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## Tax competition within Metropolitan areas

Tidiane Ly

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Discipline : Sciences économiques

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Tidiane LY

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# **Concurrence fiscale dans les agglomérations urbaines.**

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Etienne LEHMANN, Professeur, Université Paris 2, Rapporteur

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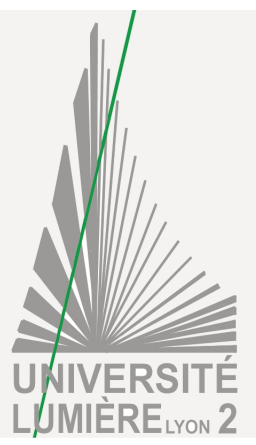
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UNIVERSITÉ LUMIÈRE LYON II

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Doctoral School:  
ED 486 *Sciences Économique et de Gestion*

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# Tax competition within Metropolitan areas

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by  
Tidiane LY

Economics

Dissertation presented and publicly defended in  
Candidacy for the degree of PhD in Economics  
on November 30, 2018

**Jury:**

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*To my parents.*





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# Introduction

*Existing business-tax competition models focus only on the tax choices of metropolitan areas and cannot be used to examine the tax choices of competing sub-metropolitan (local) government.* [Braid \(1996\)](#)

*An even more important extension for urban public finance is to incorporate mobility of residents. New approaches are needed to analyze more “urban” fiscal competition, approaches in which [...] locational features play a greater role.* [Brühart et al. \(2015\)](#)

## 1. Research question

To study the policy choices of local governments, special attention should be paid to economic agents’ mobility. This mobility puts governments into a context of competition to attract the most ‘profitable’ agents. The degree and the nature of agent’s mobility are key to distinguish the economic environment in which the different levels of government make their policy decisions. While national governments account for the location responses of firms’ (or more specifically capital) to their policy, cross-country household mobility is more limited. However, households are much more mobile within countries, so that regional governments also need to account for residential mobility.<sup>1</sup> The lowest governmental level, usually qualified as *local*, must not only to account for a higher degree of capital and residential mobility than upper government layers, but it must also account for another type of household mobility: workers’ mobility (also qualified as commuting).<sup>2</sup>

In this thesis, we are specifically interested in these low-level jurisdictions, such as municipalities, counties, districts and townships, whose local governments face a high degree of mobility of capital, residents and workers. The main claim of our thesis is

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<sup>1</sup> Most OECD countries have experienced a substantial mobility of population across regions and cities. Indeed, 2 percent of the total population changes residence annually ([OCDE, 2013](#)).

<sup>2</sup> In France, around 75% of the people living in a municipality were working in another municipality in 2018.

that the existing local public economic literature — and more specifically, the tax competition literature — did not pay enough attention to this strong mobility of the agents. Especially, household mobility is most often ignored in the literature and to date, there exists no model including capital, residents' and workers' mobility, to our knowledge.<sup>3</sup> By assuming immobility of households (either residents or workers or both), previous work depicts more a regional or national environment than a local one, as summarized by [Brühart et al. \(2015\)](#): “This immobility assumption makes the basic tax competition model better suited to competition among larger units than to competition among municipalities within a single city”.

Agents' mobility is especially important for the purpose of this thesis which aims at providing new insights on how and why local governments choose the level of their various policy instruments. The policy instrument set available to municipalities (and lower-level jurisdictions) can be rich in decentralized countries (e.g. France, Switzerland, US).<sup>4</sup> Municipalities typically compete among each other by providing public services to households and firms which are financed by raising taxes on various tax bases (e.g. capital, residents, labor and land). And a variety of other instruments can also be available to municipalities such as land-use policy instruments (e.g. building permits and square footage cap). The theoretical and empirical studies conducted in this thesis investigate how these various policy instruments, together, are used by municipalities, and how the mobility of the different agents — which might be viewed as the agents' relative bargaining power — influence their choice. In sum, the research question of this thesis can be summarized as follows:

*Within metropolitan areas, how do competing local governments, facing a high mobility of capital, residents and workers, choose their various policy instruments?*

Addressing this question is interesting from a theoretical viewpoint since it fills the gap in the literature mentioned above, but it also matters from an empirical perspective as well. Indeed, fiscal, socio-demographic, economic and political data at the municipal level are among the most accessible ones. This is testified by the enormous amount of empirical studies of local governments' behavior. Our thesis can help to provide better theoretical grounds for future empirical work and pave the way for new approaches in the study of local governments' choices where agents' mobility plays a central role.<sup>5</sup>

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<sup>3</sup> There exists however a number of models focusing on each of these mobility (see [section 2](#)).

<sup>4</sup> See e.g. [Blöchlinger and Rabesona \(2009\)](#) for international comparisons of the policy instrument sets available at the local level.

<sup>5</sup> [Chapter 3](#) is an illustration of such an empirical study of municipalities' choices when facing

Of course, a number of contributions have already analyzed elements of our research question. Then, a further study of this issue must be defended. We provide more justification in the next section which states the background from which this thesis takes its starting point.

## 2. Background

This thesis mainly belongs to the tax competition literature which is itself part of local public economics. The tax competition literature contains a considerable variety of contributions which all converge toward the same purpose: understanding the policy choices (mainly in terms of taxation and public services provision) of regional or local governments connected by agents' mobility. Since this general purpose embraces our research question, a selective overview of the existing tax competition literature is necessary to understand the starting point of the present thesis. For convenience, the important strands of the tax competition literature that we discuss in this section and the following one are reported in [Table 1](#), as well as some representative contributions for each of them.

### *2.1. The early capital tax competition model*

The start of the tax competition literature can be dated to the late 1980's with the seminal contributions by [Zodrow and Mieszkowski \(1986\)](#) and [Wilson \(1986\)](#).<sup>6</sup> The basic finding of this early literature is the following. The governments of autonomous jurisdictions connected by mobile capital (investment in machinery and equipment used by firms) tends to set inefficiently (regarding the Pareto criterion) low capital taxes and provide an inefficiently low level of public goods to their residents. From a given jurisdiction's viewpoint, raising higher capital taxes entails capital outflows towards other jurisdictions which not only reduces the wage of local residents but also deprives the local capital tax revenues. This leads each local government to set low capital taxes. This downward pressure exerted by capital mobility on capital tax rates is inefficient for the economy as a whole since when making its choice each single local government does not account for the benefits for other jurisdictions of higher capital tax rates: capital outflows (economic loss) for one jurisdiction correspond to capital inflows (economic benefit) for others. This prisoner's dilemma outcome in which the positive externality of capital is ignored by a single jurisdiction ([Wildasin,](#)

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a high mobility of both firms and household.

<sup>6</sup> [Oates \(1972\)](#) actually initiated the first academic discussion about tax competition. But it had taken around a decade for the first formal tax competition models to appear.

**Table 1.** A taxonomy of the tax competition literature.

	Mobility		Dissociation	Framework	
	Firms/ capital	Residents	Workers	Residents & Workers	Core-periphery or Asymmetry
A. CAPITAL OR RESIDENTIAL MOBILITY					
Zodrow and Mieszkowski (1986); Wilson (1986)	✓				
Hoyt (1991); Krelove (1993); Wilson (1997)		✓			
B. RESIDENT-WORKER MOBILITY					
Wilson (1995); Richter and Wellisch (1996)	✓	✓	✓		
C. COMMUTING					
Braid (1996, 2000)	✓		✓		
Braid (2002)	✓		✓		✓
D. ASYMMETRIC TAX COMPETITION					
Wilson (1991); Bucovetsky and Wilson (1991)	✓				✓
Epple and Zelenitz (1981); Hoyt (1992)		✓			✓
Kächelein (2014)	✓		✓		✓
Janeba and Osterloh (2013)	✓				✓
E. SUB-METROPOLITAN TAX COMPETITION					
Gagné et al. (2016)	✓		✓	✓	✓
Chapter 1, 2, 3	✓	✓	✓	✓	
Chapter 4	✓	✓	✓	✓	✓

NOTE.—Check marks ✓ indicate a feature is present in a model. The classification depends not only on the features of the models but also on the focus of the papers. Notice that in Gagné et al. (2016), residents are mobile only within (not across) jurisdictions contrary to Chapter 1–4 in which they are only mobile across jurisdictions. In Chapter 4 residents are not only mobile across but also within jurisdictions.

1989) leads to an inefficiently low level of public good in each jurisdiction.

The model developed by Zodrow and Mieszkowski (1986) and Wilson (1986) is

often regarded as the start of the local tax competition literature and is still today used as a theoretical background in many empirical works studying capital taxation of low-level jurisdictions such as municipalities. An important shortcoming however arise when regarding this framework as describing the local level. Indeed, households are assumed to be fully immobile in the early tax competition model. This assumption clearly does not fit with basic real-life facts: intra-country migrations and commuting are undeniable realities. But more than a simple issue of coincidence with real life (a model always needs simplifications), this immobility assumption also raises major concerns regarding the main result of the early tax competition literature.

First, in the presence of immobile households, the tax competition result does not resist the introduction of other taxes to finance local public goods. Whenever a tax on households — which is a widespread tax instrument in practice — is introduced in the model, a zero tax on capital is chosen by jurisdictions which set all the tax burden on immobile households. There is in this case no downward pressure of capital mobility on tax rates and public goods are efficiently provided.

Second, introducing residential mobility across jurisdictions would mitigate the prisoner's dilemma problem described above. Indeed, household inter-jurisdictional mobility links the level of utility obtained by the residents of different jurisdictions. Thus, household mobility forces local authorities to account for the effect on other jurisdictions of choosing too low capital tax rates; capital taxes and public good provision are not too low anymore (see e.g. [Wilson, 1995](#)). This discussion shows that a consistent local tax competition model needs to account for residents' mobility to be able to describe the policy decisions of local governments.

## *2.2. Residential tax competition*

Tax competition among jurisdictions connected by mobile residents is actually the focus of another strand of the literature initiated in the early 1980's by [Epple and Zelenitz \(1981\)](#) and [Henderson \(1985\)](#), which has been developed in parallel with the capital tax competition literature. In these models where businesses are absent,<sup>7</sup> residents are freely mobile across jurisdictions and have to pay a housing tax (qualified as “property taxes”) in their jurisdiction of residence. Jurisdictions also collect a tax on their fixed land endowment which is evenly distributed among all households of the economy. The important result of this literature was established by [Hoyt \(1991\)](#) and [Krelove \(1993\)](#). It is stated by [Hoyt](#) as “the property tax is a head tax, albeit a distorting one in this case, which ensures that population changes

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<sup>7</sup> The only production sector is the housing building sector.



do not lead to imbalances in the government budget”, and summarized by [Krelove](#) as “the property tax can be viewed as a type of congestion fee”.

This result can be summarized as follows. First, despite the availability of a tax on their fixed land endowment, jurisdictions make use of their housing tax. Second, the primary role of the housing tax is to internalize the congestion entailed by the consumption of the local public good by mobile residents, just as a head tax. This result has played an important role for subsequent modeling of residential mobility in the tax competition literature (and in this thesis in particular). It implies that when including residential mobility in a tax competition model, it is sufficient to consider a head tax and to assume an inelastic supply of housing and an inelastic individual housing demand.<sup>8</sup> Housing taxation and elastic supply and demand for housing simply adds the traditional distortion of commodity taxation (the so-called Ramsey rule).

Beyond this major result, the residential tax competition literature does not provide the coherent tax competition model with households’ and firms’ mobility able to describe the behavior of local jurisdictions choosing multiple local policy instruments that we are looking for. Indeed, this literature focuses on households and ignores firms’ mobility. In this regard, this literature is symmetrically opposed to the early tax competition literature which focuses on capital mobility and assumes immobile households ([subsection 2.1](#)).

### *2.3. Household mobility in the capital tax competition model*

An important step towards a more complete local tax competition model has been reached in the late 1990’s with the contributions by [Wilson \(1995\)](#), [Richter and Wellisch \(1996\)](#) and [Brueckner \(2000\)](#) which combine the features of the capital tax competition and the residential tax competition literatures to build the first models with both capital and residents’ mobility.<sup>9,10</sup> As might be expected, the introduction of residents’ mobility in the capital tax competition model, sweeps away the inefficiently low capital taxation identified in the early tax competition. Households’ mobility forces local governments to account for their taste so that local public goods are efficiently provided; and even if local governments have access to a

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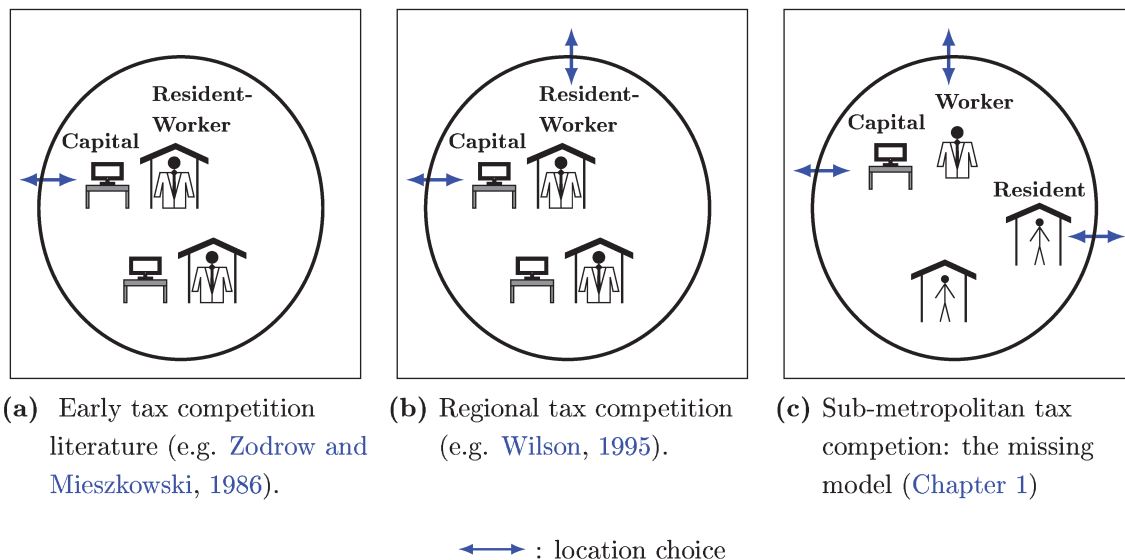
<sup>8</sup> These simplifications are adopted in most of the subsequent tax competition literature including residents’ mobility, and in all this thesis.

<sup>9</sup> A difference, which appears minor here, distinguishes these contributions. In [Richter and Wellisch \(1996\)](#) consider several mobile firms using a fixed amount of capital, while [Wilson \(1995\)](#) and [Brueckner \(2000\)](#) consider a single firm using an endogenous amount of mobile capital.

<sup>10</sup> The cited contributions all assume perfect household mobility, but other papers as [Wellisch \(1996\)](#) consider imperfectly mobile households (and perfectly mobile capital).

tax on residents, the capital tax is still used.

Regarding our quest for a coherent local tax competition model, two strengths of these models should be highlighted. First, they provide the first insights about the policy decisions made by jurisdictions when they face both capital and household mobility. They displace the research focus from the efficient level of local public good provision towards studying more generally the role of various local policy instruments in the presence of a high mobility of multiple agents (households and firms). Second, the integration of both households' and firms' mobility allows to study, within a unified framework, how jurisdictions make their decision when a possibly wide range of policy instruments are available, such as taxes on capital, residents and land, public services provided not only to households but also to firms. The study by [Wellisch and Hulshorst \(2000\)](#) is a good illustration of this type of multidimensional analysis. This approach will also be followed in this thesis.



**Figure 1.** Tax base mobility in the capital tax competition literature.

However, this literature does not fulfill all the requirements of an appropriate tax competition framework allowing to study sub-metropolitan jurisdictions such as municipalities. As depicted on panel (b) of [Figure 1](#), these models assume that residents necessarily work in their jurisdiction of residence and therefore preclude commuting. While household immobility in the early capital tax competition model (panel (a) of [Figure 1](#)) is more suited to inter-country competition, the non-dissociation of residents and workers in the models with mobile residents-workers makes these models more suited to regional competition than to local competition given the high level of commuting in metropolitan areas.

This conclusion is also drawn in [Braid \(1996\)](#), which introduced the first capi-

tal tax competition model with households commuting to work. [Braid's](#) framework laid the basis to model commuting in the standard tax competition framework.<sup>11</sup> However, [Braid \(1996\)](#) ignores residential mobility which limits the practical applications of the model since, like in the standard capital tax competition model, taxes on residents make any other tax instrument irrelevant. This certainly explains why source-based labor taxes are central in [Braid \(1996\)](#). However, in most OECD countries, labor taxes are often unavailable at the local level ([Blöchlinger and Rabesona, 2009](#), see e.g.). Instead, local residential taxes is a widespread policy instrument.

Finally, this overview of the existing tax competition literature shows that a tax competition model relevant to study the policy decisions of sub-metropolitan jurisdictions using various local policy instruments and facing capital, residents' and workers' mobility is missing — as illustrated on panel (c) of [Figure 1](#). More generally, while many useful formal tools are present in various branches of the tax competition literature, a unified sub-metropolitan tax competition theory is still to be built. This is the starting point of this thesis. Through this thesis, we aim not only at contributing to fill this gap in the literature, but also at providing new theoretical and empirical insights into our knowledge of the policy decisions made by sub-metropolitan governments.

### 3. Overview of the chapters

With the basic objective of studying sub-metropolitan governments' policy choices in the presence of highly mobile capital, residents and workers, the thesis is divided into four chapters.

#### 3.1. *Chapter 1*

[Chapter 1](#) is a proposal of a first coherent sub-metropolitan tax competition model with relevant assumptions on agents' mobility, allowing to study a variety of local policy instruments within the same framework. In this sense, this chapter contributes to fill the literature gap highlighted in the preceding section and depicted in panel (c) of [Figure 1](#). This chapter plays a central role in this thesis for two reasons. First, it lays the theoretical basis for modeling tax competition within metropolitan

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<sup>11</sup> The initial framework developed in [Braid \(1996\)](#) has been extended in [Braid \(2000, 2002\)](#) in which spatial concerns and asymmetries among jurisdictions are introduced, and in [Braid \(2005\)](#) in which external ownership of land is studied. Several subsequent contributions have used the framework developed in [Braid \(1996\)](#). For instance, [Kächelein \(2014\)](#) studies, in this framework, capital tax competition among jurisdictions endowed with different population size.

areas. Under general assumptions, it highlights the key economic mechanisms at stake in a metropolitan area where capital, residents and workers are mobile and reveals how local governments make their decisions in this particular environment. The new economic structure introduced in this chapter is then present in all the subsequent chapters, and it is expanded in [Chapter 2](#) and [Chapter 4](#). Second, this chapter provides new theoretical results which allow to better understand the behavior of sub-metropolitan governments. These results open the way to new empirical investigations, as performed in [Chapter 3](#).

In order to develop this new theory of sub-metropolitan tax competition, we build on the regional tax competition models developed in [Wilson \(1995\)](#) and [Richter and Wellisch \(1996\)](#). Two assumptions are relaxed in order to make the model suitable for the local level. The first assumption that we abandon is the requirement that households live and work in the same jurisdiction. In a metropolitan area composed of a many small jurisdictions, we consider households who choose their home jurisdiction so as to maximize their utility and commute to work in the jurisdiction which allows them to obtain the highest possible wage. This assumption makes from [Chapter 1](#) the first tax competition model with capital, residents and workers mobility, as depicted in panel (c) of [Figure 1](#).

The second assumption which is relaxed from the regional tax competition framework is the absence of land consumption by households — ie. housing, since housing supply is inelastic.<sup>12</sup> In the regional tax competition model, since households are actually essentially regarded as workers, their land consumption is ignored; only firms consume land which is viewed as a simple fixed production factor. Disconnecting residents and workers, as done in this chapter, requires to have a more precise consideration of residents' behavior, so that introducing residential land appears necessary to regard residents as consistent entities. Therefore, [Chapter 1](#) is the first tax competition model in which mobile residents and firms both consume land. It highlights a new type of competition between private agents: the competition for local land between households and firms. The implications of this new interaction for the public policies conducted by local governments are examined in detail in this chapter.

The behavior of local governments in this sub-metropolitan environment is analyzed in the cases where a rich set of local policy instruments is available. Specifically, two cases are examined: (1) when public goods provided to residents and public production factors provided to firms are financed by a tax on residents and two separate taxes on capital and business land used by firms; (2) when these public

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<sup>12</sup> See [subsection 2.2](#) for the justification of the assumption of inelastic housing supply.

services to residents and firms are financed by a tax on residents and a single business tax on capital and business land. The outcome of the decentralized choices of local governments is described and compared to the regional tax competition findings. Moreover, these decentralized policies are compared to a first-best situation where a central planner chooses the policy instruments so as to achieve Pareto-efficiency.

### *3.2. Chapter 2*

[Chapter 2](#) is a discussion around the sub-metropolitan tax competition model introduced in [Chapter 1](#). It, first, discusses the free-mobility assumptions made about workers and residents location. It also investigates interventions from the central government that could be led to tackle inefficient local governments' decisions.

While household mobility is a significant fact with metropolitan areas, assuming perfect mobility of workers, as done in [Chapter 1](#), might admittedly be regarded as an inappropriate hypothesis in view of the important commuting costs that can be born by households who commute to work in another jurisdiction than their home jurisdiction. In this chapter we introduce commuting costs in the framework developed in the first chapter. We examine how commuting costs affect the behavior of private agents (especially households) and the resulting departure from the results derived in [Chapter 1](#) regarding the policy choices of the local governments. Introducing commuting costs in our sub-metropolitan tax competition model is insightful in that it allows to better figure out the specific policy decisions of low-level jurisdictions when it might be too costly for residents to engage in commuting. Commuting costs can create a strong link between the population size and the amount of workers employed in a jurisdiction. They bring the behavior of sub-metropolitan governments closer to that of regional governments studied in the regional tax competition literature. It is therefore important to examine how local governments specifically behave when residents' and workers' location are linked by the existence of commuting costs.

Nonetheless, this integration of commuting costs in the sub-metropolitan tax competition model of [Chapter 1](#) might be regarded only as a preliminary investigation of their impact on local policies. Indeed, since the model introduced in the first chapter does not contain any spatial dimension, the commuting costs introduced in this chapter are simple fixed costs entailed by commuting households. This quite restrictive assumption entails extreme households choices since in certain jurisdictions all residents choose to work in their home jurisdiction and are somehow 'locked' in the jurisdiction by the commuting costs. [Chapter 3](#) investigates a more realistic spatial definition of commuting costs and depicts a clearer picture of the preliminary findings drawn in this chapter.

[Chapter 2](#) also calls into question the unlimited residential mobility assumed in

[Chapter 1](#). It is indeed typically the case that residents with different degrees of mobility coexist within jurisdictions: the pecuniary and psychic costs of leaving one's home vary among individuals. To investigate the effects of such a heterogeneity, this chapter proposes an extension of the model in which two groups of households are distinguished. The first group (the “rich”) includes immobile households owning all local land in their home jurisdiction and the second group (the “poor”) is composed of perfectly mobile households with no landownership.<sup>13</sup> In this setting, the policies chosen by local governments tend to be in favor of immobile households. The chapter examines how potentially diverging interests of mobile and immobile households can affect the local policies compared to what was found in [Chapter 1](#).

In practice, combining related tax bases allows to save on administration costs ([Hettich and Winer, 1988](#)). Thus, it is common for statutory restrictions to require local authorities to levy a single business property tax rate on both capital and land inputs.<sup>14</sup> [Chapter 1](#) shows that this single tax constraint leads to inefficient local policy choices. [Chapter 2](#) discusses several policies that could be led by the central government to tackle this issue: dissociation of the components of the business property tax base, vertical transfers and introduction of local land-use restriction policy instruments. The pros and the cons of each of these measures are discussed.

In particular, this chapter sheds a new light on the so-called “zoning” policies. Introduced in the sub-metropolitan framework developed in the first chapter, land-use policy instruments allow jurisdictions not only to control their population size (as in e.g. [Hamilton, 1975](#), and many subsequent contributions) but also the amount of land used by firms — which is to our knowledge not studied in the existing literature. This chapter depicts how such instruments which are both household-oriented and firm-oriented can be used to address the issue of a single business property tax constraint. It also paves the way for future investigations of the crucial role that this two-sided local policy instrument can play for sub-metropolitan jurisdictions.

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<sup>13</sup> Alternatively, a continuum of degrees of household mobility could have been introduced, but a thorough investigation of the effect of household imperfect mobility is beyond the scope of this thesis. For studies of the effect of imperfectly mobile households on regional governments, the reader is referred to the plentiful tax competition literature with a continuum of degrees of household mobility (e.g. [Burbidge and Myers, 1994](#); [Mansoorian and Myers, 1993, 1996, 1997](#); [Wellisch, 1994, 1995, 1996](#)).

<sup>14</sup> E.g. in the United States the legal restrictions in 40 out of the 50 states impose equal rates on real property (land and buildings) and personal property (equipment, machinery, inventories...). Source: the online database published by the [Lincoln Institute of Land Policy, 2014](#). In France, the *taxe professionnelle* (1975-2010) was another example of an identical statutory tax rate on capital and business land.

### 3.3. Chapter 3

Chapter 3 is an empirical investigation of the effect of a tax base mobility on the level of the related tax rate chosen by local governments. The importance of this study in the tax competition literature can be made clearer by looking back to the main theoretical result of the early capital tax competition literature (subsection 2.1). This result can be summarized as follows: capital mobility exerts a downward pressure on the capital tax rates and then on the level of local public goods which drives local governments to make inefficient decisions. Surprisingly, while the existence of a downward pressure of capital mobility on capital tax rates quasi-systematically recalled in empirical (and theoretical) papers, very few attention has been paid to whether this essential result is verified empirically. This surprising lack of interest for this result representing the basis of the tax competition literature can be explained by two reasons.

The first reason is that another type of evidence of the existence of tax competition among jurisdictions has focused the attention of researchers following the seminal contribution by Brueckner and Saavedra (2001). Their empirical strategy consists in estimating the effect of neighboring jurisdictions' business tax rate on the tax rate chosen by jurisdictions. Estimation of a positive impact is interpreted as an evidence of tax competition among jurisdictions. Many contributions confirmed this prediction using this method.<sup>15</sup> This empirical approach is based on the seminal theoretical contribution by Wildasin (1988). This theoretical paper extends the model in Zodrow and Mieszkowski (1986) — which considers atomistic jurisdictions — to the case of large jurisdictions with market power on the capital market.<sup>16</sup> An important result of this paper is that capital mobility links capital tax rates of jurisdictions so that a given jurisdiction's tax rate can be expressed as a linear increasing function of the tax rates of the other jurisdictions.

This approach raises several issues. First, it requires to consider jurisdictions having market power on the capital market. Yet, most studies use municipal-level data which makes this assumption less plausible. Indeed, most municipalities are typically atomistic regarding the capital market. With the financial international integration of markets, capital is highly mobile internationally so that a municipality

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<sup>15</sup> This approach has been followed by a considerable number of studies (e.g. Brueckner and Kim, 2003; Revelli, 2005; Allers and Elhorst, 2005; Charlot and Paty, 2007; Hauptmeier et al., 2012).

<sup>16</sup> Notice that introducing market power for jurisdictions does not alter the main result derived in Zodrow and Mieszkowski (1986) stating that capital mobility exerts a downward pressure on capital tax rates and public good provision whose formal statement is recalled in footnote 17. See Chapter 4 in Wellisch (2006) for more details.

competes not only with its direct neighbors but also with other municipalities from other countries. It then seems unlikely that the decisions made by a municipal government have a significant impact on the (national or even international) return to capital.

Second, this empirical approach does not clearly identify the cause of the positive interdependence of the local tax rates. Wildasin's (1988) result precisely requires that this interdependence is due to capital flows among jurisdictions. The empirical literature does not verify this mechanism. This is all the more problematic as a serious alternative explanation would entail the same finding: yardstick competition among local governments. One could follow Besley and Case (1995) who argue that "voters use the tax policy of neighboring jurisdictions as information to evaluate the performance of their incumbent politicians", which forces local authorities to mimic their neighbors. This alternative political explanation of positively correlated local tax rates does not need any tax competition.

A third limitation can be seen in the spatial econometric approach followed by Brueckner and Saavedra (2001). Following the identification problem in spatial econometric research pointed to by Gibbons and Overman (2012), several contributions reexamined the interdependence among local business tax rates. Applied to tax competition, the point made by Gibbons and Overman (2012) is that standard spatial econometric methods — maximum likelihood or IV based on neighbors' socio-demographic characteristics — do not allow to identify the causal effect of the tax rate of neighbors on a jurisdiction's tax rate. The authors therefore invite subsequent research to exploit quasi-natural experiments to address this issue. This criticism has been followed by several recent papers in the tax competition literature (e.g. Isen, 2014; Baskaran, 2014) who showed that previous estimates of the local tax reaction functions were largely overestimated and that exploiting quasi-natural experiments suggest that there exist no evidence of a positive effect of the tax rate of neighbors on a jurisdiction's tax rate. This striking result might be viewed as an evidence against the existence of tax competition at the local level. However, it can also only reflect that, since capital is at least nationally (or even internationally) highly mobile, a given municipality does not compete more with its direct neighbors than with other farther municipalities. This argument seems to be a good motive to go back to the initial result highlighted by Zodrow and Mieszkowski (1986) and wonder if there exists empirical evidence of a downward pressure exerted by capital mobility on local business tax rates.

A second reason can explain that the empirical literature on tax competition showed little interest in investigating the effect of capital mobility on local tax rates. It is to be found in the theoretical formulation of this important result. Formally, Zodrow and Mieszkowski (1986) derive an equation in which the level of



the local public good provision (and then implicitly the level of the capital tax rate) is expressed as an inverse function of the elasticity of the local capital with respect to the local capital tax rate.<sup>17</sup> This implies that in order to test empirically the negative effect of capital mobility on the capital tax rate, one first needs to obtain a measure of the elasticity of capital with respect to the capital tax rate — which is a proxy for the degree of the capital mobility. Yet, estimating an elasticity is a quite tedious task in itself. Probably tedious enough to discourage empirical investigations to use this approach.

Another idea could be, without sticking exactly to the theoretical result in [Zodrow and Mieszkowski \(1986\)](#), to build another proxy for the degree of capital mobility. To our knowledge, only one study has attempted to follow this approach to date: [Carlsen et al. \(2005\)](#) use as proxy for capital mobility the geographic profit variability in the industrial sector in Norway. The authors' results suggest that, as predicted by the early tax competition literature, capital mobility exerts a downward pressure on business tax rates. This type of approach raises two concerns. First, the proxy for capital mobility needs to be convincing enough since it has *a priori* no strong theoretical support from the existing theoretical literature. Second, the endogeneity of capital mobility — which necessarily depends on the level of capital taxation — requires to implement a convincing instrumental strategy in the absence of exploitable exogenous changes.<sup>18</sup>

The basic purpose of [Chapter 3](#) is precisely to examine the effect of capital mobility on local business taxes based on a solid theoretical background. To this aim, we exploit the French local business property tax reform implemented in 2010. The reform removed the capital investment from the local business property tax base, the so-called '*Taxe professionnelle*', which represented roughly 80% of its tax base. More precisely, while their business property tax base consisted of the capital investments (machinery and equipment) made by firms and the real property (buildings) they used, French local governments ended up with a business real property tax only. This change in the composition of tax base has implied a dramatic change in the degree of mobility of the business property tax base since it turned from a taxation relying mostly on capital into a taxation relying exclusively on business real property. At the same time, a state grant was allocated to each municipality for the exact amount

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<sup>17</sup> Formally, the well-known result derived by [Zodrow and Mieszkowski \(1986\)](#) is  $MWP(G_i) = 1/(1 + \varepsilon_i)$ , where  $G_i$  is the local public good provided in jurisdiction  $i$ ,  $MWP(\cdot)$  is the sum of the marginal willingness to pay for the local public good of the residents of  $i$ , and  $\varepsilon_i = k'_i \tau_i^K / k_i$  is the elasticity of the local capital  $k_i$  with respect to the local capital tax rate  $\tau_i^K$ .

<sup>18</sup> In [Carlsen et al. \(2005\)](#), the mobility variable is instrumented by employment shares of seven industrial sectors lagged by more than twenty years.

of their capital tax revenues before the reform.

From the early tax competition literature, it is possible to extrapolate the effect of such a drastic cut in the mobile part (capital) of the business property tax base (capital and land) which has been accompanied with a budgetary compensation. We can indeed expect that a decrease in the degree of mobility of the business property tax base has spurred municipal authorities to increase their business property tax rate. To further investigate this intuition, we proceed in two steps.

In the first step, based on the theoretical framework developed in [Chapter 1](#) allowing to study the behavior of sub-metropolitan governments, we develop a stylized theoretical model which allows us to examine the precise design of the reform — removal of the capital part of the tax base accompanied with a compensation grant. This allows us to make clear-cut predictions of how the reform is expected to affect not only the business property tax but also the tax on residents.<sup>19</sup> In the second step, we confront our theoretical predictions with the data. We build a data set of local taxation and socio-demographic, political and economic characteristics for more than 11,800 French municipalities from 2006 to 2012. Following our theoretical model, we use the capital share in the business property tax base in 2009 (the last pre-reform year) as a proxy for the business property tax base mobility. Then, we follow a difference-in-differences approach to estimate the effect of the cut in the business tax base mobility entailed by the reform on the business property tax rate and on the tax rate on residents of French municipalities. Our results suggest that capital mobility does exert a downward pressure on business property tax rates (see [section 4](#) in this introduction).

The approach followed in this chapter contributes to the existing literature by refreshing our thinking of tax competition at the local level by updating the early finding of the initial literature. It responds to the recent contributions (e.g. ?) which, based on the traditional approach aiming at estimating tax rate reaction functions, seemed to find evidence against the existence of tax competition at the local level. This chapter suggests that alternative empirical strategies based on theoretical frameworks better suited to the proper municipal context might be more relevant to examine tax competition among sub-metropolitan jurisdictions such as municipalities.

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<sup>19</sup> Our analysis in [Chapter 1](#) revealed that due to the interaction of households and firms on local land markets in sub-metropolitan jurisdictions, it does not make much sense to consider uniquely business taxation. Moreover, the integration of taxes on residents in [Chapter 1](#) provides important new theoretical and empirical.

### 3.4. Chapter 4

The sub-metropolitan tax competition model developed in [Chapter 1](#), as the first tax competition model considering capital, residents' and workers' mobility, is an important step towards a better understanding of sub-metropolitan governments' choices. However, this model misses a key real-life feature of metropolitan areas which calls for further developments. Indeed, most metropolitan areas are typically composed of a large central municipality (referred to as *city*) surrounded by many small municipalities (referred to as *towns*). By focusing on atomistic jurisdictions, [Chapter 1](#), and then [Chapter 2](#) and [3](#), ignore the existence of cities — which are large enough to have market power — and the competition that can occur between the city and the surrounding towns. This typical structure of metropolitan area is of high importance for the general purpose of our thesis which — let us remember — is to provide a better understanding of the behavior of local governments within metropolitan areas.

