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Neither big government, nor laissez-faire

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CORE

DISCUSSION PAPER

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**How to make the metropolitan area work?
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Carl GAIGNE ¹, Stéphane RIOU ²
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Abstract

We study how political boundaries and tax competition among jurisdictions interact with the labor and land markets to determine the economic structure and performance of metropolitan areas. Contrary to general belief, institutional fragmentation and cross-border commuting need not be welfare-decreasing, but the size of the central city matters for welfare. Under tax competition the central business district is too small. Tax competition also prevents public policy enhancing global productivity to produce their full impact. Although our results support the idea of decentralizing the supply of local public services by independent jurisdictions, they also highlight the need of coordinating tax policies.

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

JEL Classification: H41, H71, R12

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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). Since metropolitan areas also produce a sizable and growing share of the wealth of nations, we may safely conclude that there is a need for a sound economic analysis of those entities.¹

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 metropolitan area. The standard approach to jurisdiction/club 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 (Scotchmer, 2002; 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 metropolitan area affects the location of firms and consumers. It is well documented empirically

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

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, 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 the 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 fraction of jobs 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 city may be higher or lower than that in the suburban districts. Yet, 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.

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 areas providing the public services and the employment centers by choosing where consumers live and work. It is never desirable to amalgamate the suburban areas with the central one. Moreover, the economic boundary of the central city always encompasses its administrative boundary. This implies that *the administrative and economic boundaries of the central city do not coincide*, a result that clashes with the general belief that these boundaries should be the same (OECD, 2006). This is because the planner chooses the size of a supply area 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, jobs are shared between the central and suburban areas.

2. We then study the decentralized outcome when the number of independent jurisdictions and their administrative boundaries are exogenously given (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 public services. To finance them, 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 city need not reside therein, which incentivizes the central city government to practice *tax exporting*. This result shows the importance of working with a setting in which the commuting pattern is endogenous.

We also show that, under corporate tax competition, when the population size of the central city is optimal, the central business district is too small, whereas the former is too large when the size of the latter is optimal. Therefore, redrawing the border of the central city is not the remedy to correct the misallocation of jobs 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. It should be stressed, however, that the misallocation of jobs is exacerbated when the relative population size of the central city is small. Furthermore, although higher agglomeration economies, lower commuting costs, or both raise the global efficiency of the metropolitan area, the gap between the optimal and equilibrium central business districts grows. Thus, *tax competition prevents public policy enhancing the global productivity of the metropolitan area to produce their full impact*.

3. Once it is recognized that suburbanites commuting to the central business district 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 production costs borne by its residents (Section 5). All in all, the central city residents are hurt twice by the suburbanites' free-riding behavior: *they end up bearing higher provision costs for their public services and earning lower wages*. This concurs with Katz for whom the culture of competition that prevails in many metropolitan areas is damaging to the central city.

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.

Our analysis suggests that neither the amalgamation nor the decentralization among competing jurisdictions is the best way to govern large metropolitan areas. Instead, 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. In other words, our findings point to the need for a common governance in a few well-defined domains, that is, tax policies. 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). As for the transportation policy, different institutional systems prevail, ranging from the local to the federal government.

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 services and the labor and land markets.

The model is presented in the next section, whereas Section 3 describes the socially optimal organization of the 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 central business district 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 and discusses possible extensions.

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 local jurisdictions, and (iii) a homogeneous good, the numéraire, produced by profit-maximizing firms whose locations are endogenous.

2.1 Jurisdictions and the provision of public goods

The metropolitan area (MA) is formed by $m + 1$ jurisdictions. It is endowed with a *hub-and-spoken* transportation network, which means that the $m \geq 2$ suburban jurisdictions are connected only to the central city, which has a direct access to all suburbanites. Formally, the MA is thus described by m one-dimensional half-lines sharing the same initial point $x = 0$. Distances and locations are expressed by the same variable x measured from 0.

The central city hosts the central business district (CBD) of the MA at $x = 0$, while each suburban jurisdiction may, or may not, accommodate a secondary business district (SBD). 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 MA 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 MA.

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.

Although several of the results shown in Section 4 hold true in the case where the boundaries between the central city and the suburban jurisdictions are different, we assume that the institutional setting is symmetric. Indeed, proving the existence of a (pure-strategy) Nash equilibrium in a tax game often requires strong assumptions (Laussel and Le Breton, 1998; Rothstein, 2007). In a symmetric MA, we are able to show the existence of a unique tax equilibrium. In addition, using a symmetric setting vastly simplifies the comparison between the equilibrium and social optimum. From now on, the central city is thus assumed to share the same boundary b with each suburban jurisdiction, while all suburban jurisdictions have the same outer limit $B = L/m$. Hereafter, we will distinguish between the boundary b and the economic limit y of the central city, which is defined the boundary of the CBD labor pool. As a result, the central city population (ℓ_0) and a suburban jurisdiction population (ℓ) are, respectively, given by

$$\ell_0 = mb \quad \ell = B - b$$

with $\ell_0 + m\ell = L$. This implies that the SBDs (if any) are symmetrically located around the central city at a distance x^s from the CBD.

