption good within the metropolitan area are much lower than workers' commuting costs, a firm's revenue I is assumed to be independent of its location. How the equilibrium value of I is determined is immaterial for our analysis because I does not enter the profit/utility differential between any two places.

3 The Optimal Metropolitan Area

In this section, we assume that a social planner maximizes total welfare in the metropolitan area by choosing the population of the central city and those of the suburban jurisdictions, consumers' and firms' locations, hence the commuting pattern. This is achieved by through the choice of the optimal administrative (b_i) and economic (y_i) boundaries of the central city and the number (m) of suburban jurisdictions. Our setting being symmetric about the CBD, the outer and inner administrative boundaries of the suburban jurisdictions as well as the economic boundaries are such that $B_i = B \equiv L/m$, $b_i = b$, and $y_i = y$ for all $i = 1, \dots, m$. We consider the following three commuting patterns: (i) a consumer lives and works in the central city; (ii) a consumer lives in an edge-city but works in the central city; and (iii) a consumer resides and works in the same suburban jurisdiction.

Individual utilities being linear, the total welfare W_T within the metropolitan area may be defined as follows:

$$W_T = PE - CC - GC - PC \quad (9)$$

which involves (i) the productive efficiency gains generated by the clustering of firms in the CBD:

$$PE = myE$$

where y is the location of the individual indifferent between working in the CBD or the SBD; (ii) the commuting costs borne by the individuals working in the CBD or in the SBDs:

$$CC = m \int_0^y \tau x dx + m \int_y^B \tau \left| x - \frac{B+y}{2} \right| dx$$

where the planner chooses to locate the SBD at the middle point $x^s = (B+y)/2$ of the segment $[y, B]$ because E is independent of distance from the CBD; (iii) the congestion costs of the public good borne by consumers in all jurisdictions:

$$GC = \alpha b^2 m^2 + \alpha (L - mb)^2 / m;$$

and (iv) the cost of providing a public good in all jurisdictions:

$$PC = (m + 1)G.$$

3.1 The optimal economic and administrative size of jurisdictions

Assume that the number m of jurisdictions is given. By choosing b , the planner determines the population size in each type of jurisdiction (ℓ_0 and ℓ). Evidently, a marginal expansion of the central city (a higher b) reduces the number of residents in all suburban jurisdictions. Consequently, the congestion cost decreases therein, whereas it rises in the central city.

Differentiating W_T with respect to b yields

$$\bar{b} = \frac{B}{m+1} < B. \quad (10)$$

Thus, regardless of the values of L and m it is always optimal to break up the metropolitan area into $m + 1$ independent jurisdictions. The optimal size of a suburban jurisdiction is equal to

$$\bar{\ell} = B - \bar{b} = \frac{L}{m+1} > 0.$$

The optimal size of the central city being equal to $\bar{\ell} = m\bar{b}$, the central and suburban jurisdictions all have the same population size. As a result, congestion costs in public services are equalized across jurisdictions. Note also that the optimal number of suburbanites is larger than the number of urbanites. Both populations decrease at the same pace with the institutional fragmentation of the metropolitan area (m).

Furthermore, by choosing y , the planner determines the size of the CBD (my) and that of each SBD ($B - y$). Total commuting costs CC reach their lowest value when the average traveled distance is minimized, i.e. $y = B/3 \geq \bar{b}$. The productive efficiency of the metropolitan area is maximized when all firms are located in the CBD, i.e. $y = B$. Because y does not affect directly the congestion costs GC , the optimal economic boundary of the central city

is the outcome of the trade-off between commuting costs and agglomeration economies. By implication, the optimal value of y must belong to the interval $(B/3, B)$.

Differentiating W with respect to y , we obtain the optimal economic boundary of the central city:

$$\bar{y} = \frac{B}{3} + \frac{2E}{3\tau} > \bar{b} \quad (11)$$

because $m \geq 2$. As a consequence, the CBD labor pool always encompasses the central city, while the SDBs are located in the suburban jurisdictions. As the intensity of agglomeration economies rises (E), the CBD grows at the expense of the SDBs. Likewise, when the total population of the metropolitan area gets larger, the labor pool of both types of cities expands; however, the employment share of the CBD decreases.

It remains to check under which condition the metropolitan area is polycentric ($\bar{y} < B$). This is so if and only if

$$E < \tau B. \quad (12)$$

In this event, the optimal metropolitan area involves $m + 1$ local labor markets. Thus, high commuting costs, low agglomeration economies, or both generate the decentralization of jobs. In the same vein, because B increases with L , a population hike fosters the emergence of SDBs. By contrast, because B decreases with m , a higher number of suburban jurisdictions promotes the concentration of jobs in the central city because the average commuting to the CBD is shorter. Moreover, as the CBD labor pool encompasses the central city, the employment rate in the central city always exceeds 1 whereas it is smaller than 1 in the suburban cities.

In addition, the size of the CBD is equal to

$$m\bar{y} = \frac{L}{3} + \frac{2mE}{3\tau} \quad (13)$$

which exceeds the size of a SDB. Put differently, *the CBD is always larger than a SDB*. Note, however, that the CBD employment level need not exceed the total number of suburban jobs. Indeed, the former is greater than the latter if and only if $E > \tau B/4$. As a result, when $\tau B/4 < E < \tau B$, the metropolitan area is polycentric, even though the CBD captures the majority of jobs.

If the condition (12) does not hold, agglomeration economies are too strong, commuting costs are too small, or the number of suburban jurisdictions is too large for SDBs to emerge: $\bar{y} = B$. Under these circumstances, the agglomeration of firms and jobs in the CBD, whence a monocentric metropolitan area, is socially desirable. Interestingly, the labor market is integrated though the metropolitan area is fragmented into several suburban jurisdictions. This means that, at the social optimum, the *institutional fragmentation* of the metropolitan area and the *agglomeration* of firms and jobs in the CBD do not necessarily conflict.

Furthermore, for any given $m \geq 2$, *the optimal administrative and economic boundaries of the central city never coincide*. To be precise, the planner always chooses for the central city a population size smaller than the population size of its labor pool. However, the suburbs may, or may not, host firms and workers. In other words, when a benevolent planner is empowered to choose both the residential location and workplace of individuals, merging all places within a single large city is never socially desirable.

3.2 The optimal number of jurisdictions

The planner may also choose the degree of fragmentation of the metropolitan area through the variable m . Two cases must be distinguished. In the first one, it is optimal to concentrate firms in the CBD. Differentiating W_T with respect to m thus leads to the following equilibrium condition:

$$\frac{\tau L^2}{2m^2} + \frac{\alpha L^2}{(m+1)^2} - G = 0 \quad (14)$$

which does not have a simple analytical solution for the optimal number \bar{m} of jurisdictions. Note that (14) includes the trade-off between the gross utility of public expenditures and congestion costs, as in Alesina and Spolaore (1997) who do not account for commuting costs.

It is readily verified that $d\bar{m}/d\tau > 0$, $d\bar{m}/dL > 0$, and $d\bar{m}/dG < 0$. Lowering commuting costs and/or raising public expenditures leads to a smaller number of suburban jurisdictions. As a consequence, the optimal fragmentation of the metropolitan area is governed by the trade-off between commuting costs and increasing returns. In particular, when public expenditures G associated with a new jurisdiction is large and/or commuting costs are low, it is never optimal to fragment the metropolitan area ($\bar{m} = 0$). On the other hand, fragmentation is always desirable when the total population is sufficiently large.

In the second case, it is optimal to break up the metropolitan area into several cities. The optimal value of m is now implicitly given by

$$\frac{\tau L^2}{6m^2} + \frac{\alpha L^2}{(m+1)^2} + \frac{E^2}{3\tau} - G = 0$$

which, unlike (14), depends on the level E of agglomeration economies.

The impact of population size (L) and public expenditures (G) is the same as in the first case. However, lowering the unit commuting cost (τ) now has an ambiguous impact on the optimal number of cities. Indeed, two opposing effects are at work. On the one hand, for a given \bar{y} , decreasing the unit commuting cost reduces the total level of commuting costs within the metropolitan area. This incentivizes the planner to select a smaller value for \bar{m} because this reduces total public expenditures. On the other hand, since \bar{y} increases when the unit commuting cost falls, \bar{m} should increase to reduce total commuting costs. The former effect dominates the latter one when E is sufficiently low.

Proposition 1 comprises a summary.