[Chapter 4](#) considers a metropolitan area composed not only of many small towns, as in preceding chapters, but also of a central city with market power. To investigate the differences and the relations among city and towns within a sub-metropolitan tax competition context, this chapter addresses the following basic question: who, the central city or the suburban towns, set the highest taxes on capital and residents in a metropolitan area and why?

[Chapter 4](#) is not the first contribution to consider this question. It consolidates an important, and fairly heterogeneous, strand of the tax competition literature which deals with asymmetries among jurisdictions. Observing that central cities usually have a larger population than the suburban towns, the traditional tax competition literature provides an unambiguous answer to our question: the city charges higher tax rates than the towns. First, the capital tax competition literature argues that, having more market power on the capital market due to its relatively higher endowment of labor, the central city is intended to raise a higher capital tax rate ([Bucovetsky, 1991](#); [Wilson, 1991](#); [Bucovetsky, 2009](#)). Second, the residential tax competition literature finds, similarly, that since largest municipalities have more market power on the housing market than smaller ones, a city should set higher tax rates on residents (absent other taxes) than small towns ([Epple and Zelenitz, 1981](#); [Hoyt, 1992](#)).<sup>20</sup>

This clear-cut theoretical result does not always coincide with basic empirical facts. Indeed, in a given urban area, there are usually a non-negligible share of suburban towns charging higher tax rates on capital and/or on residents than the

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<sup>20</sup> See [Table 1](#) for the properties of these models with asymmetric tax competition.

central city. For instance, in 2009 among the ten most populated French metropolitan areas, 54% of the suburban towns set a higher tax rate on capital than the city of their metropolitan area and 41% set a higher housing tax rate.<sup>21</sup> Regarding the theoretical literature cited above, these observations are hardly understandable.

Chapter 4 aims precisely at providing insights into the possible reasons why suburban towns may or may not set higher tax rates on capital and/or residents than a central city. To this end, we need to modify the existing frameworks mentioned above to better account for sub-metropolitan features. Specifically, the early asymmetric tax competition model mentioned above suffers from two main shortcomings to capture properly the interactions between a city and its surrounding towns. First, the point made in Chapter 1 is still missing in these models where either households or firms are immobile (or ignored) as visible in Table 1. To avoid this pitfall, the model developed in this chapter includes the basic structure of Chapter 1 which allows to consider capital, residents' and workers' mobility. Second, in the early asymmetric tax competition models, city and towns are actually only considered as jurisdictions with different population sizes but are similar in every other extent. In these early models, there is no actual core-periphery structure, as in urban economics models, with commuting of suburbanite to work in the city (commuting is absent from these models) and there are no agglomeration forces explaining that the city concentrate more activities.

To have better chance to explain why suburban towns may potentially set higher tax rates on capital and/or residents than the city, Chapter 4 builds a new sub-metropolitan asymmetric tax competition model. It includes capital, residents' and workers' mobility, a spatial core-periphery structure and allows for agglomeration economies. Moreover, the urban structure of the model allows to integrate a new feature. Households consume public goods not only as residents but also as workers. Specifically, contrary to most (if not all) previous tax competition models, workers are not considered as a simple production factor but also as households who benefit from public services in the jurisdiction where they work. It is typically the case that individuals prefer to work in a municipality with more public services and amenities (security, public cleanliness, state of roads...). This last feature allows to consider a more realistic definition of workers than previous contributions in which the absence of urban structure did not allow to identify workers as actual individuals. It also gives a new explanation for the existence of local public good spillovers across municipalities, which is a central tenet of the tax competition literature. While most existing contributions model spillovers by assuming that local public goods provided

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<sup>21</sup> Chapter 4 provides further stylized facts going in the same direction.

in a given jurisdiction benefit indiscriminately to all residents of other jurisdictions (e.g. Gordon, 1983; Wellisch, 1994), Chapter 4 assumes that (part of) these spillovers are originally due to workers mobility.

The model developed in Chapter 4 is an original contribution to the tax competition literature in that it is the first model to integrate both the traditional concerns of the standard tax competition literature (e.g. taxation of mobile capital and local public good provision) and an explicit urban economics structure (spatial representation of the metropolitan area with commuting from the suburb to the city).<sup>22</sup>

This chapter contributes to fill the gap between the tax competition literature and the urban economics literature. This task is, in our view, essential for local public economics. Recent models of urban economics capture a considerable amount of real-life features of MAs (e.g. agglomeration economies, unemployment, sorting, trade...) which could profitably be introduced into local public economics model to study how local governments can address a bunch of issues. Empirical literature could also benefit from strengthened link between local public economics and urban economics, in view of the considerable amount of data available at the municipal level.

## 4. Main results

### 4.1. Chapter 1

Besides the more precise modeling of the sub-metropolitan environment of local jurisdictions, the main contribution of Chapter 1 is to highlight the distortion caused by a single local business property tax imposed on capital and land used by firms within sub-metropolitan jurisdictions. In short, we show that the single local business property tax reveals that the downward pressure exerted by capital on business tax rates entails inefficient local governments' choices specific to the sub-metropolitan context.

To identify the distortions caused by a single business property taxation, we first characterize the choices made by local jurisdictions when two separate business taxes on capital and land are available. We show that in this case, these two tax

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<sup>22</sup> The urban structure in this chapter is closely related to that in the tax competition model developed in Gagné et al. (2016). However, the absence of capital mobility and of endogenous public good provision makes the model in Gagné et al. (2016) closer to an urban economics model including tax competition among municipalities. On the contrary, Chapter 4 is a traditional tax competition framework including features from urban urban economic models. This makes the findings of this chapter more easily comparable to the results derived in the existing tax competition literature

instruments as well as the tax on residents, the public good provided to households and the public factors (or subsidies) provided to firms are chosen at a Pareto efficient level. More precisely, local governments set a zero capital tax on mobile capital and a sufficiently high tax on business land to allow all other local policy instruments to be set at an efficient level.

Then, we introduce a single business property tax constraint so that local governments vote a single tax rate on capital and land. We show that in this case, local authorities are now forced to tax capital at a positive level, but the presence of capital in the business property tax base spurs them to choose an inefficiently low level of the tax on business land compared to the first-best level. We show that this inefficiently low business taxation leads to two new findings compared to the previous literature.

First, local governments choose to distort neither their local public good provision nor their taxation on residents. This result is important since it shows that residents' mobility forces local governments to account for the tastes of their constituents, in line with the well-known [Tiebout's \(1956\)](#) result. Compared to the early tax competition model in [Zodrow and Mieszkowski \(1986\)](#), this result indicates that while capital mobility entails a downward pressure on local business tax rates leading to an inefficiently low business taxation, this does not result in an inefficiently low level of public good in the presence of household mobility. Thus, accounting for residents' mobility in a sub-metropolitan tax competition model matters.

Second, local governments choose to distort their provision of local public factor to firms. Since they are now constrained to charge a positive tax on capital, local government engage in an inefficient competition for mobile capital by distorting their public factor provision. Specifically, jurisdictions which are able to attract capital-intensive (resp. land-intensive) firms by augmenting their public factor provision are now providing an inefficiently high (resp. low) level of public factors. This result is interesting since it is one of the first characterization of competition for mobile capital engaged by sub-metropolitan governments using their public factor provision policy.

One originality of the results derived in this chapter is that they exploit the single business property taxation to highlight the effect of capital mobility on the local policy instruments. This idea is further developed and exploited in [Chapter 3](#) which includes a labor tax.

## *4.2. Chapter 2*

The results derived in this discussion chapter address the two following questions: (1) How does limited household mobility affect the results derived in [Chapter 1](#)?

(2) Which policy can tackle the distortions entailed by a single business property taxation constraint?

The sub-metropolitan tax competition model introduced in [Chapter 1](#) assumes that commuting entails no cost. This chapter relaxes this assumption by introducing a fixed commuting cost and shows that the behavior of jurisdictions with high and low local demand for labor relative to their population is ultimately not affected by the existence of commuting costs. The local workforce in these jurisdictions is exclusively driven by local firms' needs. The framework of [Chapter 1](#) fully applies to these two types of jurisdictions. They can represent the majority of jurisdictions in metropolitan areas where commuting costs are relatively low due, for instance, to a well developed transportation network or to the small size of the metropolitan area. However, the existence of commuting costs matters for jurisdictions with an intermediate level of labor demand. For these jurisdictions, residents find that it is too costly to commute so that they work in their home jurisdiction. This 'quasi-immobility' of workers provides local authorities with a scope for action on the local labor market by using their tax on residents as a labor tax.

We show that this ability to directly influence local labor alters the way these jurisdictions use their tax on residents compared to [Chapter 1](#). Specifically, when they are constrained to use a single business property tax on capital and business land, they use not only the public factor to attract more capital intensive firms (as in [Chapter 1](#)) but also the tax on residents (contrary to [Chapter 1](#)). More generally, this result shows that commuting costs, by introducing a link between the population and the workforce in jurisdictions, change the economic nature of their local policy instruments. In the presence of commuting costs, the resident-oriented policy instruments (here the tax on residents) are not only used to control residents' mobility, but they also allow municipalities to stimulate or mitigate their attractiveness on workers. This intuition is further developed in [Chapter 4](#).

[Chapter 1](#) assumes that all the residents are perfectly mobile across jurisdictions. This chapter relaxes this assumption by introducing a group of immobile landowners who coexist with mobile households without landownership. We show that if mobile and immobile residents have the same marginal willingness to pay for local public goods, the model boils down to that in [Chapter 1](#). However, in practice, landowners are usually richer than non-landowners and therefore have a comparatively higher marginal willingness to pay for the local public good. In this case, we showed that if local governments are constrained to use a single business property tax on capital and business land, they now provide an inefficiently high level of public good. Specifically, "rich" households (ie. landowners) take advantage of their greater marginal willingness to pay for the public good to spur local authorities to provide an inefficiently high level of public good, in view of reducing the amount of business

land in favor of residential land. This result is specific to the sub-metropolitan tax competition context introduced in [Chapter 1](#), since it stems from the competition between households and firms for local land markets. This result contrasts with most of the existing literature since [Zodrow and Mieszkowski \(1986\)](#) and [Wilson \(1986\)](#) whose theoretical prediction goes in the opposite direction: tax competition among jurisdictions would lead to an inefficiently low level of local public good.

While a unique business property tax on capital and business land might be justified on political and administrative grounds, [Chapter 1](#) showed that this single tax constraint leads to inefficient local policy choices. [Chapter 2](#) discusses several policies that could be led by the central government to tackle this issue: dissociation of the business property tax bases, vertical transfers and introduction of local land-use restriction policy instruments. The pros and the cons of each of these measures are discussed. This discussion suggests that, regarding financial costs and inequalities, the most promising measure might be the introduction of local land-use restriction policy instruments. This chapter sheds a new light on the so-called “zoning” policies. From the sub-metropolitan framework developed in [Chapter 1](#), it appears that land-use policy instruments allow jurisdictions not only to control their population size (as in e.g. [Hamilton, 1975](#), and many subsequent contributions) but also the amount of land used by firms — which is to our knowledge not studied in the existing literature. This chapter depicts how such instruments which are both household-oriented and firm-oriented can be used to address the issue of a single business property tax constraint, but it also paves the way for future investigations of the crucial role that this two-sided local policy instrument can play for sub-metropolitan jurisdictions.

### *4.3. Chapter 3*

[Chapter 3](#) investigates the result of the traditional tax competition literature stating that a tax base mobility entails a downward pressure on the related tax rate. This chapter provides both theoretical and empirical results.

To test the impact of tax base mobility on tax rates within metropolitan areas, we first develop a stylized theoretical model which takes as a starting point the model in [Chapter 1](#). Municipalities compete for mobile capital and residents by using a single business property tax on both capital and business land and a tax on residents to finance a local public good. We analyze the impact of removing capital from the business property tax base, which therefore becomes a tax on business land only. We show that this institutional change affects the local tax rates via two different effects. First, the budgetary effect entails that shrinking the business property tax base spurs municipalities to increase their tax rates on residents and firms. Second, the capital-mobility effect implies that the new business property tax



base (business land) being less mobile, municipalities can charge a higher business tax rate and alleviate the tax on residents.

The budgetary effect and the capital-mobility effect on tax rates of a removal of capital from the business property tax base can *a priori* not be disentangled. However, we also show that if the central government guarantees municipalities a compensation covering the revenue loss resulting from the deletion of the capital tax base, the budgetary effect is neutralized. Such a revenue compensation therefore allows to identify the capital-mobility effect that we want to address in this chapter.

Then, to test empirically the existence of the capital-mobility effect on the local tax rates, we exploit a French reform, which changes the composition of the main local business tax base in 2010. The reform indeed removed the capital investment, which was around 80% from the local business property tax base (of the so-called '*Taxe professionnelle*'). More precisely, while their business property tax base consisted in the capital investments (machinery and equipment) made by firms and the real property (buildings) they used, French local governments ended up with a business real property tax only. This change in the composition of tax base has implied a dramatic change in the degree of mobility of the business property tax base since it turned from taxation relying mostly on capital into taxation relying exclusively on business real property. At the same time, a state grant was allocated to each municipality for the exact amount of their capital tax revenues before the reform.

To analyze the impact of this reform — which coincides with our theoretical setting — we build a data set of local taxation and socio-demographic, political and economic characteristics for more than 11,800 French municipalities from 2006 to 2012. We use the capital share in the business property tax base in 2009 (the last pre-reform year) as a proxy for the tax base mobility. Using a difference-in-differences (DD) approach, we consider this continuous variable — the capital share in the tax base — as our treatment effect.

Our DD estimates show that a drastic cut in the amount of a mobile tax base (capital) relative to a far less mobile tax base (buildings) has led French municipalities to raise their business property tax rates while decreasing their housing tax rates. Since a perfect state compensation was allocated to French municipalities, in line with our theoretical results, our empirical investigation suggests that the increase in the business tax rate was motivated by a less mobile tax base and not by a budgetary effect. Our analysis also suggests that this increase in the business property taxation due to the decline in the tax base mobility allowed French municipalities to alleviate the tax burden on households by cutting their housing tax.

#### 4.4. Chapter 4

The purpose of [Chapter 4](#) is to answer the following question: who, the central city or the suburban towns, sets the highest taxes in a metropolitan area and why? To address this issue, we develop a new sub-metropolitan tax competition model which contributes to fill the gap between local public economics and urban economics. It involves an asymmetric metropolitan area with a central municipality surrounded by satellite municipalities linked by mobile capital and mobile residents who can commute to work; both households and firms compete for local land markets. A new feature is that workers benefit from local public goods provided at their workplace and generate congestion. Four main results are derived.

The first result is the following. Agglomeration forces lead the city, where firms are usually more capital intensive, to set higher (lower) capital tax rates than the towns when capital is a gross substitute (complement) for other inputs (capital and land).

Let us briefly explain the intuition behind this important result. Agglomeration economies spurs municipalities to set lower tax rates on capital in order to attract more capital.<sup>23</sup> However, if capital is productive enough in a municipality, it alleviates this downward pressure exerted by agglomeration economies on the municipality's capital tax rate. In other words, a municipality sets a capital tax higher than that of the others if capital is productive enough.

The reason why the ordering of the level of the capital tax rate between the center and the suburb is therefore ambiguous is due to the presence of two opposite effects. The first effect is that in the city, which usually concentrates more capital, the marginal product of capital tends to be lower than in the towns. This spurs the city to set a relatively lower tax rate than the towns. However, the concentration of capital in the city also entails a second effect: the lower marginal product of capital applies to a larger number of capital units than in towns, which can imply a higher overall productivity of capital. This spurs the city to set a relatively higher tax rate than the towns.

Which of these two effects dominates depends on the degree of substitutability of capital with the other inputs. If capital is highly (resp. weakly) substitutable with other inputs, the marginal output of capital decreases slowly (resp. quickly) when the amount of capital increases, and then the second (resp. first) effect dominates:

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<sup>23</sup> An intermediate result showed in [Chapter 4](#) is that agglomeration economies can be viewed as a positive externality not accounted for by capital owners who therefore invest a too low quantity of capital in jurisdictions from the viewpoint of local authorities. This is the reason why agglomeration economies spurs them to decrease their capital tax rate.

the city raises higher (resp. lower) capital tax rate than the towns.

This result is important since it highlights the ambiguous role of agglomeration economies in the ordering of the level of the capital tax rate between the center and the suburb. Since this ordering depends on the substitutability of capital with other production factors, it suggests that further empirical investigation could lead to distinguish MAs according to their sectoral composition.

The second result of this chapter is the following. Taxes on residents are higher (lower) in the city than in the suburb when a sufficiently high (low) share of workers are employed in the CBD.<sup>24</sup>

As standard, in our urban framework, if a larger number of workers are employed in a business district (CBD or SBD), the commuting to work in this business district is more costly, that is jobs are less accessible there. Then, our second result can be rephrased as follows: if jobs are not accessible enough in the suburb compared to the city, the towns are driven to set a higher tax rate on residents relative to the city. The intuition behind this result is straightforward. In the presence of commuting costs, when the population size of a municipality increases, more workers desire to work in its business district,<sup>25</sup> which becomes less accessible. To control the level of accessibility to its business district a municipality increases its tax rate on residents if a large number of workers are employed in its business district. The interest of this result is that it emphasizes a new link between local taxes on residents and job accessibility.

The third result of this chapter is the following. The unavailability of local labor taxes drives the city to decrease (increase) its tax on residents (capital) relative to that of the towns.

The intuition behind this result is the following. Absent labor taxation, a municipal government cannot optimally control the inflow of workers in its jurisdiction. However, workers by consuming the local public good provided at their workplace generate congestion costs. Our third result shows that the city uses its market power to distort its policy instruments in view of controlling the amount of workers in the CBD. It indicates that, if it cannot control the workforce employed in the CBD, the city limits the size of the firms in the CBD. To do so, it increases the tax on capital, which cuts the amount of capital in the CBD, and it decreases the tax on residents to encourage residential land instead of business land.<sup>26</sup>

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<sup>24</sup> As usual, CBD is the acronym for *central business district* and SBD for *secondary business district*.

<sup>25</sup> Notice that this pattern echoes [Chapter 2](#).

<sup>26</sup> Notice that this result does not mean that the city views workers as being exclusively costly. They, of course, entail benefits since they increase the production in the municipality. It simply

The fourth result of this chapter is the following. The absence of local labor taxes entails an under-provision of local public goods.

The intuition behind this result is the same as that behind the cut in the tax on residents: to control the workforce size in their business district, city and towns decrease their provision of local public goods to (relatively) limit the size of their business district.

The third and fourth results point out the key role of labor taxes in MAs. While, in practice, they are often the missing tool in the tax instrument set of municipalities (see e.g. [Blöchliger and Rabesona, 2009](#)), our analysis shows that this might entail important inefficient distortion in the policy setting of municipalities. In particular, this chapter reveals a new distortion in local public good provision entailed by the public good consumption of mobile and costly workers. The absence of labor taxes could ultimately harm residents of municipalities. This result might be viewed as a plea for the availability of labor taxes to municipalities.

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means that workers are also costly since they entail congestion (e.g. need for more cleaning facilities, more police services...). These costs which cannot be internalized by a local labor tax are indirectly internalized by the other taxes.



# Chapter 1

## Sub-metropolitan tax competition with household and capital mobility

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### Abstract

This chapter investigates the efficiency properties of tax competition between sub-metropolitan jurisdictions when capital, residents and workers are mobile, and both households and firms compete for local land markets. We analyze two decentralized equilibria: (1) with a local tax on residents and two separate local taxes on capital and land inputs, efficiency is achieved and the existence of a *marginal fiscal cost* due to residents' mobility is revealed; (2) combination of the taxes on capital and land inputs into a single business property tax leads local authorities to charge inefficiently high taxation on capital. We show that capital mobility induces a reduction in the business land taxation and local public inputs are used to offset the distorting effects of the business property tax, accounting for the distorting impact of workers' mobility.

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## 1. Introduction

It is generally acknowledged that decentralization of many central government activities to lower levels of government is desirable if jurisdictions are linked by high mobility of households and firms. Mobility can force local authorities to take account of agents' preferences (Tiebout 1956; McLure 1986).<sup>1</sup> This suggests the need to understand local governments' behavior in lower-level jurisdictions such as counties, municipalities, townships and districts where agents' mobility is especially high. However, the framework provided by the traditional tax competition literature is more tailored to competition between regions or states within a federation, and little attention has been paid to the proper features of the sub-metropolitan level. The purpose of the present chapter is to propose a tax competition model adapted to the specific environment of low-level jurisdictions which enables investigation of the efficiency properties of sub-metropolitan tax competition in the context of mobile capital and households.

Tax competition among sub-metropolitan governments (or *municipalities*) occurs within a specific context of fiscal relations which differ from those typical of upper government layers. First, the municipal level is characterized by high levels of household interjurisdictional mobility. By comparison, individual mobility in response to short-run public policy changes is much smaller across metropolitan areas and especially across states, which is in line with the immobility hypothesis of Zodrow and Mieszkowski (1986) and Wilson (1986). This high mobility of the tax base in municipalities leads to stronger tax competition between sub-metropolitan governments. Second, competition among municipalities occurs within metropolitan areas composed of a large central jurisdiction and many small communities. While the center has some market power and therefore can behave strategically, the vast majority of municipalities are atomistic.<sup>2</sup> In this chapter, the focus is on tax competition between atomistic jurisdictions. Several recent contributions (see e.g. Janeba and Osterloh 2013; Gagné et al. 2016; and Chapter 4) focus on core-periphery relations.<sup>3</sup> The third and most significant specificity of municipal level is the dual nature of household mobility across jurisdictions. A mobile household typically chooses both a place of residence and a workplace, which potentially are located in

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<sup>1</sup>See, e.g., Oates (1972), Wellisch (2006) and Wildasin (2013) for discussion of the advantages and disadvantages of decentralization of public policies.

<sup>2</sup>Brühart et al. (2015) provide strong empirical evidence of a high level of urban fragmentation within metropolitan areas (or "cities"). Atomisticity partly explains the lack of spatial interactions between municipalities found in e.g., Isen (2014) and Baskaran (2014).

<sup>3</sup>See Brühart et al. (2015) for a comprehensive overview of this recent literature.

two different municipalities.<sup>4</sup> Given this specific local environment, an analysis of municipal governments decisions requires an appropriate theoretical framework.

There is a fairly large literature on the efficiency properties of federal systems when firms - or more specifically capital - and households are mobile across jurisdictions. Early contributions were introduced by [Wilson \(1995\)](#), [Richter and Wellisch \(1996\)](#) and [Brueckner \(2000\)](#). See [Wellisch \(2006\)](#) for a comprehensive review. The simplest models involve small jurisdictions with policies that do not affect prices or utility in other jurisdictions, perfectly mobile capital and residents-workers, and a fixed land factor.<sup>5</sup> Local governments provide congestible local public goods financed by various tax instruments. A central result is that a residence-based head tax on mobile households to internalize their congestion costs and an undistorsive tax on land to balance the local budget are sufficient to achieve Pareto efficiency of the competitive equilibrium between jurisdictions. Such an efficiency-supporting tax structure is qualified as *complete*. [Wellisch and Hulshorst \(2000\)](#) demonstrate that with the introduction of several firms and local impure public factors this efficiency result still holds, provided that jurisdictions can raise local poll taxes on mobile firms. Inefficiencies occur whenever one of these tax instruments is unavailable or is replaced by a distortive tax.<sup>6</sup>

While the above contributions differ in important respects, they all assume that mobile individuals work in their chosen residential location, and consequently, they treat wage as a jurisdiction-specific variable. This makes the above models appropriate to study tax competition between large jurisdictions such as regions or states.<sup>7</sup> However, as [Braid \(1996\)](#) notes, within a metropolitan area, having decided on a residential location, households can commute to work anywhere in the metropolis, which equalizes wages (potentially net of commuting costs) across jurisdictions. In Braid's model, sub-metropolitan jurisdictions compete for mobile capital and work-

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<sup>4</sup>See e.g. [McKenzie \(2013\)](#) for empirical evidence of the significance of county-to-county commuting in the United States.

<sup>5</sup>While this chapter is concerned with households' perfect mobility, which may be relevant at the municipal level, other papers which investigate regional tax competition focus on imperfectly mobile households. Based on the model proposed by [Mansoorian and Myers \(1993\)](#), several authors, such as [Burbidge and Myers \(1994\)](#) and [Wellisch \(1994\)](#), study tax competition when individuals have different degrees of home attachment. [Bucovetsky \(2011\)](#) studies the situation where households face a fixed uniform mobility cost when moving from one jurisdiction to another.

<sup>6</sup>Using [Richter and Wellisch \(1996\)](#)'s framework, [Wellisch and Hulshorst \(2000\)](#) analyze the distortions induced by the absence of either an undistorsive tax on land or one of the direct taxes on households and firms. [Wilson \(1995\)](#) demonstrates that contrary to head taxes on households, labor taxes on individual labor supply induce underprovision of public goods.

<sup>7</sup>[Mieszkowski and Zodrow \(1989\)](#) refer to this type of models as *regional* models, whereas they qualify as *metropolitan* models, those that study tax competition within a metropolitan area.



ers, but residents are assumed to be immobile. Conversely, Hoyt (1991), Krelove (1993) and Wilson (1997) employ the model developed originally by Epple and Zenlenitz (1981) and Henderson (1985) to study the policy choices of sub-metropolitan governments when households are free to choose their residential location; however, these works ignore the location of labor and businesses.

This chapter extends the tax competition model with residents'-workers' mobility developed by Wilson (1995) and Richter and Wellisch (1996) (WRW hereafter) and investigates the efficiency properties of tax competition between sub-metropolitan jurisdictions when capital and households are mobile. There are two main features that distinguish our model from the models in the literature. First, previous studies focus on workers', residents' or workers'-residents' mobility; the framework proposed here integrates both residents' and workers' mobility as separate household choices. In lower-level jurisdictions, this is empirically more relevant, and allows clarification of the role of each market from the perspective of local authorities.<sup>8</sup> The second and most important characteristic of this model is the presence of a common land market for households and firms; the previous literature which considers both households' and firms' mobility, sees land use as confined to firms. Specifically, in contrast to the WRW model which focuses on labor markets, in low-level jurisdictions the interactions of interest between mobile households and firms takes place in local land markets through land rent adjustments. The other features of the model are standard. A federation consisting of a large number of small jurisdictions is considered. Like residents and workers, capital is perfectly mobile throughout the federation, while each jurisdiction is endowed with a fixed amount of land. Each household owns an equal share of the federation's total capital and land endowments. Local authorities provide congestible public goods and pure public inputs financed by endogenous multiple tax instruments.

Two decentralized equilibria are studied in this chapter. In the first, local governments are assumed to finance public expenditure by levying of a residence-based head tax on households and two source-based taxes on firms - a capital tax, and a business land tax.<sup>9</sup> In the WRW framework, since all land serves as an input,

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<sup>8</sup>Gaigné et al. (2016) develop a urban economic model with asymmetric tax competition within metropolitan areas which also integrates both residential and labor mobility of households. Contrary to the present chapter, in response to local policy changes residents are mobile within jurisdictions and not across them. Moreover, in Gaigné et al. (2016) public services are exogenous, while efficiency of endogenous local public service provision is central to our analysis. Thus, the results in Gaigné et al. (2016) should be regarded as complementary to those in this chapter.

<sup>9</sup>Business taxes are source-based since both local private inputs are partially owned by non-residents.

the business land tax which relies on a fixed factor, is undistortive. Thus the tax structure is complete, a congestion fee is raised on households, capital is not taxed, and public services are provided efficiently.<sup>10</sup> This chapter extends these findings allowing mobile residents also to consume land, so that business land use becomes endogenous. Although each separate tax is now distortive, the overall tax structure remains complete. A noteworthy change in the first-best tax policy however occurs. To control the size of its residential population, a jurisdiction needs to increase the head tax to above the marginal crowding cost: since new residents replace firms on the local land market, and thereby erode the business land tax base, they involve an additional marginal cost that also needs to be internalized.

In practice, combining related tax bases allows to save on administration costs (Hettich and Winer, 1988).<sup>11</sup> Thus, it is common for statutory restrictions to require local authorities to levy a single business property tax rate on both capital and land inputs.<sup>12</sup> Introducing a combined business property tax appears to be a natural departure from the first-best tax structure (e.g. Wilson 1984, 1995; Braid 1996). In the second decentralized equilibrium analyzed in this chapter, local governments may freely choose the levels of a single business property tax levied on both capital and land inputs, and a head tax on residents. Our analysis provides two new insights. First, the only tax distortion caused by the property tax is an inefficiently low taxation of business land in order to attract mobile capital. Due to the interactions between households and firms in local land markets, local authorities do not need to compensate for this decline by increasing their tax on residents, which contrasts with findings in the WRW framework.<sup>13</sup> Second, this chapter extends Wilson's (1995) focus on local public goods, to include local public inputs, and provides an optimal

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<sup>10</sup>This corresponds to the first-best case in Wilson (1995). Similar outcomes are obtained by Wellisch and Hulshorst (2000) in Richter and Wellisch's (1996) framework with several firms involving congestion but no capital. In their framework, due to firms congestion, the optimal poll business tax is a congestion fee.

<sup>11</sup>Hettich and Winer (1988, 1999) characterize the optimal number of activities within a tax base, accounting for the administrative and political costs. Another rationale for a combined tax is that it might be difficult, in practice, to disentangle closely related tax bases. For instance, land improvements which constitute a type of capital, are often integrated in the land tax base (Fisher, 2015).

<sup>12</sup>E.g. in the United States the legal restrictions in 40 out of the 50 states impose equal rates on real property (land and buildings) and personal property (equipment, machinery, inventories...). Source: the online database published by the Lincoln Institute of Land Policy, 2014. In France, the *taxe professionnelle* (1975-2010) was another example of an identical statutory tax rate on capital and land.

<sup>13</sup>When regional authorities are constrained to use a combined business property tax, Wilson (1995) shows that the distortions are balanced among all their tax instruments.

second-best provision rule which reveals that local public inputs are provided so as to balance the location distortions caused by the property tax. It highlights the key role of workers' mobility in the choice of the local public input supply.<sup>14</sup>

Beyond the current analysis, the proposed model provides a basis from which to examine the efficiency properties of various possible local tax systems and local public policy instruments (see [Chapter 2](#)); as such, it can be relied on to address a number of issues related to optimal taxation in sub-metropolitan jurisdictions in a decentralization context. In addition, our analysis suggests the need for more empirical investigations of business property tax limitation reforms (see [Chapter 3](#)). Several reforms resulting in capital being drastically limited or removed from the local combined property tax base have been implemented in the United States (Ohio, 2005; Michigan, 2014) and in Europe (France, 2010). Empirical investigation of their impact on the local tax mix and the local provision of public services would provide new insights into tax competition at the sub-metropolitan level.

The paper is organized as follows. [Section 2](#) specifies the general model. [Section 3](#) characterizes the efficient allocation in a metropolitan area and derives a baseline efficiency-supporting tax system. [Section 4](#) studies decentralized competitive equilibria with a complete tax instrument set, and with a combined business property tax. [Section 5](#) concludes.

## 2. The model

### 2.1. The economy

Consider a federation, which can be regarded as a metropolitan area, consisting of  $n$  atomistic sub-metropolitan jurisdictions indexed by  $i = 1, \dots, n$ . The federation is exogenously endowed with  $\mathcal{K}$  units of capital. Its fixed total population is denoted  $\mathcal{P}$ . Each jurisdiction  $i$  is endowed with a fixed land supply  $\mathcal{L}_i$ , is inhabited by  $R_i$  mobile residents, and hosts  $W_i$  mobile workers, such that

$$\mathcal{P} = \sum_{i=1}^n R_i, \quad (1.1a)$$

$$\mathcal{P} = \sum_{i=1}^n W_i, \quad (1.1b)$$

Note that equations (1.1) make explicit a first distinguishing feature of this frame-

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<sup>14</sup>This provision rule echoes [Matsumoto and Sugahara \(2017\)](#). Their framework differs in several respects from the one proposed here, but the main difference is that we account for the existence of an untaxed mobile factor (labor).

work: each of the  $R_i$  residents in jurisdiction  $i$  could potentially work in another jurisdiction, so that  $R_i$  and  $W_i$  do not necessarily coincide at the level of jurisdiction  $i$  which contrasts to what is postulated in the WRW framework. Relaxing this assumption allows us to account for the fact that within a metropolitan area, residential location and workplace decisions are separated.

Firms in community  $i$  produce a private numeraire good which can be consumed anywhere in the metropolis. The production technology in jurisdiction  $i$  is described by the well-behaved production function  $F^i \equiv F(W_i, K_i, L_i, z_i)$ , where the three private factors  $W_i$ ,  $K_i$  and  $L_i$  respectively correspond to labor, capital and land, while  $z_i$  is the public input provided by community  $i$ .  $F^i$  exhibits constant returns to scale in private factors.<sup>15</sup> Marginal products are positive and decreasing, and all factors are assumed to exhibit two-by-two technological complementarity so that cross derivatives of  $F^i$  are positive.<sup>16</sup> Since all capital is used in the federation, we have

$$\mathcal{K} = \sum_{i=1}^n K_i. \quad (1.2)$$

Each resident of community  $i$  derives utility from private consumption, a congestible public good and one unit of land, which is inelastically demanded in the individual's jurisdiction of residence.<sup>17</sup> Thus, a resident is characterized by the utility function  $U^i \equiv U(x_i, g_i, R_i)$ , where  $x_i$  denotes private consumption, and  $g_i$  is the level of congestible public good provided by community  $i$ . Marginal utility of  $x_i$  and  $g_i$  is positive and non-increasing, and  $U^i$  is decreasing in  $R_i$  due to congestion.<sup>18</sup> The total cost function of providing the local public good and input in community  $i$  is denoted by  $C^i \equiv C(g_i, z_i)$  which is expressed in units of the private good. Marginal costs are positive and non-decreasing.

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<sup>15</sup>Making the alternative assumption that  $F^i$  exhibits constant returns to scale in all factors including the public input would not affect significantly the analysis in this chapter, since the number of firms is normalized to one (see [Matsumoto, 1998](#)). The case of constant returns to scale in private factors is chosen for convenience and is usually considered as the empirically more relevant case (see footnote 56).

<sup>16</sup>The usual assumption that factors are complement in production is reasonable given the aggregation of production.

<sup>17</sup>For the sake of simplicity, we do not consider housing construction so that households and firms use land directly, and we assume that the individual demand for land is inelastic. In [Hoyt \(1991\)](#), [Krelove \(1993\)](#) and [Wilson \(1997\)](#), housing production uses mobile capital and fixed land, and the individual housing demand is elastic. Krelove shows that housing taxation entails usual distortions from optimal commodity tax theory. See [Wilson \(2003\)](#) for a survey of this literature.