Each jurisdiction has to supply a bundle of public services to its residents, which gives them the same given utility level G across the MA (e.g. schools, daily care clinics, recreational facilities). Assuming that G is the same across jurisdictions vastly simplifies the analytical developments. We discuss in subsection 5.1 the case in which the central city supplies a wider range of public services than the suburban jurisdictions. When the supplied population is $l = \ell_0, \ell$, the cost of providing these services is given by

$$C(l) = F + \frac{c}{2}l^2$$

where F stands for a jurisdiction's investment outlays and $cl^2/2 > 0$ the variable production cost, which increases with the population size l of the jurisdiction. This specification features two characteristics that are frequently encountered in the provision of local public services: (i) the need to build infrastructures having a minimum size and (ii) the congestible nature of these

infrastructures, so that supplying a rising number of users requires growing expenditures.³ Only the local residents use the public services supplied by their jurisdictions. In subsection 5.1, we allow the cross-border commuters to consume the central city public services.

Each jurisdiction must balance its budget. This is achieved by allowing a jurisdiction to use two instruments, that is, a *property* tax levied on the land rent prevailing in the jurisdiction and a *business* tax paid by the firms located therein.

When a suburban jurisdiction accommodates a SBD, we call it an *edge city* to differentiate it from the central city. In this case, the MA 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 MAs.

2.2 Workers and land rents

The unit commuting cost $\tau > 0$ borne by consumers is the same in both the central city and the suburban jurisdictions, perhaps because transportation infrastructures are planned at the level of the entire MA. Therefore, commuting costs are equal τx or $\tau |x - x^s|$ according to the location of her employment center. Each jurisdiction owns its land and the aggregate land rent is evenly redistributed among the residents.⁴

Let y be the endogenous location of the individual indifferent between working in the CBD or in any SBD. As will be seen below, a commuting pattern such that $y < b$ is never an equilibrium or a solution chosen by the planner. Consequently, only the following three patterns may emerge: (i) when $b < y < B$, there are one CBD and m SBDs; (ii) when $b < y = B$, there are no SBDs but $m + 1$ jurisdictions; and (iii) when $b = y = B$, 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 MA.

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

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

where $R_0(x)$ is the land rent at a distance x from the CBD, while w_0 is the wage paid by the

³In other words, we assume that the extra cost generated by a bigger population is reflected in the provision cost of the public services. Alternatively, we could assume that the public services are congestible ($G - cl$) but supplied at a zero marginal cost.

⁴Instead 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.

firms located in CBD, t_0 the property tax levied by the central city government, while

$$ALR_0 = m \int_0^b R_0(x) dx$$

is the aggregate land rent in the central city. When a consumer lives in a suburban jurisdiction and works in the central city, her indirect utility becomes

$$V_0^s(x) = w_0 - (1 + t)R(x) - \tau x + G + \frac{ALR}{\ell} \quad (2)$$

where $R(x)$ and t are, respectively, the land rent and property tax in a suburban jurisdiction, while

$$ALR = \int_b^B R(x) dx.$$

Last, when a consumer lives and works in a suburban jurisdiction, her indirect utility is

$$V^s(x) = w - (1 + t)R(x) - \tau |x - x^s| + G + \frac{ALR}{\ell} \quad (3)$$

where w is the wage rate paid in a SBD.

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 and t_0 the property tax set in the central city.

The land rent prevailing in a suburban jurisdiction is given by

$$R(x) = \max \{ \Phi_0^s(x), \Phi^s(x), 0 \} \quad (5)$$

where $\Phi_0^s(x)$ ($\Phi^s(x)$) is the bid rent at x of a worker living in a suburban jurisdiction and working in the central city (an edge city). Given $V_0^s(x)$ and $V^s(x)$, the equilibrium land rent is such as $\partial V_0^s(x)/\partial x = \partial V^s(x)/\partial x = 0$. As a consequence, the bid rents are

$$\Phi_0^s(x) = r_0^s - \frac{\tau}{1 + t} x \quad \Phi^s(x) = r^s - \frac{\tau}{1 + t} |x - x^s|$$

where both r_0^s and r^s will be determined in subsection 4.1.2; t is the property tax set in a suburban jurisdiction. 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 MA 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. However, our setting can easily be extended to the case of firms producing a differentiated good under monopolistic competition. Note also that the numéraire can be used to import other goods produced in other specialized cities, as in Henderson (1974).

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 MA 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 MA. Hence, all firms located in a MA 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 setting that captures endogenous agglomeration economies as well as spillovers between the CBD and the SBDs, and show that our main results are unaffected.

Let Π_0 (Π) be the profits earned by a firm set up in the central city (an edge city). A firm located in the CBD earns net profits equal to

$$\Pi_0 = I - (w_0 - E) - T_0 \quad (6)$$

where I denotes the firm's revenue, while $(w_0 - E)$ is the fixed production cost borne in the CBD.

Because our setting is symmetric, all suburban jurisdictions charge the same business tax rate T and SBD-firms pay the same wage w . Thus, when a firm sets up in an edge city, its profit function becomes:

$$\Pi = I - w - T. \quad (7)$$

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 , we get

$$w_0 = I + E - T_0 \quad w = I - T. \quad (8)$$

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 MA 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 thus immaterial for our analysis because I does not enter the profit/utility differentials that drive workers' and firms' locational choices.

3 The Optimal Metropolitan Area

In this section, we assume that a social planner maximizes total welfare in the MA by choosing the size and number of areas supplying public services as well as consumers' and firms' locations, hence the commuting pattern. In doing so, the planner faces the same trade-offs as the market and the local governments: (i) to centralize (decentralize) the provision of public services with the aim of minimizing investment costs (operating costs) and (ii) to concentrate firms and jobs in the CBD (disperse firms and jobs through the CBD and SBDs) with the aim of maximizing agglomeration economies (minimizing commuting costs). What we call here the supply areas, the boundaries of which are chosen by the planner, are not to be confused with the political jurisdictions that are independent entities competing to attract firms and consumers within exogenously given boundaries. However, although the jurisdictions' areas will be given in the sections where we study the decentralized outcome, they will play a role similar to that of the supply areas.