Proposition 1 *Consider a central planner maximizing total welfare within the metropolitan area. Then, the optimal metropolitan area involves institutional fragmentation and commuting from the suburban jurisdictions to the central city.*

4 Tax Competition and the Metro Structure

We now consider a decentralized tax setting in which the institutional environment, i.e. the number of suburban jurisdictions and the administrative boundary between these jurisdictions and the central city are given. Our purpose in this section is to find how b and m affect the tax policies and the location of jobs.

The spatial structure of the metropolitan area implies that competition among jurisdictions is strategic: each suburban jurisdiction competes directly with the central city only whereas the central city competes with every suburban jurisdiction. The interactions between local governments and market forces are described by a three-stage game that blends atomic and non-atomic players. There are three groups of players: a continuum of consumers, a continuum of firms, and $m+1$ local governments. Consumers choose where to live and where to work; firms choose where to locate and the wage to pay to their employees; and local governments choose a business tax and a property tax. In the first stage, consumers are free to choose the jurisdiction they want to join and their location therein, anticipating the property tax they will pay and the wage they will earn. Therefore, in equilibrium consumers will reach the same utility level. In the second stage, the population in all jurisdictions has already been determined, so that local governments can choose simultaneously and non-cooperatively a business tax and a property tax to maximize the total welfare of their residents. Last, firms choose their profit-maximizing locations and consumers their workplace, while land and labor markets clear. The locations of the SBDs are determined when firms choose their locations in this third stage.

Once consumers are mobile, the specification of governments' objective is known to be a controversial issue (Scotchmer, 2002; Cremer and Pestieau, 2004). Our three-stage game obviates this difficulty because governments know who their residents are, and thus may determine the total welfare to maximize. Moreover, the relationship between jobs and people having often the nature of an "egg-and-chicken" problem, firms choose their locations and consumers their workplaces simultaneously.

We seek a subgame perfect Nash equilibrium. As usual, the game is solved by backward induction. Because characterizing the equilibria of all subgames is long and tedious, we find it convenient to restrict ourselves to the equilibrium path. In particular, consumers being mobile and identical, they anticipate that they reach the same (indirect) utility level V^* at the end

of the game. Denoting by y_i the location of the consumer indifferent between working in the CBD or in the i th SBD, we have $V^* = V_0(x)$ for $0 \leq x \leq b$, $V^* = V_i^0(x)$ for $b < x \leq y_i$, and $V^* = V_i^i(x)$ for $y_i < x \leq B_i$. Though proving the existence of a (pure-strategy) Nash equilibrium in a tax game often requires strong assumptions (Laussel and Le Breton, 1998; Rothstein, 2007), we show the existence of a unique equilibrium.

The socially optimal metropolitan area being symmetric, we find it reasonable to focus on a symmetric equilibrium: $T_i = T$ and $t_i = t$ for $i = 1, \dots, m$. In this event, wages paid in the SBDs are the same: $w_i = w$ for $i = 1, \dots, m$. Anticipating this outcome, in the first stage suburbanites distribute themselves symmetrically around the central city, which means that $B_i = B$ for $i = 1, \dots, m$. Since there is no vacant land, we have $B = L/m$. Note also that working with a symmetric outcome vastly simplifies the comparison between the equilibrium and social optimum.

4.1 Labor and land market equilibrium

In the third stage, firms and consumers observe the tax rates chosen by the local governments. Then, firms select a location as well as the wage they pay while consumers choose their working places. Because consumers are mobile, they accurately anticipate in the first stage that the equilibrium land rent equalizes utility across mobile individuals.

4.1.1 Job location

Wages being given by (8), it remains to determine the distribution of jobs within the metropolitan area. For this, determine the distribution of jobs within the metropolitan area, we must find the location y of the marginal worker, which is the same along all rays. We assume throughout this section that y exceeds b and determine the conditions for this to hold in equilibrium. As in the foregoing, the location of the SBD (x^s) is the middle point of the segment connecting y and B :

$$x^s = y + \frac{B - y}{2}. \quad (15)$$

The worker at y is indifferent between the CBD or the SBD if and only if $V_i^0(y) = V_i^i(y)$ or, equivalently,

$$w_0 - w_i = \tau y - \tau(x^s - y) = \tau \frac{3y - B}{2}. \quad (16)$$

In other words, CBD- and SBD-workers do not earn the same wage and the difference between wages must compensate the marginal worker for the difference in commuting costs along any ray. Plugging (8) and (15) into (16), we obtain the equilibrium economic boundary of the central city:

$$y^*(T_0, T) = \frac{B}{3} + \frac{2[E - (T_0 - T)]}{3\tau} \quad (17)$$

which generally differs from the administrative boundary b . Evidently, the economic boundary expands (shrinks) with T (T_0) because the central city becomes relatively more (less) attractive.

Furthermore, the equilibrium shares of firms located in the CBD and in a SBD are, respectively, given by

$$\theta_0 = \frac{my^*}{L} \quad \theta = \frac{B - y^*}{L}. \quad (18)$$

Using (17), it is readily verified that my^* increases with m if and only if E is greater than $T_0 - T$, that is, the wage paid in the CBD exceeds that paid in an edge city. In this case, a more fragmented metropolitan area has smaller SBDs.

4.1.2 Land rent

We now turn to the determination of the equilibrium land rents. Since all the tax rates are given, (1) and (8) imply that the (indirect) utility of a consumer residing in the central city is given by

$$V_0(x) = I + E - T_0 - (1 + t_0)R_0(x) - \tau x + G - \alpha\ell_0 + \frac{ALR_0}{\ell_0} \quad (19)$$

for $0 \leq x \leq b$. There are two groups of suburbanites living in the i th jurisdiction: those who work in the CBD and pay the land rent R_i^0 , and those who work in their SBD and pay the land rent R_i^i . Using (2) and (8) shows that the utility of a consumer belonging to the first group is

$$V_i^0(x) = I + E - T_0 - (1 + t)R_i^0(x) - \tau x + G - \alpha\ell + \frac{ALR}{\ell} \quad (20)$$

with $b < x \leq y^*$, while using (3) and (8) implies that the utility of a consumer belonging to the second group is

$$V_i^i(x) = I - T - (1 + t)R_i^i(x) - \tau|x - x_i^s| + G - \alpha\ell + \frac{ALR}{\ell} \quad (21)$$

with $y^* < x \leq B$. Using the equilibrium conditions $V^0 = V_i^0 = V_i^i = V^*$, we are now equipped to determine the value of r_0 for the central city as well as the values of r_i^0 and r_i^i for the suburban jurisdictions.

Because there is no competition for land at y^* and B , we have $R_i^i(y^*) = R_i^i(B) = 0$. This in turn implies

$$r_i^i = \frac{\tau(B - y^*)}{2(1 + t)}$$

which yields

$$R_i^i(x) = \frac{\tau(B - y^*)}{2(1 + t)} - \frac{\tau}{1 + t}|x - x_i^s|.$$

Replicating this argument where $R_i^0(y^*) = 0$, we obtain

$$r_i^0 = \frac{\tau}{1 + t}y^*$$

and thus

$$R_i^0(x) = \frac{\tau}{1+t}(y^* - x).$$

Using the above two expressions for the land rents, we get the aggregate land rate in any edge city:

$$ALR = \frac{\tau}{1+t} \left[\frac{(y^* - b)^2}{2} + \frac{(B - y^*)^2}{4} \right] \quad (22)$$

which decreases with the property tax rate t .

Using the equilibrium condition $V_0(b) = V_i^0(b)$ and (4), we get

$$r_0 = \frac{1}{1+t_0} \left[\tau(y^* - b) + \alpha(\ell - \ell_0) + \frac{ALR_0}{\ell_0} - \frac{ALR}{\ell} \right] \quad (23)$$

which shows that the central city's land rent capitalizes the differences in congestion costs and in the aggregate land rent redistributed across local residents. For any given value of t_0 , whence of r_0 , we have

$$R_0(x) = r_0 - \frac{\tau}{1+t_0}x.$$

Consequently,

$$ALR_0 = m \int_0^b R_0(x) dx = \frac{\ell_0}{t_0} \left[\tau \left(y^* - \frac{b}{2} \right) + \alpha(\ell - \ell_0) - \frac{ALR}{\ell} \right] \quad (24)$$

which also decreases with the property tax set in the central city. Plugging this expression in (23) shows that r_0 depends on the two property tax rates, whereas r_i^i and r_i^0 are independent of t_0 .