<sup>18</sup>See e.g. [Boadway \(1980\)](#) for a similar specification of congestion. Empirical evidence of congestion are provided in [Borcherding and Deacon \(1972\)](#) and [Bergstrom and Goodman \(1973\)](#). See also [McMillan et al. \(1981\)](#) and [Edwards \(1990\)](#).

To complete the description of the economy, since no vacant land is allowed, in each jurisdiction  $i$  we have

$$\mathcal{L}_i = R_i + L_i. \quad (1.3)$$

The land use condition (1.3) points out the second distinguishing characteristic of this framework.<sup>19</sup> In the WRW model, since households do not consume land, firms use the entire local land as an input (ie.  $\mathcal{L}_i = L_i$ ) so that the model incorporates a fixed factor. In the economy considered here, this assumption is relaxed and all private factors - labor, capital and land - are variable.

## 2.2. Private behavior

Households, both as residents and workers, are assumed to be perfectly mobile within the federation. As residents, households decide on a location which maximizes their utility. They incur no mobility cost so that free migrations equate utility levels across jurisdictions:

$$U(x_i, g_i, R_i) = U(x_j, g_j, R_j) \quad (1.4)$$

for all  $i, j$  in  $\{1, \dots, n\}$ .

As a worker, each individual is endowed with one unit of labor, inelastically supplied in the jurisdiction of the federation which offers the highest wage. Costless commuting entails that the same wage  $w$  prevails throughout the federation.<sup>20</sup> Moreover, each resident of the federation possesses an identical fraction of the total capital endowment  $\mathcal{K}$  which she invests in the jurisdiction where she receives the highest return. Since capital is perfectly mobile across jurisdictions, in equilibrium the same return to capital  $r$  prevails across the whole federation. Also, landownership is shared equally among all metropolis residents. From the perspective of an atomistic jurisdiction, the wage rate  $w$  and the capital return  $r$  are exogenous.<sup>21</sup> However, since local land endowments are fixed, the land rent  $\rho_i$  is endogenous and specific to jurisdiction  $i$ . All prices are expressed in terms of the numeraire good. Based on the above, the real income of an individual is

$$y = w + \frac{r\mathcal{K} + \sum_{i=1}^n \rho_i \mathcal{L}_i}{\mathcal{P}} \quad (1.5)$$

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<sup>19</sup>Note that there may be differences in local land endowments  $\mathcal{L}_i$ . This chapter is in fact not restricted to the study of symmetric equilibria across jurisdictions.

<sup>20</sup> The integration of commuting costs into the model is discussed in [Chapter 2](#).

<sup>21</sup>Commuting is a noticeable departure from the WRW framework. In this literature where commuting is not allowed, the benefits of local policies capitalize into the wage rate which is therefore an endogenous jurisdiction-specific variable even if jurisdictions are atomistic. This explains the central role of local labor markets in this literature.

which indicates that the individual income is independent of the jurisdiction of residence. Households use their income to consume the private good  $x_i$  and their one-unit land use, paying the land rent  $\rho_i$ . The local government  $i$  collects a residence-based head tax  $\tau_i^R$ . Because individuals consume a single unit of land,  $\tau_i^R$  can be interpreted either as a unit tax on residential land consumption or as a head tax. The budget constraint of a representative resident of jurisdiction  $i$  can be written as

$$x_i + \rho_i = y - \tau_i^R \quad (1.6)$$

Firms choose labor  $W_i$ , capital  $K_i$  and land  $L_i$  as to maximize profits  $F^i - wW_i - (r + \tau_i^K)K_i - (\rho_i + \tau_i^L)L_i$ , where  $\tau_i^K$  and  $\tau_i^L$  are respectively two unit source-based taxes on capital and business land use in community  $i$ .<sup>22</sup> Factor prices and taxes are taken as given by firms. Profit maximization implies that firms' competitive behavior equalizes marginal factor products and factor gross prices:

$$F_W^i = w \quad (1.7)$$

$$F_K^i = r + \tau_i^K, \quad (1.8)$$

$$F_L^i = \rho_i + \tau_i^L, \quad (1.9)$$

where (as in all this chapter) subscripts stand for derivatives.<sup>23</sup> Constant returns to scale result in

$$F^i - wW_i - (r + \tau_i^K)K_i - (\rho_i + \tau_i^L)L_i = 0, \quad (1.10)$$

which means that there is no profit opportunity at equilibrium.

The local public sector must satisfy the following budget constraint:

$$\tau_i^R R_i + \tau_i^K K_i + \tau_i^L L_i = C(g_i, z_i). \quad (1.11)$$

that is, tax revenues collected from residents, capital and business land use must cover the costs of public service provision.

### 3. Pareto efficiency

Before studying potential distortions of decentralization, we derive a baseline Pareto-efficient allocation of production factors, households and public services within the

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<sup>22</sup>These taxes are source-based since capital and business land are partially owned by non-residents, as apparent in (1.5). The analysis in this chapter would be strictly identical if  $\tau_i^K$  and  $\tau_i^L$  had been directly introduced into the individual's budget constraint (1.5).

<sup>23</sup>For reasons of space the framework does not consider local taxes on labor inputs. However, as discussed below, the results can easily be extended to labor taxes.

federation. In this section, we ignore individual local governments and consider instead a unique benevolent central planner. Since we are interested in allocations that are compatible with costless migrations of residents, the central planner's choice has to rule out interjurisdictional utility differentials.<sup>24</sup> Therefore, the planner's program consists of choosing a feasible allocation which maximizes utility in a jurisdiction, say 1, under the resource constraints (1.1)-(1.3) and the migration equilibrium condition (1.4):

$$\text{maximize } U(x_1, g_1, R_1)$$

choosing  $x_i, g_i, z_i, R_i, W_i, K_i$  and  $L_i$  subject to (1.1)-(1.4) and

$$\sum_{i=1}^n F(W_i, K_i, L_i, z_i) = \sum_{i=1}^n [R_i x_i + C(g_i, z_i)], \quad (1.12)$$

where condition (1.12) is the feasibility constraint of the economy: global output has to cover households' private consumption and the costs of providing public services.<sup>25</sup>

It is straightforward to prove that the necessary conditions for the central planner's problem then result in:<sup>26</sup>

$$R_i \frac{|U_R^i|}{U_x^i} + F_L^i + x_i = R_j \frac{|U_R^j|}{U_x^j} + F_L^j + x_j, \quad (1.13)$$

$$F_K^i = F_K^j, \quad (1.14)$$

$$F_W^i = F_W^j, \quad (1.15)$$

$$R_i \frac{U_g^i}{U_x^i} = C_g^i, \quad (1.16)$$

$$F_z^i = C_z^i, \quad (1.17)$$

for all  $i, j$  in  $\{1, \dots, n\}$ ,

where  $|\cdot|$  denotes absolute value.<sup>27</sup> Rules (1.13), (1.14) and (1.15) define the efficient allocations of residents, capital and workers across jurisdictions. Condition (1.13) states that the efficient residential allocation of individuals across jurisdictions requires that the costs of a marginal resident are equalized among communities. There

<sup>24</sup>This approach considers that the social planner cannot directly control migrations and is consistent with most studies with household mobility (e.g. Myers and Papageorgiou 1993; Richter and Wellisch 1996; Wellisch 2006; Wildasin 2013).

<sup>25</sup>Note that the central planner do not need to use taxes in order to determine the Pareto-efficient allocation since its resources come from the direct control of firms.

<sup>26</sup>The planner's problem may well be solved by a so-called corner solution. That is, an allocation for which there is no production or no resident in some jurisdictions. We ignore this well-known problem in regional economics.

<sup>27</sup>An appendix is available from the author upon request detailing the derivations of (1.13)-(1.17).

are three kinds of such costs.<sup>28</sup> First, when entering a jurisdiction, a new resident decreases the utility of all residents in  $i$  due to congestion:  $R_i|U_R^i|/U_x^i$ . Second, she replaces a unit of business land and thus, reduces the jurisdiction's output by  $F_L^i$ . Third, she consumes  $x_i$  units of the private good. Unlike residents, marginal capital and workers involve benefits, their marginal products  $F_K^i$  and  $F_W^i$  but no cost. According to condition (1.14) and (1.15), the efficient allocations of capital and labor require that their respective marginal benefits are equalized among jurisdictions. Conditions (1.16) and (1.17) characterize the efficient supplies of local public services. According to condition (1.16), the efficient provision of the local public good  $g_i$  satisfies the usual Samuelson condition: the sum of the marginal willingness to pay for the local public good of  $i$ 's residents (on the left-hand side - LHS) equates to its marginal cost (on the on the right-hand side - RHS). As stated by condition (1.17), a similar requirement characterizes the efficient level of public input: the marginal product of the public input on the RHS must be equal to its marginal cost on the LHS.

The efficient allocation characterized in (1.14)-(1.16) highlights several features of low-level jurisdictions which are essential for this analysis. At first, conditions (1.13) and (1.15) show that residents and workers assume very different roles at the sub-metropolitan level. On the one hand, new residents in a jurisdiction entail only social and economic costs since they conduct no local productive activity.<sup>29</sup> On the other hand, inflows of new workers, who do not consume public goods, bring nothing but benefits - from a jurisdiction perspective, labor plays a role similar to that of capital.<sup>30</sup> Another distinguishing characteristic of the sub-metropolitan level is highlighted by the presence of the marginal product  $F_L^i$  in (1.13). It is specific to the interaction among households and firms through their use of a common local land. Thus, in contrast to the WRW model, even in the absence of congestion, residents are still costly from the jurisdiction's viewpoint. This is expected to increase the incentive for the local authorities to levy higher taxes on residents to internalize this specific marginal opportunity cost. This is explored further in section 4.

The above characterization of efficient allocation was derived assuming that the

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<sup>28</sup>Alternatively, as shown by the land market clearing condition (1.3), condition (1.13) also characterizes the efficient location of business land.

<sup>29</sup>Recall that the central planner do not levy taxes on residents. This explains why from its viewpoint, residents only entail costs that it balances among jurisdictions. However, local governments tax residents, so that in the decentralized equilibria analyzed in section 4, residents entail not only costs but also benefits from the individual jurisdictions' viewpoint.

<sup>30</sup>This should be compared to the case of higher-level jurisdictions. In this case, conditions (1.13) and (1.15) are merged, reflecting the fact that residents are not only costly but also generate some local benefits through their marginal productivity  $F_W^i$  (e.g. Richter and Wellisch, 1996).



central planner's choices replace the agents' decision-making process. Although enlightening from a theoretical point of view, the efficiency conditions obtained in this way can hardly be compared with the outcomes of decentralized equilibria in which local authorities cannot directly control the economic variables. Thus, suppose now that the central planner aims to implement the efficient allocation characterized in (1.13)-(1.17), choosing  $(\tau_i^R, \tau_i^K, \tau_i^L, g_i, z_i)_{i \in \llbracket 1, n \rrbracket}$  and accounting for the private behaviors and the local budget constraints described in section 2. The efficiency conditions change to:

**Result 1.1.** *Efficient local tax system and public service provision, in a metropolitan area where the public policy instruments set  $\{\tau_i^R, \tau_i^K, \tau_i^L, g_i, z_i\}$  is available, are characterized by*

$$\tau_i^R - R_i \frac{|U_R^i|}{U_x^i} - \tau_i^L = \tau_j^R - R_j \frac{|U_R^j|}{U_x^j} - \tau_j^L, \quad (1.18)$$

$$\tau_i^K = \tau_j^K, \quad (1.19)$$

$$R_i \frac{U_{g_i}^i}{U_x^i} = C_g^i, \quad (1.20)$$

$$F_z^i = C_z^i, \quad (1.21)$$

and business land taxes  $\tau_i^L$  are set so as to clear the local budget restrictions (1.11),

for all  $i, j$  in  $\{1, \dots, n\}$ .

*Proof.* See [Appendix A](#). □

According to condition (1.18), an efficient location of residents and business land within the federation requires that the net marginal benefits of residents between jurisdictions are equalized. When entering community  $i$ , a new resident brings in  $\tau_i^R$  additional tax revenues but generates a congestion cost  $R_i |U_R^i| / U_x^i$  and a marginal fiscal cost  $\tau_i^L$ . This second cost stems from the crowding out of a unit of business land by the new resident which reduces the tax revenues from  $\tau_i^L$ . The marginal fiscal cost of households which is a central aspect of the present study, reflects the specific interaction of households and firms on local land introduced - similar to the  $F_L^i$  term in (1.13). Condition (1.18) thus extends the net marginal benefits equalization rule for efficient location of residents derived in the WRW model (Wellisch, 2006). Similarly, condition (1.19) states that for capital to locate efficiently, the net marginal benefits of capital location have to be equalized across jurisdictions. Since capital involves no marginal cost, efficiency requires a uniform

taxation of capital throughout the federation.<sup>31</sup> Finally, conditions (1.20) and (1.21) simply restate the Samuelson rules for efficient public service provision.

Thus, the efficient allocation can be achieved provided that the tax instrument set of Result 1.1 is available and local governments behave according to conditions (1.18)-(1.21) 1.1.<sup>32</sup> The remainder of the chapter focuses on the extent to which decentralized local governments' decisions do lead to efficiency. This question is all the more relevant here since all the above taxes are distortive. It means that none of these individually enables local governments to finance the public services and perform interjurisdictional resource transfers without distorting the agents' behavior.<sup>33</sup>

#### 4. Decentralized equilibria with multiple tax instruments

We now introduce benevolent local governments acting in the best interest of their own residents. In order to analyze the efficiency properties of decentralized equilibria when local governments choose their tax policies and their supply of local public services, we consider a metropolis comprised of a large number  $n$  of atomistic jurisdictions. Thus, any jurisdiction perceives the choices made in other communities as independent of its own decisions. In the sequel, attention is focused on a representative jurisdiction  $i$ . In subsection 4.1, local governments behavior is specified. Subsection 4.2 characterizes optimal local public policies when the tax instrument set is comprised of three taxes on respectively residents, capital and business land use. In subsection 4.3 a decentralized equilibrium in which the two latter taxes are replaced by a single business property tax on both capital and business land use is analyzed.

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<sup>31</sup>Notice that the symmetric role of capital and labor in this economy allows one to deduce that any uniform level of local labor tax would ensure an efficient location of workers across jurisdictions. This requirement is met since the absence of a labor tax can be considered a uniform zero-tax on labor.

<sup>32</sup>It may be inferred from Result 1.1 that the location-based taxes on residents alone do not allow to sustain efficiency. Jurisdictions must use the source-based taxes on capital and business land to finance the public services and perform the efficient interjurisdictional transfers of resources. Indeed, as shown in e.g. Myers (1990), Hercowitz and Pines (1991) and Krelove (1992) : in a federation with household mobility, interjurisdictional transfers of resources are necessary to sustain efficiency.

<sup>33</sup>This contrasts with the literature in which an undistortive tax - usually a source-based tax on (fixed) business land - allows to clear the local budget constraints and achieve resource transfers (see e.g. Proposition 2.3 in Wellisch (2006)).

### 4.1. Local government behavior

#### 4.1.1. Location decisions

Household and capital locations are not under the direct control of local government. However, a rational government must take account of location responses to its policy. The first analytical step then is to characterize the decentralized location decisions of households and capital from the perspective of jurisdiction  $i$ . It might be helpful at this stage to review the model variables:  $\{\rho_i; W_i; R_i; L_i; K_i\}$  are endogenous economic variables in jurisdiction  $i$ ;  $\{\tau_i^R; \tau_i^K; \tau_i^L; g_i; z_i\}$  are control variables for local government  $i$ ;  $\{\mathcal{L}_i; w; r; \mathcal{P}\}$  are exogenous from jurisdiction  $i$ 's perspective where  $\mathcal{L}_i$  is the land endowment specific to jurisdiction  $i$ ,  $w$  and  $r$  are the prices prevailing in the entire metropolis, and  $\mathcal{P}$  is the federal population. Finally, for community  $i$   $\{\rho_j; W_j; R_j; L_j; K_j; \tau_j^R; \tau_j^K; \tau_j^L; g_j; z_j; \mathcal{L}_j\}$  are exogenous if  $j \neq i$ .

In equilibrium, households are indifferent between residing in community  $i$  or in some other community  $j$ . Thus, utility is further equated across jurisdictions. Integrating the household's budget constraint (1.6) into the free mobility condition (1.4), it follows that from jurisdiction  $i$ 's viewpoint, a migration equilibrium is defined by the  $n - 1$  bilateral relations:

$$U(y - \rho_i - \tau_i^R, g_i, R_i) = U(y - \rho_j - \tau_j^R, g_j, R_j) \quad (1.22)$$

for all  $j = 1, \dots, n$  such that  $j \neq i$ ,

where  $y$  is as defined by (1.5). The presence of the individual's income on the RHS of (1.22) shows that decisions made in jurisdiction  $i$  affect the level of utility enjoyed by its residents whether they continue to reside in  $i$  or move to some other community  $j$ . Wherever a resident chooses to settle, she will still own her initial share  $\mathcal{L}_i/\mathcal{P}$  of jurisdiction  $i$ 's land endowment. Hence, any variation in the local land rent  $\rho_i$  will affect her income, and thereby her welfare, regardless of her location. However, since the equilibrium bundle  $(x, g, R)$  usually differs between jurisdictions, a given change in  $\rho_i$  will have a different effect on the utility of a resident initially living in  $i$  depending on the jurisdiction chosen for relocation.<sup>34</sup> These differentiated income effects might make it technically demanding to characterize households' location responses to local policy changes. However, they are fairly peripheral to this analysis since they are not a major determinant of households' location choices in practice.

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<sup>34</sup>A given increase (decrease) in the individual's income will, *ceteris paribus*, increase (reduce) the satisfaction of the residents living in the community, and especially since the equilibrium amount of the local public good is higher (lower) than private consumption - assuming diminishing marginal rate of substitution.

Therefore, the following analysis is restricted to the reasonable case where such effects are ignored by mobile households:

**Assumption 1.1.** *The function  $U$  satisfies the following condition:  $\frac{\partial U}{\partial x}(x, g, R) = \frac{\partial U}{\partial x}(x', g', R')$ , for all bundles  $(x, g, R)$  and  $(x', g', R')$  such that  $U(x, g, R) = U(x', g', R')$ .*

An example of utility function which satisfies the above assumption is the common class of additively-separable functions,  $U(x, g, R) = x + v(g, R)$ .<sup>35</sup> Assumption 1.1 guarantees that any marginal change in the individual's income has a neutral effect on the migration equilibrium (1.22). That is, mobile residents perceive that income, and therefore the utility prevailing in other jurisdictions, are exogenous. In formal terms, to derive population reactions to its policy, local government  $i$  considers the following modified migration equilibrium condition:

$$U(\bar{y} - \rho_i - \tau_i^R, g_i, R_i) = \bar{u}, \quad (1.23)$$

where  $\bar{y}$  and  $\bar{u}$  are some exogenous variables from the representative jurisdiction's viewpoint. Thus, the responses of capital  $K_i$ , residents  $R_i$  and workers  $W_i$  to changes in local government's policy instruments  $\tau_i^R$ ,  $\tau_i^K$ ,  $\tau_i^L$ ,  $g_i$  and  $z_i$  can be derived from the necessary conditions for the optimal demand for labor (1.7) and capital (1.8) from local firms, and the migration equilibrium condition (1.23). Inserting (1.3) and (1.9) into (1.7), (1.8) and (1.23), we obtain the following three-equation system in  $K_i$ ,  $W_i$  and  $R_i$ :

$$F_W(W_i, K_i, \mathcal{L}_i - R_i, z_i) - w = 0, \quad (1.24)$$

$$F_K(W_i, K_i, \mathcal{L}_i - R_i, z_i) - \tau_i^K - r = 0, \quad (1.25)$$

$$U[\bar{y} - F_L(W_i, K_i, \mathcal{L}_i - R_i, z_i) - \tau_i, g_i, R_i] - \bar{u} = 0, \quad (1.26)$$

where  $\tau_i \equiv \tau_i^R - \tau_i^L$  is the tax spread between household and business land taxes. It represents the tax revenue generated by a resident net of her marginal fiscal cost. The three location conditions (1.24), (1.25) and (1.26) allow us to derive  $K_i$ ,  $W_i$  and  $R_i$  as implicit functions of  $\tau_i$ ,  $\tau_i^K$ ,  $\tau_i^L$ ,  $g_i$  and  $z_i$ .

#### 4.1.2. Local government objective

Local authorities in jurisdiction  $i$  are assumed to maximize the utility of a representative resident,  $U(x_i, g_i, R_i)$ . Note that despite households' perfect mobility, the

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<sup>35</sup>Additive-separability is a widespread hypothesis in tax competition models. However, utility need not be linear in consumption. E.g., Assumption 1.1 holds also for  $U(x, g, R) = \Phi[x + v(g, R)]$ , whenever  $\Phi$  is a bijective function, which is guaranteed by the usual assumptions:  $\Phi$  is continuous and  $\Phi' > 0$ .

community perceives that it can influence the level of satisfaction of its residents since, in contrast to mobile households, local government takes account of the effects of marginal income changes on its residents' satisfaction. Since households ignore these effects when deciding on a residential location, changes in the jurisdiction's policy instruments induce variations in utility which are not offset completely by households' subsequent migrations. It follows also that the utility-maximizing local government's objective boils down to maximizing the local net land rent  $\rho_i \mathcal{L}_i$ , which allows us to state that:

**Lemma 1.1.** *Suppose that Assumption 1.1 holds. If jurisdictions are small and residents are perfectly mobile, then a utility-maximizing local government aims at maximizing the net land rent in its jurisdiction.*

*Proof.* See Appendix B. □

Lemma 1.1 raises some comments. It highlights that an individual can increase its satisfaction in two main ways. She can first move to another jurisdiction if utility is lower in her current jurisdiction. Thus, she can “vote with her feet” (Tiebout, 1956). But she can also stay in her home jurisdiction and vote for its desired local public policy. Doing so, she will be able to raise her local land income. Households need to use these two alternative ways if they wish to obtain the highest possible satisfaction. Indeed, if they decide on local policy but stay immobile, some utility differentials can remain across jurisdictions. Thus, some households could be better-off by moving to jurisdictions with higher utility level. On the contrary, if households only migrate across jurisdictions but do not choose local public policy, utility would be equalized among jurisdictions but not necessarily the highest it could be.

Moreover, according to Lemma 1.1, local governments pursue a policy favoring local landowners. This is consistent with most models of tax competition among many small jurisdictions in the presence of perfect mobility of residents (e.g. Henderson 1985; Hoyt 1991; Krelove 1993; Wilson 1995; Wellisch 2006).<sup>36</sup> In this chapter, land-rent-maximizing behavior stems from household perfect mobility. However,

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<sup>36</sup>The result stated in Lemma 1.1 requires a separation of individuals' decisions as consumers and landowners. It is ensured by the neutrality hypothesis (Assumption 1.1) introduced in this chapter. Other approaches are also possible. For example, Wilson (1995) and Wellisch and Hülshorst (2000) assume an Arrow-Debreu separation, while Henderson (1985) assumes that the local policy is conducted by absentee landowners. Alternatively, Hoyt (1991) postulates that the policy instruments are controlled by some immobile landowners who aim at maximizing their net wealth. In all these frameworks, the individual income  $y$  is treated as exogenous, while local authorities maximize the local land rent in order to maximize the income of landowners. Assumption 1.1 allows to reconcile these two seemingly incompatible assumptions.

there can be other reasons for this behavior. Following Bucovetsky (1995), it could be argued that in practice landowners constitute a majority of the voter residents in a number of local jurisdictions. Moreover, their greater interest in the community may explain that they are more prone to lobbying local authorities compared to non-landowners.<sup>37</sup>

#### 4.2. First-best policy

We assume first that local governments can use three different tax instruments: a head tax on households  $\tau_i^R$ , a unit tax on capital  $\tau_i^K$  and a unit tax on business land use  $\tau_i^L$ . In what follows, we assume without loss of generality that the local tax instrument set is  $\{\tau_i; \tau_i^K; \tau_i^L\}$ . Local public policies are thus constrained by the following budget restriction:

$$\tau_i R_i + \tau_i^K K_i + \tau_i^L \mathcal{L}_i = C(g_i, z_i), \quad (1.27)$$

where the definition of  $\tau_i$  and (1.3) are used to substitute respectively for  $\tau_i^R$  and  $L_i$  into (1.11). Written in this form, the budget constraint shows that local government  $i$  considers its tax instrument set as composed of two taxes on mobile tax bases - the net tax on residents  $\tau_i$  and the capital tax  $\tau_i^K$  - and a tax  $\tau_i^L$  levied on the fixed total land endowment. Note that the business land tax remains a distortive tax since it still alters the demand for land from local firms. However, the budget constraint (1.27) reveals that local authorities use the distortive tax on residents to offset any change in tax revenues caused by business land use variations, so that they can use  $\tau_i^L$  as if it were undistortive.

Let us consider in the sequel that the local government freely chooses  $\tau_i$ ,  $\tau_i^K$ ,  $g_i$  and  $z_i$ , while  $\tau_i^L$  adjusts endogenously so as to satisfy (1.27). From Lemma 1.1 the objective of the local government is to maximize the local net land rent  $\rho_i \mathcal{L}_i$ . Using the land market clearing condition (1.3), the zero-profit requirement (1.10), and replacing  $\rho_i$  with (1.9), local government  $i$ 's objective can be rewritten as follows:

$$\Omega_i \equiv \rho_i \mathcal{L}_i = F^i + F_L^i R_i - wW_i - (r + \tau_i^K)K_i - \tau_i^L \mathcal{L}_i. \quad (1.28)$$

Using the budget constraint (1.27) to substitute  $\tau_i^L$  into (1.28), it follows that the

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<sup>37</sup>To be consistent with this alternative argument, immobile landowners can be introduced in the model. It can be showed that this would not affect any of the results derived in this chapter provided that mobile and immobile residents have the same marginal willingness to pay for the local public good. See Chapter 2 for further discussion.

local government's problem is to maximize:

$$F(W_i, K_i, \mathcal{L}_i - R_i, z_i) - wW_i - rK_i + [F_L(W_i, K_i, \mathcal{L}_i - R_i, z_i) + \tau_i]R_i - C(g_i, z_i) \quad (1.29)$$

choosing  $\tau_i$ ,  $\tau_i^K$ ,  $g_i$  and  $z_i$ . Recalling that  $W_i$ ,  $K_i$  and  $R_i$  depend on the policy instruments so as to satisfy (1.24)-(1.26), the first-order conditions for optimal local government behavior are:<sup>38</sup>

$$\frac{d\Omega_i}{dt_i} = \left( \tau_i + R_i \frac{U_R^i}{U_x^i} \right) \frac{\partial R_i}{\partial t_i} + \tau_i^K \frac{\partial K_i}{\partial t_i} + \left( R_i \frac{U_g^i}{U_x^i} - C_g^i \right) \frac{\partial g_i}{\partial t_i} + (F_z^i - C_z^i) \frac{\partial z_i}{\partial t_i} = 0 \quad (1.30)$$

$$\text{with } t_i \in \{\tau_i; \tau_i^K; g_i; z_i\}, \text{ and } \frac{\partial t_i}{\partial t_i'} = \begin{cases} 1 & \text{if } t_i = t_i' \\ 0 & \text{otherwise.} \end{cases}$$

In other words, conditions (1.30) indicate that local government  $i$  chooses each policy instrument so as to equalize the marginal benefits and marginal costs it induces, while taking account of economic agents' mobility.<sup>39</sup> The location responses of residents and capital to changes in any policy variable  $t_i$ ,  $\partial R_i/\partial t_i$ ,  $\partial W_i/\partial t_i$  and  $\partial K_i/\partial t_i$  can be derived by total differentiation of the location system (1.24)-(1.26). Their signs are summarized below:

**Lemma 1.2.** *The equilibrium responses of residents, workers and capital to changes in the policy instruments have the following signs:*

- (i)  $\frac{\partial R_i}{\partial t_i} < 0$  and  $\frac{\partial K_i}{\partial t_i}, \frac{\partial W_i}{\partial t_i} > 0$ , for  $t_i \in \{\tau_i; z_i\}$ ,
- (ii)  $\frac{\partial R_i}{\partial t_i} > 0$  and  $\frac{\partial K_i}{\partial t_i}, \frac{\partial W_i}{\partial t_i} < 0$ , for  $t_i \in \{\tau_i^K; g_i\}$ .

*Proof.* See Appendix C, for the detailed derivation of the location responses.<sup>40</sup>  $\square$

<sup>38</sup>The detailed derivation of the necessary conditions (1.30) is provided in Appendix C.

<sup>39</sup>Notice that (20) in Wilson (1995) and (16)-(19) in Wellisch and Hulshorst (2000) are qualitatively similar to (1.30). The differences in results between these contributions and ours is mainly due to the new location pattern entailed by the present framework (see Lemma 1.2 hereafter).

<sup>40</sup>Derivation of the location responses requires that the local public good involve congestion,  $U_R^i < 0$ , as assumed in this chapter (see footnote 59). This requirement must be met since all factors are variable; in the WRW model, deriving the location responses requires the presence of a fixed production factor.

Lemma 1.2 depicts the way political decisions affect the location choices of mobile households and capital in equilibrium. It states that an increase in the net tax on residents induces an outflow (resp. inflow) of residents (resp. capital and labor). A decrease in public good provision has the same impact. A higher capital tax decreases (resp. increases) the equilibrium quantity of capital and labor (resp. number of residents). Decreasing the public input supply entails similar effects.

The equilibrium location responses require some comments. Notice first, that since  $\tau_i^L$  does not appear in the location system (1.24)-(1.26), changes to the business land tax have no impact on population or capital provided that the tax spread between  $\tau_i^R$  and  $\tau_i^L$  is unchanged. This confirms that even relaxing the hypothesis of a fixed land factor which is usual in the WRW framework, the business land tax  $\tau_i^L$  can still be used as an undistortive tax. Second, all responses of private inputs used by firms - labor, capital and land - are in the same direction. This result follows directly from the hypothesis of technological complementarity among inputs. Thus, although the framework does not account explicitly for the number of firms (unlike that proposed by Richter and Wellisch (1996) for example) the intuition of firms' location is maintained. The last comment highlights the main novel insight provided by this chapter: whatever the instrument used, local authorities face a systematic trade-off between attracting residents, therefore driving out firms, and vice versa. This trade-off reflects the interactions of households and firms in local land markets. For example, by cutting household taxation, local government attracts new residents. This inflow exerts upward pressure on the local land rent which in turn, reduces the local demand for business land and induces capital and labor outflows. This compromise is specific to lower-level jurisdictions, and therefore is not part of the WRW model. At the regional level, where residents and workers cannot be dissociated, the flow of worker-residents usually follows the flow of firms (see e.g. Wellisch and Hulshorst, 2000).

Inserting the location responses into the necessary conditions (1.30), we obtain the following result:

**Result 1.2.** *In equilibrium, under perfect interjurisdictional competition, local government  $i$  chooses  $\tau_i^R$ ,  $\tau_i^K$ ,  $\tau_i^L$ ,  $g_i$  and  $z_i$  in accordance with the following decision rules:*

$$\tau_i^R = R_i \frac{|U_R^i|}{U_x^i} + \tau_i^L, \quad (1.31)$$

$$\tau_i^K = 0, \quad (1.32)$$

$$R_i \frac{U_g^i}{U_x^i} = C_g^i, \quad (1.33)$$

$$F_z^i = C_z^i, \quad (1.34)$$



while satisfying the budget restriction (1.27), so that

$$\tau_i^L = \frac{R_i}{\mathcal{L}_i} \left( \frac{C^i}{R_i} - R_i \frac{|U_R^i|}{U_x^i} \right). \quad (1.35)$$

*Proof.* See Appendix D. □

Conditions (1.31)-(1.34) characterize the behavior of any jurisdiction in the federation, so that the efficiency conditions (1.18)-(1.21) are satisfied in the decentralized equilibrium. Moreover, following condition (1.35), whenever the marginal congestion cost of public services  $R_i|U_R^i|/U_x^i$  exceeds the per capita cost  $C^i/R_i$ , the business land tax is negative and thus, becomes a subsidy, and the tax on residents can be charged at below the marginal congestion cost according to condition (1.31). However, it is well known that when provision of local public services entails marginal costs that exceed average costs, private markets are expected to supply local public services efficiently (Boadway, 1980).<sup>41</sup> This chapter focuses on public services which require a public supply:

**Assumption 1.2 (scale economies).** *The marginal congestion cost is lower than the per capita cost of local public services, so that  $R_i|U_R^i|/U_x^i < C^i/R_i$ .*

Assumption 1.2 is common in tax competition models dealing with household mobility.<sup>42</sup> It implies that an efficient tax instrument set cannot be reduced to a head tax on residents: in order to dedicate this tax to controlling their population size, local governments need another instrument to finance public services. This is precisely the role of the business land tax  $\tau_i^L$ , as apparent in condition (1.35).<sup>43</sup> Nonetheless, due to the trade-off faced by local authorities between hosting households and hosting firms (Lemma 1.2),  $\tau_i^L$  also constitutes an additional cost for welcoming new residents.

According to condition (1.31), local governments have incentives to choose household taxation in order to internalize the two marginal costs involved by an additional

<sup>41</sup>The proof of this common result adapted to the present framework is available in an additional appendix, available from the author upon request.

<sup>42</sup>See e.g. Wilson (1995), Richter and Wellisch (1996) and Wellisch and Hulshorst (2000). Notice that Assumption 1.2 is a simplifying assumption which can be dropped without affecting any of the results of this chapter. It would just require to adapt slightly the interpretations, accounting for the fact that  $\tau_i^L$  could be a subsidy.

<sup>43</sup>The  $R_i/\mathcal{L}_i$  term in (1.35) - which can be written also as  $1 - L_i/\mathcal{L}_i$  - simply recalls that from a budgetary perspective, broadening a tax base allows to lower the related tax rate. However, this budgetary effect is of minor importance to this analysis.

resident: the congestion cost  $R_i|U_R^i|/U_x^i$  and the marginal fiscal opportunity cost  $\tau_i^L$  caused by the erosion of the business land tax base.<sup>44</sup> In addition, since capital generates no congestion, the optimal capital tax is zero as (1.32) shows. This confirms that atomistic jurisdictions using multiple tax instrument sets have no incentives to tax capital (Bucovetsky and Wilson, 1991). Note also that since workers involve no congestion, any additional local source-based tax on labor, either on firms or on households, would also be set at zero by the local authorities.<sup>45</sup> Finally, conditions (1.33) and (1.34) indicate that local public services are provided efficiently. The main findings from this subsection can be summarized in the following proposition:

**Proposition 1.1.** *Suppose that local governments control  $\tau_i^R$ ,  $\tau_i^K$ ,  $\tau_i^L$ ,  $g_i$  and  $z_i$ . Then, the decentralized equilibrium is characterized by*

- (i) *a tax on residents that exceeds the marginal congestion cost of residents to internalize their marginal fiscal cost,*
- (ii) *a zero-tax on capital,*
- (iii) *efficient provision of local public goods and factors.*

Proposition 1.1 generalizes the usual first-best results of the WRW model and offers two new insights.<sup>46</sup> First, in the literature, a complete tax structure requires taxes to internalize the mobility costs of agents and an undistortive tax, usually levied on a fixed production factor. Proposition 1.1 extends this result to a tax instrument set composed solely of distortive taxes. The explanation for this result is that in the absence of vacant land, a local government can levy taxes on its entire fixed land endowment using separate distortive taxes on residents and business land use. The tax on residents plays a dual role - being a part of the undistortive tax but also an instrument to control residents' mobility. Thus, household taxes allow local

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<sup>44</sup>Notice that  $\tau_i^R$  and  $\tau_i^L$  play a symmetric role from the local government's viewpoint. Alternatively  $\tau_i^R$  can be used to clear the budget constraint and  $\tau_i^L$  to internalize the net marginal fiscal cost of business land use  $\tau_i^R - R_i|U_R^i|/U_x^i$ . In this case, the level of  $\tau_i^L$  is defined by (1.31) and the level of  $\tau_i^R$  is obtained by inserting (1.31) into (1.35). This symmetry has important implications when the tax structure is constrained (subsection 4.3).