Owing to symmetry, b , y and B are the same along each spoken. There are three types of commuting patterns: (i) a consumer lives and works in the central city; (ii) a consumer lives in a suburban supply area but works in the central city; and (iii) a consumer resides and works in the same suburban supply area.

Individual utilities being linear, the total welfare W_T within the MA may be defined by the

total surplus:

$$W_T = m \int_0^B G dx + PE - CC - PC \quad (9)$$

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 a SBD; (ii) the commuting costs borne by the individuals working in the CBD or in the SBDs:

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

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 to the CBD; and (iii) the cost of providing the various public services in all jurisdictions:

$$PC = (m+1)F + \frac{c}{2}\ell_0^2 + m\frac{c}{2}\ell^2.$$

3.1 The optimal size of supply areas and labor pools

Assume that the number $m+1$ of supply areas is given. By choosing the boundary b of the central city, the planner determines the population size in each supply area. Evidently, a marginal expansion of the central city (a higher b) reduces the number of residents in all suburban supply areas. As a consequence, the cost of public services 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 decentralize the provision of public services into $m+1$ supply areas. The optimal size of a suburban supply area is equal to

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

while the optimal size of the central city is equal to $\bar{\ell} = m\bar{b}$. Thus, the central city and the suburban supply areas have the same population size. As a result, production costs in public services are equalized across all supply areas. Note also that, at the optimum, the total number of suburbanites exceeds the number of the central city residents.

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 MA is maximized when all firms are located in the CBD, i.e. $y = B$. Because y does not affect directly the production cost of the public services, 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:

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

where $\bar{y} > \bar{b}$ when $m > 2$ and $\bar{y} = \bar{b}$ when $m = 2$. As a consequence, the CBD labor pool always encompasses the central city, while the SDBs are located in the suburban supply areas. Even when there is no agglomeration externality ($E = 0$), $\bar{y} > \bar{b}$ when $m > 2$. Indeed, the central position of the CBD in the transportation network makes the cross-border commuting socially desirable. As the intensity of agglomeration economies rises (E), the level of commuting costs decreases (τ), or both, the CBD grows at the expense of the SDBs. Likewise, when the total population of the MA 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 MA is polycentric ($\bar{y} < B$). This is so if and only if

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

In this event, the optimal MA 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 $B = L/m$, a population hike fosters the emergence of SDBs.

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 SBD. Put differently, *the CBD is always larger than a SBD*. However, 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 MA 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 both for SDBs to emerge: $\bar{y} = B$. Under these circumstances, the agglomeration of firms and jobs in the CBD, whence a monocentric MA, is socially desirable. Interestingly, the labor market is integrated though the supply of public services is decentralized within the MA. In other words, at the social optimum, the *decentralization* of public services within the MA and the *agglomeration* of firms and jobs in the CBD do not necessarily conflict.

3.2 The optimal number of supply areas

The planner may also choose the degree of decentralization in the provision of public services through the variable m . Since $L = mB$, choosing m amounts to choosing the spatial extent of the MA. Two cases must be distinguished. In the first one, it is optimal to concentrate firms and jobs in the CBD. Differentiating W_T with respect to m at \bar{b} and \bar{y} leads to the following equilibrium condition:

$$\frac{\tau L^2}{2m^2} + \frac{c}{2} \left(\frac{L}{m+1} \right)^2 - F = 0 \quad (14)$$

which does not have a simple analytical solution for the optimal number \bar{m} of jurisdictions. Note that (14) includes the standard trade-off between the fixed cost of a supply area and the cost saved on the incumbent supply areas when a new supply area is added to the MA. And indeed, $d\bar{m}/dF < 0$ and $d\bar{m}/dc > 0$. It is also readily verified that $d\bar{m}/d\tau > 0$ and $d\bar{m}/dL > 0$. Lower commuting costs, a less populated MA, or both lead to a smaller number of suburban supply areas. As a consequence, the optimal structure of the MA is governed by the trade-off between commuting costs and the cost of providing public services. In particular, if F is high (low), the planner provides the public services by means of a small (large) number of supply areas.

In the second case, it is optimal to break up the MA into several employment centers. The optimal value of m is now implicitly given by

$$\frac{\tau L^2}{6m^2} + \frac{E^2}{3\tau} + \frac{c}{2} \left(\frac{L}{m+1} \right)^2 - F = 0$$

which, unlike (14), depends on the level E of agglomeration economies because not all firms are located at the CBD.

The impact of L , F and c 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 supply areas. 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 MA. This incentivizes the planner to select a smaller value for \bar{m} because this reduces total investment outlays. 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, unless increasing returns in producing public services are very strong, the optimal metropolitan area involves several suburban areas supplying public services as well cross-border commuting from the suburban areas to the central city.*

Thus, when increasing returns in producing public services are not too strong (F is not too high), the “fragmentation” of the MA into several suburban areas supplying each the public services need not be wasteful. Likewise, cross-border commuting from the suburbs to the central city is not evidence of a suboptimal political organization of the MA.

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 (m) and the administrative boundary (b) between these jurisdictions and the central city are given. Our purpose is to find how the institutional parameters b and m , as well as the main economic parameters, affect the tax policies and the location of firms and jobs.