Figure 2 provides a side view of the land rent profile. It shows that the land rent is not continuous at the boundary b because consumers just inside and outside that boundary face different property taxes and congestion costs and live in jurisdictions that have different populations, different costs per capita of financing the public good, and different aggregate land rent per capita. The above expressions show that the land rent profile varies with the economic boundary of the central city.

Figure 2 about here

Furthermore, the equilibrium land rents $R_i^i(x)$, $R_i^0(x)$ and $R_0(x)$ fully capitalize the property tax levied by the jurisdiction containing the location x . Hence, when the local tax increases, the land rent is shifted downward. Note, however, that while $R_i^i(x)$ and $R_i^0(x)$ do not depend on the central city's property tax, the tax policy of the suburban jurisdictions generates a fiscal externality capitalized in the land rent paid in the central city. Indeed, (4) and (24) imply that $R_0(x)$ rises with t . Moreover, our framework allows determining the costs and benefits

that are capitalized and *where* the capitalization arises (Starrett, 1981). There is “external capitalization” in the central city because workers move from the suburban jurisdictions to the CBD.

Before proceeding, note also that the full price of land in the central city, defined by $(1 + t_0)R_0(x)$, decreases (increases) with t_0 (t) through a pure land capitalization effect of the property tax rates captured by r_0 . By contrast, the full price of land $(1+t)R_i^i(x)$ and $(1+t)R_i^0(x)$ that prevail in the suburban jurisdictions are independent of the property tax. This property crucially depends on the assumption of symmetric suburban jurisdictions.

4.2 Tax competition between the central and suburban jurisdictions

Business and property taxes allow each local government to finance the local public good provided to its residents. Hence, the budget constraint of jurisdiction $i = 0, 1, \dots, n$ is given by

$$G = T_i\theta_iL + t_iALR_i$$

where T_i is the business tax and t_i the property tax levied in jurisdiction i . One appealing feature of our tax game is that we may determine the business tax rates independently of the property tax rates.

4.2.1 Business tax

Local governments set non-cooperatively their business tax rates with the aim of maximizing the welfare of their residents. Specifically, the central city maximizes W_0 with respect to T_0 , while every suburban jurisdiction maximizes W with respect to T . Since firms choose their locations in the third stage, governments anticipate the consequences of their choices on the size of their business districts. Depending on the impact of tax competition on firms’ locations, two cases may arise: $\theta^* > 0$ ($\theta_0^* < 1$) and $\theta^* = 0$ ($\theta_0^* = 1$).

The polycentric metropolitan area At the tax competition stage, the welfare in the central city is given by

$$W_0 = m \int_0^b V(x)dx = \ell_0(I + E - T_0) + \alpha\ell_0(G - \alpha\ell_0) - t_0ALR_0 - \tau \frac{mb^2}{2} \quad (25)$$

where we have used (19). Substituting the budget constraint $G = T_0\theta_0L + t_0ALR_0$ and the labor market balance condition $\theta_0L = \ell_0 + m(y^* - b)$ into (25), we obtain

$$W_0 = \ell_0(I + G + E) + mT_0(y^* - b) - G - \tau \frac{mb^2}{2} - \alpha\ell_0^2 \quad (26)$$

where $\ell_0 = mb$.

The novelty here is that raising the business tax T_0 gives rise to two opposing effects. First, through the lower wage paid to the CBD workers (see (8)) a higher business tax generates tax exporting because a fraction of the CBD workers lives outside the central city ($y^* > b$).⁶ A higher business tax also induces a few suburban workers to shift to their respective SBD, which means that the extent of tax exporting ($y^* - b$) shrinks with T_0 . In other words, a rise in T_0 yields a smaller CBD, that is, a smaller fiscal basis. The equilibrium corporate tax in the central city is the outcome to this trade-off. Note that a marginal increase in T_0 has no impact on the commuting costs within its jurisdiction because all the residents work in the CBD. However, by reducing the number of CBD firms, it affects the commuting costs paid by the suburban consumers, an effect not internalized by the central city government.

A suburban jurisdiction involves two types of workers, those who work in the CBD and those who work in their own SBD. Using (20) and (21) as well as the budget constraint $F = T\theta L + tALR$ where $\theta L = B - y^*$, the total welfare in a suburban jurisdiction is given by

$$W = (y^* - b)(I + G + E - T_0) + (B - y^*)(I + G - T) + T(B - y^*) - G - \left(\int_b^{y^*} \tau x dx + \int_{y^*}^B \tau |x - x^s| dx \right) - \alpha \ell^2. \quad (27)$$

Note that the total commuting costs borne by the residents of an edge city are given by

$$\int_b^{y^*} \tau x dx + \int_{y^*}^B \tau |x - x^s| dx = \tau \left[\frac{(y^*)^2 - b^2}{2} + \frac{(B - y^*)^2}{4} \right].$$

A marginal decrease in T raises the share of jobs in the SBD, and thus reduces commuting costs within the i th edge city. In addition, a smaller number of firms in the CBD decreases the productive efficiency of the metropolitan area. A suburban government takes into account the efficiency loss occurring within its sole jurisdiction through the lower wage paid to some of its residents. In sum, unlike the central city government, a suburban government cares about the trade-off between commuting costs and agglomeration economies, but it does so within its own jurisdiction only.

Differentiating W_0 (W) with respect to T_0 (T) yields:

$$\frac{dW_0}{dT_0} = \frac{2mE}{3\tau} - \frac{2m(2T_0 - T) + 3\tau\ell_0}{3\tau} + \frac{L}{3} \quad (28)$$

and

$$\frac{dW}{dT} = -\frac{2T}{3\tau} \quad (29)$$

where $d^2W_0/dT_0^2 < 0$ and $d^2W/dT^2 < 0$ hold. Using (29), we obtain

$$T^* = 0. \quad (30)$$

⁶See Wildasin and Wilson (1998) for a discussion on tax competition with tax exporting.

In other words, the suburban governments neither tax nor subsidize firms. Plugging (30) into (28) and solving for T_0 , we get the equilibrium business tax set in the central city:

$$T_0^* = \frac{E}{2} + \frac{\tau(B - 3b)}{4}. \quad (31)$$

Hence, the business tax set by the central city raises with the intensity of agglomeration economies, whereas the elasticity of the fiscal basis decreases with τ (see (17)).

Observe that T_0^* decreases with b . Indeed, when b increases, it follows from (17) that the fiscal basis remains the same when T_0 and T are given. Hence, the extent of tax exporting $y^* - b$ shrinks. This incentivizes the central city's government to lower its tax rate to expand its fiscal basis. Furthermore, $B = L/m$ decreases with the number of suburban jurisdictions, and thus the equilibrium tax rate increases. As in Hoyt (1991), but in a different context, reducing the number of suburban jurisdictions softens tax competition and allows the central city to set a higher business tax.

Note that, at the tax rates (31) and (35), the economic boundary of the central city is given by

$$y^* = \frac{B}{6} + \frac{E}{3\tau} + \frac{b}{2}. \quad (32)$$

This expression shows how τ and E interact to determine the economic boundary of the central city through the ratio E/τ : the lower commuting costs or the stronger agglomeration economies, the larger number of suburbanites working in the CBD. This cross-border commuting flow highlights how the suburban areas benefit from the productivity gains generated by the concentration of firms in the central city (Haughwout and Inman, 2009). Furthermore, the economic size of the central city also rises with its administrative size. Last, when the metropolitan area population L gets larger all employment centers grow. However, the CBD grows at a lower rate than the SBDs. As a result, when the population of the metropolitan area is sufficiently large, the number of suburban jobs exceeds the number of jobs in the central city.

It remains to check that $b < y^* < B$. The condition $y^* < B$ holds if and only if

$$b < \hat{b} \equiv \frac{5B}{3} - \frac{2E}{3\tau}. \quad (33)$$

Thus, for the metropolitan area to be polycentric, it must be that $E < 5\tau B/2$. In other words, jobs are decentralized at the tax competition outcome when at least one of the following conditions is satisfied: (i) the metropolitan area population is large, (ii) commuting costs are high, and (iii) agglomeration economies are not too large.

Furthermore, $y^* > b$ if and only if

$$b < \tilde{b} \equiv \frac{B}{3} + \frac{2E}{3\tau} \quad (34)$$

which means that the central city population cannot be too large for the CBD to attract suburbanite workers. When $b \geq \tilde{b}$, we show in Appendix A that $y^* = b$. In other words, the economic limit of the central city is never smaller than its administrative limit.