<sup>45</sup>Allowing workers to cause congestion would not change the results of this chapter, provided that a local tax on labor is also introduced to allow local authorities to internalize this additional cost.

<sup>46</sup>The conditions stated in Result 1.2 are essentially the same as the first-best results discussed in Wilson (1995) (section 3). However, Wilson's results exclude two elements: (1) the marginal fiscal cost  $\tau_i^L$  in (1.31); (2) condition (1.34) since his analysis focuses on local public goods. Result 1.2 can be seen also as an extension of the optimal behavioral rules in Wellisch and Hulshorst (2000) (section 2).

governments to use the distortive taxes on business land so as to clear the local budget constraint.<sup>47</sup> The second novel insight is related to the identification of a new marginal cost of household mobility, namely the marginal fiscal cost of residents. This cost which highlights the fact that local authorities face a constant trade-off between hosting firms and hosting households (Lemma 1.2), provides a new rationale for the heavy reliance on local household taxes observed in practice, apart from congestion costs which might be quite low and difficult to measure by the local authority.

### 4.3. A household tax and a business property tax

Let us now consider the case where local governments are not allowed to levy separate taxes on capital and land factors. The purpose is to derive the distortions expected from such a constrained tax instrument set, and explain why local governments decide to depart from efficiency. Local governments are assumed to use two different tax instruments only: a head tax on residents  $\tau_i^R$  and a business property tax  $\tau_i^P$  which consists in a unit tax on both capital and land factors.<sup>48</sup> Local government  $i$  is assumed, without loss of generality, to control the tax instrument set  $\{\tau_i; \tau_i^P\}$ , where  $\tau_i \equiv \tau_i^R - \tau_i^P$ . Therefore, its budget constraint becomes:

$$\tau_i R_i + \tau_i^P (K_i + \mathcal{L}_i) = C(g_i, z_i). \quad (1.36)$$

It is assumed that while  $\tau_i$ ,  $g_i$  and  $z_i$  are chosen freely,  $\tau_i^P$  adjusts to clear (1.36). Using the budget constraint to substitute  $\tau_i^P$  into (1.28) - where  $\tau_i^K$  and  $\tau_i^L$  are replaced by  $\tau_i^P$  - results in (1.29). Thus, the local government's objective does not change, and the optimal choices of  $\tau_i$ ,  $g_i$  and  $z_i$  are still characterized by the necessary conditions (1.30). Only the location responses of households and capital differ from the first-best case. Inserting them into the first-order conditions, we derive the following result:

**Result 1.3.** *In equilibrium, under perfect interjurisdictional competition, local gov-*

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<sup>47</sup>Household taxes also allow local governments to employ the business land tax so as to perform the efficient resource transfers (see footnote 32).

<sup>48</sup>Wilson (1995) and Braid (1996) investigate a similar combined tax which they refer to as a "business property tax". We retain this terminology in our paper and refer to the sum  $K_i + L_i$  as "business property".

ernments choose  $\tau_i^R$ ,  $\tau_i^P$ ,  $g_i$  and  $z_i$  in accordance with the following decision rules:

$$\tau_i^R = R_i \frac{|U_R^i|}{U_x^i} + \left(1 + \frac{K_i}{L_i}\right) \tau_i^P, \quad (1.37)$$

$$R_i \frac{U_g^i}{U_x^i} = C_g^i, \quad (1.38)$$

$$\frac{F_z^i - C_z^i}{K_i} = \varepsilon_i \left[ F_{Kz}^i - F_{Lz}^i + (F_{KW}^i - F_{LW}^i) \frac{\partial W_i}{\partial z_i} \Big|_{(\bar{K}_i, \bar{L}_i)} \right], \quad (1.39)$$

while satisfying the budget restriction (1.36), so that

$$\tau_i^P = (1 - \kappa_i) \frac{R_i}{\mathcal{L}_i} \left( \frac{C^i}{R_i} - R_i \frac{|U_R^i|}{U_x^i} \right), \quad (1.40)$$

where  $\kappa_i \equiv K_i/(K_i+L_i)$  denotes the capital share in the business property and  $\varepsilon_i < 0$ , its elasticity with respect to  $\tau_i^P$ ; and  $(\partial W_i/\partial z_i)|_{(\bar{K}_i, \bar{L}_i)} > 0$  is workers' reaction to a public input increase, given  $K_i$  and  $L_i$ .

*Proof.* See [Appendix E](#). □

The competitive equilibrium with a combined business property tax is thus characterized by an inefficient allocation - compared to conditions (1.18)-(1.21). To interpret the behavioral rules stated in Result 1.3, it must be emphasized that, under Assumption 1.2, condition (1.40) requires the property tax  $\tau_i^P$  to be positive. That is, jurisdictions are not able to balance their budget without taxing mobile capital, as was possible with two separate business taxes on capital and land.<sup>49</sup> Local governments consequently decide to distort their policy instruments to compensate for this overtaxation of mobile capital. The first of these distortions appears in the choice of the property tax itself. Condition (1.40) shows first that, except in the rare case of a perfectly symmetric equilibrium, property tax levels are intended to differ across jurisdictions, which entails a misallocation of capital in the federation (condition (1.19) is violated).<sup>50</sup> Interestingly, condition (1.40) offers further information about the causes of this misallocation. It shows that, ceteris paribus, jurisdictions with lower desired business land taxes - as defined by the first-best decision rule (1.35) - and those with more capital-intensive firms are expected to set more attractive

<sup>49</sup>In the first-best setting (subsection 4.2), only the allocation of local land between residents and firms was distorted by  $\tau_i^L$ . This distortion could be offset by the use of  $\tau_i^R$ . Here,  $\tau_i^P$  also distorts the location of capital which leads to sub-efficiency. Indeed,  $\tau_i^P$  does not enable local authorities to finance the provision of public services and achieve the resource transfers without distortion.

<sup>50</sup>In this framework, a symmetric decentralized equilibrium is all the less likely since jurisdictions potentially have different initial land endowments  $\mathcal{L}_i$ .

tax rates on capital. More generally, condition (1.40) provides a fresh and fairly intuitive characterization of combined business property taxes:

**Proposition 1.2.** *Suppose that local business taxes on capital and business land use are combined into a single local business property tax. Then:*

- (i) *the property tax level  $\tau_i^P$  is chosen between the first-best desired levels of the two taxes it combines,  $\tau_i^K$  and  $\tau_i^L$ , defined respectively by (1.32) and (1.35);*
- (ii) *the higher the capital (land) share in the overall business property of community  $i$ , the more  $\tau_i^P$  acts as a capital (land) tax.*

Proposition 1.2 indicates that tax competition for mobile capital is fiercer between jurisdictions with highly capital intensive firms, which puts downward pressure on business tax rates.<sup>51</sup> In other words, the more mobile the tax base of the combined property tax (higher capital share in the business property), the lower its rate.

Comparing condition (1.37) to the first-best decision rule (1.31), indicates that when choosing their household tax levels, local governments treat property taxes and business land taxes in a similar vein. However, the tax on residents now has to internalize an additional marginal fiscal cost  $\tau_i^P K_i/L_i$ . Again, since this distortion need not be the same in every jurisdiction, residents and thus, business land use are misallocated in the federation (condition (1.18) is violated). The intuition behind this suboptimal behavior is straightforward. Consider a small decrease in the household tax allowing community  $i$  to attract a new resident. This entry now deprives the jurisdiction of tax revenue for two reasons. First, the new resident replaces a unit of business land which entails a loss of  $\tau_i^P$ , as in the first-best case. Second, due to the complementarity between capital and land ( $F_{KL}^i > 0$ ), this decrease in business land use is accompanied by an outflow of  $K_i/L_i$  units of capital, which also reduces local tax revenues since mobile capital is now taxed at a positive rate.<sup>52</sup> In other words, by increasing the costs of hosting residents, combined taxation of capital and business land, leads local governments to charge inefficiently high household taxes with respect to business land taxation. This distortion is larger in jurisdictions with highly capital-intensive firms, because they incur higher marginal fiscal costs when new residents crowd out local firms. Here, we are interested in the extent to which local governments actually increase the household tax level. To address

<sup>51</sup>To our knowledge, the literature does not provide such a characterization of combined business property taxes. Most studies focus on the distortions caused by a tax structure incorporating a business property tax, without deriving its explicit level.

<sup>52</sup>Since, inputs prices ratios are not directly affected by changes in  $\tau_i^R$ , homogeneity of  $F^i$  implies that the relative demand for inputs  $K_i/L_i$  is unchanged.

this, recall that business property taxes are usually lower than business land taxes, especially in jurisdictions with more capital intensive firms (Proposition 1.2). This should in part at least, offset the increase in the marginal fiscal cost of residents. Integrating (1.35) and (1.40) respectively into (1.31) and (1.37) reveals that  $\tau_i^R$  is not distorted,<sup>53</sup> which can be summarized in:

**Proposition 1.3.** *Suppose that local business taxes on capital and business land use are combined into a single local business property tax. Then, despite the increase in the marginal fiscal cost of residents due to the positive taxation of capital, local governments have no incentive to distort local taxes on residents.*

Thus, jurisdictions have no incentive to tax mobile residents too heavily, since by lowering their property taxes in order to attract mobile capital, they reduce the increased marginal fiscal cost of mobile residents to its optimal first-best value. Although the introduction of a business property tax distorts the allocation of residents and business land across jurisdictions, the household tax setting is not distorted. That is, local governments distort only the tax instrument that has been constrained. This result contrasts with the analysis in Wilson (1995) which shows that regional authorities balance the distortions between the tax on residents and the property tax. The reason for this difference is that at the sub-metropolitan level, due to the compromise between residents and firms, the tax on residents and the tax on business land play a symmetric role: each of these taxes can be used to internalize the other one, while the other tax allows to clear the local budget constraint.<sup>54</sup> Thus, in a constrained environment, local authorities have no incentive to distort both instruments and distort only the most appropriate one.<sup>55</sup> Here, the objective of attracting more capital can be achieved directly by lowering  $\tau_i^P$ . Hence, it is not necessary to distort  $\tau_i^R$ .

According to condition (1.38) local governments have no incentive to distort the provision of local public goods, since this would not directly influence capital location,  $\partial F_K^i / \partial g_i = 0$ . The only effect of local public good supply on the marginal productivity of capital is through residents' location responses. Thus, under perfect mobility of households across small jurisdictions, local public goods are provided in accordance with the Samuelson rule. As in the first-best case, decentralized provision of public goods with property taxation provides local governments with the incentives to internalize the preferences of residents.

<sup>53</sup>In both cases  $\tau_i^R = (C^i + L_i |U_R^i| / U_x^i) / (R_i + L_i)$ .

<sup>54</sup>See footnote 44.

<sup>55</sup>In the WRW framework, each tax has its own role to play. Therefore, when the tax structure is constrained, each tax is used separately to alleviate directly or indirectly the lack of available instruments, while continuing to play its first-best role partially. See Wellisch (2006).

However, condition (1.39) reveals that local governments distort their supply of local public input. The LHS of (1.39) is the average distortion per capital unit caused by an inefficient supply of local public inputs - compared to the Samuelson rule. The RHS shows the direction of this distortion. The term  $F_{Kz}^i + F_{KW}^i (\partial W_i / \partial z_i)|_{(\bar{K}_i, \bar{L}_i)}$  is the overall capital-augmenting impact of the public input - that is, the increase in the marginal product of capital induced by an incremental amount of  $z_i$ .<sup>56</sup> Indeed, an additional unit of the public factor increases  $F_K^i$  not just directly, as a technological complement to capital but also indirectly by attracting new workers who improve the productivity of capital as well. Likewise,  $F_{Lz}^i + F_{LW}^i (\partial W_i / \partial z_i)|_{(\bar{K}_i, \bar{L}_i)}$  represents the land-augmenting effect of  $z_i$ . Hence, condition (1.39) states that public inputs are over(under)-provided, i.e.  $F_z^i < (>) C_z^i$ , when the capital-augmenting impact of the public input is stronger (weaker) than its land-augmenting impact. To interpret this result, recall that property taxation involves suboptimally high taxation of mobile capital relative to business land from the jurisdiction's standpoint (Proposition 1.2). In response, local authorities use public factors to encourage capital location in their jurisdiction whilst not overly stimulating land input demand. By so doing, they increase the capital share in the business property  $\kappa_i$ , which allows them to compensate - at least in part - for the distortive effect of the property tax.<sup>57</sup> Finally, the elasticity  $\varepsilon_i$  in (1.39) reveals that the more  $\tau_i^P$  distorts  $\kappa_i$ , the greater the distortion of the local public input. In other words, in jurisdictions where business property taxation involves a stronger distortive effect, local authorities further distort their public input supply to outweigh the first distortion. In the extreme case when capital is not taxed (ie.  $\tau_i^P = 0$ ), the public input provision is not distorted.<sup>58</sup> It occurs when there are no scale economies in the public services provision, which implies that  $\tau_i^P$  does not need to be positive to clear the local budget. In this case, the business property tax can be set simultaneously at the first-best desired levels of a capital tax and a business land tax. In summary, we have:

**Proposition 1.4.** *Suppose that local business taxes on capital and business land use*

<sup>56</sup>The literature on public inputs distinguishes two categories of public factors depending on the technology considered (Hillman 1978; McMillan 1979; Feehan 1989). This chapter assumes "factor-augmenting" public inputs (i.e.  $F^i$  is CRS in private factors only), usually considered as the empirically more relevant case. It implies that public inputs only increase private factors productivity unlike "firm-augmenting" public inputs (i.e.  $F^i$  is CRS in all factors) which also increase the firms' profit. Comparing the outcomes of these two specifications is beyond the scope of the present analysis. See Matsumoto (1998) for such a comparison when public inputs are financed by a capital tax.

<sup>57</sup>Intuitively, condition (1.39) reads: the local public input is over(under)-provided if and only if it allows jurisdiction  $i$  to attract capital(land)-intensive firms.

<sup>58</sup>Indeed,  $\tau_i^P = 0$  implies  $\varepsilon_i = 0$  since  $\varepsilon_i = \frac{\tau_i^P}{K_i + L_i} \frac{F_{WW}^i}{F_{WL}^i F_{KW}^i - F_{WW}^i F_{KL}^i}$  (see Appendix E).

are combined into a single local business property tax. Then:

- (i) local public goods are provided efficiently;
- (ii) public inputs are over(under)-provided when the overall capital-augmenting impact of the public input is stronger (weaker) than its overall land-augmenting impact. This distortion increases with the sensitivity of the capital share in the business property to changes in the property tax.

Part (i) of Proposition 1.4 is similar to the efficiency result derived in Wilson (1995) and Richter and Wellisch (1996): under residents' perfect mobility across atomistic jurisdictions, when the tax instrument set consists of a direct tax on residents and a distortive tax, local governments provide public goods efficiently.<sup>59</sup> However, a novel finding from this analysis is that due to competition between households and firms on land markets, local authorities also do not distort household taxes when they can also tax business land (Proposition 1.3). Intuitively, since the direct effect of establishing a business property tax is to distort firms' behavior, local authorities choose to use the instruments that directly affect firms ( $\tau_i^P$  and  $z_i$ ) to tackle these distortions, while optimally choosing household-oriented instruments ( $\tau_i^R$  and  $g_i$ ).

Part (ii) of Proposition 1.4 is in line with a recent contribution by Matsumoto and Sugahara (2017). The present study offers several novel insights. First, it reveals the balancing function of local public inputs. The basic reason why local authorities distort their provision of local public factors is to offset the distortions caused by the combined property tax - which is too high (low) for a capital (business land) tax (Proposition 1.2).<sup>60</sup> Second, we find a distorting impact specific to workers' mobility (or any untaxed mobile factor). To make this intuitively transparent, suppose, for example, a community where both the public input and workers involve a land-augmenting effect which dominates the capital-augmenting effect:  $E_z^i \equiv F_{Kz}^i - F_{Lz}^i < 0$ , and  $E_W^i \equiv F_{KW}^i - F_{LW}^i < 0$ . It follows from (1.39) that the public input is under-provided and that higher labor mobility - an increase in  $(\partial W_i / \partial z_i)|_{(\bar{K}_i, \bar{L}_i)}$  - exacerbates this under-provision. However, generally  $E_z^i$  and  $E_W^i$  need not have the same sign. Consequently, ignoring the mobility of labor and other untaxed mobile factors might lead not only to overestimating or underestimating the under-provision of  $z_i$ , but might also predict a misleading over-provision. This last point highlights the importance of workers' interjurisdictional mobility and the type of workers attracted by jurisdictions.<sup>61</sup>

<sup>59</sup>See also Proposition 4 in Wellisch and Hulshorst (2000).

<sup>60</sup>This result echoes the conclusions in Wellisch and Hulshorst (2000): when their tax instrument set is constrained, regional governments balance the distortions among their available instruments.

<sup>61</sup>These considerations are not accounted for in Matsumoto and Sugahara (2017) since they do



## 5. Conclusion

This chapter extends the tax competition model with residents'-workers' mobility developed by [Wilson \(1995\)](#) and [Richter and Wellisch \(1996\)](#), to account for the specific context of sub-metropolitan jurisdictions, such as counties, municipalities, districts or townships. It responds to [Brühart et al. \(2015\)](#) which highlights the lack of theoretical analysis of tax competition *within* metropolitan areas in the presence of mobile households. We examined the level of public good and input provision financed by multiple tax instruments, in an economy with residents, workers and capital mobility. Households and firms interact on both the metropolitan labor market and the local land markets, through their demand for local land. We showed that due to competition between households and firms on land markets, sub-metropolitan authorities are obliged to choose continuously between hosting residents and hosting businesses. Two decentralized equilibria have been analyzed. (1) When local governments freely choose a local head tax on residents and two separate local business taxes on capital and land inputs, the efficient allocation is achieved and reveals the existence of a marginal fiscal cost caused by residents' mobility. This cost is a new rationale for heavy reliance on household local taxes observed in practice apart from congestion costs which may actually be quite low and difficult to measure by local authorities. (2) When local authorities are constrained to use a combined business property tax, they charge inefficiently high (low) taxation on capital (land) and use public inputs so as to compensate the distortive effects of the business property tax. Sub-metropolitan governments only distort the firm-oriented instruments - property taxes and local public inputs - while optimally choosing the household-oriented instruments - taxes on residents and local public goods.

Our analysis suggests that gains could be obtained of engaging local tax limitation reforms that would involve a removal of capital from the property tax base in countries where municipalities and other sub-metropolitan jurisdictions are constrained to make use of combined business property taxes. Such reforms have been implemented in several states of the United States (Illinois, 1979; Ohio, 2005; Michigan, 2014).<sup>62</sup> The *Taxe professionnelle* reform (France, 2010) also consisted in such a tax limitation. Empirical evaluations of the outcomes of this type of reform on tax setting and public service provision could shed an interesting light on tax competition at the sub-metropolitan level (see [Chapter 3](#)).

Much remains to be done to develop our understanding of sub-metropolitan governments' behavior when facing a high degree of interjurisdictional mobility of both

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not consider an untaxed mobile factor, ie.  $(\partial W_i / \partial z_i)|_{(\bar{K}_i, \bar{L}_i)} = 0$ .

<sup>62</sup>See [Stafford and DeBoer \(2014\)](#) for a detailed discussion of such reforms in the United States.

households and firms. Our analysis could be extended to include a central city with some degree of market power (see [Chapter 4](#)). Metropolitan areas are usually composed of a core jurisdiction surrounded by many small jurisdictions. This chapter focuses on tax competition between the peripheral small jurisdictions, while implicitly taking as given the behavior of the central city. Some recent contributions study tax competition in a core-periphery context ([Janeba and Osterloh 2013](#); [Gagné et al. 2016](#)). Further work is required in this emerging area. In particular, a framework integrating both capital tax competition and household mobility should be one of the most promising direction for future research. Another possible extension is the introduction of dynamic aspects. In line with most of the existing literature, our analysis focuses on static issues. In reality, decisions made by local governments account for capital accumulation, and local public debt constitutes an important part of municipal budgets. Accordingly, local public policies are likely to be more subtle than our analysis suggests. A few recent studies have started to introduce dynamic issues in the traditional tax competition model ([Wildasin 2003, 2011](#)) or in frameworks with imperfect household mobility ([Han et al., 2013](#)).<sup>63</sup> Integrating these two types of mobility could be a promising direction for future research.

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<sup>63</sup>See [Keen and Konrad \(2014\)](#) for a review of tax competition models with dynamic aspects.



# Chapter 2

## Limited household mobility and corrective policies

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### Abstract

This chapter presents a discussion around the model introduced in [Chapter 1](#). First, we discuss two types of limited household mobility. Workers' limited mobility is addressed by introducing commuting costs in the baseline framework. We show that for jurisdictions with low or high local labor demand, the baseline results remain. However, for jurisdictions with intermediate-level labor demand, residents work where they live contrary to the baseline model; the resulting departures from the baseline results are described. Residents' limited mobility is addressed by introducing immobile landowners. We show that a single business property tax constraint leads local governments to provide an inefficiently high level of public good when immobile residents have a greater marginal willingness to pay for the local public good than mobile residents. Second, we discuss how policies can correct the distortions entailed by the single business property tax constraint. Three types of policies are addressed: dissociation of business property tax bases, vertical transfers and land-use restrictions.

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## 1. Introduction

### 1.1. *Limited household mobility*

While it is usually admitted that capital can be treated as perfectly mobile across local jurisdictions, household perfect mobility is less obvious.<sup>1</sup> Indeed, workers incur transportation costs when commuting to work outside their jurisdiction of residence and residents also incur costs (e.g. search costs) to move to another jurisdiction.<sup>2</sup> This chapter discusses the effects on the results derived in [Chapter 1](#) of relaxing the perfect household mobility assumption.

#### 1.1.1. *Commuting costs*

Commuting costs can be introduced in the model by considering a fixed cost  $c$  incurred by households if they commute outside their jurisdiction of residence.<sup>3</sup> Then, three categories of jurisdictions appear. In the first category, local firms' need for workers exceeds the local population size. Local firms pay the exogenous highest wage available in the metropolis  $w_{\text{MAX}}$  to attract outside workers. In the second category of jurisdictions, the amount of workers demanded by local firms is lower than the local population size. Local firms pay the lowest wage accepted by local residents  $w_{\text{MAX}} - c$ . In the third category of jurisdictions, the amount of workers demanded by local firms coincides with the local population size. Local firms pay a wage comprised between  $w_{\text{MAX}} - c$  and  $w_{\text{MAX}}$  depending on their need for labor. In the two first categories of jurisdictions, workers and residents do not coincide - the amount of workers is determined by the labor demand - just as in the framework introduced in [Chapter 1](#). Then, all results derived in this study remain for these jurisdictions. However, in the third category of jurisdictions, the amount of local workers is determined by the local population size.<sup>4</sup> Hence, for this type of jurisdictions with intermediate-level labor demand, the existence of commuting

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<sup>1</sup>See [Wilson \(1999\)](#) for an extended survey of the capital tax competition literature. A noticeable exception is [Lee \(1997\)](#) in which capital is treated as imperfectly mobile.

<sup>2</sup>[Mansoorian and Myers \(1993\)](#) assume that residents have attachment to their jurisdiction so that they face a psychic cost when moving to another jurisdiction.

<sup>3</sup>Since the model of [Chapter 1](#) does not include a spatial dimension, introducing commuting costs dependent on the distance between locations would require changes in the framework much beyond the scope of the chapter. See [Chapter 3](#) for a spatial tax competition model with commuting costs dependent on distance.

<sup>4</sup>The case of this category of jurisdictions is close to the WRW framework (see [section 1 of Chapter 1](#)) since residents work where they live. However, regional models still differ from the present case since they ignore residential land.

costs provides the ability to directly affect their local workforce through their public policy instruments - ie. the public goods and the household tax.

This ability to directly influence local labor alters the way these jurisdictions use their public policy instruments compared to other jurisdictions. Specifically, when they are constrained to use a single business property tax on capital and business land, they use not only the public input as a balancing instrument but also the tax on residents. A jurisdiction which cannot directly affect workers location distorts its public input provision in order to affect the productivities of capital and business land both directly and indirectly through the attraction of new workers (condition (1.39)). However, a jurisdiction which can directly affect workers location using its tax on residents prefer to use this tax to attract workers rather than further distorting its public input.

Finally, commuting costs create a type of jurisdictions whose all residents prefer to work at home. This provides their local government with a scope for action on the local labor market which affects the local public policy. Nevertheless, commuting costs do not affect the behavior of governments in jurisdictions with relatively high or low labor demand with respect to their population size. The model in [Chapter 1](#) certainly better applies to this type of jurisdictions or to metropolises where jurisdictions in which residents coincide with workers represent a minority of the jurisdictions, because commuting costs are low enough.

### 1.1.2. *Immobile landowners*

It is typically the case that residents with different degrees of mobility coexist within jurisdictions; the pecuniary and psychic costs of leaving one's home jurisdiction vary among individuals. To account for this heterogeneity, the simplest common approach adopted in the literature consists in distinguishing between "rich" immobile households and "poor" mobile households (e.g. [Wildasin, 1983, 1991](#); [Richter and Wellisch, 1996](#)). A rationale behind this is that richer households are more often longstanding homeowners attached to their jurisdictions, for whom moving to another location implies significant transaction costs. Following this approach, a group of immobile residents owning all local land in their jurisdiction can be introduced in the framework of [Chapter 1](#).<sup>5</sup>

Whenever mobile and immobile residents have different preferences, a discrep-

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<sup>5</sup>An alternative approach to account for different degrees of household mobility is followed in [Mansoorian and Myers \(1993\)](#), which considers a continuum of individual home attachment degrees. However, introducing a Hotelling space of preferences as in [Mansoorian and Myers \(1993\)](#) might be complex in the framework of [Chapter 1](#) with many atomistic jurisdictions.

ancy appears between the interests of local governments, which now represent immobile residents, and the interests of mobile residents. More specifically, we show in this chapter that if mobile and immobile residents have the same marginal willingness to pay (MWP) for local public goods, all the results derived in [Chapter 1](#) are unchanged.<sup>6</sup> However, if immobile landowners have a greater MWP for the local public good than mobile residents, in the presence of a single business property tax constraint, local governments now over-provide the public good (contrary to [Result 1.3](#)).<sup>7</sup> The intuition behind this result is that in order to balance the distortion caused by the business property tax, governments increase their public good provision in order to attract more mobile households and exert an upward pressure on the land rent. This acts as an incentive for firms to decrease their use of business land relative to capital.

There is no over-provision of local public goods in the absence of immobile residents, since mobile residents force local governments to internalize their preferences by migrating. This is no longer true when the local public policy is controlled by immobile residents. In this case, immobile residents can take advantage of their greater MWP for public goods to over-provide them and thus affect firms' choices.

## 1.2. *Corrective policies*

While a unique business property tax on capital and business land could be justified on political and administrative grounds, this single tax constraint leads sub-metropolitan governments to pursue inefficient local public policies, as [Chapter 1](#) shows. Indeed, a single business property tax rate on capital and land inputs forces local governments, for budgetary reasons, to set an excessively high taxation of mobile capital and an inefficiently low taxation of business land in order to account for capital mobility. This inefficiency requires interventions from the central government. This chapter discusses the relevance of different types of intervention for tackling this inefficiency.

### 1.2.1. *Dissociation of capital and business land taxation*

The basic problem of the single business property tax rate is that it is levied on two tax bases with different mobility degrees. Since capital is perfectly mobile and

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<sup>6</sup>For instance, all residents have the same MWP if utility is additively separable, such that  $U(x, g, R) = x + v(g, R)$ .

<sup>7</sup>Note that in this framework, richer households' MWP for the local public good is at least as high as that of poorer households due to diminishing marginal rates of substitution. This theoretical ordering of MWPs is also the most relevant case in practice.

entails no cost, it should not be taxed, while immobile land should contribute to funding public services. Levying a single tax on these two tax bases, local governments use it half as a capital tax and half as a business land tax, which induces inefficiency. In other words, the Tinbergen principle stating that there should be at least as many instruments as there are objectives is not met. Then, a first possible reform could be to replace the business property tax rate with two separate tax rates respectively on capital and business land. However, dissociating tax bases can increase administrative and political costs (e.g. [Hettich and Winer, 1988, 1999](#); [Wilson, 1995](#)). Moreover, tax systems are in practice very complex, which is detrimental to consent to taxation and transparency in the use of tax revenues. Hence, increasing this complexity by dissociating tax bases which are not identical but still close, raises political concerns.

An alternative way to dissociate capital and business land taxation without increasing the number of tax rates is to remove capital from the business property tax base.<sup>8</sup> It boils down to imposing an optimal zero-taxation of capital and turning the business property tax into a simple land tax. Local authorities would then be free to use the new business tax to finance public services without fearing capital outflows. However, such a measure also has drawbacks. First, the central government usually has to compensate tax limitation reforms with vertical transfers to maintain the level of local public services provided.<sup>9</sup> Hence, revenues have to be raised (through new taxation or additional debt) to finance this measure which might entail economic distortions. Second, eliminating capital taxation might induce negative redistributive consequences. Third, so far capital has been supposed to entail no cost when locating in a jurisdiction, which is actually not the case in practice. For instance, the use of capital by local firms can create pollution (e.g. [Wellisch, 1995](#)). Then, an imposed zero-taxation on capital would enable local governments to bring capital owners to internalize such negative externalities.

### *1.2.2. Vertical transfers*

Direct vertical transfers from the central government to the local jurisdictions is an alternative measure to address the inefficiency problem of the single business property taxation without depriving local authorities of the power to tax capital. Indeed, a well-designed grant scheme would enable local governments both to lower

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<sup>8</sup>See [section 1](#) for examples of countries where such reforms have been implemented.

<sup>9</sup>Otherwise, such measures could be too unpopular to be implemented. For instance, all French local jurisdictions have been compensated by national grants after the removal of capital from the business property tax base in 2010 (see [Chapter 3](#)).



their business property tax, thus accounting for capital mobility, and to finance the efficient level of public services. The simplest way to see this in the present of [Chapter 1](#) is to introduce general nonmatching grants financed by a lump-sum national head tax.<sup>10</sup> We show that a grant scheme such that, in each jurisdiction, the per capita grant covers the gap between the per capita cost of public services and the marginal congestion cost of new residents completely removes the distortions caused by the single business property taxation.<sup>11</sup>

Numerical simulations performed in this chapter show that this optimal corrective grant scheme is generally U-shaped: more per capita grant should be provided to jurisdictions with smaller and larger population size. Jurisdictions with a low population size have a poor ability to raise money to finance the high fixed costs usually required to provide public services. At the other end of the scale, crowded jurisdictions have particularly high expenditure needs. Then these two types of jurisdictions need to receive substantial financial support from the central government to prevent them from raising excessively high business property taxes on capital.<sup>12</sup>

In practice, to provide each municipality with the appropriate level of grant, the central government needs to have a precise knowledge of municipal characteristics. Such an omniscience is hardly conceivable. Instead, the central government usually designs the grant scheme based on the per capita expenditure of municipalities, which is observable and therefore often used as a proxy for municipalities' financial needs. Then, traditional moral hazard problems can potentially occur leading municipalities to distort their provision of public services. Hence, it is not sure that a system with vertical transfers entails less distortions than a system with single business property taxation only.

### 1.2.3. *Land use restrictions*

In [Chapter 1](#), competition for local land markets among residents and firms is subject to no limitation: if individuals wish to move to a jurisdiction, they simply need to be ready to pay a high enough land rent for crowding out some local firms. This

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<sup>10</sup>See [Fisher \(2015\)](#) for a classification of intergovernmental grants and a presentation of their various economic effects.

<sup>11</sup>It is indeed straightforward to see from (1.40) that such a grant scheme provides local governments with the incentives to set a zero business property tax, which removes the distortions from (1.37)-(1.39). In words, this grant scheme allows local governments to use their household tax as a congestion fee while being ensured that their public service provision is financed without relying excessively on the business property tax.

<sup>12</sup>Various justifications for higher grants to smaller and larger jurisdictions are discussed respectively in [Kitchen \(2007\)](#) and [Slack \(2007, 2010\)](#).

free land market assumption is not fully realistic since local authorities usually have various instruments to directly regulate residents' and firms' land use in their jurisdiction (e.g. building permit and square footage cap).<sup>13</sup> It is worth noticing that local land-use restriction policies are not a limitless power granted to local authorities. Indeed, they are bounded by national laws (e.g. limited ability to expel residents and firms) and local authorities have to account for the private decisions of economic agents (e.g. granting building permits is not much useful if local land is not attractive). They are nonetheless a key instrument in local public policy and, as such, must be regarded as a serious candidate for solving the business property tax inefficiency.

The most direct way to introduce local land-use restriction policies in the model of [Chapter 1](#) is to allow local governments to directly control the share of land that they respectively supply to residents and firms. Local governments are assumed to account for private agents' responses to their public policy choices; but for simplicity, local land-use restriction policies are assumed not to be bounded by law. Then, we show that local governments are able to fully deal with the inefficiency arising from the single business property taxation. The reason for this efficient behavior is that land-use restriction policy enables local authorities to finance their public service provision through the control of their population size instead of charging an inefficiently high tax on capital.

Two significant changes in the model appear, compared to [Chapter 1](#). First, resident location now follows public budgetary rationales rather than private interests of individuals. The local population increases when additional tax revenues are needed, and it decreases following a budget constraint release, which actually means that local governments employ land use regulation policy as a budgetary tool.<sup>14</sup> Second, a noticeable change in the resident tax setting occurs. Since households and firms do not compete for land anymore, there is now a gap between the business and residential local land rents. The tax on residents is then used to internalize not only the congestion costs but also this rent gap.<sup>15</sup> Since business land rents are usually higher than residential land rents in practice, this would provide an additional rationale for the high levels of household local taxation observed.

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<sup>13</sup>See e.g. [Deakin \(1989\)](#), [Downs \(1991\)](#) and [Quigley and Rosenthal \(2005\)](#) for taxonomies of land use regulation policies.