The spatial structure of the MA 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. Thus, we have $V^* = V_0(x)$ for $0 \leq x \leq b$, $V^* = V_0^s(x)$ for $b < x \leq y$, and $V^* = V^s(x)$ for $y < x \leq B$. We call y the *economic boundary* of the central city, which is defined as the limit of the area that includes all the individuals working in the CBD.

The socially optimal MA 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 $i = 1, \dots, m$. Since there is no vacant land, we have $B = L/m$. Since $w_i = w$, it must be that $y_i = y$. Note, finally, that using 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 MA. For this, 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 $V_0^s(y) = V^s(y)$ or, equivalently,

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

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. Moreover, stronger agglomeration economies yield a bigger CBD while lowering commuting costs have the same effect 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. At this condition also, my^* increases with m . In this case, a more fragmented MA has smaller SBDs.

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

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

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

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

for $0 \leq x \leq b$. There are two groups of suburbanites living in a suburban jurisdiction: those who work in the CBD and pay the land rent R_0^s , and those who work in their SBD and pay the land rent R^s . Using (2) and (8) shows that the utility of a consumer belonging to the first group is

$$V_0^s(x) = I + E - T_0 - (1 + t)R_0^s(x) - \tau x + G + \frac{ALR}{\ell} \quad (20)$$

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

$$V^s(x) = I - T - (1 + t)R^s(x) - \tau |x - x^s| + G + \frac{ALR}{\ell} \quad (21)$$

with $y^* < x \leq B$. Using the equilibrium conditions $V_0 = V_0^s = V^s = V^*$, we are now equipped to determine the value of r_0 for the central city as well as the values of r_0^s and r^s for the suburban jurisdictions.

At $x = B$, the land rent equals the opportunity cost of land, which is zero. At $x = y^*$, the land rent must be equal to 0 for $V(y^*) = V(B)$ to hold. Indeed, if a consumer offers a positive bid to reside at y^* , her utility is given by $V(y^*) < V(B)$. The results in turn imply

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

which yields

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

Since $R^s(y^*) = 0$, repeating the above argument leads to

$$r_0^s = \frac{\tau}{1 + t}y^*$$

and thus

$$R_0^s(x) = \frac{\tau}{1 + t}(y^* - x).$$

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 $V_0(b) = V_0^s(b)$ and (4), we get

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

which shows that the central city 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,

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

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 live in jurisdictions with different costs per capita for the public services 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 $R_0(x)$, $R_0^s(x)$ and $R^s(x)$ 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 $R^s(x)$ and $R_0^s(x)$ do not depend on the central city property tax, the tax policy of the suburban jurisdictions generates a tax 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 $(1+t)R^s(x)$ and $(1+t)R_0^s(x)$ 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 $i = 0, 1, \dots, m$ is given by

$$F + c\frac{\ell_i^2}{2} = T_i\theta_i L + t_i ALR_i$$

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

$$W_0 = m \int_0^b V(x) dx = \ell_0(I + E - T_0 + G) - t_0 ALR_0 - \tau \frac{mb^2}{2} \quad (25)$$

where we have used (19). Substituting the budget constraint $F + c\ell_0^2/2 = T_0\theta_0 L + t_0 ALR_0$ and the labor market balance condition $\theta_0 L = \ell_0 + m(y^* - b)$ into (25), we obtain

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

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 ($y^* > b$).⁵ A

⁵See Wildasin and Wilson (1998) for a discussion on tax competition with tax exporting.

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 $F + c\ell^2/2 = T\theta L + tALR$ where $\theta L = B - y^*$, the total welfare in a suburban jurisdiction is given by

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

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 MA. 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:

$$\frac{dW_0}{dT_0} = m \left[(y^* - b) - \frac{2T_0}{3\tau} \right] \quad (28)$$

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

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

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 rises with the intensity of agglomeration economies because more firms want to benefit from a central location. Similarly, lowering commuting costs leads to a smaller business tax rate because the location of jobs is more sensitive to a change in the spatial difference in business tax rates when commuting costs lower (the elasticity of the tax base with respect to the tax rate increases when τ falls).

Observe that T_0^* decreases with b . Indeed, when b increases, (17) implies that y^* remains the same when T_0 and T are given. Hence, the extent of tax exporting $y^* - b$ shrinks. This incentivizes the central city 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, since the business tax rate decreases with b , the CBD becoming more fiscally attractive, and thus the economic size of the central city also rises with b .

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

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

For the MA to be polycentric, \hat{b} must be positive and smaller than B . The former holds if and only if $E < 5\tau B/2$, while the latter amounts to $E < \tau B$, which is the more stringent condition. Using $E < \tau B$ shows that the central city business tax (31) is always positive. Summing up, jobs are decentralized at the tax competition outcome when at least one of the following conditions is satisfied: (i) the MA 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 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.*

Note that the above result holds true when $E = 0$. Thus, the positive tax differential reflects two types of asymmetries: the first one is due to the central position of the CBD in the transportation network, while the other stems from the presence of agglomeration economies at the CBD. 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 want to locate there. This implies a larger number of cross-border commuters, and thus a broader extent of tax exporting.⁶

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 (30) 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. The wage gap is positive if and only if $L < 3bm + 2Em/\tau$. When this inequality does not hold, 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 MA becomes smaller. For the MA 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 MA 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 allows a better exploitation of agglomeration economies while the central city government sets a lower business tax.

⁶Jofre-Monseny (2013) and Koh et al. (2013) find, respectively, that higher agglomeration economies increase business tax rates in Spanish and German municipalities.