The next proposition summarizes our results.

Proposition 2 *The central city government always sets a higher business tax than the suburban governments.*

The positive tax differential reflects the asymmetry between the central and edge cities. In particular, the tax differential widens when agglomeration economies in the central city get stronger. The intuition behind this finding is clear. As noted by Baldwin and Krugman (2004), a locale with a comparative advantage can set a higher corporate tax rate because more firms are located there. This implies a larger number of cross-border commuters, and thus a broader extent of tax exporting.⁷

How does the wage differential between CBD- and SBD-workers vary with the population size? Imagine a flow of in-migrants who occupy the suburban areas, thus implying urban sprawl through an increase in B . It then follows from (31) and (35) that the tax rate in the central city rises whereas the tax rate set by the suburban jurisdictions remains equal to 0. As a consequence, w_0^* decreases while $w^* = I$. This in turn implies that the wage differential $w_0^* - w^* = 3\tau(y^* - B/3)/2$ shrinks when L increases. It is positive if and only if $L < 3bm + 2Em/\tau$. In other words, as the metropolitan population L rises, a growing share of the labor force works in the edge cities. In the limit, when the inequality no longer holds, the SBD-workers earn a higher wage than the CBD-workers. Despite its comparative advantage in terms of accessibility and the existence of agglomeration economies, wages in the central city fall below those paid in the edge cities. Yet, a fraction of suburbanites still choose to work in the central city, the reason being that the suburban jurisdictions become so large that, for the workers close to the boundary b , commuting to the SBD is more expensive than commuting the CBD.

The reversal of fortune between the CBD and the SBDs is the reflection of the insufficient exploitation of the agglomeration economies in the central city whose relative size in the metropolitan area becomes smaller. For the metropolitan area to better exploit the productivity gains associated with the concentration of firms, the administrative boundary of the central city must be increased. This shows once more how the boundary of the central city may affect the efficiency of the metropolitan area and the welfare of its inhabitants, especially in a context of rapid urban growth.

Note, however, that the disadvantage of being a small central city may be overcome if commuting costs are sufficiently low. In this case, more jobs are created in the CBD, which

⁷Jofre-Monseny (2013) finds that higher agglomeration economies increase business tax rates in Spanish municipalities.

allows a better exploitation of agglomeration economies while the central city's government sets a lower business tax.

The monocentric metropolitan area When (33) does not hold, all jobs are concentrated in the CBD and the urban labor market is integrated. In other words, when agglomeration economies are sufficiently strong, we fall back on the standard monocentric city model of urban economics (Fujita, 1989; Zenou, 2009). The corresponding equilibrium tax paid by the CBD firms is obtained by replacing b with \hat{b} into (31), that is, the value of b that satisfies $y^* = B$ or, equivalently, $\theta = 0$:

$$T_0^* = \frac{E}{2} + \frac{\tau(B - 3\hat{b})}{4} = E - \tau B. \quad (35)$$

This expression is always nonnegative because $E < \tau B$ would imply $\hat{b} > B$.

Note that the tax rate T_0^* decreases with b as long as $b < \hat{b}$ and becomes flat and equal to (35) when b exceed \hat{b} . In this event, agglomeration economies are sufficiently strong for the central city's government to choose a tax rate that blockades the emergence of SBDs. Note (35) is the highest rate that satisfies this property. In other words, the central city behaves as if it were a monopolist that sets the limit-price to deter the entry of competitors.

When the metropolitan area is monocentric, a deeper institutional fragmentation raises the corporate tax set in the central city. Indeed, since there are no SBDs, the central city government has no incentive to reduce its tax rate when the degree of fragmentation increases. Because its population raises with m , the central city government can shift the cost of the public good toward firms without affecting the attractiveness of the CBD.

4.2.2 Property tax

It remains to determine the equilibrium property taxes, which are residual because G is exogenous. Since $T^* = 0$, the property tax revenue of a suburban jurisdiction is equal to the public good cost: $t^*ALR = G$. Using this expression and (22), we obtain the equilibrium property tax given by

$$t^* = \frac{G}{\tau} \left[\frac{(y^* - b)^2}{2} + \frac{(B - y^*)^2}{4} - \frac{G}{\tau} \right]^{-1}. \quad (36)$$

In suburban jurisdictions, the property tax increases (decreases) with the administrative boundary b (B) because the fiscal basis of a suburban jurisdiction shrinks (expands). For the same reason, a larger number of suburban jurisdictions leads to a higher property tax. The central city's economic boundary also influences the property tax rate t^* . However, unlike b that always triggers a tax hike, an increase in y^* may generate a tax drop. Indeed, $dt^*/dy^* < 0$ if and only $y^* > (2b + B)/3$ or, equivalently, $E/\tau > (B + b)/2$. In other words, an expansion of the central city's economic boundary allows the suburban governments to decrease their

property tax if and only if commuting costs are low enough, agglomeration economies are high, or both.

As for the central city, its budget constraint implies that the equilibrium property tax satisfies the relationship:

$$t_0^* = \frac{G - T_0^* m y^*}{ALR_0}$$

where ALR_0 depends on t_0^* . There is no need to solve this equation, however. Indeed, once $T_0^* m y^*$ is determined, the value of $t_0 ALR_0$ is constant regardless of the value of t_0 (see (24)). Put differently, once the business tax is chosen, the budget constraint is satisfied through the adjustment of the land tax base ALR_0 only. Thus, there is a continuum of property tax equilibria. Note, however, that the actual value of t_0 has no impact on the common utility level in the metropolitan area.

4.3 Is the CBD too large or too small?

Comparing (11) and (17) reveals that the CBD reaches its first-best size if and only if $T_0 = T$, whereas fiscal competition yields a positive tax differential equal to T_0^* . In accordance with the literature, we find that fiscal competition delivers an inefficient outcome, which takes here the concrete form of too small a CBD. In other words, a fragmented metropolitan area in which tax competition prevails is inefficient. As shown in subsection 5.2, the desirability of tax harmonization across the metropolitan area is an artefact of our modelling strategy of agglomeration economies.

Furthermore, under tax harmonization, (17) implies that $y^* = \bar{y}$ is independent of the common business tax rate \bar{T} . In this case, the central city would lean a high business rate because the tax exporting effect $\bar{T}m(\bar{y} - b)$ increases linearly with \bar{T} . It then follows from (26) that consumers in the central city are better off when \bar{T} is larger. Conversely, as shown by (27) that decreases with \bar{T} , residents in the suburban jurisdictions are worse off. As a consequence, under tax harmonization, the central city and the edge cities have opposing interests, thus highlighting the difficulty for the jurisdictions to agree on a common tax rate.

Observe that the efficiency loss generated by the misallocation of capital decreases when the central city population is raised. Indeed, when b increases the central city chooses to set a lower business tax because the fraction of workers residing outside its limit decreases (the extent of tax exporting shrinks). The administrative boundary at which the misallocation of capital vanishes under tax competition is given by the solution to $y^*(b) = \bar{y}$, where \bar{y} is the optimal economic boundary of the central city. Therefore, a planner seeking the efficient allocation of capital under tax competition chooses the administrative boundary $b = \tilde{b}$, which exceeds the optimal boundary \bar{b} . In this event, there is no cross-border commuting, hence no tax exporting, which is precisely the source for the misallocation of capital. In doing so, the planner does not

deliver the social outcome ($\tilde{b} > \bar{b}$). Indeed, the central city is too large, whereas the suburban jurisdictions are too small. This results in a suboptimal distribution of people across local public goods. Conversely, choosing \bar{b} for the administrative boundary of the central city leads to an insufficient concentration of jobs in the CBD ($y^*(\bar{b}) < \bar{y}$). In sum, under corporate tax competition, *when the population size of the central city is optimal, the CBD is too small, whereas the central city is too large when the size of the CBD is optimal.*

Likewise, a larger number of suburban jurisdictions exacerbates fiscal competition. This incentivizes the central city's government to decrease its tax rate, thus reducing the misallocation of capital.