<sup>14</sup>Then, the location response pattern of [Lemma 1.2](#) is altered by the presence of land-use restriction policy.

<sup>15</sup>The intuition the the following. Consider a jurisdiction where households pay a lower land rent than firms. Then, the replacement of a business land unit by a new resident entails a decrease in the land rent generated in the jurisdiction. This loss must be internalized by households through the resident tax.

This discussion highlights the beneficial role of land-use restriction policy to balance the inevitable rigidity of local tax systems. This suggests that economic gains might be obtained from providing local governments with more autonomy regarding land use regulation. However, the limits fixed by national laws are certainly justified on social and political grounds. Hence, the determination of the appropriate level of control provided to local governments over local land use calls for further analysis, balancing benefits and costs of land use control policies.<sup>16</sup>

This chapter formally develops the discussion above by introducing various extensions to the framework developed in [Chapter 1](#). The chapter is organized as follows. [Section 2](#) recalls the main results stated in [Chapter 1](#). [Section 3](#) discusses the introduction of commuting costs and immobile landowners in the model in the baseline model. [Section 4](#) discusses dissociation of the business property tax bases, vertical transfers and land-use restrictions, and shows how such policies can correct the distortions entailed by the single business property tax constraint. [Section 5](#) concludes.

## 2. Baseline results

In this section, we recall the two main results of the chapter which will be compared to in the remainder of this chapter. [Table 2.1](#) recalls the main variable definitions of the model in [Chapter 1](#), for a given atomistic jurisdiction  $i = 1, \dots, n$ .<sup>17</sup>

Income from capital and land are equally distributed among all households in the economy. Then, the individual income is:

$$y = w + \frac{r\mathcal{K} + \sum_{i=1}^n \rho_i \mathcal{L}_i}{\mathcal{P}} \quad (2.1)$$

In the case where local governments are allowed to choose separate tax rates on capital and business land, the local budget constraints is

$$\tau_i^R R_i + \tau_i^K K_i + \tau_i^L L_i = C^i \quad (2.2)$$

and the decentralized equilibrium is characterized by [Result 1.2](#) in [Chapter 1](#) that we recall in [Result 2.1](#) below.

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<sup>16</sup> This analysis goes beyond the scope of this chapter and is left for future research.

<sup>17</sup> [Table 2.1](#) indicates the usual first-order derivative signs. Recall that  $U_R^i < 0$  due to congestion. The following usual second-order signs are assumed:  $F_{XX}^i < 0$  and  $F_{XY}^i > 0$  if  $X \neq Y$ ;  $U_{xx}^i, U_{gg}^i > 0$  and  $C_{gg}^i, C_{zz}^i < 0$ , where subscripts stand for derivatives (as in all this chapter). See [Chapter 1](#) for more details.

**Table 2.1.** Definition of variables and functions of the baseline model

Functions	endogenous variables
$U^i \equiv U(x_i, g_i, R_i) : \text{utility of a resident}$ + + -	$R_i : \text{residents in } i$ $K_i : \text{capital in } i$
$F^i \equiv F(W_i, K_i, L_i, z_i) : \text{production}$ + + + +	$L_i : \text{business land in } i$ $W_i : \text{workers in } i$
$C^i \equiv C(g_i, z_i) : \text{cost of public services}$ + +	$\rho_i : \text{land rent in } i$ $x_i : \text{numeraire good in } i$
exogenous variables	control variables
$\mathcal{L}_i : \text{total land in } i$	$\tau_i^R : \text{tax on residents in } i$
$r : \text{capital return in the metropolis}$	$\tau_i^K : \text{capital tax in } i$
$w : \text{wage rate in the metropolis}$	$\tau_i^L : \text{business land tax in } i$
$\mathcal{P} : \text{population in the metropolis}$	$\tau_i^P : \text{business property tax in } i$
$\mathcal{K} : \text{capital in the metropolis}$	$g_i : \text{local public good in } i$ $z_i : \text{local public input in } i$

NOTE.— $U^i$  is assumed to satisfy [Assumption 1.1](#) in [Chapter 1](#).

**Result 2.1 (Baseline).** *In equilibrium, under perfect interjurisdictional competition, local government  $i$  chooses  $\tau_i^R$ ,  $\tau_i^K$ ,  $\tau_i^L$ ,  $g_i$  and  $z_i$  in accordance with the following decision*

*rules:*

$$\tau_i^R = R_i \frac{|U_R^i|}{U_x^i} + \tau_i^L, \quad (2.3)$$

$$\tau_i^K = 0, \quad (2.4)$$

$$R_i \frac{U_g^i}{U_x^i} = C_g^i, \quad (2.5)$$

$$F_z^i = C_z^i, \quad (2.6)$$

while  $\tau_i^L$  allows to balance the budget restriction (2.2), so that

$$\tau_i^L = \frac{R_i}{\mathcal{L}_i} \left( \frac{C^i}{R_i} - R_i \frac{|U_R^i|}{U_x^i} \right) > 0. \quad (2.7)$$

Notice first that the positive sign of  $\tau_i^L$  results from the assumption of scale economies in the provision of public services,  $C^i/R_i > R_i|U_R^i|/U_x^i$  (see [Assumption 1.2](#) in [Chapter 1](#)). Notice also that the equilibrium level of  $\tau_i^R$  is obtained by inserting (2.7) into (2.3):

$$\tau_i^R = \frac{L_i}{\mathcal{L}_i} \left( \frac{C^i}{L_i} + R_i \frac{|U_R^i|}{U_x^i} \right) \quad (2.8)$$

In the case where local governments are constrained to choose a single business tax rate on capital and business land, the local budget constraints is

$$\tau_i^R R_i + \tau_i^K K_i + \tau_i^L L_i = C^i \quad (2.9)$$

and the decentralized equilibrium is characterized by [Result 1.3](#) in [Chapter 1](#) that we recall:

**Result 2.2 (Baseline).** *In equilibrium, under perfect interjurisdictional competition, local governments choose  $\tau_i^R$ ,  $\tau_i^P$ ,  $g_i$  and  $z_i$  in accordance with the following decision rules:*

$$\tau_i^R = R_i \frac{|U_R^i|}{U_x^i} + \left(1 + \frac{K_i}{L_i}\right) \tau_i^P, \quad (2.10)$$

$$R_i \frac{U_g^i}{U_x^i} = C_g^i, \quad (2.11)$$

$$\frac{F_z^i - C_z^i}{K_i} = \varepsilon_i \left[ F_{Kz}^i - F_{Lz}^i + (F_{KW}^i - F_{LW}^i) \frac{\partial W_i}{\partial z_i} \right], \quad (2.12)$$

while  $\tau_i^P$  allows to balance the budget restriction (2.9), so that

$$\tau_i^P = (1 - \kappa_i) \frac{R_i}{\mathcal{L}_i} \left( \frac{C^i}{R_i} - R_i \frac{|U_R^i|}{U_x^i} \right) > 0, \quad (2.13)$$

where  $\kappa_i \equiv K_i/(K_i + L_i)$  denotes the capital share in the business property and  $\varepsilon_i = \frac{\tau_i^P}{K_i + L_i} \frac{F_{WW}^i}{F_{WL}^i F_{KW}^i - F_{WW}^i F_{KL}^i} < 0$ , its elasticity with respect to  $\tau_i^P$ ; and  $\partial W_i / \partial z_i > 0$  is workers' reaction to a public input increase, given  $K_i$  and  $L_i$ .<sup>18</sup>

Note that the equilibrium level of  $\tau_i^R$  is obtained by inserting (2.13) into (2.10), and we obtain once again (2.8). In order to briefly outline the main changes in local governments' behavior due to the single business property tax constraint, let us highlight the main implications of [Result 2.2](#) in the following corollary:

**Corollary (Baseline).** *In equilibrium, under perfect interjurisdictional competition, local governments choose  $\tau_i^R$ ,  $\tau_i^P$ ,  $g_i$  and  $z_i$  so that:*

$$\tau_i^R = \frac{L_i}{\mathcal{L}_i} \left( \frac{C^i}{L_i} + R_i \frac{|U_R^i|}{U_x^i} \right) \quad (2.14)$$

$$0 < \tau_i^P < \frac{R_i}{\mathcal{L}_i} \left( \frac{C^i}{R_i} - R_i \frac{|U_R^i|}{U_x^i} \right) \quad (2.15)$$

$$R_i \frac{U_g^i}{U_x^i} = C_g^i \quad (2.16)$$

$$F_z^i < C_z^i \quad \text{if and only if} \quad F_{Kz}^i + F_{KW}^i \frac{\partial W_i}{\partial z_i} > F_{Lz}^i + F_{LW}^i \frac{\partial W_i}{\partial z_i} \quad (2.17)$$

<sup>18</sup>Notice that we have replaced the notation  $(\partial W_i / \partial z_i)|_{(K_i, L_i)}$  used in [Chapter 1](#) by  $\partial W_i / \partial z_i$  to alleviate the exposition.

Relying on the above corollary we can summarize the central findings in [Chapter 1](#) (Propositions [1.2](#) to [1.4](#)). First, conditions [\(2.14\)](#) and [\(2.16\)](#) being strictly identical to [\(2.5\)](#) and [\(2.8\)](#), we deduce that constraining local governments to set a unique tax rate on capital and business land tax base do not alter their use of household-oriented instruments - ie. resident taxes  $\tau_i^R$  and local public goods  $g_i$ . Second, comparing [\(2.15\)](#) to [\(2.4\)](#) and [\(2.7\)](#) shows that when local governments are constrained to tax capital and business land at the same rate, they choose to under-tax business land and over-tax capital. This setting of  $\tau_i^P$  is an intermediate way allowing them to finance local public services while accounting for capital mobility. Third, condition [\(2.17\)](#) indicates that a single business property tax constraint leads local authorities to over(under)-provide the local public input, compared to the Samuelson rule [\(2.12\)](#), when the overall capital-augmenting impact of the public input is stronger (weaker) than its overall land-augmenting impact. This setting of  $z_i$  allows local governments to partly offset the distortions induced by the setting of  $\tau_i^P$ .

### 3. Limited household mobility

While it is usually admitted that capital can be treated as perfectly mobile across local jurisdictions, household perfect mobility is less obvious.<sup>19</sup> Indeed, workers incur transportation costs when commuting to work outside their jurisdictions of residence and residents also costs (e.g. search costs) to move to another jurisdiction.<sup>20</sup> This section examines the effects on the baseline results in [section 2](#) of relaxing the perfect household mobility assumption. [Subsection 3.1](#) introduces commuting costs in the model. [Subsection 3.2](#) introduces a group of immobile landowners who coexist with perfectly mobile residents.

#### 3.1. Commuting costs

In this subsection, we relax the assumption of costless commuting across jurisdictions. Since the model of [Chapter 1](#) does not include a spatial dimension, introducing commuting costs dependent on the distance between locations would require changes in the original framework much beyond the scope of the chapter.<sup>21</sup> Thus, in the sequel, we consider a fixed cost that households incur if they choose to commute

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<sup>19</sup>See [Wilson \(1999\)](#) for an extended survey of the capital tax competition literature. A noticeable exception is [Lee \(1997\)](#) in which capital is treated as imperfectly mobile.

<sup>20</sup>[Mansoorian and Myers \(1993\)](#) assume that residents have attachment to their jurisdiction so that they face a psychic cost when moving to another jurisdiction.

<sup>21</sup>See [Chapter 3](#) for a spatial tax competition model with commuting costs dependent on distance.

outside their jurisdiction of residence. We show that for jurisdictions with low or high local labor demand, the baseline results remain, while for jurisdictions with intermediate-level labor demand residents work where they live; we also describe the resulting departures from the baseline results.

The assumptions of the baseline framework, described in [section 2 of Chapter 1](#), are changed as follows. Assume that each household of the metropolis incurs a commuting cost  $c$  if she works outside her jurisdiction of residence. The commuting cost  $c$  can be interpreted as a subscription fee to a transportation network covering the whole metropolis. Denote  $w_{\text{MAX}}$  the highest wage prevailing in the metropolis. Since jurisdictions are atomistic,  $w_{\text{MAX}}$  is exogenous from jurisdiction  $i$  viewpoint.<sup>22</sup> Each household of the metropolis supplies its one-unit labor endowment in the jurisdiction of the metropolis offering the highest wage net of commuting costs. Hence, the total labor supply to jurisdiction  $i$  is:

$$W_i^S = \begin{cases} 0 & \text{if } w_i < w_{\text{MAX}} - c \\ R_i & \text{if } w_{\text{MAX}} - c \leq w_i \leq w_{\text{MAX}} \\ \infty & \text{if } w_i > w_{\text{MAX}} \end{cases} \quad (2.18)$$

In words, (2.18) indicates that the amount of labor supplied in jurisdiction  $i$  has the following stepwise shape. First, if the wage in  $i$  is lower than the net (of commuting cost) maximum wage available elsewhere, no household supplies her labor endowment in  $i$ . Any household is better off if she works in a jurisdiction with wage  $w_{\text{MAX}}$  instead of working in  $i$ . Second, if the wage in  $i$  lies between the net and the gross maximum wage, only the  $R_i$  residents of  $i$  desire to work in  $i$ . Thus, while it is too costly for a resident of  $i$  to commute to another jurisdiction, other households still prefer to work in a jurisdiction with wage  $w_{\text{MAX}}$  or in their jurisdiction of residence. Third, if the wage in  $i$  exceeds the gross maximum wage, an infinitely large number of residents wish to work in  $i$ .<sup>23</sup> Indeed, all residents living in municipalities with wage equal to (or below)  $w_{\text{MAX}} - c$  now wish to work in  $i$ .

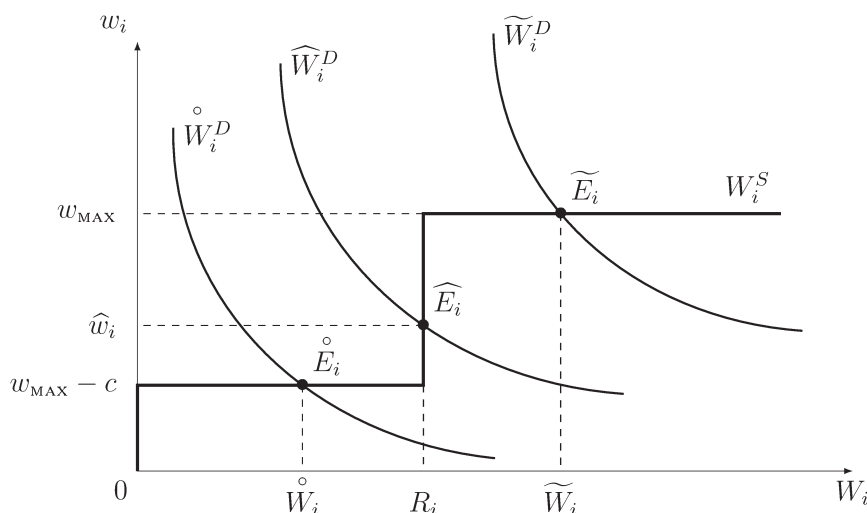
Since a well-behaved production function  $F^i$  is assumed, the demand for labor by firms of jurisdiction  $i$ ,  $W_i^D$ , is decreasing in  $w_i$ . Then, in the presence of commuting

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<sup>22</sup>Note that an underlying assumption behind the exogeneity of  $w_{\text{MAX}}$  is that in the equilibrium  $w_{\text{MAX}}$  prevails in a large number of jurisdictions. This can be modelled assuming that the metropolis is composed of  $m$  classes of municipalities, where each class  $j = 1, \dots, m$  contains a large number,  $n$ , of symmetric jurisdictions  $i = 1, \dots, n$ . Although integrating classes of municipalities to the model of [Chapter 1](#) would make the atomicity assumption more realistic, we ignore this additional assumption to simplify notations.

<sup>23</sup>Once again, this implicitly requires that each class of municipalities contains a large number of municipalities (see [footnote 22](#)).

costs, three types of partial equilibria, depending on the local labor demand intensity, can arise in the labor market of  $i$ . They are depicted in Figure 2.1 in which the x-axis represents the amount of workers  $W_i$  in jurisdiction  $i$  and the y-axis represents the wage  $w_i$  prevailing in  $i$ .



**Figure 2.1.** Labor market partial equilibrium in jurisdiction  $i$ .

Equilibrium  $\overset{\circ}{E}_i$  in Figure 2.1 depicts the case where firms' demand for labor in jurisdiction  $i$ ,  $\overset{\circ}{W}_i^D$ , is relatively low given the the number of residents of  $i$ ,  $R_i$ .<sup>24</sup> In this equilibrium where jurisdiction  $i$  exports labor, local firms' needs for labor are so low that they can afford to provide the lowest wage accepted by residents of  $i$  to work in  $i$ , that is  $w_{\text{MAX}} - c$ . On the contrary, equilibrium  $\widetilde{E}_i$  is characterized by a relatively high local demand for labor  $\widetilde{W}_i^D$  which induces a labor import by jurisdiction  $i$ . In this case, to attract workers residing in jurisdictions where the lowest wage (ie.  $w_{\text{MAX}} - c$ ) prevails, local firms have to guarantee them the minimum gross wage they accept to commute to  $i$ , that is  $w_{\text{MAX}}$ .<sup>25</sup> Equilibrium  $\widehat{E}_i$  illustrates the case of an intermediate local labor demand  $\widehat{W}_i^D$ . In this case local firms' labor demand is sufficiently high for them to hire all the  $R_i$  residents of  $i$ , by accepting to

<sup>24</sup>In this model jurisdictions might differ in labor demand intensity due to exogenous local factors  $\gamma_i$  affecting the production technology  $F^i \equiv F(K_i, W_i, L_i; \gamma_i)$ . On a practical ground, these factors fostering a relatively high local labor demand could be geographical (e.g. seaside towns) or historical (e.g. working-class towns) for instance.

<sup>25</sup>More precisely, firms of  $i$  must provide a wage equal to  $w_i = w_{\text{MAX}} - c + \epsilon$  (with  $\epsilon > 0$ ) to attract these residents. Indeed, if  $\epsilon = 0$ , they receive the same wage ( $w_{\text{MAX}} - c$ ) whether they commute to  $i$  or work in their residence location. Following (2.18), they would weakly prefer to work in their home jurisdiction in this case. However, for notational convenience, we ignore  $\epsilon$  since its introduction does not affect the analysis.



pay at least the price of their outside option,  $w_{\text{MAX}} - c$ . However, local firms' needs for labor are not high enough that they are willing to pay the maximum wage  $w_{\text{MAX}}$  in order to attract non-resident workers. Depending on their need for workers, local firms are ready to pay a greater or lesser wage (between  $w_{\text{MAX}} - c$  and  $w_{\text{MAX}}$ ) to the  $R_i$  residents of  $i$ .

The understanding of the three types of partial equilibria described above allows to grasp the main distinction between this framework integrating commuting costs ( $c > 0$ ) and the baseline model with costless commuting ( $c = 0$ ) in [Chapter 1](#). This main difference lies in the existence of the  $\hat{E}$ -type equilibria induced by  $c > 0$ . In words, the presence of commuting costs induces, in each jurisdiction  $i$  a range of intermediate-level wages for which residents decide to work in  $i$ . Within this wage range workers coincide with residents ( $W_i = R_i$ ) and the local wage  $w_i$  is endogenously determined within jurisdiction  $i$ .<sup>26</sup>

On the contrary, whenever the local demand for labor is high (or low) enough for  $\tilde{E}$ -type (or  $\overset{\circ}{E}$ -type) equilibria to occur, the local wage is exogenously fixed at  $w_{\text{MAX}}$  (or  $w_{\text{MAX}} - c$ ) and residents of  $i$  do not necessarily work in  $i$ . This corresponds precisely to the baseline framework in [Chapter 1](#), and [Result 2.1](#) and [Result 2.2](#) are unchanged:

**Result 2.3 (Commuting costs).** *Consider jurisdictions with relatively low or high local labor demands. Then, the decision rules of local governments are characterized by [Result 2.1](#) and [Result 2.2](#).*

Interestingly, if commuting costs are low, it might well be the case that very few, if any at all, jurisdictions have their wage within the intermediate-level wage range for which residents coincide with workers. Hence, the baseline model in [Chapter 1](#) is broadly applicable for low levels of commuting costs.

In the remainder of this subsection, we focus on jurisdictions with intermediate levels of local labor demand, in order to investigate the extent to which the baseline results are affected in this case. Let us focus on a representative jurisdiction  $i$  with intermediate-level labor demand. Starting from the baseline framework, we must assume now that residents coincide with workers, ie.  $R_i = W_i$ , and that the local wage in  $i$ ,  $w_i$  is endogenous. The other hypothesis of the model of [Chapter 1](#) are unchanged. Then, following the same steps as for deriving (1.29), the local government's objective can be written as:

$$F(R_i, K_i, \mathcal{L}_i - R_i, z_i) - rK_i + [F_L(R_i, K_i, \mathcal{L}_i - R_i, z_i) - F_W(R_i, K_i, \mathcal{L}_i - R_i, z_i) + \tau_i]R_i - C^i$$

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<sup>26</sup>This case where residents work where they live is similar to what is assumed in regional tax competition models with household mobility (e.g. [Wilson, 1995](#); [Richter and Wellisch, 1996](#)). However, these frameworks differ from the present one since they ignore residential land.

where  $F_W^i$  still denotes the marginal product of labor which is the first argument of  $F^i \equiv F(R_i, K_i, L_i)$ . It is easily showed that differentiating the above objective with respect to  $t_i \in \{\tau_i; \tau_i^K; g_i; z_i\}$ , we obtain the baseline first-order conditions (1.30). Only the location responses  $\partial R_i / \partial t_i$  and  $\partial K_i / \partial t_i$  differ from the baseline case. They are implicitly obtained from the following system:

$$F_K(R_i, K_i, \mathcal{L}_i - R_i, z_i) - \tau_i^K - r = 0, \quad (2.19)$$

$$U[\bar{y} + F_W(R_i, K_i, \mathcal{L}_i - R_i, z_i) - F_L(R_i, K_i, \mathcal{L}_i - R_i, z_i) - \tau_i, g_i, R_i] - \bar{u} = 0, \quad (2.20)$$

where  $\tau_i^K$  should be replaced by  $\frac{\tau_i R_i - C^i}{K_i + \mathcal{L}_i}$  in the case of a single business property tax constraint. Then, the decentralized equilibrium in the case where local governments are allowed to use separate taxes on capital and business land is characterized by the following result:

**Result 2.4 (Commuting costs).** *Consider jurisdictions with intermediate local labor demands. In equilibrium, under perfect interjurisdictional competition, local government  $i$  chooses  $\tau_i^R, \tau_i^K, \tau_i^L, g_i$  and  $z_i$  in accordance with the baseline results (2.3)-(2.7).*

*Proof.* See [Subsection 3.2](#). □

[Result 2.4](#) is identical to the baseline [Result 2.1](#). It is not surprising since, as explained in [subsection 4.2](#) in [Chapter 1](#), by using both the household tax  $\tau_i^R$  and the business land tax  $\tau_i^L$ , local government  $i$  can treat  $\tau_i^L$  as an undistortive tax on its fixed land endowment  $\mathcal{L}_i$ , while using  $\tau_i^R$  as an instrument to control the local population size  $R_i$ . It follows that:  $\tau_i^R$  is used to internalize the marginal congestion cost and the marginal fiscal cost entailed by a new resident in the jurisdiction (condition (2.3)); capital is not taxed (condition (2.4)); and public services are provided in accordance with Samuelson rules (2.5) and (2.6).

The decentralized equilibrium in the case where local governments are constrained to choose a single business tax rate on capital and business land is characterized by [Result 2.5](#) below.

**Result 2.5 (Commuting costs).** *Consider jurisdictions with intermediate local labor demands. In equilibrium, under perfect interjurisdictional competition, local governments choose  $\tau_i^R$ ,  $\tau_i^P$ ,  $g_i$  and  $z_i$  in accordance with the following decision rules:*

$$\tau_i^R \begin{matrix} < \\ > \end{matrix} \frac{L_i}{\mathcal{L}_i} \left( \frac{C^i}{L_i} + R_i \frac{|U_R^i|}{U_x^i} \right) \quad \text{if and only if} \quad F_{KW}^i \begin{matrix} > \\ < \end{matrix} F_{LW}^i \quad (2.21)$$

$$0 < \tau_i^P < \frac{R_i}{\mathcal{L}_i} \left( \frac{C^i}{R_i} - R_i \frac{|U_R^i|}{U_x^i} \right) \quad (2.22)$$

$$R_i \frac{U_g^i}{U_x^i} = C_g^i \quad (2.23)$$

$$F_z^i \begin{matrix} < \\ > \end{matrix} C_z^i \quad \text{if and only if} \quad F_{Kz}^i \begin{matrix} > \\ < \end{matrix} F_{Lz}^i \quad (2.24)$$

*Proof.* See [Subsection 3.2](#). □

[Result 2.5](#) shows that, in the presence of a single business property tax constraint, governments in jurisdictions with an intermediate-level labor demand behave differently from governments in jurisdictions with high(low)-level labor demand, whose behavior is not affected by the presence of commuting costs (see [Result 2.3](#)). Thus, to understand the consequences of commuting costs in the model of [Chapter 1](#), the remainder of this subsection compares the constrained decision rules of these two types of governments - formally, conditions (2.14)-(2.17) are compared with conditions (2.21)-(2.24).

The comparison of conditions (2.22) and (2.23) with the baseline conditions (2.15) and (2.16) shows that the existence of commuting costs does not substantially affect the way local governments choose  $\tau_i^P$  and  $g_i$ . In other words, even for jurisdictions with intermediate-level labor demand,  $\tau_i^P$  still has to not only account for capital mobility but also enable the local governments to satisfy their budget constraints, which leads to an over(under)-taxation of business land (capital), as condition (2.22) indicates. Moreover, residents' mobility still provides local governments with the right incentives to internalize their preferences regarding the amount of local public good provided  $g_i$ , as condition (2.23) shows.

However, the existence of commuting costs alters local governments' use of  $\tau_i^R$  and  $z_i$ , as can be seen by comparing conditions (2.21) and (2.24) with the baseline conditions (2.14) and (2.17). Specifically, in jurisdictions with intermediate-level labor demand, commuting costs lead local authorities to offset the business property tax distortions by distorting both  $\tau_i^R$  and  $z_i$  - according to (2.21) and (2.24). However, in jurisdictions with low or high labor demand (or absent commuting costs),

local governments only distort  $z_i$  - according to (2.17).<sup>27</sup> To understand this difference, we must make the economic meaning of conditions (2.21) and (2.24) clear.

Let us begin with condition (2.21). Commuting costs imply that residents and workers are the same persons in jurisdictions with intermediate-level labor demand ( $\hat{E}$ -type equilibria in Figure 2.1). In this case, the tax on residents  $\tau_i^R$  is a relevant instrument to balance the over(under)-taxation of capital (business land) entailed by the business property tax. Indeed, cutting  $\tau_i^R$  allows to attract new workers, which by input complementarity increases the marginal product of capital relative to that of business land, if  $F_{KW} > F_{LW}$ . Then, as stated in condition (2.21), residents are under-taxed if the capital augmenting impact of an additional worker is stronger than his business land augmenting impact.<sup>28</sup> However, using  $\tau_i^R$  to influence directly workers location is only possible in jurisdictions with intermediate-level labor demand. In jurisdictions with low or high labor demand ( $\overset{\circ}{E}$ -type or  $\tilde{E}$ -type equilibria in Figure 2.1), where residents and workers do not coincide, the amount of local workers is merely determined by firms' labor demand, not by the number of residents. This explains why, as stated in condition (2.14), these local governments do not distort their resident tax setting.

Let us now turn to condition (2.24) which indicates that in jurisdictions with an intermediate-level labor demand, similarly to  $\tau_i^R$ ,  $z_i$  is distorted to compensate the distortions caused by the business property tax setting. That is, local governments in these jurisdictions over-provide the local public input  $z_i$  if raising  $z_i$  increases the marginal product of capital relative to that of business land (formally,  $F_{Kz} > F_{Lz}$ ).<sup>29</sup> This should be contrasted with the local public input provision rule in jurisdictions with low or high labor demand. Indeed, condition (2.17) shows that governments of these jurisdictions, when deciding on the level of  $z_i$ , also account for the attraction exerted by the public input on workers. This difference in governments' behavior is not surprising. As seen above, in jurisdictions with intermediate-level labor demand, governments can directly affect workers' location using  $\tau_i^R$ , while governments of jurisdictions with low or high labor demand cannot. Then, the latter use  $z_i$  to influence workers' location in order to increase the marginal product of capital relative to that of business land.

We conclude this subsection by a summary its main result. In the presence of

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<sup>27</sup>Recall that  $\frac{L_i}{L_i} \left( \frac{C^i}{L_i} + R_i \frac{|U_R^i|}{U_x^i} \right)$  is the level of  $\tau_i^R$  chosen by local governments when they are not constrained as stated in condition (2.8).

<sup>28</sup>Symmetrically, raising  $\tau_i^R$  increases the marginal product of capital relative to that of business land, if  $F_{KW} < F_{LW}$ , which explains the over-taxation of residents in this case.

<sup>29</sup>Symmetrically, decreasing  $z_i$  increases the marginal product of capital relative to that of business land, if  $F_{Kz} < F_{Lz}$ , which explains the under-provision in this case.

commuting costs, a class of jurisdictions whose workforce coincide with the local population can appear. When a single business property tax constraint is imposed, these jurisdictions choose to distort both their resident tax setting and their public input provision, contrary to other jurisdictions which behave as if commuting costs were absent by only distorting the latter. The basic reason for this different behavior is that commuting cost can introduce a link between residents and workers which is exploited by local authorities to control their local workforce size using their resident taxes.

### 3.2. Mobile and immobile residents

Assuming that all residents are perfectly mobile as in [Chapter 1](#) might appear as a strong assumption. In practice, jurisdictions are often composed of landowners who are relatively little mobile and renters who are much more mobile. To account for this feature, in this subsection we introduce some heterogeneity among households by adding a group of immobile residents who own all local land in their jurisdiction of residence.<sup>30 31</sup> We show that this change in the model of [Chapter 1](#) does not alter the baseline [Result 2.1](#) and [Result 2.2](#) when mobile and immobile residents have the same marginal willingness to pay (MWP) for the local public good, what arise for additively separable utility functions for instance. When MWPs can differ among the two household groups, we show that local public goods are over-provided when a single business property tax is imposed.

The assumptions of the baseline framework, described in [section 2](#) of [Chapter 1](#), are changed as follows. We assume that jurisdiction  $i$  is inhabited by  $R_i^I$  identical immobile residents and  $R_i^M$  identical perfectly mobile residents. Their utility is respectively  $U^{Ii} \equiv U(x_i^I, g_i, R_i^I + R_i^M)$  and  $U^{Mi} \equiv U(x_i^M, g_i, R_i^I + R_i^M)$ . Since all local land is assumed to be possessed by immobile inhabitants, their individual budget constraints are respectively  $x_i^I + \rho_i = rk + \rho_i \mathcal{L}_i / R_i^I + w - \tau_i^R$  and  $x_i^M + \rho_i = rk + w - \tau_i^R$ .<sup>32</sup> While  $R_i^I$  is exogenous, the number of mobile residents living in  $i$

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<sup>30</sup>To model the coexistence of households with different degree of residential mobility, we only consider the two extreme cases of infinite and no home attachment. A more general formulation would be to consider a continuum of home attachment degrees. However, introducing a [Hotelling](#) space of preferences as in e.g. [Mansoorian and Myers \(1993\)](#) might be complex in a model with many small jurisdictions, hence the simplifying assumption made here.

<sup>31</sup>This heterogeneity among households is common in the literature. See e.g. [Wildasin \(1983\)](#) and [Richter and Wellisch \(1996\)](#). Also, [Wildasin \(1991\)](#) distinguishes between rich immobile households and poor mobile households.

<sup>32</sup>Note that the only difference between immobile and mobile residents is that the former have land income contrary to the latter. Utility functions are assumed to be identical for mobile and immobile residents.

$R_i^M$  is endogenously determined by the free-mobility condition:

$$U(rk + w - \rho_i - \tau_i^R, g, R_i^I + R_i^M) = \bar{u}$$

where  $\bar{u}$  is the exogenous level of utility of mobile households prevailing in the metropolis. As in the baseline model, each (mobile or immobile) household supplies its one-unit labor endowment in the jurisdiction of the metropolis with the highest wage. Since there is no commuting cost, wages are still equated across jurisdictions and exogenous due to atomicity. The land market clearing condition is:

$$R_i^I + R_i^M + L_i = \mathcal{L}_i \quad (2.25)$$

Since the local government cannot affect the utility of mobile residents,<sup>33</sup> its objective is to maximize the utility of a representative immobile residents. This can be interpreted as indicating that local public policy is controlled by immobile residents. Then, local government  $i$ 's problem is:

$$\max_{(\tau_i^R, \tau_i^K, \tau_i^L, g_i, z_i)} U \left( rk + \frac{\rho_i \mathcal{L}_i}{R_i^I} + w - \rho_i - \tau_i^R, g_i, R_i^I + R_i^M \right)$$

subject to

$$\tau_i^R(R_i^I + R_i^M) + \tau_i^K K_i + \tau_i^L L_i = C(g_i, z_i) \quad (2.26)$$

where  $\tau_i^P \equiv \tau_i^K = \tau_i^L$  in the case of a single business property tax constraint. Following the same steps as for deriving (1.29), the local government's objective can be written as:

$$U^{Ii} = U \left( \frac{F^i - wW_i - rK_i + (F_L^i + \tau_i)R_i^M - C^i}{R_i^I} + rk + w, g_i, R_i^I + R_i^M \right)$$

where  $\tau_i^L$  or  $\tau_i^P$  has been substituted using the local budget constraint. Then, for  $t_i \in \{\tau_i; \tau_i^K; g_i; z_i\}$ , the first-order conditions of local government  $i$   $dU^{Ii}/dt_i = 0$  are:

$$\left( \tau_i + R_i^M \frac{U_R^{Mi}}{U_x} + R_i^I \frac{U_R^{Ii}}{U_x} \right) \frac{\partial R_i^M}{\partial t_i} + \tau_i^K \frac{\partial K_i}{\partial t_i} + \left( R^M \frac{U_g^{Mi}}{U_x^{Mi}} + R_i^I \frac{U_g^{Ii}}{U_x^{Ii}} - C_g^i \right) \frac{\partial g_i}{\partial t_i} + (F_z^i - C_z^i) \frac{\partial z_i}{\partial t_i} = 0$$

where the same steps as for deriving (1.30) have been used. And the location responses  $\partial R_i^M/\partial t_i$  and  $\partial K_i/\partial t_i$  are implicitly obtained from the following system:

$$F_W(W_i, K_i, \mathcal{L}_i - R_i^I - R_i^M, z_i) - w = 0, \quad (2.27)$$

$$F_K(W_i, K_i, \mathcal{L}_i - R_i^I - R_i^M, z_i) - \tau_i^K - r = 0, \quad (2.28)$$

$$U[rk + w - F_L(W_i, K_i, \mathcal{L}_i - R_i^I - R_i^M, z_i) - \tau_i, g_i, R_i^I + R_i^M] - \bar{u} = 0, \quad (2.29)$$

<sup>33</sup>Indeed, contrary to Chapter 1 local authorities have no scope for influencing mobile residents' satisfaction since in the present case, mobile residents do not own land.

where  $\tau_i^K$  should be replaced by  $\frac{\tau_i(R_i^I + R_i^M) - C^i}{K_i + \mathcal{L}_i}$  in the case of a single business property tax constraint. Then, the decentralized equilibrium in the case where local governments are allowed to use separate taxes on capital and business land is characterized by the following result:

**Result 2.6 (With immobile residents).** *In equilibrium, under perfect interjurisdictional competition, local government  $i$  chooses  $\tau_i^R$ ,  $\tau_i^K$ ,  $\tau_i^L$ ,  $g_i$  and  $z_i$  in accordance with the following decision rules:*

$$\tau_i^R = R_i^M \frac{|U_R^{Mi}|}{U_x^{Mi}} + R_i^I \frac{|U_R^{Ii}|}{U_x^{Ii}} + \tau_i^L, \quad (2.30)$$

$$\tau_i^K = 0, \quad (2.31)$$

$$R_i^M \frac{U_g^{Mi}}{U_x} + R_i^I \frac{U_g^{Ii}}{U_x} = C_g^i, \quad (2.32)$$

$$F_z^i = C_z^i, \quad (2.33)$$

while satisfying the budget restriction (2.26), so that

$$\tau_i^L = \frac{R_i}{\mathcal{L}_i} \left( \frac{C^i}{R_i} - R_i^M \frac{|U_R^{Mi}|}{U_x^{Mi}} - R_i^I \frac{|U_R^{Ii}|}{U_x^{Ii}} \right). \quad (2.34)$$

*Proof.* See Subsection 3.2. □

Result 2.6 is qualitatively identical to the baseline result with homogenous residents (Result 2.1). The only change is that local government  $i$  now accounts for the differences in the MWP for the local public good among mobile and immobile residents, as well as differences in the marginal congestion cost they incur.