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 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 MA 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 is residual because $F + c\ell_i^2/2$ 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

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

In suburban jurisdictions, the property tax may increase or decrease with the administrative boundary b . Indeed, whereas t^* may increase with b because the fiscal basis of a suburban jurisdiction shrinks, the opposite effect may arise because, the jurisdiction becoming less populated, the public services are less costly to provide. Obviously, the latter effect dominates when c is high enough. For the same reason, a larger number of suburban jurisdictions has an ambiguous effect on the property tax. The central city economic boundary also influences the property tax rate t^* . In particular, 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 economic boundary allows the suburban governments to decrease their property tax if and only if commuting costs are low, agglomeration economies are strong, or both.

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

$$t_0^* = \frac{F + c\ell_0^2/2 - T_0^*my^*}{ALR_0}$$

where ALR_0 depends on t_0^* . There is no need to solve this equation, however. Indeed, once $T_0^*my^*$ is determined, the value of t_0ALR_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 MA, so that any equilibrium value may be chosen.

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 tax competition yields a positive tax differential equal to T_0^* . In accordance with the literature, we thus find that business tax competition delivers an inefficient outcome. This takes here the concrete form of too small a CBD since

$$y^* - b = \frac{1}{2}(\bar{y} - b).$$

Furthermore, (17) implies that $y^* = \bar{y}$ regardless 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, because (27) decreases with \bar{T} , residents in the suburban jurisdictions are worse off. As a consequence, the central city and the edge cities have opposing interests, thus highlighting the difficulty for the jurisdictions to agree on a common tax rate. As shown in subsection 5.2, the desirability of tax harmonization critically depends on our modelling strategy of agglomeration economies. What is robust for enhancing the productive efficiency of the MA is the need to coordinate business tax policies.

Observe that the productive efficiency loss generated by the misallocation of capital decreases when the central city population raises. 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 jurisdictions. 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.*

Last, like in standard oligopoly theory, a larger number of suburban jurisdictions exacerbates competition. This incentivizes the central city 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 productive efficiency loss decreases when the relative population size of the central city increases and/or the number of suburban jurisdictions rises.*

Note that higher agglomeration economies, lower commuting costs, or both raise the global productive efficiency of the MA, mEy^* , because the CBD attracts more firms. However, the relative productive efficiency loss, $mE(\bar{y} - y^*)$, also increases when agglomeration economies are higher and/or commuting costs lower. This is because the planner internalizes the whole benefits generated by these two effects, whereas the local governments do not. To be precise, the fiscal externality generated by the central city government onto the suburban jurisdictions is given by

$$m \frac{dW}{dT_0} \Big|_{T_0=T_0^*} = -m(y^* - b)$$

which is proportional to the extent of tax exporting ($y^* - b$), while its magnitude increases with E and decreases with τ . Therefore, we have:

Proposition 4 *Tax competition prevents public policies that aim to enhance the global productivity of the MA to deliver their full potential impact.*

4.4 Does redrawing the central city limit remedy the misallocation of jobs?

We now consider a second-best approach in which the planner chooses the central city administrative boundary or the number of suburban jurisdictions, which maximizes the total welfare

within the MA, 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 MA 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 a polycentric MA.

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

$$b^* = \frac{2E + B(8c + \tau)}{3\tau + 8c(m + 1)}$$

where $y^*(b^*) > b^* > \bar{b}$ 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 and a decentralized supply of public services. However, unlike the first-best solution, *suburban jurisdictions are always 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 MA m^* maximizing the total welfare $W_T^s = W_0 + mW$. It is implicitly given by the equilibrium condition:

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

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 the population size (L), the intensity of agglomeration economies (E) and the cost parameter capturing the crowding effect of public services (c), while it decreases with investment outlays (F). However, tax competition incentivizes the planner to establish a more fragmented MA 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, that is, reduces their population size, to alleviate the efficiency loss associated with the insufficient concentration of firms in the CBD.

To sum up,

Proposition 5 *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 is bigger than the first-best central city.

Equally important, the planner can improve the efficiency of the distribution of firms by investing in transport infrastructure within the whole MA. Indeed, lowering commuting costs entices the central city government to decrease its business tax rate. This in turn leads more firms to set up in the CBD, which reduces the productivity losses generated by institutional fragmentation and tax competition. In this case, the need of redrawing the boundaries of the central city is less stringent.

5 Spillovers

A large MA is 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 services provided in their own jurisdiction and in the central city. These consumers, enjoy a utility level equal to $2G$ from consuming all the public services.

5.1.1 The optimal metropolitan area

That suburbanites consume the public services supplied in the central city is known to be a major source of distortion in the allocation of public resources within a MA. In presence of such spillovers, the analysis of Section 3 is no longer valid. This is because the planner faces an additional trade-off: on the one hand, the suburbanites' enjoy an additional utility gain given by $m(y - b)G$; on the other hand, the cost of the public services provided by the central city rises by an amount equal to $c(my)^2/2 - c(mb)^2/2$. If the total utility change is negative, that is, $G - cm(b + y)/2 < 0$, the analysis of Section 3 holds true because consuming the public

services supplied in the central city makes the suburbanites worse-off. On the contrary, when $G > cm(b + y)/2$, the social welfare function becomes

$$W_T = mBG + m(y - b)G + myE - \frac{m\tau}{2}y^2 - m\tau\left(\frac{B - y}{2}\right)^2 - \frac{c}{2}(my)^2 - \frac{cm}{2}(B - b)^2 - (m + 1)F. \quad (38)$$

Solving the first-order conditions for welfare maximization (38) with respect to b and y yields

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

where $\bar{b}^{sp} > 0$ if and only if cB exceeds G ; otherwise, $\bar{b}^{sp} = 0$.