To summarize,

Proposition 3 *In a polycentric metropolitan area, corporate tax competition yields insufficient concentration of jobs and firms in the CBD. Furthermore, the efficiency loss decreases when the relative population size of the central city increases and/or the metropolitan area gets more fragmented.*

4.4 Central city limits and metropolitan fragmentation

We now consider a second-best approach in which the planner chooses the central city's administrative boundary or the number of suburban jurisdictions, which maximizes the total welfare within the metropolitan area, prior to the game described above. In other words, the planner first chooses the welfare-maximizing value of b , or m , and then lets consumers, firms and local governments to pursue their own interest. It is readily verified that, when the metropolitan area is monocentric, the first-best and second-best approaches yield the same city size and the same degree of fragmentation. Therefore, from now on we focus on the case of polycentric metropolitan areas.

The administrative limit of the central city maximizing total welfare when T_0 and T are given by the equilibrium tax rates is given by

$$b^* = \frac{2E + (\tau + 16\alpha)B}{3\tau + 16\alpha(m + 1)}$$

where $y^* > b^* > \bar{b}$ for $m \geq 2$ and $B > b^*$ as long as $B > y^*$. Hence, as in the first-best solution, the welfare-maximizing boundary under tax competition involves institutional fragmentation. However, unlike the first-best solution, *suburban jurisdictions are smaller than the central city.* Because tax competition favors the edge cities at the expense of the central city, the second-best approach aims to reduce this distortion by fostering a bigger central city.

The planner may also determine the degree of fragmentation of the metropolitan area m^* that maximizes the total welfare given by $W_T^s = W_0 + mW$. This is implicitly given by the

first-order condition:

$$\frac{\partial W_T^s}{\partial m} = -G + \frac{E}{4} \frac{E + b\tau}{\tau} + \frac{3\tau}{16} \left(\frac{L^2}{m^2} - b^2 \right) + \alpha \left[\frac{L^2}{m^2} - (1 + 2m) b^2 \right] = 0 \quad (37)$$

with $\partial^2 W_T^s / \partial m^2 < 0$. As in the first best analysis, for a given administrative border b , m^* increases with population size (L) and agglomeration economies (E) but decreases with public expenditures (G). However, tax competition incentivizes the planner to establish a more fragmented metropolitan area than in the first-best configuration. Indeed, the optimality condition (37) evaluated at $b = \bar{b}$ and $m = \bar{m}$ implies that

$$\left. \frac{\partial W_T^s}{\partial m} \right|_{m=\bar{m}, b=\bar{b}} = \frac{3\tau}{16} \left[\left(\frac{L}{3\bar{m}} \right)^2 - \left(\bar{b} - \frac{2E}{3\tau} \right)^2 \right]$$

which is positive for all $m \geq 2$. Therefore, the planner raises the number of edge cities, or reduces their population size, to alleviate the efficiency loss associated with the insufficient concentration of firms in the CBD.

To sum up,

Proposition 4 *Assume a polycentric metropolitan area in which the planner chooses the limit of the central city or the number of jurisdictions. Then, the welfare-maximizing boundary is such that the metropolitan area is formed by several jurisdictions, while there is commuting from the suburban jurisdictions to the central city. Furthermore, the second-best central city size is larger than the first-best city size.*

Because the first-best and second-best approaches yield the same outcome when the metropolitan area is monocentric while $b^* > \bar{b}$ when the metropolitan area is polycentric, we may conclude that the planner simultaneously chooses to reduce the economic size of the central city through the emergence of SBDs and to make the central city population bigger. In other words, *the administrative and economic boundaries of the central city do not move in the same direction*. The reason for this rather unexpected result is that the planner cares only about congestion costs when the metropolitan area is monocentric, whereas he also takes commuting costs and agglomeration economies into account when the metropolitan area is polycentric.

5 Spillovers

Large metropolitan areas are replete with external effects of different types. The usual suspects are the consumption by suburbanites working in the CBD of public services provided by the central city and the presence of agglomeration economies and spillovers between firms. In this section, we discuss what our main findings become in each of these two cases. As in the foregoing, we first consider the optimal outcome, and then characterize the equilibrium generated by tax competition.

5.1 Public good spillovers

So far, we have neglected the possibility for the suburbanites working in the CBD to consume the public services provided in the central city. Instead, we now assume that in-commuters cannot be excluded from the consumption of these services. In this case, suburbanites working in the CBD benefit from both the public goods provided in their own jurisdiction and in the central city.

5.1.1 The optimal metropolitan area

That suburbanites consume public services supplied in the central city is known to be a major source of distortion in the allocation of public resources within metropolitan areas. Therefore, the analysis of Section 3 is no longer valid in presence of public good spillovers. This is because the planner faces a further trade-off: on the one hand, the suburbanites' enjoy an additional utility gain given by $m(y-b)G$; on the other hand, the public good provided by the central city is more congested, and thus generates an additional cost equal to $\alpha(my)^2 - \alpha(mb)^2$. If the total net utility is negative, that is, $G < \alpha m(y+b)$, the analysis of Section 3 holds true. When the net gain is positive, the social welfare function becomes

$$W_T = mBG + m(y-b)G + myE - \frac{m\tau y^2}{2} - m\tau \left(\frac{B-y}{2}\right)^2 - \alpha(my)^2 - \alpha m(B-b)^2. \quad (38)$$

Differentiating (38) with respect to b and y yields the optimal administrative and economic boundaries:

$$\bar{b}^{sp} = B - \frac{G}{2\alpha} < B \quad \bar{y}^{sp} = \frac{2E + 2G + \tau B}{3\tau + 4\alpha m} \quad (39)$$

where $\bar{b}^{sp} > 0$ if and only if $2\alpha B$ exceeds G , a condition we assume to hold.

The question we address is to figure out how public good spillovers shape the optimal organization of the metropolitan area. One way consists in comparing \bar{y}^{sp} with \bar{y} and \bar{b}^{sp} with \bar{b} . The expression (39) shows that the central city's population size shrinks, whereas its economic size expands with G . More precisely, we have $\bar{b}^{sp} < \bar{b}$ and $\bar{y}^{sp} > \bar{y}$ if and only if

$$G > 2\alpha m(2E + \tau B) / 3\tau \quad (40)$$

which implies that G exceeds $\alpha m(\bar{y}^{sp} + \bar{b}^{sp})$.

When (40) holds, the presence of public good spillovers leads the planner to choose a smaller central city but a larger CBD because the weight of the term $m(y-b)G$ in (38) is high. In this case, we have $\bar{y}^{sp} - \bar{b}^{sp} > \bar{y} - \bar{b} > 0$, which implies a deeper discrepancy between the two city limits.

By contrast, when (40) does not hold, we still have $\bar{y}^{sp} - \bar{b}^{sp} > 0$ as long as $G > \alpha m(\bar{y}^{sp} + \bar{b}^{sp})$. As a consequence, we always have $\bar{y}^{sp} - \bar{b}^{sp} > 0$. Furthermore, it is optimal to have a spillover in

the consumption of the public good. In brief, if G is sufficiently large, *cross-border consumption of public goods is socially desirable*.

5.1.2 The decentralized outcome

As in the foregoing, we assume that G exceeds the congestion cost generated by the larger number of users, for otherwise in-commuters would not consume the central public services. The indirect utility of a consumer living in the central city becomes $v_0(x) \equiv V_0(x) - \alpha m(y - b)$, while the indirect utility of a suburbanite working in the central city is given by $v_i^0(x) \equiv V_i^0(x) - \alpha m y + G$. Equalizing $v_0(x)$ and $v_i^0(x)$ yields the equilibrium economic boundary of the central city:

$$y^{sp}(T_0, T) = \frac{\tau B}{3\tau + 2\alpha m} + \frac{2(E + G - T_0 + T)}{3\tau + 2\alpha m}$$

which increases (decreases) with G (α) because the central city becomes more (less) attractive to the suburbanites.

Evidently, the government of the central city internalizes the congestion effects generated by the cross-commuters. As for the suburban governments, two cases may arise: (i) they focus only upon the welfare effects of their own supply of public services; (ii) they adopt an opportunistic behavior by internalizing the welfare effects of the central city's public services consumed by their out-commuters. In what follows, we consider the first case; the second one, which is solved in Appendix B, yields similar results.