The decentralized equilibrium in the case where local governments are constrained to choose a single business tax rate on capital and business land is characterized by the following result:

**Result 2.7 (With immobile residents).** *In equilibrium, under perfect interjurisdictional competition, local governments choose  $\tau_i^R$ ,  $\tau_i^P$ ,  $g_i$  and  $z_i$  in accordance with the following decision rules:*

$$\tau_i^R = R_i^M \frac{|U_R^{Mi}|}{U_x^{Mi}} + R_i^I \frac{|U_R^{Ii}|}{U_x^{Ii}} + \left( 1 + \frac{K_i}{L_i} \right) \tau_i^P, \quad (2.35)$$

$$R_i^M \frac{U_g^{Mi}}{U_x} + R_i^I \frac{U_g^{Ii}}{U_x^{Ii}} \leq C_g^i \quad \text{if and only if} \quad \frac{U_g^{Ii}}{U_x^{Ii}} \geq \frac{U_g^{Mi}}{U_x^{Mi}}, \quad (2.36)$$

$$\frac{F_z^i - C_z^i}{K_i} = \varepsilon_i \left[ F_{Kz}^i - F_{Lz}^i + (F_{KW}^i - F_{LW}^i) \frac{\partial W_i}{\partial z_i} \Big|_{(\bar{K}_i, \bar{L}_i)} \right], \quad (2.37)$$

and the budget restriction (2.26) is satisfied, so that

$$\tau_i^P = (1 - \kappa_i) \frac{R_i}{\mathcal{L}_i} \left( \frac{C^i}{R_i} - R_i^M \frac{|U_R^{Mi}|}{U_x^{Mi}} - R_i^I \frac{|U_R^{Ii}|}{U_x^{Ii}} \right). \quad (2.38)$$

*Proof.* See [Subsection 3.2](#). □

Conditions (2.35), (2.37) and (2.38) are similar to the baseline conditions (2.10), (2.12) and (2.13) of [Result 2.2](#). That is, the presence of immobile landowners do not alter the way local governments use tax rates on residents  $\tau_i^R$ , tax rates on business property  $\tau_i^P$  and public inputs  $z_i$ . Regarding the local public good provision rule (2.36), two cases must be distinguished.

First, when mobile and immobile residents have the same MWP for the local public good, ie.  $U_g^{Ii}/U_x^{Ii} = U_g^{Mi}/U_x^{Mi}$ , condition (2.36) is identical to the baseline condition (2.11).<sup>34</sup> In this case, immobile residents who control the local policy have incentive to internalize mobile residents' preferences for local public goods since they are similar to their own preferences. It follows that the introduction of immobile landowners in the model does not alter the results of [Chapter 1](#) if mobile and immobile residents have the same MWP for public goods.

Second, when immobile residents have a greater MWP for the local public good than mobile residents, ie.  $U_g^{Ii}/U_x^{Ii} > U_g^{Mi}/U_x^{Mi}$ , condition (2.36) indicates that local governments over-provide local public goods.<sup>35</sup> To get the intuition behind this result, recall that when local governments are constrained to tax capital and business land at the same rate, they have to under(over)-tax business land (capital).<sup>36</sup> In other terms, they view the amount of business land used in their jurisdiction as excessively high with respect to the amount of capital.<sup>37</sup> To offset this distortion, local governments over-provide local public goods in order to attract new mobile residents and exert an upward pressure on the land rent. This acts as an incentive for firms to decrease their use of business land relative to capital.

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<sup>34</sup>For example, mobile and immobile residents will have the same MWP for public goods if  $U = \phi[x + v(g, R^I + R^M)]$ , which contains the common class of additively-separable utility functions for a specific case.

<sup>35</sup>Notice that due to the law of diminishing marginal rate of substitution, immobile residents always have a greater or equal MWP for the local public good than mobile residents, ie.  $U_g^{Ii}/U_x^{Ii} \geq U_g^{Mi}/U_x^{Mi}$ .

<sup>36</sup>See [Proposition 1.2](#) in [Chapter 1](#).

<sup>37</sup>Note that if  $\tau_i^P = 0$ , which arises absent scale economies according to (2.38), local governments have no incentive to distort their public good provision, ie.  $R_i^M U_g^{Mi}/U_x + R_i^I U_g^{Ii}/U_x^{Ii} = C_g^i$  (see (A.46) in the appendix section). Indeed, local governments do not distort their instruments if they can finance local public services without taxing capital.



Finally, note that this over-provision of local public goods is not observed in the baseline model because in the absence of immobile residents, mobile residents force local governments to internalize their preferences by migrating. This is no longer true when the local public policy is controlled by immobile residents. In this case, immobile residents can take advantage of the fact that they have a greater MWP for public goods than mobile residents to over-provide the local public good.

## 4. Corrective policies

The main conclusion of [Chapter 1](#) is that while a unique business property tax could be justified on political and administrative grounds, it leads sub-metropolitan governments to pursue inefficient local public policies. This inefficiency requires interventions from the central government. The purpose of this section is to address the following question: which type of interventions are appropriate for tackling this inefficiency?

A single business property tax rate on capital and land inputs forces local governments, for budgetary reasons, to set an excessively high taxation of mobile capital and an inefficiently low taxation of business land in order to account for capital mobility. Two kinds of relevant interventions can then be implemented. The first type of measures allow local governments to disentangle capital and business land taxation. They are discussed in [subsection 4.1](#). The second type of measures provide local governments with additional ways to finance their public service provision other than using the business property tax. Two of them are addressed in this section: vertical transfers and land-use restrictions covered respectively in [subsection 4.2](#) and [subsection 4.3](#).

### *4.1. Dissociation of capital and business land taxation*

The basic problem of the single business property tax rate is that it is levied on two tax bases with different mobility degrees. Since capital is perfectly mobile and entails no cost, it should not be taxed, while land, being immobile, should contribute to funding public services. Since they have only one tax instrument for these two tax bases, local governments use it half as a capital tax and half as a business land tax, which induces inefficiency.<sup>38</sup> In other words, the Tinbergen principle that there should be at least as many instruments as there are objectives is not met.

Then, a natural reform which could be implemented to tackle the inefficiency caused by the business property tax rate is to replace it with two separate tax rates.

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<sup>38</sup>Condition (2.15) is indeed an intermediate solution between conditions (2.4) and (2.7).

However, such a reform has also drawbacks. Indeed, dissociating tax bases can entail more administrative and political costs to levy tax revenues.<sup>39</sup> Moreover, tax systems are in practice very complex, which is detrimental to consent to taxation and transparency in the use of tax revenue. Hence, increasing this complexity by dissociating tax bases, which are not identical but still close, raises political concerns.

An alternative way to dissociate capital and business land taxation without increasing the number of tax rates is to remove capital from the business property tax base.<sup>40</sup> Such a reform actually boils down to imposing the optimal zero-taxation of capital and turning the business property tax into a simple land tax. Then, local authorities will be free to use the new tax to finance public services without fearing capital outflows. However, this reform also has disadvantages in practice. First, central government usually has to compensate tax limitation reforms with vertical transfers to maintain the level of local public services provided. Otherwise, such measures could be too unpopular to be implemented.<sup>41</sup> Hence, this reform might be very costly to implement and it could require levying new national taxes which might entail economic distortions. Second, eliminating the taxation of capital and make public services only rely on taxes on residents and landowners might induce negative redistributive consequences. Third, so far we have assumed that capital entails no cost when locating in a jurisdiction, which is actually not the case in practice. For instance, the use of capital by local firms can be accompanied by pollution.<sup>42</sup> In this regard, a nationally imposed zero-tax on capital would enable local governments to bring capital owners to internalize such negative externalities. Then, a reform which addresses the inefficiency induced by single business property taxation without completely depriving local authorities of the power to tax capital might arguably be a better solution. We discuss such measures in the next two sections.

#### *4.2. Vertical transfers*

As discussed in the previous section, substituting single business property taxation with another tax structure has disadvantages. Thus, it might be a better solution for a central government to keep this tax in the local public policy instrument set,

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<sup>39</sup>See e.g. [Hettich and Winer \(1988, 1999\)](#) and [Wilson \(1995\)](#).

<sup>40</sup>Such reforms have been implemented in France (2010) and in the United States (Illinois, 1979; Ohio, 2005; Michigan, 2014). See [Stafford and DeBoer \(2014\)](#) for a detailed discussion of such reforms in the United States.

<sup>41</sup>For instance, all French local jurisdictions have been exactly compensated by national grant for the removal of capital from the business property tax base in 2010.

<sup>42</sup>See e.g. [Wellisch \(1995\)](#) for a model with waste emissions by local firms.

while providing local governments with additional ways to finance their public service provision. This would enable local governments both to lower their business property tax, thus accounting for capital mobility, and to finance the efficient level of public services. There are several ways for a central government to help local governments to finance public services.<sup>43</sup> The most immediate method is to directly provide them with vertical transfers to help them fulfill their budget constraints. The objective of this section is to examine the extent to which such vertical transfers allow to solve the inefficiency problem raised by the business property taxation. We show that positive vertical transfers to jurisdictions facing scale economies in the provision of their public services is a proper solution to circumvent the business property tax rigidity problem. Then, based on a numerical simulation, we discuss the shape of the optimal grant scheme depending on the population size of jurisdictions in the metropolis.

There exist many types of vertical transfers (or grants) from the central government to sub-central governments.<sup>44</sup> In this section, we introduce *general nonmatching* grants in the baseline framework of [Chapter 1](#) with single business property taxation. Formally, each government  $i$  receive a grant  $S_i$  which can be used to provide public goods or public inputs (ie. *general* grant). Furthermore,  $S_i$  do not depend on the fiscal decisions of the local government (ie. *nonmatching* grant).<sup>45</sup> Then, the local budget constraint of government  $i$  becomes:

$$\tau_i^R R_i + \tau_i^P (K_i + L_i) + S_i = C^i$$

Suppose that to finance the grant system, the central government collects a lump-sum tax  $T$  from each individual which is independent of her location.<sup>46</sup> The individual income net of the national tax is:

$$y = w + \frac{r\mathcal{K} + \sum_{i=1}^n \rho_i \mathcal{L}_i}{\mathcal{P}} - T$$

and the grant scheme of the central government must satisfy the following budget constraint

$$\mathcal{P}T = \sum_{i=1}^n S_i$$

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<sup>43</sup>This section and the following one discuss such methods, but other policies could be implemented such as encouraging local debt, creating various new tax instruments or developing the local public furniture of private goods and services.

<sup>44</sup>See e.g. [Fisher \(2015\)](#) for a classification of intergovernmental grants.

<sup>45</sup>See e.g. [Wildasin \(1989\)](#) and ? for a tax competition model with matching grants.

<sup>46</sup>In this framework, without loss of generality  $T$  can be for instance a land tax collected by the central government in each jurisdiction  $i = 1, \dots, n$ , so that  $T = \sum_{i=1}^n \theta_i \mathcal{L}_i / \mathcal{P}$ , where  $\theta_i$  is a tax rate decided by the central government.

All the other assumptions of the model of [Chapter 1](#) remain the same.

As is traditional in the literature, we assume that local governments take central government policies as parametrically given. Formally, this supposes a two stage-game where in the first stage the central government (Stackelberg leader) by choosing  $\{S_i, T\}_{i \in [1;n]}$ , and in the second stage every atomistic government  $i$  (follower) chooses  $\{\tau_i^R, \tau_i^P; g_i, z_i\}$  accounting for private agents' behavior. To solve this simple game, let us start as usual by the second stage by considering the behavior of a local government  $i$ . Since  $S_i$  and  $T$  are exogenous from the viewpoint of government  $i$  (and private agents), it is straightforward to show that conditions (2.10)-(2.12) in [Result 2.2](#) are unchanged, and that condition (2.13) becomes:

$$\tau_i^P = (1 - \kappa_i) \frac{R_i}{\mathcal{L}_i} \left( \frac{C^i}{R_i} - R_i \frac{|U_R^i|}{U_x^i} - \frac{S_i}{R_i} \right) \quad (2.39)$$

We now turn to the first stage: the central governments choice of  $S_i$  and  $T$ . The central government can a variety of different objective. However, as discussed in the beginning of this section, it is assumed that the grant system is specifically implemented to help local authorities alleviate their inefficiently high taxation of capital. From (2.39), we can see that the central government enables local governments to as an optimal zero-capital tax by providing them with a grant  $S_i$  covering the excess of the per capita cost of public services  $C^i/R_i$  over the marginal congestion cost  $R_i|U_R^i|/U_x^i$ . Then, the following result immediately arises:<sup>47</sup>

**Result 2.8 (vertical transfers).** *In equilibrium, under perfect interjurisdictional competition, choosing a corrective grant scheme  $\{S_i\}_{i \in [1;n]}$  such that:*

$$\frac{S_i}{R_i} = \frac{C^i}{R_i} - R_i \frac{|U_R^i|}{U_x^i} > 0, \quad (2.40)$$

*financed by a head tax  $T = \sum_{i=1}^n S_i/\mathcal{P}$ , the central government leads local governments to choose  $\tau_i^R, \tau_i^P, g_i$  and  $z_i$  in accordance with the following decision rules:*

$$\tau_i^R = R_i \frac{|U_R^i|}{U_x^i}, \quad (2.41)$$

$$\tau_i^P = 0, \quad (2.42)$$

$$R_i \frac{U_g^i}{U_x^i} = C_g^i, \quad (2.43)$$

$$F_z^i = C_z^i. \quad (2.44)$$

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<sup>47</sup>Note that conditions (2.41)-(2.44) are simply conditions (2.10)-(2.13) with  $\tau_i^P = 0$ .

[Result 2.8](#) confirms that when they are provided with the appropriate per capita grant level, local governments behave efficiently. Indeed, conditions (2.41), (2.43) and (2.44) coincide exactly with the first-best conditions (2.3), (2.5) and (2.6). Moreover the decision rule (2.42) characterizing the choice of the property tax  $\tau_i^P$  meets not only the first-best requirement of no capital taxation in condition (2.4) but also the budget clearing condition in (2.7) since the budget is now clearing owing to grants. In sum, [Result 2.8](#) shows that by providing local governments with an alternative way to finance the local public services breaks the ambiguity of the role played by the business property tax which can now be used as an optimal capital tax.

Condition (2.40) is informative about the optimal per capita grant scheme. Per capita grant must cover the gap between the per capita cost of public services and the marginal congestion cost of new residents' consumption of public goods. The intuition behind this result is that since the resident tax  $\tau_i^R$  is specifically used to internalize congestion costs as can be seen from (2.41), any additional per capita cost need to be financed by other instruments. Hence, the role of vertical transfers is precisely to take on this burden in order to free the business property tax.

From condition (2.40) it appears that jurisdictions with larger per capita expenditure needs (high  $C^i/R_i$ ) should receive higher per capita grants.<sup>48</sup> The literature on vertical transfers often link expenditure needs with the size of jurisdictions. Hence, to obtain more intuition about the shape of the optimal grant scheme, we provide numerical results representing per capita grant as a function of the size (ie. total population  $\mathcal{P}$ ) of metropolitan areas composed of symmetric municipalities.<sup>49</sup> We assume the following functional forms:  $F(W_i, K_i, L_i, z_i) = K_i^a W_i^b L_i^{1-a-b} z_i^d$ ,  $U(x_i, g_i, R_i) = x_i + \frac{1}{\alpha} (g_i/R_i)^\alpha$  and  $C(g_i, z_i) = g_i + z_i + f$ .<sup>50</sup> [Figure 2.2](#) represents per capita grant as a function of the population size of the metropolis.

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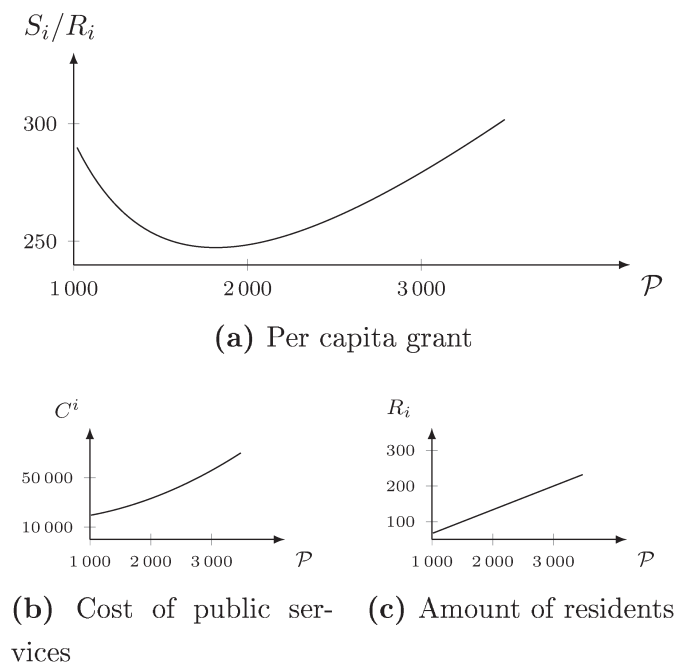
<sup>48</sup>[Reschovsky \(2007\)](#) properly defines expenditure needs and explains how they should drive fiscal equalization programs.

<sup>49</sup>Notice the numerical results derived hereafter remain if we consider municipalities with different sizes.

<sup>50</sup>The following parameter values have been chosen:

Parameter	n	$\mathcal{K}$	$\mathcal{L}$	$\gamma$	$\alpha$	a	b	d	fc
Value	15	$\mathcal{P}$	$0.1\mathcal{P}$	0.001	0.005	0.3	0.65	0.1	15000

See [subsection 3.2](#) for more details about the primitive equations that lead to [Figure 2.2](#) and for additional graphs.



**Figure 2.2.** Vertical transfers  $S_i/R_i$  and metropolis size  $\mathcal{P}$ .

As [Figure 2.2a](#) shows, the optimal corrective per capita grant scheme is U-shaped: more per capita grant should be provided to larger and smaller metropolis, in order to prevent them raising excessively high business property taxes.<sup>51</sup> The intuition behind this shape is the following. In smaller metropolis, jurisdictions have a low population and thus a poor ability to raise money to finance the public services. Then, they need to be assisted to finance the high fixed costs usually required to provide public services. At the other end of the scale, in larger metropolis, crowded jurisdictions have particularly high expenditure needs which, here again, must be supported by the central authority.

This section has shown that vertical transfers to help municipalities finance their local public services can solve the inefficiency problem raised by single business property taxation. However, some limits of this solution must be pointed out. First, implementing such a grant scheme can in practice be very costly and require important rise in national taxes. Then, it might be difficult to gain acceptance by the public opinion to enforce this measure. Second, in order to provide each municipality with the appropriate level of grant, the central government needs to have a precise knowledge of its characteristics.<sup>52</sup> Such an omniscience is hardly conceivable. Instead, the

<sup>51</sup>Detailed discussions of various justifications for higher grants to larger jurisdictions can be found in [Slack \(2007, 2010\)](#) and arguments in favor of higher grants to smaller jurisdictions are discussed in [Kitchen \(2007\)](#).

<sup>52</sup>Indeed, by considering that the central government acts as a Stackelberg leader, the above

central government usually designs the grant scheme according to observables such as the per capita expenditure of municipalities. Then, traditional moral hazard problem can occur potentially leading municipalities to distort their provision of public services. Hence, it is not sure that a system with vertical transfers entails less distortions than a system with single business property taxation only.

### 4.3. *Land use restrictions*

In [Chapter 1](#), competition for local land markets among residents and firms is subject to no limitation. If individuals wish to move to a jurisdiction, they simply need to be ready to pay a high enough land rent for crowding out some local firms. This free land market assumption allows to highlight local governments' public finance choices when they face a strong tax base sensitivity due to residents' mobility. However, this assumption is not fully realistic since local authorities usually have various instruments to directly regulate residents' and firms' land use in their jurisdiction (e.g. building permit, square footage cap).<sup>53</sup> It worth noticing that land-use restriction policies are not a limitless power granted to local authorities. Indeed, local land-use restriction policies are bounded by national laws (e.g. limited ability to expel residents and firms) and they have to account for the private decisions of economic agents (e.g. granting building permits is not much useful if local land is not attractive). They are nonetheless a key instrument in local public policy and, as such, must be regarded as a strong candidate for solving the business property tax inefficiency.

This subsection examines the extent to which land-use restriction policy allows local governments to circumvent the rigidity of the instrument set imposed by the single business property taxation. For this purpose, we introduce in the baseline framework the possibility for local authorities to directly control the share of land they respectively supply to residents and firms. For simplicity, it is assumed that local land-use restriction policies are not bounded by law. However, local governments account for private agents' responses to their public policy choices. We show that land-use restriction policies enable local governments to fully deal with the inefficiency arising from the single business property taxation by providing more control over tax revenues. We also describe how the introduction of land-use restriction policies changes the resident tax setting and the location pattern of residents and

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developments assume that the central government has a perfect knowledge of the second stage outcome.

<sup>53</sup>See e.g. [Deakin \(1989\)](#), [Downs \(1991\)](#) and [Quigley and Rosenthal \(2005\)](#) for taxonomies of land use regulation policies.

firms.

Formally, the only assumption which differs from the baseline framework described in [section 2 of Chapter 1](#) is that local government  $i$  can directly control the supply of residential land  $R_i^S$  and the supply of business land  $L_i^S$  in its jurisdiction. That is, government  $i$  freely chooses  $R_i^S$  and  $L_i^S$ , being constrained by the total local land endowment, so that:

$$R_i^S + L_i^S = \mathcal{L}_i. \quad (2.45)$$

Since residents are perfectly mobile throughout the metropolis, utility in  $i$  is still equal to the utility level  $\bar{u}$  prevailing in the metropolis. The demand for residential land  $R_i^D$  is therefore characterized by the migration condition:

$$U(\bar{y} - \rho_i^R - \tau_i^R, g_i, R_i^D) = \bar{u}, \quad (2.46)$$

where  $\bar{y}$  is the individual income and  $\rho_i^R$  is the residential land rent.<sup>54</sup> Condition (2.46) defines the local demand for residential land  $R_i^D$  as a negative function of the residential local land rent  $\rho_i^R$ .<sup>55</sup> The firms' demand for land input  $L_i^D$  is characterized by the well-known condition:

$$F_L(W_i, K_i, L_i^D, z_i) = \rho_i^L + \tau_i^P \quad (2.47)$$

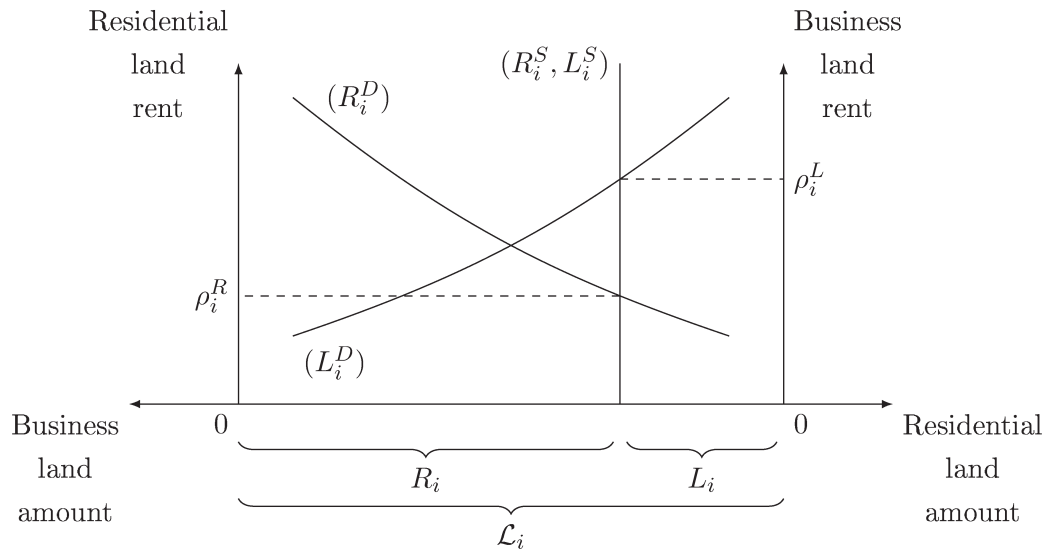
which defines the local demand for business land  $L_i^D$  as a negative function of the residential local land rent  $\rho_i^L$ .

Before proceeding, let us make clear how land-use restriction policy changes the mechanisms on the local land market, compared to the free land market in [Chapter 1](#).

<sup>54</sup>Recall that, assuming that  $U(\cdot)$  is satisfy [Assumption 1.1 in Chapter 1](#),  $\bar{y}$  and  $\bar{u}$  are exogenous from an atomistic jurisdiction viewpoint. See [subsection 4.1.1 in Chapter 1](#).

<sup>55</sup>This negative relation is interpreted as follows: when  $\rho_i^R$  increases, jurisdiction  $i$  becomes less attractive than other jurisdictions, ie.  $U^i < \bar{u}$ . Then, residents leave  $i$  to locate in another jurisdiction, ie.  $R_i^D$  decreases. Besides, note that outflows of residents raises utility in  $i$  since they release the population density pressure in  $i$  ( $U_R^i < 0$ ). This lead to a new migration equilibrium, ie.  $U^i = \bar{u}$ .





**Figure 2.3.** Partial equilibrium on the local land market

Figure 2.3 represents the land market equilibrium in jurisdiction  $i$ . It depicts the residential (resp. business) demand as a decreasing function of the residential (resp. business) land rent on the right (resp. left)-oriented graph. The free land market equilibrium locates at the intersection of the two demand curves  $(R_i^D)$  and  $(L_i^D)$ . In this equilibrium residents and firms pay the same land rent, since they compete for the same land plots. Figure 2.3 also depicts the business and residential land supplies fixed by local authorities: the vertical line  $(R_i^S, L_i^S)$ . The equilibrium with land-use restrictions is therefore located at the respective intersections of the demand curves  $(R_i^D)$  and  $(L_i^D)$  and the supply curve  $(R_i^S, L_i^S)$ . Contrary to the free market equilibrium, the residential land rent  $\rho_i^R$  differs from the business land rent  $\rho_i^L$ , which reflects the absence of competition for land.<sup>56</sup>

This difference in land rents is important for local authorities. To understand this, consider a policy which directly allows  $i$  to attract a small amount of residents in the two types of equilibria. In the free market equilibrium, it requires a public policy which shifts the residential land demand curve  $(R_i^D)$  towards right. In the new equilibrium both the amount of residents  $R_i$  and the residential land rent  $\rho_i^R$  will have increased by small amounts. Hence, the new residents pay almost the same land rent as the firms they have crowded out. In the equilibrium of a market with land-use restrictions, attracting a small amount of residents requires a public policy which shifts the land supply curve  $(R_i^S, L_i^S)$  towards right. In the new equilibrium

<sup>56</sup>Note that Figure 2.3 represents the case where  $\rho_i^L > \rho_i^R$ , which means that firms pay higher land rents than households. Empirically, this is certainly the most relevant case, but the present framework do not impose such a constraint.

the amount of residents  $R_i$  and the residential (resp. business) land rent  $\rho_i^R$  (resp.  $\rho_i^L$ ) will have increased (resp. decreased) by small amounts. But since there exists an important land rent gap - assumed to be positive on [Figure 2.3](#) - the new residents pay a much smaller land rent than firms they have crowded out. Then, a sharp and important difference exists between the two types of equilibria. In the free market equilibrium, crowding-outs of firms by residents induce small variations in the total land rent generated in the jurisdiction, while these variations can become very significant when land-use restriction policies are present. As will be seen below, this difference explains an important difference in the resident tax setting compared to the baseline result in [Chapter 1](#).

Let us return to the description of the model. Local land markets are in equilibrium so that we can denote  $R_i \equiv R_i^D = R_i^S$  and  $L_i \equiv L_i^D = L_i^S$  the equilibrium amounts of residents and business land. The remaining assumptions are similar to the baseline framework. The firms' demand for capital and labor are characterized by:

$$F_W(W_i, K_i, L_i, z_i) = w \quad (2.48)$$

$$F_K(W_i, K_i, L_i, z_i) = r + \tau_i^P \quad (2.49)$$

In order to achieve its objective to maximize the utility of its constituents, local government  $i$  chooses  $\tau_i^R, \tau_i^P, g_i, z_i$  and  $R_i$ , and satisfies the following budget constraint:

$$(\tau_i^R - \tau_i^P)R_i + \tau_i^P(K_i + \mathcal{L}_i) = C^i. \quad (2.50)$$

where  $L_i$  has been substituted in (2.9) using (2.45), since choosing the amount of residents  $R_i$ , government  $i$  also determines the amount of business land  $L_i$  from (2.45). In what follows, we assume without loss of generality that the local government freely chooses  $\tau_i^R, \tau_i^P, g_i$  and  $z_i$ , while  $R_i$  adjusts endogenously so as to satisfy (2.50).<sup>57</sup> Moreover, since the local government can directly control neither the level of the residential and business land rents nor the location of workers and capital, it has to account for responses of all these variables to its policy decisions. Formally, this means that government  $i$  has to account for the location functions implicitly defines  $\rho_i^R(\tau_i^R, \tau_i^P, g_i, z_i)$ ,  $\rho_i^L(\tau_i^R, \tau_i^P, g_i, z_i)$ ,  $W_i(\tau_i^R, \tau_i^P, g_i, z_i)$ ,  $K_i(\tau_i^R, \tau_i^P, g_i, z_i)$  and  $R_i(\tau_i^R, \tau_i^P, g_i, z_i)$  which are implicitly defined by (2.46)-(2.50).

From [Lemma 1.1](#) in [Chapter 1](#), utility-maximizer local government  $i$ 's objective is to maximize the local land rent  $\rho_i^R R_i + \rho_i^L L_i$ . Then, following the same steps as

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<sup>57</sup>The results derived hereafter do not depend on the instrument used to clear the local budget constraint (2.50). Treating  $R_i$  as the adjustment variable makes the interpretations more suited for comparisons with [Chapter 1](#), and then allows to better understand the effect of introducing land-use restrictions in the local policy instrument set.

for deriving (1.29), the local government's objective can be written as:

$$F(W_i, K_i, L_i) - wW_i - rK_i + (\rho_i^R + \tau_i^R)R_i - C^i$$

Then, for  $t_i \in \{\tau_i; \tau_i^K; g_i; z_i\}$ , the first-order conditions of local government  $i$  are:

$$\left( \tau_i^R + R_i \frac{U_R^i}{U_x^i} - \tau_i^P + \rho_i^R - \rho_i^L \right) \frac{\partial R_i}{\partial t_i} + \tau_i^P \frac{\partial K_i}{\partial t_i} + \left( R \frac{U_g^i}{U_x^i} - C_g^i \right) \frac{\partial g_i}{\partial t_i} + (F_z^i - C_z^i) \frac{\partial z_i}{\partial t_i} = 0 \quad (2.51)$$

where the same steps as for deriving (1.30) have been used.

It is informative about the mechanisms at stake in this model with land-use restriction policy to have a look at the equilibrium responses of residents, workers and capital to changes in the policy instruments. It can be shown that for  $t_i \in \{g_i; z_i\}$ :<sup>58</sup>

$$\frac{\partial R_i}{\partial t_i} > 0 \quad \text{and} \quad \begin{cases} \frac{\partial K_i}{\partial g_i}, \frac{\partial W_i}{\partial g_i} < 0 \\ \frac{\partial K_i}{\partial z_i}, \frac{\partial W_i}{\partial z_i} > 0 \quad (\text{or } < 0) \end{cases} \quad (2.52)$$

and for  $t_i \in \{\tau_i^R; \tau_i^P\}$ :

$$\frac{\partial R_i}{\partial t_i} < 0 \quad \text{and} \quad \begin{cases} \frac{\partial K_i}{\partial \tau_i^R}, \frac{\partial W_i}{\partial \tau_i^R} > 0 \\ \frac{\partial K_i}{\partial \tau_i^P}, \frac{\partial W_i}{\partial \tau_i^P} < 0 \quad (\text{or } > 0) \end{cases} \quad (2.53)$$

Thus, the possibility for local governments to control their local land use significantly alters the location response pattern, as (2.52) and (2.53) show.<sup>59</sup> The most important change, compared to location responses absent land-use restrictions, lies in the resident location responses. Indeed, resident location now follow public budgetary rationales rather than private interests of individuals. Indeed, the local population  $R_i$  increases when additional tax revenues are needed (e.g. increase in  $g_i$  or  $z_i$ ), and it decreases following a budget constraint release (e.g. increase in  $\tau_i^R$  or  $\tau_i^P$ ), which confirms that local governments employ land use regulation policy as a budgetary tool. In comparison, absent land regulation, the local population increases in jurisdictions which improve their attractiveness to residents (increase in  $g_i$  or decrease

<sup>58</sup>See ?? for the derivation of these signs.