The question we address here is to figure out how public good spillovers affect the optimal organization of the MA. One solution consists in comparing \bar{y}^{sp} with \bar{y} and \bar{b}^{sp} with \bar{b} . The expression (39) shows that the central city population size shrinks whereas its economic size expands with G . More precisely, when the condition $G > cm(\bar{b}^{sp} + \bar{y}^{sp})/2$ holds, we always have $\bar{b}^{sp} < \bar{b}$ while $\bar{y}^{sp} > \bar{y}$ if and only if

$$G > cm\left(\frac{E}{3\tau} + \frac{B}{3}\right). \quad (40)$$

When (40) holds, the presence of public good spillovers leads the planner to choose a smaller central city but a larger CBD, the reason being that the value of $m(y - b)G$ in (38) is high. In this case, the discrepancy between the two central city limits \bar{b}^{sp} and \bar{y}^{sp} gets wider. More generally, it is readily verified that $\bar{y}^{sp} - \bar{b}^{sp} > 0$ when $G > cm(\bar{b}^{sp} + \bar{y}^{sp})/2$ holds. In sum, when the utility of the public services is sufficiently large, *their cross-border consumption is always socially desirable*.

5.1.2 The decentralized outcome

In the presence of public good spillovers, the indirect utility of a consumer living and working in suburban city remains unchanged, but the indirect utility of a suburbanite working in the central city is now given by $v_i^0(x) \equiv V_i^0(x) + G$. Equalizing these indirect utilities yields the equilibrium economic boundary of the central city:

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

which increases with G because the central city becomes more attractive to the suburbanites.

The objective function of the central city government is given by

$$W_0^{sp} = W_0(y^{sp}) - c(my^{sp})^2/2 + c\ell_0^2/2$$

while the suburban governments maximize

$$W^{sp} = W(y^{sp}) + (y^{sp} - b)G.$$

The first order conditions are now given by

$$\frac{dW_0^{sp}}{dT_0} = m \left[(y^{sp} - b) - \frac{2T_0}{3\tau} + \frac{2cm}{3\tau} \right] \quad \text{and} \quad \frac{dW^{sp}}{dT} = -\frac{2T}{3\tau}$$

which implies

$$T_0^{sp} = G - \frac{3\tau G}{2(3\tau + cm)} - \frac{9b\tau^2}{4(3\tau + cm)} + \frac{(3\tau + 2cm)(B\tau + 2E)}{4(3\tau + cm)} \quad (41)$$

while $T^{sp} = T^* = 0$. Standard calculations reveal that $dW_0^{sp}/dT_0 > 0$ when $T_0 = T_0^*$. As a result, *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 thus increases, whereas the provision cost of public services is higher. Both effects lead the central city to increase its business tax. In the suburban jurisdictions, the effects are opposite. On the one hand, fewer firms locate in a SBD, so that the corresponding local government collect less income from firms. On the other, a share of the residents enjoy the consumption of more public services. The two effects cancel each other, so that the tax rate set by the suburban jurisdictions does not change.

The existence of public good 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 residents bear a higher provision cost for the public good. However, since the business tax paid by the CBD firms is higher ($T_0^{sp} > T_0^*$), the central city workers get a lower pay. In contrast, the SBD workers earn the same wage because $T^{sp} = T^* = 0$. As a consequence, *the central city residents are hurt twice through an externality effect and an income effect*. Therefore, the free-riding problem between the central city and the suburban jurisdictions has implications that go beyond the standard consumption effects generated by spillovers. This makes the cooperation between the central and edge cities even more compelling for the MA to be efficient.

The central city economic boundary is now such that

$$\bar{y}^{sp} - y^{sp} = \frac{3\tau + cm}{3\tau} (y^{sp} - b)$$

Hence, when public good spillovers occur ($y^{sp} - b > 0$), we have $\bar{y}^{sp} > y^{sp}$. There is again insufficient concentration of firms and jobs in the CBD. However, it is not clear whether the presence of spillovers exacerbates the misallocation of jobs within the MA. Indeed, although the

higher business tax set by the central city deters firms to locate in the CBD, the consumption of the central city public services by suburbanites tends to generate more jobs in the CBD. The ultimate impact depends on the parameter values. In addition, the discrepancy between \bar{y}^{sp} and y^{sp} increases with G since $G - T_0^{sp}$ and, in turn y^{sp} , increases with G . Thus Proposition 3 holds true in the presence of public good spillovers.

Proposition 5 comprises a summary.

Proposition 6 *Assume that the suburbanites working in the CBD consume the central city public services. Then, the tax differential between the central city government and the suburban governments raises and the size of CBD remains too small.*

5.1.3 The central city as a bigger 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 range of more differentiated and specialized services.

The optimal population size of the central city increases because of the higher utility stemming from the consumption of the public services:

$$\bar{b}^\beta = \bar{b} + \frac{\beta(G-1)}{c(m+1)} > \bar{b}$$

which need not be smaller than B . As a result, the institutional structure of the MA now depends on the *relative* provision of public services between the central city and the suburban jurisdictions, i.e. β . 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 $(\beta - 1)G/cm > B$, a condition that is unlikely to hold in a large MA.