The central city government maximizes the social welfare function $W_0 - \alpha m(y^{sp} - b)$ whereas the suburban governments maximize (27) in which $y^*(T_0, T)$ given by (17) is replaced with $y^{sp}(T_0, T)$. Differentiating the corresponding expressions, it can be shown that the equilibrium business tax rates are given by

$$\begin{aligned} T_0^{sp} &= \frac{(3\tau + 2\alpha m)(2E + \tau B - 3\tau b) + 6\alpha\tau m\ell_0}{4(3\tau + \alpha m)} \\ T^{sp} &= \frac{\alpha m[2E + \tau B + 3\tau b - 2\alpha(m - 1)\ell_0]}{2(3\tau + \alpha m)} - G. \end{aligned} \quad (41)$$

It follows immediately from (31) that *the business tax set by the central city is higher in the presence than in the absence of public good spillovers*. The reason is easy to grasp. More workers lure the CBD because they can enjoy the public services provided by the central city. This entices more firms to set up there. The extent of tax exporting increases, whereas its public services are subject to more congestion. Both effects lead the central city to increase its business tax. Moreover, because the consumption of the central public services by outside workers makes the CBD more attractive, the suburban governments choose to subsidy firms to restore their attractiveness ($T^{sp} < 0$). Therefore, $T_0^{sp} - T^{sp}$ exceeds $T_0^* - T^*$. As a consequence, *the CBD is smaller in the presence than in the absence of public good spillovers*.

At the above tax rates, the economic boundary of the central city is such that

$$y^{sp} = \frac{2E + \tau B + 3\tau b - 2\alpha(m-1)\ell_0}{2(3\tau + \alpha m)}$$

so that $T^{sp} = \alpha m y^{sp} - G < 0$ whereas $y^{sp} > b$ if and only if

$$b < \frac{2E + \tau B}{3\tau + 2\alpha m^2}.$$

Note that $y^{sp} = y^*$ when $\alpha = 0$. By contrast, when α is positive, we have $y^{sp} < y^*$. In addition, the stronger the congestion effect (a higher α), the smaller the CBD. All in all, the economic size of the central city shrinks in the presence of public good spillovers. Moreover, it is readily verified that $y^{sp} > b$ and $G > \alpha m y^{sp}$ imply $\bar{y}^{sp} > y^{sp}$. Because \bar{y}^{sp} grows with G whereas y^{sp} remains constant, we may conclude that stronger public good spillovers exacerbate the insufficient concentration of firms and jobs in the CBD.

Observe that the existence of spillovers has both expected and unexpected redistributive implications for consumers living in the central and peripheral jurisdictions. First, the out-commuting suburbanites benefit from more public services whereas the central city's residents bear a higher congestion cost. This is not the end of the story, however. Since the business tax paid by the CBD firms is higher, the central-city's workers get a lower pay. By contrast, the SBD workers earn a higher wage as the suburban firms are subsidized. As a consequence, *central city's residents are hurt twice through an externality effect and an income effect*. The free-riding problem between the central city and the suburban jurisdictions thus has implications that go beyond the standard consumption effects generated by spillovers. In particular, it makes the cooperation between the central and edge cities even more compelling for the metropolitan area to be efficient.

Proposition 5 comprises a summary.

Proposition 5 *Assume that the suburbanites working in the CBD consume the central city public services. Then, the central city government raises its business tax whereas the suburban governments subsidize firms. Furthermore, public good spillovers exacerbate the insufficient concentration of firms and jobs within the metropolitan area.*

5.1.3 The central city as a big supplier of public services

The central city often supplies a broader range of public services than the suburban jurisdictions. It is, therefore, legitimate to ask what the above findings become in such a context. To show it, we assume that the central city provides a public good of size βG . Alternatively, if G is a CES-bundle of differentiated public services, βG represents a wider range of services.

The optimal population size of the central city increases because the additional congestion costs borne by the central city's residents are offset by a higher utility stemming from the

consumption of the public services. It is readily verified that the optimal central city border \bar{b} is now given by

$$\bar{b} = \frac{B}{m+1} + \frac{(\beta-1)G}{2\alpha(m+1)}$$

which need not be smaller than B . As a result, the institutional structure of the metropolitan area now depends on the *relative* provision of public services between the central city and the suburban jurisdictions. The optimal size of the central city increases with the range of public services it provides, whereas the suburban jurisdictions shrink. In the limit, the planner chooses to have a single jurisdiction only if $(\beta-1)G > 2\alpha L$, a condition that is unlikely to hold in a large metropolitan area.

Note that higher public expenditures in the central city do not affect its optimal economic boundary as long as the suburbanites do not consume this good. Thus, the optimal metropolitan area may be institutionally fragmented while having an integrated labor market or may involve a single jurisdiction together with several employment centers. Moreover, since the business tax competition process does not depend on G , this asymmetry in public policies has no impact the jurisdictions' business taxes, and thus Proposition 3 holds true.

When suburbanites working in the CBD consume the central city's public services, this one becomes even more attractive. In this case, the discrepancy between the optimal administrative and economic boundaries is exacerbated. Indeed, the administrative limit in (39) is unaffected because the planner has no reason to differentiate across CBD-workers. By contrast, \bar{y}^{sp} increases with β because more consumers are able to enjoy the wider array of public services provided by the central city. Furthermore, as shown by (41) in which G is replaced with βG , the suburban governments lower their business tax. As a consequence, the tax gap widens and Proposition 5 holds true.

5.2 Firm spillovers

As mentioned in subsection 2.3, treating E as a constant constitutes a crude approximation of agglomeration economies and firms' spillovers. Given the importance played by these effects in the working of a metropolitan area, we find it important to study what our main findings become under a more general specification for the agglomeration economies in which E varies with the distribution of firms within the metropolitan area. To this end, we consider a setting used in the literature (Baldwin et al., 2005; Rosenthal and Strange, 2004).

Let $n = L$ be the total number of firms. When a firm is located in the CBD, its profits become $\Pi_0 = I - (w_0 - E_0) - T_0$ where

$$E_0 = n_0 + \lambda(n - n_0) \tag{42}$$

stands for the productivity gain associated with a central location. In this expression, E_0 increases with the number n_0 of firms located in the central city, whereas $\lambda \in (0, 1)$ measures the intensity of the spillovers between the CBD and each SBD. Hence, the benefit of being located in the CBD rises with the number of firms that locate therein as well as with the intensity of the spillovers generated by the SBDs. When a firm sets up in the i th edge city, its profit function is $\Pi_i = I - (w_i - E_i) - T_i$ with

$$E_i = n_i + \lambda n_0 \quad (43)$$

where n_i is the number of firms located in the i th SBD. Hence, an edge city benefits from interactions with the central city only, whereas the central city benefits from nonmarket interactions with all edge cities. In the symmetric case ($n_i = (n - n_0)/m$), E_0 exceeds E_i when

$$\frac{n_0}{n - n_0} > \frac{1/m - \lambda}{1 - \lambda}$$

which always holds when $\lambda > 1/m$. In other words, the CBD has a comparative advantage when λ is sufficiently large, which is similar to assuming that E is a positive constant, as in Sections 3 and 4.

5.2.1 The optimal metropolitan area

Using (42) and (43) shows that the sum of productivity gains associated with a given distribution of firms is equal to $E = E_0 n_0 + \sum_i E_i n_i$ with

$$E = my [my + \lambda m (B - y)] + m (B - y) (B - y + \lambda my).$$

It is then readily verified that maximizing productivity gains within the metropolitan area fosters a monocentric configuration ($B = y$). This is a reflection of the comparative advantage of the CBD, which unlike the SBDs interacts with each SBD. However, this argument disregards the social costs generated by workers' commuting flows. The social welfare function (9) becomes $W = E - CC - GC - PC$.

If the optimal administrative boundary of the central city is still given by \bar{b} , its optimal economic boundary now depends on the intensity of spillovers among firms. If

$$\lambda > \bar{\lambda} \equiv \frac{m + 1}{2m} - \frac{3\tau}{8m}$$

holds, then the optimal economic limit

$$\bar{y}^s = \frac{\tau B + 4B(\lambda m - 1)}{3\tau - 4(m + 1) + 8\lambda m} > \bar{b}$$

as in Section 3.

When $\lambda < \bar{\lambda}$, the social welfare function is convex. In this event, the optimal boundary is given by $\bar{y} = B$. Hence, when spillovers between the CBD and SBDs are strong, the planner chooses to reduce total commuting costs by decentralizing jobs. By contrast, when these spillovers are weak, the social optimum involves the agglomeration of firms in the CBD, for otherwise the productive efficiency losses would be too high.