<sup>59</sup> In comparison, the location responses absent land-use restrictions are (see Lemma 1.2 in Chapter 1):

$$\frac{\partial R_i}{\partial t_i} < 0 \quad \text{and} \quad \frac{\partial K_i}{\partial t_i}, \frac{\partial W_i}{\partial t_i} > 0 \quad \text{for } t_i \in \begin{cases} \{\tau_i^R; z_i\} \\ \{\tau_i^P; g_i\} \end{cases}$$

in  $\tau_i^R$ ) or lowers their attractiveness to firms (increase in  $\tau_i^R$  or decrease in  $z_i$ ), as stated in Chapter 1.

Besides, note that local authorities do not face a systematic trade-off between hosting mobile residents and hosting mobile capital and workers as is the case in Chapter 1. The location response signs in (2.52) and (2.53) show that this trade-off still characterizes variations in the household-oriented instruments ( $g_i$  and  $\tau_i^R$ ). As in Chapter 1, the explanation is that new households crowd out business land, entails outflows of capital and workers (due to input complementarity). However, this trade-off is much less likely in response to variations in the firm-oriented instruments ( $z_i$  and  $\tau_i^P$ ). To understand this consider a small rise in  $z_i$ .<sup>60</sup> By increasing the productivity of other factors, it allows to attract more capital and workers. Meanwhile, in order to finance these additional public services, the local government increases its population cap. Thus, the direct effect raising  $z_i$  or cutting  $\tau_i^P$  is to increase both the population  $R_i$  and the amount of mobile inputs  $K_i$  and  $W_i$ . This result which sharply contrasts with Chapter 1, and simply recalls once again that land use regulation policy are used as a financing instrument. Finally, notice that (2.52) and (2.53) also indicate that it may happen that an increase in  $z_i$  or a cut in  $\tau_i^P$  induce outflows of capital and workers. The reason for this unusual result is that the land-use policy favoring households reduces the size of business lands which in turn entails outflows of capital and workers. As a consequence, it is theoretically possible that a firm-oriented policy which in practice is implemented to attract more capital and labor induce the opposite effect since it needs to be financed by a population increase. However, this result requires that land increases a lot more capital and labor productivity than public inputs do. This assumption is not reasonable in the present framework which considers rough land on which households and firms build the equipment they need.

The decentralized equilibrium in the case where local governments are allowed to fix land-use restrictions but are constrained to set a single business property tax rate on capital and land inputs is characterized by the following result:

**Result 2.9 (Land use restrictions).** *In equilibrium, under perfect interjurisdictional competition, local governments choose  $\tau_i^R$ ,  $\tau_i^P$ ,  $R_i$ ,  $g_i$  and  $z_i$  in accordance*

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<sup>60</sup>A small cut in  $\tau_i^P$  has the same impact.

with the following decision rules:

$$\tau_i^R = R_i \frac{|U_R^i|}{U_x^i} + \rho_i^L - \rho_i^R \quad (2.54)$$

$$\tau_i^P = 0 \quad (2.55)$$

$$R_i \frac{U_g^i}{U_x^i} = C_g^i \quad (2.56)$$

$$F_z^i = C_z^i \quad (2.57)$$

and the residential land use  $R_i$  allows to satisfy the local budget constraint so that:

$$R_i = \frac{C^i}{\tau_i^R} \quad (2.58)$$

*Proof.* See ??.

□

**Result 2.9** shows that allowing local governments to directly control land use in their jurisdiction leads to efficient local public policies. As conditions (2.56) and (2.57) indicate, all local public services are efficiently provided. The inefficient provision of public inputs which occurs in the absence of local land control (condition (2.12)) disappears. The reason for this efficient behavior is that land-use restriction policy provide local authorities with the ability to finance their public service provision through the control of their population size instead of charging an inefficiently high tax on capital. Indeed, as condition (2.55) reveals, the business property tax can be used as a capital tax - whose desired level is zero due to capital mobility - since it does not have to play the role of financing instrument. Indeed, this role is played by land use regulation policy, as condition (2.58) indicates.

Condition (2.54) reveals that a noticeable change occurs in the resident tax setting as compared to the first-best resident tax setting absent land use regulation characterized by condition (2.3). When land-use restrictions are allowed, the resident tax  $\tau_i^R$  do not have to internalize the marginal fiscal cost  $\tau_i^L$  induced the crowding-out of a unit of business land by a new resident, since business land is not taxed anymore (condition (2.55)). However, the tax on residents has to internalize the gap between the business land rent and the residential land rent  $\rho_i^L - \rho_i^R$ . The above discussion of Figure 2.3 allows to understand this. To interpret this result, assume that  $\rho_i^L - \rho_i^R > 0$  which is certainly the most relevant case from an empirical viewpoint. In this case, when a new resident enters jurisdiction  $i$ , she entails not only a congestion cost  $R_i|U_R^i|/U_x^i$  but she also induces a decrease in the total land rent of the jurisdiction since she pays a lower land rent than businesses she crowded out. Yet, recall that the objective of the benevolent local government is precisely

to maximize the total land rent generated in its jurisdiction. This explains that it raises  $\tau_i^R$  to above the marginal congestion cost in order to bring mobile residents to internalize this land rent loss.

Finally, let us conclude this section with a summary of its main findings. The first of these is that land-use restriction policy, as an additional budgetary instrument, allow to solve the inefficiency problem caused by business property taxation. It prevents local governments from setting inefficiently high taxes on capital in order to finance public services. In practice, land-use restriction policy has an important place in the range of local public policy instruments. Our analysis sheds light on their beneficial role to balance the inevitable rigidity of local tax systems. However, as discussed in the beginning of this section, national laws usually limit the ability of local governments to control local land use. While these limitations are certainly justified on social and political grounds, our analysis suggests that economic gains could be obtained from providing local governments with more autonomy regarding land use regulation.

## 5. Conclusion

The sub-metropolitan tax competition model introduced in [Chapter 1](#) assumes that commuting entails no cost. This chapter relaxed this assumption. We showed that the behavior of jurisdictions with high and low local demand for labor relative to their population is ultimately not affected by the existence of commuting costs. The local workforce in these jurisdictions is uniquely driven by local firms' needs. The framework of [Chapter 1](#) fully applies to these types of jurisdictions. They can represent the majority of jurisdictions in metropolitan areas where commuting costs are relatively low due, for instance, to a well developed transportation network or to the small size of the metropolitan area. However, the existence of commuting costs matters for jurisdictions with an intermediate level of labor demand. For these jurisdictions, residents find that it is too costly to commute so that they work in their home jurisdiction. This 'quasi-immobility' of workers provides local authorities with a scope for action on the local labor market by using their tax on residents as a labor tax.

These two polar cases of jurisdictions where the local workforce is either fully determined by firms' needs or fully immobile are obviously extreme and result from the fact that the commuting costs are modeled as a fixed cost in this chapter. However, the analysis led in this chapter highlights a quite general proposition stating that commuting costs, by introducing a link between the population and the workforce in jurisdictions, change the economic nature of their local policy instruments. In the presence of commuting costs, the resident-oriented policy instruments (resi-

dential tax, public goods) are not only used to control residents' mobility, but they also allow municipalities to stimulate or mitigate their attractiveness on workers. This highlights the ambiguous role of the resident-oriented policy instruments and suggests the need for local instrument specifically oriented towards workers, such as a local labor taxes. This is further discussed in [Chapter 4](#) which introduces a spatial tax competition model comprising commuting costs depending on the distance between jurisdictions.

[Chapter 1](#) assumes that all residents are perfectly mobile across jurisdictions. It is however typically the case that residents with different degrees of mobility coexist within jurisdictions. To account for this heterogeneity, this chapter introduced a group of immobile landowners who coexist with mobile households without landownership. We showed that if mobile and immobile residents have the same marginal willingness to pay for local public goods, the model boils down to that in [Chapter 1](#). However, in practice, landowners are usually richer than non-landowners and therefore have a comparatively higher marginal willingness to pay for the local public good. In this case, we showed that if local governments are constrained to use a single business property tax on capital and business land, they now provide an inefficiently high level of public good. This result is specific to the sub-metropolitan tax competition context introduced in [Chapter 1](#), since it stems from the competition between households and firms for local land markets. This result contrasts with most of the existing literature since [Zodrow and Mieszkowski \(1986\)](#) and [Wilson \(1986\)](#) whose theoretical prediction goes in the opposite direction: tax competition among jurisdictions would lead to an inefficiently low level of local public good. In this chapter we showed that "rich" households (ie. landowners) take advantage of their greater marginal willingness to pay for the public good to spur local authorities to provide an inefficiently high level of public good, in view of reducing the amount of business land in favor of residential land.

While a unique business property tax on capital and business land might be justified on political and administrative grounds, [Chapter 1](#) showed that this single tax constraint leads to inefficient local policy choices. This chapter discussed several policy that could be led by the central government to tackle this issue: dissociation of the business property tax bases, vertical transfers and introduction of local land-use restriction policy instruments. The pros and the cons of each of these measures have been discussed. This discussion suggests that, regarding financial costs and inequalities, the most promising measure might be the introduction of local land-use restriction policy instruments. This chapter sheds a new light on the so-called "zoning" policies. From the sub-metropolitan framework developed in [Chapter 1](#), it appears that land-use policy instruments allow jurisdictions not only to control their population size (as in e.g. [Hamilton, 1975](#), and many subsequent contributions) but

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also the amount of land used by firms — which is to our knowledge not studied in the existing literature. This chapter depicts how such instruments which are both household-oriented and firm-oriented can be used to address the issue of a single business property tax constraint, but it also paves the way for future investigations of the crucial role that this two-sided local policy instrument can play for sub-metropolitan jurisdictions.





## Chapter 3

# Local taxation and tax base mobility: Evidence from France

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### Abstract

This chapter investigates the impact of tax base mobility on local taxation. First, we develop a theoretical model in order to examine the connection between local business property taxation and tax base mobility within a metropolitan area. We find that, in the presence of a budget compensation, decreasing capital intensity in business property tax base, composed of capital and land, increases the business property tax rates and decreases the tax rates on residents. We test this result using a French reform which changed the composition of the main local business tax base in 2010. Difference-in-difference estimations show that in 2010, the reduction in tax base mobility indeed resulted in a 14% rise in business property tax rates and a reduction in housing tax rates of 1.3%, compared to pre-reform average levels.

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\*This chapter is co-written with Sonia Paty, Professor of Economics, University Lumière Lyon II. It has been submitted to *Regional Science and Urban Economics* and is currently under first-round revision. This chapter corresponds to the revised version.

## 1. Introduction

On February 9, 2009, the French President declared: “the *Taxe professionnelle* will be removed in 2010 because I want France to retain its businesses”. Less than a year later, 80% of the tax base of the French local business property tax, the so-called ‘*Taxe professionnelle*’, had been removed. Prior to the reform, business property tax relied both on capital investments (equipment and machinery) and real property (building and land) used by firms. The reform removed the capital part from the tax base. Similar reforms resulting in capital being limited in or removed from the local combined property tax base have been implemented in some states in the United States of America (Ohio in 2005 and Michigan in 2014).<sup>1</sup> This quasi-natural experiment represents a unique opportunity to investigate how a change in the degree of mobility of their tax base affects the tax rates set by municipalities. The objective of the chapter is to exploit the 2010 French local tax reform, to study the impact of the degree of mobility of the local business tax base on local tax rates, and, specifically on the business property tax and the housing tax rates.

The link between local taxes and tax base mobility was mooted initially in tax competition literature in the form of the efficiency problem caused by business capital mobility across local jurisdictions on the provision of local public goods. The basic problem is summarized in Oates (1972) as: “The result of tax competition may well be a tendency toward less than efficient levels of output of local public services.” Oates points to the cause of this inefficiency as being “an attempt to keep tax rates low to attract business investment [by] local officials.” Thus, capital mobility pushes each single competing local government to charge inefficiently low capital taxes, since it fears that capital leaves its jurisdiction for a more attractive one. This non-cooperative behavior leads to a “prisoner’s dilemma” problem (Boadway and Wildasin, 1984) where all capital tax rates are too low and local public goods are under-provided. This major result has been confirmed by many subsequent contributions. Zodrow and Mieszkowski (1986) and Wilson (1986) provide the basic framework showing that capital mobility drives local jurisdictions to charge inefficiently low capital tax and supply inefficiently low levels of local public goods. Wildasin (1989) demonstrates that this tax competition problem is due to a positive fiscal externality on other jurisdictions which is ignored by a single jurisdiction when choosing its tax level: it ignores that by setting higher capital tax, other jurisdictions benefit from more capital. A number of studies based on the aforementioned papers develop other features of tax competition for mobile capital.<sup>2</sup>

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<sup>1</sup> See Stafford and DeBoer (2014) for a detailed discussion of these reforms in the US.

<sup>2</sup> See e.g. Wilson (1999), Wilson and Wildasin (2004) and Wellisch (2006) for comprehensive

To study the relationship between taxes and capital mobility at the local level, two concerns emerge from the early contributions cited above. First, since most of these studies focus on the efficient provision of public goods rather than the actual tax level, equilibrium tax rules are usually not determined and the relationship between tax rate levels and capital mobility is not explicit.<sup>3</sup> Second, the framework developed in these early contributions which consider households to be immobile, is better suited to the study of large jurisdictions (such as states or countries) than to municipalities. It is indeed difficult to argue household immobility at the local level.<sup>4</sup> It raises issues also for the study of local tax settings. Indeed, in a basic tax competition model, allowing jurisdictions to choose the level not only of a capital tax but also of a residential tax leads to the following inevitable outcome: all jurisdictions will not tax capital and will impose the entire tax burden on households.<sup>5</sup> Therefore, it is difficult to explain capital taxation if we want to consider both capital and housing taxation in the same setting.

Another strand of the tax competition literature which started with [Wilson \(1995\)](#), [Richter and Wellisch \(1996\)](#) and [Brueckner \(2000\)](#) considers both residents' and capital (or more generally firm) mobility. In the framework developed by [Wilson \(1995\)](#), for instance, the equilibrium tax rates on capital and on residents are both positive.<sup>6</sup> It also appears that household mobility forces local governments to internalize their residents' preferences so that public goods are always provided efficiently (if residential taxes are available), which confirms the well-known result in [Tiebout \(1956\)](#). Since public good provision is often peripheral in these studies, tax rate levels assume an important role. Taxation rules generally are characterized for multiple institutional setting hypotheses, and both capital and residents responses to policy changes are explicit in these rules (see e.g. [Wellisch and Hulshorst, 2000](#)). However, in these models household mobility is still not in line with with municipal characteristics, since residents are assumed to be mobile across jurisdictions but

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reviews of this literature.

<sup>3</sup> [Zodrow and Mieszkowski \(1986\)](#) expresses the marginal rate of substitution of the local public good as an inverse function of capital elasticity with respect to the capital tax rate. Several empirical studies use functional forms to derive the reduced form of the capital tax rate. However the resulting tax rate equation does not show a clear link between the tax rate and the capital tax base.

<sup>4</sup> Most OECD countries experience a substantial population mobility across regions and cities. ([OCDE, 2013](#)) shows that 18 million people change residence annually, in 28 observed OECD countries. This correspond to 2% of the total population.

<sup>5</sup> There is a resident tax in [Zodrow and Mieszkowski \(1986\)](#), but it is set exogenously.

<sup>6</sup> The tax on residents is used to internalize the congestion costs generated by residents but is not sufficient to satisfy the budget constraint so the capital tax also is used.

necessarily work in their jurisdiction of residence. This feature is more appropriate to large jurisdictions such as regions or states as noted in [Braid \(1996\)](#) which developed a sub-metropolitan tax competition model in which capital and workers are mobile, but residents are immobile. [Ly \(2018\)](#) combines the features of the above frameworks into a sub-metropolitan tax competition model in which capital, residents and workers are all mobile.<sup>7</sup>

To test the impact of tax base mobility on tax rates in metropolitan areas, we first develop a theoretical model which builds on the model in [Ly \(2018\)](#) which was designed to analyze tax competition among sub-metropolitan governments. Local jurisdictions understood as municipalities, compete for mobile capital and for mobile residents using a single business property tax on both capital and business land and a tax on residents to finance a local public good.<sup>8</sup> [Ly \(2018\)](#) shows that the equilibrium business property tax rate depends negatively on the share of capital in the business property tax base and that the rate of the tax on residents does not depend directly on this capital share. In this paper, we further investigate these relations. Specifically, we analyze the impact of removing capital from the business property tax base which therefore becomes a tax on business land only. We show that this institutional change affects the local tax rates via two different effects. First, the budgetary effect entails that shrinking the business property tax base spurs municipalities to increase their tax rates on residents and firms. Second, the capital-mobility effect implies that since the new business property tax base (business land) becomes less mobile, municipalities can charge a higher business tax rate and reduce their tax on residents.

The budgetary effect and the capital-mobility effect on tax rates of a removal of capital from the business property tax base can *a priori* not be disentangled. However, we show also that if the central government guarantees municipalities a compensation to cover the revenue losses resulting from removal of the capital tax base, the budgetary effect is controlled for. Compensation for lost revenue allows us to identify the capital-mobility effect which is our focus in this chapter.<sup>9</sup>

To test the existence of the capital-mobility effect on the local tax rates, we

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<sup>7</sup> Note that the urban tax competition model developed in [Gagné et al. \(2016\)](#) also combines resident, firm and worker mobility.

<sup>8</sup> For simplicity, we do not model labor mobility explicitly. However, our sub-metropolitan tax competition framework would allow to introduce costless commuting across municipalities ([Braid, 1996](#); [Ly, 2018](#)) without affecting any of our results.

<sup>9</sup> Formally, we derive reduced forms for the resident and business property tax rate changes as a function of the eliminated capital share in the business property tax base. This capital share can be regarded as a proxy for the degree of capital mobility of the business property tax base in the context of the French local tax reform of 2010.

exploit a 2010 French reform, which changed the composition of the main local business tax base. The reform removed capital investment from the local business property tax base (the so-called '*Taxe professionnelle*'), which represented around 80% of this tax base. More precisely, while the French local municipality business property tax base consisted of capital investments (machinery and equipment) and firms' real property (buildings) used by firms, municipalities ended up with a business real property tax only. This change to the composition of the tax base caused a dramatic change to the degree of mobility of the business property tax base ; it turned from taxation relying mostly on capital into taxation relying exclusively on business real property. At the same time, a state grant was allocated to each municipality equal to the amount of their pre-reform capital tax revenues.<sup>10</sup>

By analyzing the impact of this reform, we address the following question: how and to what extent the local business tax rate is affected by a change in the tax base composition? To address this, we build a dataset of local taxation and socio-demographic, political and economic characteristics for more than 11,800 French municipalities from 2006 to 2012. We use the share of capital in the business property tax base in 2009 (the last pre-reform year) to proxy tax base mobility. Using a difference-in-difference (DD) approach, we consider this continuous variable — the share of capital in the tax base — as our treatment variable.

Our DD estimates show that a drastic cut in the mobile part of the tax base (capital) relative to the far less mobile part of the tax base (buildings) led French municipalities to increase their business property tax rates and decrease their housing tax rates. Since a perfect state compensation was allocated to French municipalities, in line with our theoretical results, our empirical investigation suggests that the increase in the business tax rate was motivated by a less mobile tax base and not by a budgetary effect. Our analysis also suggests that this increase in the business property taxation due to the decline in the tax base mobility allowed French municipalities to alleviate the tax burden on households by cutting their housing tax.

This chapter contributes to the empirical tax competition literature which tends to focus on the estimation of tax reaction functions, where a municipality tax rate depends on the tax rates in nearby municipalities (Brueckner and Saavedra, 2001; Brueckner and Kim, 2003; Revelli, 2005; Allers and Elhorst, 2005; Charlot and Paty, 2007; Hauptmeier et al., 2012; Lyytikäinen, 2012). However, with the exception of Carlsen et al. (2005),<sup>11</sup> the empirical literature on the extent that the mobility

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<sup>10</sup> This compensation, which was assured for all the years following the reform, was constant over time.

<sup>11</sup> The mobility of the tax base is based on the geographic profit variability of industrial sectors

of local tax base leads to a downward pressure on local tax rates is very limited. Using a quasi-natural experiment, the present paper provides some initial empirical evidence of a negative relationship between local business taxation and the degree of tax base mobility, which corroborates one of the main theoretical statements of the original tax competition literature.

The remainder of the chapter is organized as follows. [Section 2](#) presents the theoretical framework underlying our empirical analysis. [Section 3](#) describes the institutional structure of French municipalities and the 2010 tax reform. [Section 4](#) discusses the identification strategy. [Section 5](#) describes the data. [Section 6](#) reports the regression results. [Section 7](#) concludes.

## 2. Theoretical background

### 2.1. Framework

We now develop a theoretical model to examine the connection between local business taxation and tax base mobility.<sup>12</sup> The economy consists of a metropolitan area composed of  $n$  small identical municipalities indexed by  $i = 1, \dots, n$ .<sup>13</sup> The metropolitan area is endowed with fixed capital and land endowments, respectively denoted  $\mathcal{K}$  and  $\mathcal{L}$ ,<sup>14</sup> and inhabited by an exogenous number of  $\mathcal{P}$  residents. The representative municipality  $i$  is inhabited by  $R_i$  perfectly mobile residents. Each resident derives utility from private consumption  $x_i$ , a congestible local public good  $G_i$  and one unit of land (housing) paying the land rent  $\rho_i$ . A resident is characterized by the utility function  $U(x_i, G_i, R_i) = x_i + \alpha \log(G_i/R_i)$ , where utility is decreasing in the municipality's population  $R_i$  due to congestion. Each resident of the economy possesses the same exogenous capital endowment  $\mathcal{K}/\mathcal{P}$  which she invests in the municipality offering the highest return. Since capital is perfectly mobile across municipalities, in equilibrium the same return to capital  $r$  prevails across

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in Norway.

<sup>12</sup> The model is in line with tax competition models with both households and firms mobility (e.g. [Wilson, 1995](#); [Richter and Wellisch, 1996](#); [Brueckner, 2000](#)). In order to better fit with features of the municipal level the present framework relies more on [Ly \(2018\)](#). Indeed, the present framework allows households to consume land and can be extended to allow household to commute to work, so that they can reside and work in separate municipalities. Introducing costless commuting would not alter any of the results derive hereafter.

<sup>13</sup> Relaxing the assumption of identical municipalities would not affect the results derived hereafter, but it simplifies the exposition. See our working paper for a version without symmetrical municipalities.

<sup>14</sup> Since housing/building supply is assumed to be inelastic, land can be regarded as a set of premises which can be used by households as housing or firms as business premises.

municipalities. From the perspective of a small municipality,  $r$  is exogenous. For simplicity, we assume that labor considerations are absent from the present framework.<sup>15</sup> The exogenous land endowment  $\ell_i$  of municipality  $i$  is equally distributed among all households of the metropolitan area, so that the individual land income is  $\sum_{i=1}^n \rho_i \ell_i / \mathcal{P}$ . The local government  $i$  collects a head tax  $\tau_i^R$  on its residents. Since the individual land consumption is inelastic,  $\tau_i^R$  can be interpreted as a housing tax. The budget constraint of a representative resident of municipality  $i$  can be written as

$$x_i + \rho_i = \frac{r\mathcal{K} + \sum_{i=1}^n \rho_i \ell_i}{\mathcal{P}} - \tau_i^R. \quad (3.1)$$

Household perfect mobility implies that utility is equal in all municipalities in equilibrium:

$$\alpha \log \left( \frac{G_i}{R_i} \right) - \rho_i - \tau_i^R = \alpha \log \left( \frac{G_j}{R_j} \right) - \rho_j - \tau_j^R \equiv u, \quad \forall j \neq i, \quad (3.2)$$

where (3.1) has been used to substitute  $x_i$  into the utility function. Due to atomicity, municipality  $i$  cannot affect variables in other jurisdictions so that  $u$  is exogenous.<sup>16</sup>

The production technology in municipality  $i$  is described by the well-behaved homogeneous (of degree 1) production function  $F^i(K_i, L_i)$ , and firms choose capital  $K_i$  and land  $L_i$  so as to maximize profits  $F^i(K_i, L_i) - [r + (1 - \theta)\tau_i^P]K_i - (\rho_i + \tau_i^P)L_i$ , where  $\tau_i^P$  is the business property tax rate, and  $\theta$  is the share of the capital tax base which is exempted from tax. The exemption rate  $\theta$ , which is exogenously fixed by the central government and applies identically to all municipalities, can only take two values: 0 (no exemption) and 1 (full exemption). Factor prices and taxes are taken as given by firms so that profit maximization implies:

$$\frac{\partial F^i}{\partial K_i}(K_i, L_i) = r + \tau_i^P(1 - \theta), \quad (3.3a) \quad \frac{\partial F^i}{\partial L_i}(K_i, L_i) = \rho_i + \tau_i^P, \quad (3.3b)$$

The land market clearing condition entails:

$$\ell_i = R_i + L_i. \quad (3.4)$$

The cost function of the provision of local public goods is  $C(G_i) = G_i + f_i$ , where the fixed costs  $f_i$  comprise, for instance, running and maintenance costs, and interests

<sup>15</sup> All the results derived in this section would be strictly identical if labor perfect mobility were introduced. See Ly (2018) for a framework with this additional feature.

<sup>16</sup> Notice that due to the quasi-linearity of the utility function,  $u$  is the metropolitan utility level net of land and capital individual income. Then, household mobility does not imply that the gross utility level is fixed from the perspective of jurisdiction  $i$ . By affecting  $\rho_i$  it can indeed affect the return to local landowners. See Ly (2018) for further details.



of past debt. The local authorities must satisfy the following budget constraint:

$$\tau_i^R R_i + \tau_i^P [(1 - \theta)K_i + L_i] + \theta \Lambda_i = G_i + f_i. \quad (3.5)$$

where  $\Lambda_i$  is an exogenous grant provided by the central government if it removes the ability to tax capital — ie.  $\theta = 1$ .

## 2.2. Local taxation choices

We now examine the taxation choices of the representative government  $i$  — index  $i$  is dropped hereafter to alleviate notations. We are especially interested in the effects of a reform consisting in the removal of capital from the business property tax base on local taxation choices. Formally, this requires to describe the optimal local taxation decisions in two configurations:  $\theta = 0$  (pre-reform) and  $\theta = 1$  (post-reform). The benevolent local government maximizes the utility of its own residents, choosing the level of  $\tau^P$ ,  $\tau^R$  and  $G$  while satisfying the local budget constraint (3.5) and accounting for private behavior characterized by (3.1)-(3.4). Specifically, the local government does not directly controls capital and household location but accounts for these location decisions when designing its policy. As shown in [Appendix A](#), the optimal behavior rules of the local authorities are:<sup>17</sup>

$$\begin{aligned} \tau^{R0} &= \alpha + \left(1 + \frac{K^0}{L^0}\right) \tau^{P0}, & (\text{TR}^0) & & \tau^{P0} &= \frac{R^0}{K^0 + L^0} \left(\alpha - \tau^{R0} + \frac{f}{R^0}\right) & (\text{BC}^0) \\ \tau^{R1} &= \alpha + \tau^{P1}, & (\text{TR}^1) & & \tau^{P1} &= \frac{R^1}{L^1} \left(\alpha - \tau^{R1} + \frac{f - \Lambda}{R^1}\right), & (\text{BC}^1) \end{aligned}$$

where the superscripts 0 and 1 respectively stand for the equilibrium value of the variables when  $\theta = 0$  and  $\theta = 1$ . Symmetry implies that, in equilibrium,  $R^0 = R^1 = \mathcal{P}/n$ ,  $L^0 = L^1 = \ell - \mathcal{P}/n$  and  $K^0 = K^1 = \mathcal{K}/n$ .

Let us first consider the pre-reform case where  $\theta = 0$ . The optimal taxation rule ( $\text{TR}^0$ ) shows that local authorities choose the level of the tax on residents so as to

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<sup>17</sup> Only the taxation rules are exposed here. However, the public good provision rules — which are peripheral to the present analysis — are also derived in [Appendix A](#) (see condition (A.67)). In both cases ( $\theta = 0$  and  $\theta = 1$ ), the local public good is provided according to the Samuelson rule: the sum of the marginal willingness to pay for the public good of all residents,  $R(\partial U/\partial G) = \alpha R/G$ , equals its marginal cost  $C'(G) = 1$ . This means that the public good is provided efficiently which is typical to models with small municipalities linked by perfectly mobile residents paying a local head tax ([Wellisch and Hulshorst, 2000](#)).

internalize the mobility costs of households and capital. To see this, suppose that a new resident enters the municipality. She brings  $\tau^R$  tax revenues — left-hand side of  $(\text{TR}^0)$  — but she also entails three marginal costs for the municipality — right-hand side of  $(\text{TR}^0)$ : a congestion cost,  $R|\partial U/\partial R| = \alpha$ , since she decreases the utility of all other residents; a fiscal cost  $\tau^P$  due to the crowd-out of one unit of business land; and an additional fiscal cost  $\tau^P \times |\partial K/\partial R| = \tau^P \times K/L$  due to capital mobility. This last marginal fiscal cost is central to our analysis. It stems from the fact that the new resident, by crowding-out one unit of business land, also generates an outflow of  $K/L$  units of capital from the municipality. If the municipal capital stock were fixed — that is, if capital were immobile — there would be no capital outflow and this last marginal fiscal cost would be zero.<sup>18</sup> Moreover, it appears that if the municipality is more capital-intensive (higher  $K/L$ ), capital mobility has a stronger impact on its taxation choices since it would suffer from larger capital outflows when losing its firms. Condition  $(\text{BC}^0)$  simply states that  $\tau^P$  allows to satisfy the budget constraint (3.5).

Let us now turn to the post-reform case where  $\theta = 1$ . Similarly to  $(\text{BC}^0)$ ,  $(\text{BC}^1)$  states that  $\tau^P$  allows to satisfy the budget constraint. The main change with respect to the pre-reform situation, appears in  $(\text{TR}^1)$ . Compared to  $(\text{TR}^0)$ , observe that the marginal fiscal cost due to capital mobility disappears. Since capital is not taxed anymore, a new resident becomes less costly relative to new firms. This spurs local authorities to set a lower (resp. higher) resident tax (reps. business property tax) relative to the business property tax (resp. resident tax). Solving  $\{(\text{TR}^0); (\text{BC}^0)\}$  for  $\{\tau^{R0}; \tau^{K0}\}$ , and  $\{(\text{TR}^1); (\text{BC}^1)\}$  for  $\{\tau^{R1}; \tau^{K1}\}$  allows to derive the reduced form of the tax on residents and the business property tax before and after the institutional change:

$$\tau^{R0} = \alpha + \frac{f}{\ell}, \quad (3.7a) \quad \tau^{R1} = \alpha + \frac{f - \Lambda}{\ell}, \quad (3.7b)$$

$$\tau^{P0} = (1 - \kappa^0) \frac{f}{\ell}, \quad (3.8a) \quad \tau^{P1} = \frac{f - \Lambda}{\ell}. \quad (3.8b)$$

where  $\kappa^0 \equiv K^0/(K^0 + L^0)$  denotes the pre-reform capital intensity in the business property tax base.

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<sup>18</sup> In this case,  $(\text{TR}^0)$  boils down to  $(\text{TR}^1)$ .

### 2.3. Capital removal without compensation

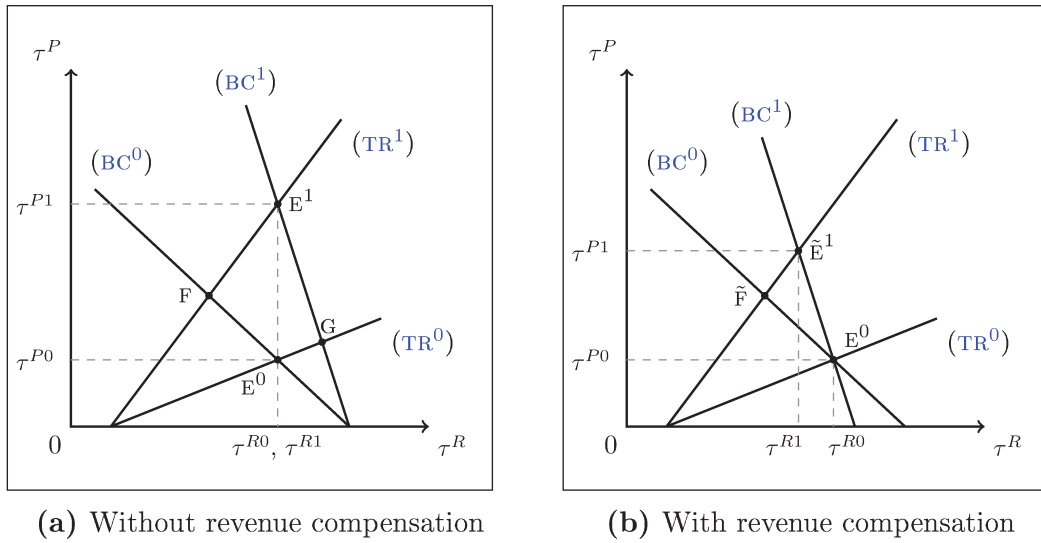
The reduced forms (3.7) and (3.8) allow to highlight the key role of the pre-reform capital intensity  $\kappa^0$  on the evolution of the tax rates accompanying the reform. To understand it, suppose for the moment that the central government removes capital from the business property tax base without compensating municipalities in return so that  $\Lambda = 0$ . Then, we have:

$$\frac{\partial(\tau^{R1} - \tau^{R0})}{\partial\kappa^0} = 0 \quad (3.9a) \quad \frac{\partial(\tau^{P1} - \tau^{P0})}{\partial\kappa^0} = \frac{f}{\ell} > 0. \quad (3.9b)$$

While (3.9a) shows that capital intensity does not affect the evolution of the tax on residents following the reform, according to (3.9b), capital intensity plays a key role in the evolution of the business property tax. More precisely, as shown by (3.8a), capital intensity exerts a downward pressure on the pre-reform tax rate, so that, the presence of capital-intensive firms spurs the municipality to increase its business property tax following the reform. The higher the pre-reform capital intensity, the higher the spike in the business property tax rate. Two rationales underly this result. First (*capital-mobility effect*), if local firms are more capital-intensive, mobile capital exerts a stronger downward pressure on the pre-reform business property tax rate due to a higher marginal fiscal cost caused by capital mobility. Second (*budgetary effect*), the tax revenue loss due to the removal of the capital tax base is more onerous in a municipality hosting more capital. Then, local authorities are also spurred to increase their business property tax rate to compensate this loss.

Further understanding of this key result may be gained from a graphical representation of equations (TR<sup>0</sup>), (TR<sup>1</sup>), (BC<sup>0</sup>) and (BC<sup>1</sup>), as depicted on Figure 3.1a. The taxation-rule curve (TR<sup>0</sup>) represents the pre-reform positive relation connecting  $\tau^R$  to  $\tau^P$ : an increase in  $\tau^P$  implies a rise in the marginal fiscal cost of new residents which is covered by a rise of  $\tau^R$ . The budget-constraint curve (BC<sup>0</sup>) represents the pre-reform negative budgetary relation linking  $\tau^P$  to  $\tau^R$ : increasing  $\tau^R$  allows local authorities to alleviate the tax burden on firms by cutting  $\tau^P$ . Thus, point E<sup>0</sup> which intersects (TR<sup>0</sup>) and (BC<sup>0</sup>), represents the pre-reform equilibrium in tax rates.