Supplying a wider range of public services in the central city does not affect its optimal economic boundary as long as the suburbanites do not consume these services. Thus, the optimal MA 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 , the asymmetry in the provision of public services has no impact on the jurisdictions' business taxes, and thus Proposition 3 holds true. In contrast, when suburbanites working in the CBD consume the central city public services, the central city 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. On the contrary, \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 central city's government increases its business tax. As a consequence, the tax gap widens and Proposition 3 holds true.

5.2 Agglomeration economies and firm spillovers

As mentioned in subsection 2.3, treating E as a constant constitutes a crude approximation of agglomeration economies. This assumption also neglects the existence of spillovers between firms located in the CBD and the SBDs. Given the importance played by these effects in the working of a MA, we find it important to study what our main findings become under a more general specification allowing for spatial externalities whose intensity varies with the distribution of firms within the MA. Specifically, we consider a specification based on Baldwin et al., (2005) and Rosenthal and Strange (2004), which takes into account both the number of firms *within* each center and the existence of spillovers *between* centers.

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

$$E_0 = n_0 + \lambda(n - n_0) \quad (42)$$

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 $\lambda \geq 1/m$. In other words, the CBD has a comparative advantage when λ is sufficiently large. The assumption used in the foregoing sections may be viewed as a limiting case of (42) in which the CBD firms benefit from the entire range of agglomeration economies generated within the MA, whereas the SBD firms do not benefit from agglomeration economies.

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 $PE = E_0 n_0 + \sum_i E_i n_i$ with

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

It is then readily verified that maximizing productivity gains within the MA 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 $W = PE - CC - PC$.

The central city supply area is still given by the array delineated by \bar{b} , whereas the optimal location of the marginal worker now depends on the intensity of spillovers among firms. When

$$\lambda < \hat{\lambda} \equiv \frac{1}{2} \frac{m+1}{m} - \frac{3\tau}{8m} \quad (44)$$

the social welfare function is increasing or convex over the interval $[\bar{b}, B]$. In this event, the optimal boundary is given by $\bar{y} = B$. When the spillovers between the CBD and the SBDs are weak, the social optimum involves the agglomeration of firms in the CBD, for otherwise the productive efficiency losses would be too high.

If $\lambda > \hat{\lambda}$ holds, then the optimal location of the marginal workers becomes

$$\bar{y}^a = \frac{B [\tau + 4(\lambda m - 1)]}{3\tau - 4(m + 1) + 8\lambda m} \in (\bar{b}, B)$$

as in Section 3. Put differently, when spillovers between the CBD and SBDs are strong enough, the planner chooses to reduce total commuting costs by decentralizing jobs.

In sum, for the optimal MA to be polycentric, it must be that $\lambda > \hat{\lambda}$. This is consistent with what we saw in subsection 3.1 where E cannot be too large for the MA to have SBDs.

5.2.2 The decentralized outcome

It is readily verified that the worker indifferent between working in the CBD or in a SBD is located at

$$y^a(T_0, T) = \frac{B[\tau + 2(\lambda m - 1)] - 2(T_0 - T)}{3\tau - 2(m + 1) + 4\lambda m} \quad (45)$$

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

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

Since the absolute value of dy^a/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.

Regarding 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 equilibrium rates in (45), we get the following equilibrium value for the central city economic boundary:

$$y^a - b = (1 - \Lambda) (\bar{y}^a - b) \quad \text{with} \quad \Lambda \equiv \frac{3\tau - 2(m+1) + 4\lambda m}{6[\tau - (m+1) + 2\lambda m]}.$$

As in Section 4, tax competition distorts the allocation of jobs and firms' locations within the MA. Since $0 < \Lambda < 1$ when λ satisfies the condition (44), it is easy to show that $b < y^a < \bar{y}^a$.

In addition, as in subsection 3.3, the CBD size is too small when the population size of the central city is optimal ($y^a(\bar{b}) < \bar{y}^a$), while the population size of the central city for which the CBD reaches its optimal size (\bar{b}^a solves $y^a(b) = \bar{y}^a$) exceeds its optimal size ($\bar{b}^a > \bar{b}$).

The following proposition is a summary.

Proposition 7 *Assume a polycentric metropolitan area. If agglomeration economies depend on the location of firms, corporate tax competition yields too small a CBD. Furthermore, 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.*

Thus, we obtain results similar to those presented in subsection 3.3. Since Proposition 3 is central for our analysis and results, we find it reasonable to say that they are not driven by the assumption of exogenous agglomeration economies. In other words, our findings will remain qualitatively the same under (42)-(43).

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 a MA. 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 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 the decentralization of public services within the MA 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, but such a policy may dampen the inefficient allocation of firms and jobs 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 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.

Although we recognize that political fragmentation is not bad per se, the tax competition process leads to an inefficient distribution of firms and jobs. This leads us to formulate some policy recommendations in the spirit of what is known as “New Regionalism” (Savitch and Vogel, 2000) - mixing a polycentric political system with inter-municipal cooperation to solve mutual problems. In a nutshell, several of our recommendations concur with the principle of subsidiarity. Our analysis also shows that some policies must be conducted at the level of the MA as a whole. For example, an integrated transportation policy that aims to lower commuting costs will increase the overall productivity of the MA. Simultaneously, it will also increase the efficiency loss generated by tax competition. In this respect, our results give credence to the large transportation projects that are being developed in Greater London (Crossrail) and Greater Paris (Grand Paris Express), but it suggests supplementing these projects with other instruments to magnify their positive impact.