5.2.2 The decentralized outcome

The study of the tax competition game under (42) and (43) requires some heavy algebra. First of all, it is readily verified that the worker is indifferent between working in the CBD or in a SBD is located at

$$y^s(T_0, T) = \frac{\tau B + 2B(\lambda m - 1) - 2(T_0 - T)}{3\tau - 2(m + 1) + 4\lambda m} \quad (44)$$

which varies with the tax differential $T_0 - T$ as (17). Rewriting the social welfare functions (25) and (27) under $y^s(T_0, T)$, we obtain

$$\frac{dW_0}{dT_0} = m(y^s - b) + mT_0 \frac{dy^s}{dT_0} + m(1 - \lambda) \frac{dy^s}{dT_0}.$$

Since the absolute value of dy^s/dT_0 decreases with λ , the third term in the right-hand side of this expression decreases with λ , and thus the impact of the first two terms becomes predominant when λ is sufficiently large.

As for the suburban jurisdictions, the tax incentives are more complex because the welfare of a CBD-worker residing in a suburban jurisdiction is affected by the CBD-externality, whereas the welfare of a SBD-worker is affected by the SBD-externality.

Solving the tax game and plugging the tax rates in (44), we get the following equilibrium value for the central city's economic boundary:

$$y^s = \frac{\tau B + 4B(\lambda m - 1) + 2b(2\lambda m - 1 - m) + 3\tau b}{6\tau - 6(m + 1) + 12\lambda m}$$

which differs from \bar{y}^s . As in Section 4, tax competition distorts the allocation of jobs and firms within the metropolitan area. Whereas exogenous agglomeration economies always generate too small a CBD, this need not be true when spillovers are endogenous. Indeed, y^s exceeds \bar{y}^s when spillovers between the CBD and SBDs are weak. Otherwise, as in Proposition 3, the equilibrium size of the CBD is smaller than its optimal size. The reason for this difference in results stems from the fact that the additional benefit of a central location increases with y at a decreasing rate when λ rises. Therefore, profits become less sensitive to the locational choices made by firms. As a result, when λ is high (low) the central city government has a weak (strong) incentive to decrease its business tax, which fosters the emergence of a small (big) CBD.

The following proposition is a summary.

Proposition 6 *In a polycentric metropolitan area corporate tax competition yields too small a CBD when spillovers between the CBD and the SBDs are sufficiently strong. Otherwise, the CBD is too large.*

6 Concluding Remarks

Metropolitan areas are non-legal entities that play a key role in the economic development of emerging and developed countries alike. This probably explains why political scientists have long been interested in issues related to metropolitan governance. The earliest approach that we are aware of -the regionalism approach that continues to shape the political debates -views the multiplicity of political jurisdictions as inherently inefficient. Political fragmentation would limit the ability to deal with area-wide urban problems that transcend local jurisdictions. The prescription is then to promote metropolitan governments and a better correspondence between administrative and functional or economic areas. In contrast to this view, the public choice approach, based on Tiebout (1956) and Ostrom, Tiebout, and Warren (1961), does not see systematic inefficiency in the polycentric political organization of metropolitan areas. Similar to market economies where firms compete to offer the best good at the best price, political fragmentation would allow residents to select the jurisdiction that offers them the best tax/service package.

Our general equilibrium model delivers a clear-cut message that strongly suggests an intermediate approach. Indeed, both the first-best and second-best solutions involve institutional fragmentation within the metropolitan area as well as an economic limit of the central city that encompasses its administrative boundary. In addition, redrawing the boundary between the central and suburban jurisdictions does not allow reaching the first best, even though such a policy may dampen the inefficient allocation of capital across employment centers. This points to the need for multifunctional governance: “small” things should be managed by local jurisdictions, and “big” things by a metropolitan government. Labor and transport issues in particular should be handled at the metropolitan area level. Although derived from a simple model, these conclusions are sufficient to show that policy recommendations based on the regionalism and public choice approaches are unwarranted.

However, although we recognize that political fragmentation is not bad per se, the underlying tax competition process leads to an inefficient distribution of jobs. This leads us to formulate some policy recommendations in the spirit of what is known in North America as “New Regionalism” (Savitch and Vogel, 2000) - mixing a polycentric political system with inter-municipal cooperation to solve mutual problems. To be precise, our analysis suggests that where the city limits are drawn matters for the efficiency of the metropolitan area be-

cause the placement may generate a misallocation of local public goods and a mismanagement of agglomeration economies. Moreover, corporate tax coordination is likely to remedy many distortions generated by tax exporting. These two recommendations would seem the minimal requirements to promote more efficient metropolitan areas.

Note that our framework could also serve to address more controversial issues in local public finance. According to Inman (2009), rethinking the governance of the metropolitan areas through Business Improvement Districts (BIDs) and Neighborhood Improvement Districts could be a way to improve the fiscal performance of large metropolitan areas. BIDs are business associations and can be considered self-financing private governments that offer supplemental services to their members. By restoring market-driven incentives in location choices, the development of BIDs within the central city would make it more attractive, thus strengthening agglomeration economies. Helsley and Strange (1998) analyze such organizations and show that their welfare effects on consumers are ambiguous and complex. However, their analysis should be extended to the case of an urban framework with the aim of determining the impact of private governments on the spatial organization of firms and consumers.

Yet it is fair to say that our findings have been obtained under several simplifying assumptions; thus care is needed in interpreting the findings. First, we did not address competition in public goods, an issue that is notoriously difficult, especially because many models are plagued with the non-existence of a Nash equilibrium. In this respect, it is worth noting that our model may be interpreted as one in which jurisdictions avoid the damaging effects of a race to the bottom by coordinating their supply of public services. Therefore, even in the absence of such distortions, our analysis has unveiled new sources of market failure. Moreover, it is well known that one political and social difficulty encountered within metropolitan areas stems from the heterogeneity of households that cluster in specific neighborhoods, which in turn generates spatial discrimination across socioeconomic groups. This issue has been tackled in the monocentric city model of urban economics but has not been explored in the context of a polycentric metropolitan area. Lastly, we did not allow consumers to choose a variable lot size by trading the homogeneous good against land. This means that a non-uniform population density emerges at the first stage of the game, which is treated parametrically in the subsequent stages. Several of our results remain valid but the determination of the equilibrium land rent within each jurisdiction is a more delicate issue.

References

Alesina, A. and E. Spolaore (1997) On the number and size of nations. *Quarterly Journal of Economics* 112: 1027-55.

- Baldwin, R.E. and P.R. Krugman (2004) Agglomeration, integration and tax harmonization. *European Economic Review* 48: 1-23.
- Baldwin, R.E., R. Forslid, P. Martin, G. Ottaviano and F. Robert-Nicoud (2005) *Economic Geography and Public Policy*. Princeton (NJ): Princeton University Press.
- Braid, R. (1996) Symmetric tax competition with multiple jurisdictions in each metropolitan area. *American Economic Review* 86: 1279-90.
- Braid, R. (2002) The spatial effects of wage or property tax differentials, and local government choice between tax instruments. *Journal of Urban Economics* 51: 429-45.
- Braid, R. (2010) Provision of a pure local public good in a spatial model with many jurisdictions. *Journal of Public Economics* 94: 890-7.
- Baum-Snow, N. (2012) Urban transport expansions, employment decentralization, and the spatial scope of agglomeration economies. Mimeo.
- Cheshire, P. and S. Magrini (2009) Urban growth drivers in a Europe of sticky people and implicit boundaries. *Journal of Economic Geography* 9: 85-116.
- Cremer, H. and P. Pestieau (2004) Factor mobility and redistribution. In: J.V. Henderson and J.-F. Thisse (eds.). *Handbook of Regional and Urban Economics. Cities and Geography*. Amsterdam: North-Holland, 2529-60.
- Cremer, H., A.-M. de Kerchove and J.-F. Thisse (1985) An economic theory of public facilities in space. *Mathematical Social Sciences* 9: 249-62.
- Duranton, G. and D. Puga (2004) Micro-foundations of urban increasing returns: theory. In: J.V. Henderson and J.-F. Thisse (eds.). *Handbook of Regional and Urban Economics. Cities and Geography*. Amsterdam: North-Holland, 2063-117.
- Epple, D. and T. Nechyba (2004) Fiscal decentralization. In: J.V. Henderson and J.-F. Thisse (eds.). *Handbook of Regional and Urban Economics. Cities and Geography*. Amsterdam: North-Holland, 2423-80.
- Epple, D. and A. Zelenitz (1981) The implications of competition among jurisdictions: Does Tiebout need politics? *Journal of Political Economy* 89: 1197-217.
- Fujita, M. (1989) *Urban Economic Theory. Land Use and City Size*. Cambridge: Cambridge University Press.
- Glaeser, E.L., and J.D. Gottlieb (2009) The wealth of cities: agglomeration economies and spatial equilibrium in the United States. *Journal of Economic Literature* XLVII: 983-1028.
- Glaeser, E.L. and M.F. Kahn (2001) Decentralized employment and the transformation of the American city. *Brookings-Wharton Papers on Urban Affairs* (2): 1-47.
- Glaeser, E.L. and M.E. Kahn (2004) Sprawl and urban growth. In: J.V. Henderson and J.-F. Thisse (eds.). *Handbook of Regional and Urban Economics. Cities and Geography*. Amsterdam: North-Holland, 2481-527.