Our framework can also serve to address more controversial issues in local public finance and transportation economics. According to Inman (2009), rethinking the governance of the MAs through Business Improvement Districts (BIDs) and Neighborhood Improvement Districts could be a way to improve the fiscal performance of a large MA. 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 a genuine urban framework with the aim of determining the impact of private governments on the spatial distribution of firms and consumers.

Our analysis supports what seems to be the minimal set of requirements needed to promote more efficient MAs. Yet, it is fair to say that our findings have been obtained under several simplifying assumptions; thus care is needed in interpreting them. 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 a MA 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 MA. Lastly, we did not allow consumers to choose a variable lot size by trading the homogeneous good against land. Several of our results remain valid when the population density is not uniform anymore but the determination of the equilibrium land rent within each jurisdiction is a more delicate issue.

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Appendix

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:

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

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

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

Since y^* decreases with T_0 , the above inequality implies that, for any given T , the central city government chooses a business tax rate $T_0^*(T)$ such that

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

always holds. In other words, the central city government chooses a business tax such that the economic and administrative boundaries now coincide. This is because the central city is sufficiently large ($b \geq \tilde{b}$) to focus on its local population only.

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

$$\begin{aligned} W = & (I - T)(B - b) - \frac{\tau}{2} \left(\frac{B + y^*}{2} - b \right)^2 \\ & - \frac{\tau}{2} \left(B - \frac{B - y^*}{2} \right)^2 - F - c \frac{\ell^2}{2}. \end{aligned}$$

Differentiating W with respect to T yields the equilibrium 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 ($y^* = b$).

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

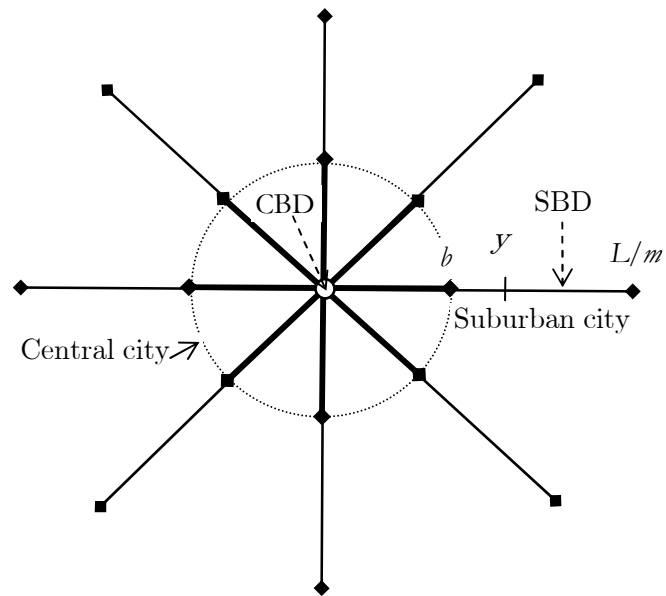
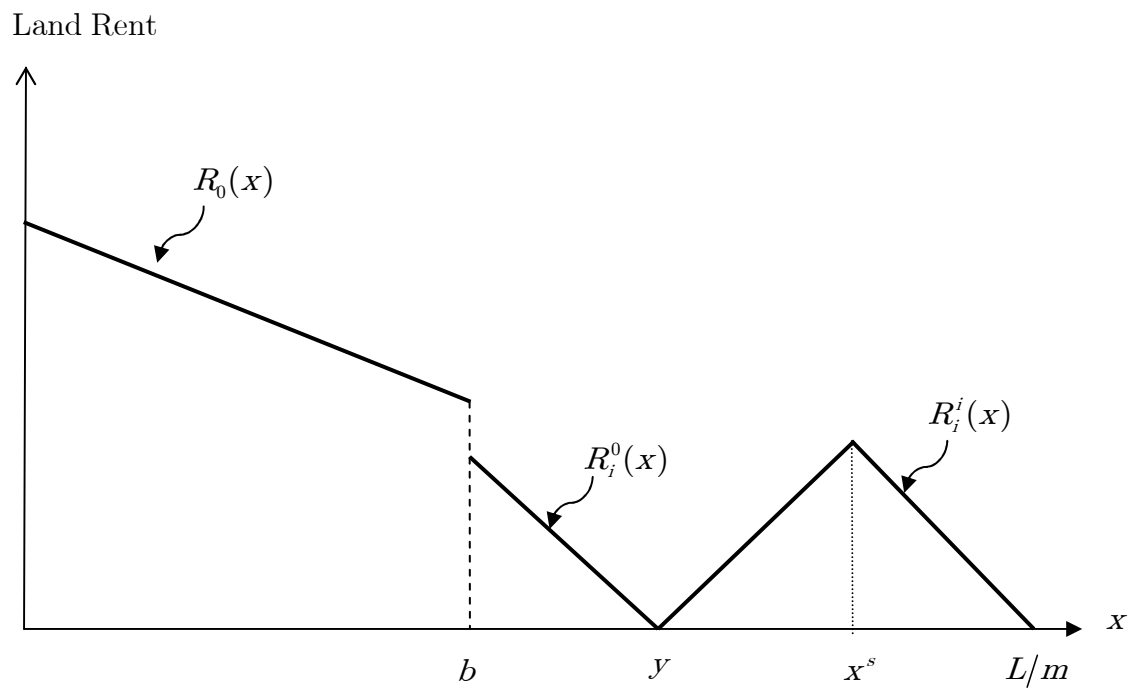


Figure 2. Equilibrium Land Rent



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