- Haughwout, A. and R. Inman (2009) How should the suburbs help their central city? Growth- and welfare-enhancing intrametropolitan fiscal distributions. *Annals of the American Academy of Political and Social Science* 621: 39-52.
- Helsley, R.W. and W.C. Strange (1998) Private government. *Journal of Public Economics* 69: 281-304.
- Hoyt, W.H. (1991) Property taxation, Nash equilibrium and market power. *Journal of Urban Economics* 30: 123-31.
- Inman, R. (2009) *Making Cities Work*. Princeton (NJ): Princeton University Press.
- Jofre-Monseny, J. (2013) Is agglomeration taxable? *Journal of Economic Geography* 13: 177-200.
- Laussel, D. and M. Le Breton (1998) Existence of Nash equilibria in fiscal competition games. *Regional Science and Urban Economics* 28, 283-96.
- Noiset, L. and W. Oakland (1995) The taxation of mobile capital by central cities. *Journal of Public Economics* 57: 297-316.
- OECD (2006) *Competitive Cities in the Global Economy*. OECD Territorial Reviews.
- Ostrom, V., C. Tiebout and R. Warren (1961) The organization of government in metropolitan areas: a theoretical inquiry. *American Political Science Review* 55: 831-42.
- Perroni, C. and K.A. Scharf (2001) Tiebout with politics: capital tax competition and constitutional choices. *Review of Economic Studies* 68: 133-54.
- Rhode, P.W. and K.S. Strumpf (2003) Assessing the importance of Tiebout sorting: local heterogeneity from 1850 to 1990. *American Economic Review* 9: 1648-77.
- Rosenthal, S.S. and W.C. Strange (2004) Evidence on the nature and sources of agglomeration economies. In: J.V. Henderson and J.-F. Thisse (eds.). *Handbook of Regional and Urban Economics. Cities and Geography*. Amsterdam: North-Holland, 2119-71.
- Rothstein, P. (2007) Discontinuous payoffs, shared resources, and games of fiscal competition: existence of pure strategy Nash equilibrium. *Journal of Public Economic Theory*: 335-68.
- Savitch H.V and R. Vogel (2000) Paths to New Regionalism. *State and Local Government Review* 32: 158-68.
- Scotchmer, S. (2002) Local public goods and clubs. In: A. Auerbach and M. Feldstein (eds.). *Handbook of Public Economics, Volume 3*. Amsterdam: North-Holland, 1997-2042.
- Starrett D. (1981) Land value capitalization in local public finance. *Journal of Political Economy* 89: 306-27.
- Tiebout, C.M. (1956) A pure theory of local public expenditures. *Journal of Political Economy* 64: 416-24.
- Wildasin, D. and J.D. Wilson (1998) Risky local tax bases: risk-pooling vs. rent-capture. *Journal of Public Economics* 69: 229-47.

Appendix A

Assume that $y^* \leq b$, which is equivalent to $b \geq \tilde{b}$. In this event, (26) no longer describes the total welfare in the central city, which is now given by the following expression:

$$W_0 = (I + E - T_0)my^* + (b - y^*)m(I - T) - m\tau\frac{(y^*)^2}{2} - m\tau\frac{b^2 - (y^*)^2}{2} - \alpha\ell_0^2 - (F - T_0my^*)$$

where y^* is given by (17). It is then readily verified that

$$\frac{dW_0}{dT_0} = m(E + T)\frac{dy^*}{dT_0} < 0. \quad (\text{A.1})$$

Since y^* decreases with T_0 , the above inequality implies that, for any T , the best reply $T_0^*(T)$ must be such that

$$y[T_0^*(T), T] = b.$$

As for the total welfare in a suburban jurisdiction, it becomes

$$W = (B - b)(I - T) - \frac{\tau}{2}\left(\frac{B + y^*}{2} - b\right)^2 - \frac{\tau}{2}\left(B - \frac{B - y^*}{2}\right)^2 - \alpha\ell^2 - [F - (B - y^*)T].$$

Differentiating W with respect to T yields the first-order condition:

$$\frac{dW}{dT} = b - y^* - \left[\frac{\tau}{2}(y^* - b) + T\right]\frac{dy^*}{dT} = 0$$

with $d^2W/dT^2 < 0$. Because $b - y^* = 0$ must hold in equilibrium, the above equality implies that $T^* = 0$ in (A.1). Plugging this value into (17) and solving for T_0 yields

$$T_0^* = E + \frac{3\tau}{2}\left(\frac{B}{3} - b\right).$$

In sum, the marginal worker is located outside the central city ($b < y^*$) or at the city border ($y^* = b$).

Appendix B

Assume now that the suburban governments internalize the spillovers and congestion costs associated with the consumption of the central city services by their out-commuters. The

objective function of the central city's government is unchanged, but suburban governments now maximize

$$W^{\text{SP}} = W^{\text{SP}} + (y^{\text{SP}} - b)G - \alpha(y^{\text{SP}} - b)my^{\text{SP}}.$$

The corresponding equilibrium tax rates are given by

$$\begin{aligned} T_0^{\text{SP}} &= \frac{(3\tau + 2\alpha m)(\tau L + 2mE + 2mG)}{12m(\tau + \alpha m)} + \frac{(3\tau + 2\alpha m)G}{6(\tau + \alpha m)} + \frac{2\alpha\ell_0(2\alpha m - 3\tau) - 9b\tau^2}{12(\tau + \alpha m)} \\ T^{\text{SP}} &= -\frac{\alpha(\tau L + 2mE)}{6(\tau + \alpha m)} - \frac{\alpha[2mG - \ell_0(3\tau + 4\alpha m)]}{6(\tau + \alpha m)}. \end{aligned}$$

The business tax set by the central city government thus increases with the extent of the spillover whereas the subsidy paid by the suburban governments increases.

The central city's economic border is now given by

$$y^{\text{SP}} = \frac{E}{3(\tau + \alpha m)} + \frac{\tau B + 3\tau b + 2\alpha\ell_0}{6(\tau + \alpha m)} + \frac{G}{3(\tau + \alpha m)}$$

which implies that the economic border of the central city increases with G because the existence of spillovers make the central city more attractive as a workplace.

Figure 1. The spatial pattern of the metropolitan area ($m=8$)

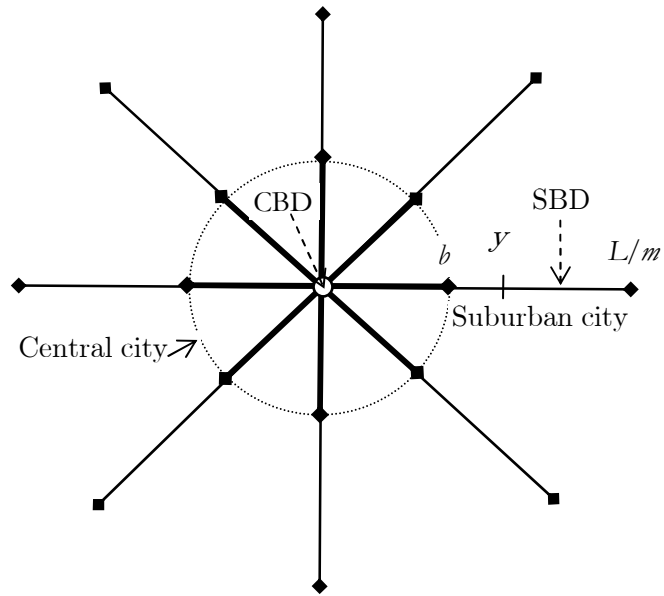


Figure 2. Equilibrium Land Rent