The reform consisting in a removal of capital from the business property tax base, induces two different effects. The first effect is a budgetary effect resulting in an increase of both tax rates to compensate the loss in tax revenues entailed by the tax base cut. This effect is illustrated by the rightward move of the budget-constraint



**Figure 3.1.** Effect of a removal of the capital tax base  $K$  on  $\tau^R$  and  $\tau^P$ . The graphs represents the equations  $(TR^0)$ ,  $(TR^1)$ ,  $(BC^0)$  and  $(BC^1)$  and the resulting equilibria both in the absence of compensation ( $\Lambda = 0$ ) on panel (a) and in the presence of compensation ( $\Lambda = \tau^{P0}K^0$ ) on panel (b). The graphs corresponds to the following parameter values:  $n = 10$ ,  $\mathcal{P} = 35$ ,  $\mathcal{L} = 50$ ,  $\mathcal{K} = 35$ ,  $\alpha = .05$  and  $f = 1.05$ .

curve from  $(BC^0)$  to  $(BC^1)$  which shifts the equilibrium from  $E^0$  to  $G$ .<sup>19</sup> The second effect due to capital mobility is characterized by a decrease in  $\tau^R$  and an increase in  $\tau^P$ . It is illustrated by the upward move of the taxation-rule curve from  $(TR^0)$  to  $(TR^1)$  and a shift of the equilibrium from  $E^0$  to  $F$ . Indeed, after the reform the local government does not incur the marginal fiscal cost due to capital mobility anymore. Thus, the marginal cost of hosting residents instead of firms becomes lower after the reform. Therefore, local authorities transfer part of the burden of financing public services on firms.

The new equilibrium  $E^1$  results from the combination of the two preceding effects. Since both the budgetary effect and the capital-mobility effect imply a rise in the business property tax, this tax increases non-ambiguously:  $\tau^{P0} < \tau^{P1}$ . Figure 3.1a also illustrates the result of equation (3.9b): a higher capital-intensity makes  $(TR^0)$  less steep which widens the gap  $\tau^{P1} - \tau^{P0}$ . However, the tax on residents is pushed up by the budgetary effect but pulled down by the capital-mobility effect. As visible on Figure 3.1a, the present stylized framework predicts that both effects exactly compensate so that  $\tau^{R0} = \tau^{R1}$  and the gap  $\tau^{R1} - \tau^{R0} = 0$  obviously does not depend

<sup>19</sup> An increase in the fixed costs  $f$  would also imply a rightward shift of  $(BC^0)$ .

on  $\kappa^0$  — which confirms (3.9a). In practice, such a perfect balancing of the budgetary and capital-mobility effects is rather unlikely,<sup>20</sup> but, this result makes clear that in the absence of compensation (ie.  $\Lambda = 0$ ), the reform has an ambiguous impact on  $\tau^R$ . We can summarize the main findings of this subsection in the following result.<sup>21</sup>

**Result 3.1.** *Absent any compensation from the central government, suppose that capital is removed from the local business property tax base. Then, the capital-mobility effect and the budgetary effect combine so that:*

- (i) *the business property tax increases, ie.  $\tau^{P1} > \tau^{P0}$ , and the tax on residents remain unchanged, ie.  $\tau^{R1} = \tau^{R0}$ ,*
- (ii) *the business property tax increase is all the more significant that the pre-reform capital intensity  $\kappa^0$  is higher.*

#### 2.4. Capital removal with compensation

The above result shows that the change in local tax rates accompanying the reform combines both a capital-mobility effect and a budgetary effect. This can make the identification of the first effect uneasy. To disentangle between the two, we now suppose that the central government removes capital from the business property tax base but compensates municipalities in return so that the post-reform compensation is  $\Lambda = \tau^{P0} K^0$ .<sup>22</sup> Then, the budgetary loss induced by the removal of the capital tax

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<sup>20</sup> In the present framework, perfect compensation of the two effects is due to the homogeneity of the production technology. It implies that when decreasing slightly  $\tau^R$ , the amount of capital by units of crowded-out business land  $(\partial K / \partial \tau^R) / (\partial L / \partial \tau^R)$  is equal to  $K/L$ . That is, the capital-intensity of firms remains constant.

<sup>21</sup> [Result 3.1](#) echoes Proposition 2 and Proposition 3 in [Ly \(2018\)](#). Three main contributions distinguish our result. First, our model allows to compare the level of the tax rates before and after the institutional change based on their reduced form while the framework in [Ly \(2018\)](#) does not allow to derive reduced forms so that the author only studies general deviations from a first-best equilibrium. Our second important contribution in [Result 3.1](#) is that our analysis allows to establish that both a capital-mobility effect and a budgetary effect interacts so as to explain the change in the tax rates. Specifically, while [Ly \(2018\)](#) only attributes the downward pressure of capital intensity on the business property tax rate  $\tau^P$  to a capital-mobility effect, we show that, in the absence of revenue compensation, the pre-reform level  $\tau^P$  would be lower than its post-reform level even if no capital-mobility effect arises. This point is of particular importance from an empirical viewpoint, since it raises an identification issue regarding the capital-mobility effect. As shown in [subsection 2.4](#), this problem can be solved by a well-designed compensation. This is the third theoretical contribution of our paper.

<sup>22</sup> As will be seen in [section 3](#), this the French government has indeed provided such a compensation.

base is offset by the central government grant. As shown in [Appendix A](#), (3.7) and (3.8) now imply:

$$\tau^{R1} - \tau^{R0} = -(1 - \sigma) \frac{f}{\ell} \kappa^0 < 0 \quad (3.10a) \quad \tau^{P1} - \tau^{P0} = \sigma \frac{f}{\ell} \kappa^0 > 0, \quad (3.10b)$$

where  $\sigma = \mathcal{P}/\mathcal{L} \in [0, 1]$  is the metropolitan household land-use rate. And then:

$$\frac{\partial(\tau^{R1} - \tau^{R0})}{\partial \kappa^0} = -(1 - \sigma) \frac{f}{\ell} < 0, \quad \frac{\partial(\tau^{P1} - \tau^{P0})}{\partial \kappa^0} = \sigma \frac{f}{\ell} > 0, \quad (3.11b)$$

(3.11a)

Equations (3.10) and (3.11) offer several important insights about the tax rate changes resulting from the removal of the capital tax base in the presence of a perfect budgetary compensation.

First, as expected from the analysis of the no-compensation case, while the business property tax still increases (equation (3.10a)), the tax on resident now decreases (equation (3.10b)). This confirms the fact that the removal of the capital tax base — which exerts a downward pressure on the pre-reform business property tax rate  $\tau^{P0}$  due to capital mobility — allows the municipality to rise the business tax rate while alleviating the taxation of households.

Second, it appears from (3.10a) that the increase in the business property tax rate is weaker than in the no-compensation case (since  $\sigma < 1$ ) presented in the previous subsection. This is also intuitive since, in the absence of budgetary effect, the rise in  $\tau^P$  is now only driven by the capital-mobility effect.

Third, equations (3.11a) and (3.10b) show that the increase (resp. decrease) in  $\tau^P$  (resp.  $\tau^R$ ) is widened by the pre-reform capital intensity. In other words, as in the no-compensation case, if the municipality hosts more capital-intensive firms it is more affected by the reform.

Again, a graphical representation allows to complete the understanding of these results. [Figure 3.1b](#) depicts the effect of the removal of the capital tax base in the presence of a perfect budgetary compensation. In this case, the budget-constraint curve only rotates around the point  $E^0$ . Compared to [Figure 3.1a](#), the points  $E^0$  and  $G$  now coincide, which simply illustrates that the pure budgetary effect is controlled for by the revenue compensation.<sup>23</sup> Then, in this case, the upward shift of (TR<sup>0</sup>)

<sup>23</sup>It is easily shown that replacing  $\Lambda$  with  $\tau^{P0}K^0$  in (BC<sup>1</sup>) and solving for  $\tau^R$  and  $\tau^P$  using (TR<sup>0</sup>), we obtain  $\tau^{R0}$  and  $\tau^{P0}$ .

allows to identify a pure capital-mobility effect.<sup>24</sup> We can summarize the main findings of this subsection in the following result.

**Result 3.2.** *In the presence of a compensation  $\Lambda = \tau^{P0}K^0$  from the central government, suppose that capital is removed from the local business property tax base. Then, the capital-mobility effect implies that:*

- (i) *the business property tax increases, ie.  $\tau^{P1} > \tau^{P0}$ , and the tax on residents decreases, ie.  $\tau^{R1} < \tau^{R0}$ ,*
- (ii) *the business property tax increase and the tax on residents decrease are all the more significant that the pre-reform capital intensity  $\kappa^0$  is higher.*

Result 3.2 (especially part (ii)) is the core theoretical prediction of the chapter. It states that a reform consisting in a removal of capital from the local business property tax base offset by a revenue compensation provided to municipalities, allows to assess the effect of capital mobility — whose proxy is the pre-reform capital intensity  $\kappa^0$  — on the tax rate levels. The remainder of the chapter exploits the 2010 French business property tax reform, which essentially consisted in the institutional change considered in this subsection, to examine the impact of capital mobility on the business property tax and on the residential (housing) tax.

### 3. Institutional setting

#### 3.1. Institutional setting before the 2010 reform

Up to 2010, the tax instruments available to French municipalities mainly consisted mainly of two direct local taxes whose rate was set by a vote among a municipal council which changes every six years based on direct voting.<sup>25</sup>

The first of these taxes is the business property tax or “*taxe professionnelle*” (TP) which was imposed on local firms and relied on the personal property (capital investments such as machinery and equipment) and the real property (land and buildings) they use, regardless of whether they own it or not.<sup>26</sup> The personal property tax base

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<sup>24</sup> Notice that the rotation of the budget constraint shifts the post-reform equilibrium from  $\tilde{E}$  to  $\tilde{E}^1$ , which might be viewed as an *indirect budgetary effect*. However, the *pure budgetary effect* is controlled for by the revenue compensation since in the absence of any capital-mobility effect, the tax rates would remain unchanged (ie.  $\tau^{R0} = \tau^{R1}$  and  $\tau^{P0} = \tau^{P1}$ ).

<sup>25</sup> The last (resp. first) municipal election before (resp. after) the reform of 2010 held in March 2008 (resp. 2014).

<sup>26</sup> Personal property is property that is movable, as opposed to real property which is immovable. See Fisher (2015) for more details about personal and real property.

(ie. capital) is evaluated according to the rate of depreciation of capital used by the firms. The real property tax base (ie. business land) is assessed according to the evaluation made nationally in 1961 for undeveloped property (agricultural land, mines, quarries, pits, etc) and in 1970 for developed property (commercial, industrial and professional buildings, etc.). National government revises these assessed rents annually through the application to all developed and undeveloped properties of a unique revaluation rate which is based on the national commodity inflation rate.

The second important tax is the local housing tax paid by all local residents. It relies on the house or apartment in which the households live, regardless of whether they own it. The housing tax base is also assessed based on a national determination of 1970 and the same annual revaluation rate is applied as in the case of the business property tax base.

The more marginal local taxes include a direct tax on developed property (houses, apartments, buildings, etc.) which is payable by the landowner and a direct tax levied on the owners of undeveloped land (mainly vacant land).<sup>27</sup> Additionally, the municipal council can levy several other minor lump-sum taxes such as taxes on domestic wastes, power transmission lines or outside advertising.<sup>28</sup>

While the focus in this chapter is on the municipal level, an analysis of the 2010 reform requires consideration of the salient features of the tax instruments prior to that date, available to the three layers of local government above the municipality level, ie. region, county and inter-municipal cooperations (called EPCIS).<sup>29</sup> First, the highest government level consists of *regions*. Similar to municipal councils, regional councils vote on the regional business property tax rate, the developed property tax rate and the undeveloped property tax rate.<sup>30</sup> However, there is no regional housing tax. Second, each region contains several *counties*. County councils vote a county-level tax rate of the four direct taxes just as the municipal councils. Third, directly above municipalities are EPCIS.<sup>31</sup> Contrary to regions and counties, the

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<sup>27</sup> Until 2010, the tax instrument set of municipalities also comprises a local tax on firms based on the value added of local firms, called “*taxe professionnelle bis*” (TP bis). Contrary to the aforementioned taxes, the choice of its rate is not left to the municipal council but is nationally fixed at a level of 1.5%. However, this tax had a very limited importance since only firms with sales revenue over 7.6 millions euros are concerned.

<sup>28</sup> See Bouvier (2018) for further details.

<sup>29</sup> Table A.1 and Table A.2 in Appendix B summarize the distribution of the tax instruments between all government layers.

<sup>30</sup> The revenue received by the region from these taxes corresponds to the regional tax rates times the regional tax base which is the sum of the municipality tax base in the region. This pattern applies to each level of government which sets them in a context of vertical tax competition.

<sup>31</sup> In 2009, there was 36,682 municipalities, 15,202 EPCIS, 101 counties and 27 regions in France — including overseas territories.



boundaries of EPCIs may slightly vary over time. Municipalities have full discretion over whether to form an EPCI or not.

### 3.2. *The French business property tax reform*

The French local business property tax reform occurred during an economic crisis. Its main objective was to stimulate investment in France by alleviating the tax burden on firms. It was implemented according to a temporal process represented in [Figure 3.2](#). The reform was announced by the President of the French Republic on February 5, 2009.<sup>32</sup>

The president's unexpected announcement gave few details about how the reform would be implemented. He announced only that the business property tax (TP) would be removed in 2010, and that further details, especially regarding revenue compensation to local governments, should be discussed with the associations of locally elected representatives. These discussions led to a first version of the law — written mostly during summer 2009 ([Guené, 2012](#)) — which was submitted by the government to the parliament on September 30, 2009. After four months of debating in the parliament which resulted in several amendments, the final version of the reform was voted on December 30, 2009 and enacted on January 1, 2010.

[Figure 3.2](#) shows that the reform was implemented rapidly (in less than a year) which reduced the possibilities for municipalities to make changes in anticipation of its implementation. It was difficult for municipalities to make anticipation changes to their 2009 tax rates since the period for the annual voting on local tax rates - January 1st to April 15th - had passed before the first version of the law was published.<sup>33</sup>

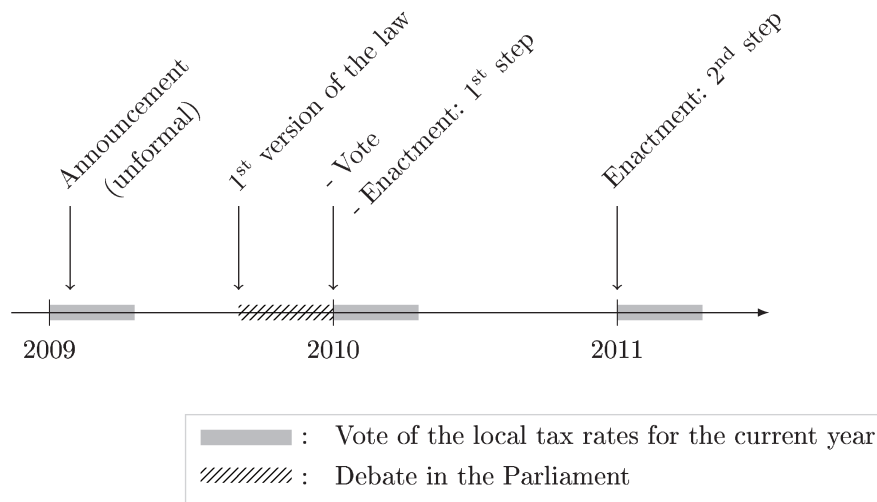
### 3.3. *Two-step enactment of the reform in 2010 and 2011*

The timeline in [Figure 3.2](#) shows also that the actual enactment of the reform was achieved in two steps which are summarized in [Table 3.1](#): the first was in January 2010 and the second in January 2011. The first step of the reform in January 2010 decreed that the municipal level would vote the tax rate of the new business property tax on business land (CFE) instead of the former on capital and business land (TP). The municipal level would receive both the revenue from the CFE and a compensation

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<sup>32</sup> This announcement has been made by the President during a television interview called “*Face à la crise*” (Facing the crisis).

<sup>33</sup> Especially, the period from the President's announcement to the first version of the law has been perceived as strongly uncertain from a legal perspective by municipalities ([Guené, 2012](#)); very few anticipation about the concrete implementation of the reform could be made.



**Figure 3.2.** Timing of the Reform. The annual voting period of local tax rates spans each year between January 1st and April 15th. The precise timing of the reform implementation was: informal announcement on February 5, 2009; 1<sup>st</sup> version of the law on September 30, 2009; vote of the final version of the law on December 30, 2009; enactment of the 1<sup>st</sup> step of the law on January 1, 2010; and enactment of the 2<sup>nd</sup> step of the law on January 1, 2011.

paid by central government equivalent to the revenue from the capital base of the TP in 2009.<sup>34</sup> Thus, in 2010, municipalities could vote for the new business property tax rate, confident that they would experience no revenue losses compared to 2009.

Additionally, firms were required from 2010 to pay two new local taxes whose revenue were not perceived by municipalities but transferred to national government in 2010. First, a new business value added tax called CVAE has been created. Its rate is fixed at 1.5% of the added value created by local firms and is paid by all firms whose sales revenue are higher than 500,000€. Second, a flat-rate tax IFER was imposed on network businesses (transport, energy and telecommunications). The level of this tax paid by each firm was related to its sector and size. Municipalities had no decision making power over the level of this tax.<sup>35</sup>

<sup>34</sup> This compensation scheme is allowed by a national grant called *Compensation relais* (Bridging compensation).

<sup>35</sup> These additional changes brought by the reform from 2011 were introduced to provide new resources to municipalities to compensate for the reductions to the business property tax base. They reduced the central government's costs related to the grant compensation mechanism.

**Table 3.1.** Main features of the reform at the municipal level.

	$\leq 2009$	2010	$\geq 2011$
A. Main local taxes			
Business property tax	$\tau^P \cdot (K + L)$	$\tau^P \cdot L$	$\tau^P \cdot L$
Housing tax	$\tau^R \cdot R$	$\tau^R \cdot R$	$\tilde{\tau}^R \cdot R$
B. New business tax revenue			
Business taxes	CVAE + IFER + TASCOM		
C. Compensation			
Revenue from capital in 2009		$\tau_{2009}^P \cdot K_{2009}$	$\tau_{2009}^P \cdot K_{2009}$
minus			<i>minus</i>
New revenue		CVAE <sub>2010</sub> + IFER <sub>2010</sub> + TASCOM <sub>2010</sub>	

NOTE.— $K$ ,  $L$  and  $R$  respectively stand for the tax base relying on capital, business land use, and residents' housing.  $\tau^P$  and  $\tau^R$  are the associated tax rates voted by the municipality.  $\tilde{\tau}^R$  is the post-reform tax on residents' housing pushed up by the transfer of the pre-reform transfer to municipalities of the county tax on residents' housing. CVAE is the new business value added tax, IFER is the flat-rate tax on network businesses, and the TASCOM is the tax on commercial building.

In January 2011, the second step of the reform consisted of several additional changes to the tax instruments at the municipal level. First, the municipal level received the CVAE and the IFER. Second, the municipal level received the share of direct tax revenues allocated previously to the higher local government levels. The municipalities benefited from the county level housing tax rate and the county and regional tax rates on undeveloped property.<sup>36,37</sup> Third, following the reform, the municipalities received transfers of state level fiscal revenues: tax on commercial buildings known as TASCOM and management costs related to housing tax and property tax.

From 2011, a new compensation mechanism was implemented via two state

<sup>36</sup> See Table A.2 in Appendix B for a summary of the way the reform affected the tax instrument set of counties and regions.

<sup>37</sup> In practice, these tax rate transfers were implicitly induced by a twofold change. First, the county housing tax and the county and regional tax on undeveloped property were removed. Second, the compensation mechanism (described below) was reduced from the amount of the county and regional tax revenues which were regarded as having been transferred to the municipalities. The effect of these two mechanisms combined can be expected to induce the municipalities to raise their tax rates to a level equal to the suppressed tax rates of higher government levels.

grants DCRTP and FNGIR to maintain the level of the municipalities' resources. The level of compensation is computed, for each municipality, as the difference between the revenue collected from the capital base of the TP in 2009 and the sum of the revenues from the new taxes referred to above which the municipality would have obtained in 2010. This difference could be positive in which case the municipality would receive a subsidy from the national government, or negative in which case the municipality pays a compensation to the national government. This compensation mechanism was designed based on the fiscal revenue level in 2010 which implies that it does not change over time. Finally, note that if the new revenues do not vary significantly compared to their 2010 level, the compensation after 2011 is equivalent to the compensation revenue lost induced by the only removal of the capital tax base, similarly to the compensation of 2010 (see [Table 3.1](#)).

#### 4. Empirical strategy

Our theoretical model developed in [section 2](#) suggests that the French business property tax reform described in the previous section represents a quasi-natural experiment to investigate the connection between the local business property tax base mobility and the level of the local tax rates on firms. The removal of the most mobile part of the business property tax base (i.e. capital) considerably reduces the degree of mobility of the business property tax base which, from 2010, relies only on business real property. From part (ii) of [Result 3.2](#), we can expect first that the municipalities deprived of a larger share of capital will increase their business property tax rate compared to municipalities with a less capital-intensive tax base before the reform. Indeed, in municipalities hosting more capital-intensive firms, this change in nature to the tax base further releases the downward pressure exerted by capital mobility on the business property tax rate.<sup>38</sup> This greater business tax relief in more capital-intensive municipalities is expected — this is our second main theoretical prediction — to drive them to decrease the tax rate on their residents (the housing tax) compared to less capital-intensive municipalities.<sup>39</sup>

To test for these results, a continuous treatment difference-in-differences (DD) regression appears as the natural empirical setting.<sup>40</sup> It allows to estimate the

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<sup>38</sup> Theoretical prediction stated in (3.11b).

<sup>39</sup> Theoretical prediction stated in (3.11a).

<sup>40</sup> See e.g. [Card \(1992\)](#) for an early application of DD regression with continuous treatment. [Card \(1992\)](#) studies the impact of a reform consisting in a federal minimum wage increase in the US; the continuous treatment variable is the share of young people likely to be affected by a minimum wage increase in each state, and the outcome variable is the teen wage. DD with continuous treatment has been used in many subsequent studies; it is a widespread approach in

effect of the capital tax base removal on the tax rates by contrasting the change in tax rate levels in municipalities with higher pre-reform removed capital intensity  $\kappa_{2009} = K_{2009}/(K_{2009} + L_{2009})$  — ie. the treatment intensity — versus those with lower  $\kappa_{2009}$ . Formally, the baseline DD model that we fit is of the form:

$$\tau_{it} = \beta_R Ratio_i + \beta_P Post_t + \beta_{RP} Ratio_i \times Post_t + \beta'_x X_{it} + \gamma_{gt} + \lambda_{it} + \varepsilon_{it}, \quad (3.12)$$

where  $\tau_{it}$  is either the business property tax rate  $\tau_{it}^P$  or the housing tax rate  $\tau_{it}^R$  voted by municipality  $i$  in year  $t = 2006, \dots, 2012$ ,  $Ratio_i$  is the removed capital share of the business property tax base in 2009 ( $\kappa_{i2009}$ ),  $Post_t$  is a dummy which is equal to 1 the post-reform years  $t = 2010, 2011, 2012$  and 0 otherwise,  $\gamma_{gt}$  is a set of EPCI and county year-specific effects,  $\lambda_{it}$  is a time-trend for municipality  $i$  allowing municipalities to follow different trends,  $\mathbf{x}_{it}$  is a vector of socio-demographic and economic control variables described in [section 5](#) below, and  $\varepsilon_{it}$  is the error term. The  $\gamma_{gt}$  effects control for time-varying unobservable shocks experienced by municipality  $i$  occurring at upper jurisdictional levels.<sup>41</sup> We cluster the standard error at the level of EPCIs of 2009.

An extended version of the baseline DD model of equation (3.12) including year-specific treatment effects within the post-reform period allows us to investigate the dynamics. It is estimated by replacing the post-treatment period dummy with year dummies for each of the post-reform years. The extended model is summarized in equation (3.13):

$$\tau_{it} = \beta_R Ratio_i + \beta'_P POST_t + \beta'_{RP} Ratio_i POST_t + \beta'_x X_{it} + \gamma_{gt} + \lambda_{it} + \varepsilon_{it} \quad (3.13)$$

where  $\beta'_P = (\beta_P^{10} \ \beta_P^{11} \ \beta_P^{12})$ ,  $\beta'_{RP} = (\beta_{RP}^{10} \ \beta_{RP}^{11} \ \beta_{RP}^{12})$ ,  $POST'_t = (Post_t^{10} \ Post_t^{11} \ Post_t^{12})$ , and  $Post_t^{10}$ ,  $Post_t^{11}$  and  $Post_t^{12}$  are year dummies respectively for 2010, 2011 and 2012.

In equation (3.12) and (3.13) the key coefficients  $\beta_{RP}$  and  $\beta_{RP}^j$  estimate the effect of the deletion of the pre-reform capital share from the business property tax base on local tax rates by contrasting changes in the tax rate level of more capital-intensive municipalities relative to less capital-intensive municipalities. It is estimated holding constant socio-demographic municipal characteristics, cross-EPCI and cross-county differences, municipal specific time trend and nationwide changes in tax rates between the pre-reform and post-reform periods.

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cases where a continuous treatment measure is available.

<sup>41</sup> It is not necessary to add regional year-specific effects since they are already captured by the county effects; each county is fully contained within a single region. This is not necessarily the case of EPCIs which can overlap several counties or regions. This is especially true for the group of municipalities which do not belong to any EPCI.

Any effect of the reform that accrue nationwide are soaked up by the time effects  $Post_t$  in (3.12) and  $POST_t$  in (3.13). Since these time effects absorb any macroeconomic factor affecting the the level of French municipalities tax rates, we do not interpret them as an effect of the pre-reform capital share removal. The coefficient on the  $Ratio_i$  main effect is also of limited relevance since it cannot be considered as an effect of the degree of mobility of the pre-reform capital share on the pre-reform tax rate levels. It not only picks up unobserved factors that determined the municipal capital intensity<sup>42</sup> but it also combines indiscriminately budgetary and capital-mobility effects.

The removal of capital from the business property tax base in 2010 was followed in 2011 by several institutional changes (section 3) at the municipal level and at upper government levels. This raises the possibility of confounding municipal tax rate trends. The time effects  $Post_t$  and  $POST_t$  will absorb these changes to the extent that they affect the overall tax rate levels of all municipalities. They will not control for differential adjustments in the tax rates voted by municipalities. This concern is addressed by including in the regression EPCI and county year-specific effect  $\gamma_{gt}$  to control for institutional changes in upper government levels and municipal time trends  $\lambda_{it}$  to control for differential adjustments at the municipal level.

For the DD approach to provide good estimates of the effect of the pre-reform capital share elimination on the tax rates ( $\beta_{RP}$  and  $\beta_{RP}^j$ ), it must be the case that the reform shall not have been fully anticipated by municipal authorities. This appears plausible in light of the fast implementation of the reform and of the fact that the very first draft of the reform law was tabled six month after the annual voting period of the local tax rates was closed (see Figure 3.2). In subsection 6.2 we present event-study graphs which go in this direction and suggest that the effect of the capital share removal was not present before the reform.

## 5. Data and summary statistics

To examine the connection between local tax rates and the composition of the municipal business property tax base, we use REI which is a yearly database<sup>43</sup> obtained from the French Ministry of Public Finance and which includes a range of local public finance variables. We use data on French mainland (excluding overseas) mu-

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<sup>42</sup> As discussed in section 6, the main reason why the coefficient  $Ratio$  has no causal interpretation is that tax rate and tax base influence one another. By integrating the  $Ratio$  term in the regressions, the DD-strategy allows to control for this pre-reform relation between the capital share in the business property tax base and the tax rate level.

<sup>43</sup> REI stands for *Recensement des éléments d'imposition*.

municipalities from 2006 to 2012 so that we consider the four year pre-reform period (2006-2009) and three post-reform years (2010-2011). In 2009, a total 27,416 municipalities reported information on their tax rates and their business property tax base and its composition.<sup>44</sup> Our dataset is based on a sample of municipalities, which had control over their tax rates in 2009. While the tax rates in 13,558 municipalities subject to municipal voting, 13,858 had adopted a single business tax (SBT) regime which delegated voting on the business property tax rate to their EPCI. We excluded the municipalities which delegated voting power and also the 1,441 which were under SBT regime for at least one year during the time span considered; this left 12,417 municipalities and after dropping municipalities with missing socio-demographic data the final sample is 11,896. Thus, our seven-year panel data includes 83,272 observations.

For each of the direct local taxes, the database provides the tax rates voted for by each jurisdictional level (municipalities, EPCIS, counties and regions) and the associated tax base net of exemptions. While the data provide the overall net tax base of the business property tax for all years, this is not true for its two components. That is, the net tax bases for capital and for business land are not available separately before 2010. However, the database provides their gross value. We use these gross tax bases to build the treatment variable: the capital share in the business property tax base in 2009.

Note that the overall gross and net business property tax bases are, not surprisingly, highly and positively correlated (Pearson's coefficient over 99.98%) in each year of the period considered.<sup>45</sup> This suggests that the gross business property tax base is an appropriate proxy for its net counterpart.

Our regressions include a number of controls for municipal, socio-demographic, political and economic characteristics, obtained from the National Institute of Statistics and Economic Studies (INSEE) and the French Ministry of Interior.<sup>46</sup> The municipal variables include size and density of the municipal population. We also include a dummy indicating whether the municipality is located in a metropolitan area or not. The definition of a metropolitan area relies on INSEE's definition of an urban area as composed of a center — a set of municipalities in a continuously built-up area with more than 2000 inhabitants and 1500 jobs — and a periphery — municipalities where at least 40% of the residents work in the center. The socio-demographic variables include the municipal median income, share of young people

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<sup>44</sup> The 8,886 remaining municipalities, which did not report the relevant fiscal information in the REI are essentially very small (231 inhabitants on average) rural (97%) municipalities.

<sup>45</sup> See [Table A.5 in Appendix C](#).

<sup>46</sup> See [Table A.3 in Appendix C](#) for descriptive statistics of the control variables.

(population aged under 15 as a percentage of the total population), schooling rate (share of population aged under 17 enrolled in school) and population share per socio-professional category: farmers, craftsmen, managers, temporary workers, employees, blue collar workers, retirees and unemployed — this last group is excluded so that the sum does not equal 1. As a political variable, we include the share of left-wing voters in the second round of the 2007 presidential election which posed a left-wing candidate against a right-wing one.

Finally, the economic variables include the share of commuters (number of individuals working outside the municipality as a percentage of the total number of workers in the municipality) and the total number firms per capita. We account also for firms' size by including the shares of firms with no employee, less than ten employees and more than 10 employees (which is the excluded category). Sectoral composition is also accounted for by including the share of firms in the four sectors: industry and building, finance and real estate, trade and retail, and other services (which is the excluded category).<sup>47</sup> The last economic variable is a dummy for whether a municipality gains or loses from the reform. It is equal to 1 if the municipality receives a positive national grant from 2011 and 0 otherwise. It controls for the fact that municipalities hosting highly capitalistic firms with low added value may have been affected differently by the reform compared to municipalities which include firms with less capital but generate higher added value; the former incur substantial capital tax revenue loss but receive a higher business value added tax from 2011 while the reverse applies to the latter type of municipalities.<sup>48</sup>

Table 3.2 presents descriptive statistics for the outcome variables (tax rate on business property and tax rate on housing) and the treatment variable (capital share in the business property tax base). It indicates a capital share in the business property tax base around 80% in 2009, so that its removal by the reform should have had a significant impact. Since its removal is perfectly compensated by the central government grant from 2010, its quantitative budgetary impact should not affect the municipality. However, it represented an important qualitative change to the nature of the business property tax base. This is the motivation for our empirical study

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<sup>47</sup> In our regressions, we control for four business sectors for the sake of parsimony. However, we also tested our results with a less aggregated hypothesis by integrating the shares of firms by category (around 32 categories) of exemption from the business property tax. They were measured as the ratio of the number of firms exempted from the business property tax relative to the total number of firms exempted. This alternative specification does not substantially alter the results.

<sup>48</sup> From Table 3.2, one can see that around 18.5% municipalities receive a positive compensation since 2011 after the entire new institutional setting has been implemented. On the contrary, the remaining municipalities return the surplus they gain from the new setting compared to the pre-reform one.



**Table 3.2.** Descriptive statistics.

	2006	2007	2008	2009	2010	2011	2012
<i>Municipal treatment and outcome variables</i>							
Capital share	.7993 (.1991)	.8015 (.2004)	.8041 (.2032)	.8018 (.2118)			
Business property tax rate	.0952 (.0526)	.0952 (.0527)	.0956 (.0528)	.096 (.0532)	.1794 (.0615)	.1802 (.0613)	.1812 (.0615)
Housing tax rate	.0808 (.0361)	.081 (.0361)	.0816 (.0363)	.0824 (.0365)	.0829 (.0389)	.1516 (.0487)	.1522 (.049)
<i>Other informative variables</i>							
County's housing tax rate	.077 (.0156)	.0784 (.0163)	.0794 (.0168)	.083 (.0178)	.0838 (.0177)		
Positive compensation after 2011						.1859 (.3891)	.1859 (.3891)
Observations	11896	11896	11896	11896	11896	11896	11896

NOTE.—Each cell contains the variable mean and standard error in parentheses. The last “positive compensation” variable is a dummy which is equal to one if the municipality receives a positive compensation from the central government following the reform and zero otherwise.

of the impact of the change from a highly mobile tax base composed essentially of capital to a far less mobile tax base composed uniquely of business real property on the voted local tax rates on business property and housing.

The evolution of the municipal tax rates is presented in [Table 3.2](#). It shows that during the whole pre-reform period (2006-2009) both the business property tax rate (around 9.5%) and the housing tax rate (around 8%) increased regularly and very moderately. This stable evolution is due in part to various institutional constraints on the evolution of the local tax rates which however, were temporarily abandoned in 2010 and 2011 to allow municipalities sufficient leeway to respond to the reform. Moreover, the evolution of the tax rates presented in [Table 3.2](#) shows no evidence of anticipation of the reform. This, combined with the stability of the pre-reform tax rates are encouraging signs that the common trend assumption holds.

We observe that the reform significantly affected the municipal tax rate levels since the two tax rates almost doubled between 2009 and 2011. The business property tax rate rose from 9.6% to 18% and the housing tax rate increased from 8.2% to 15.2%. Interestingly, these tax rate spikes show evidence of some delay: while the significant increase in the business property tax rate occurred almost entirely in 2010, the housing tax rate remained fairly stable in 2010 and jumped by 7 points in 2011. This time lag must be considered in the context of the two-step enactment of the reform ([subsection 3.3](#)).

Year 2010 is the year that the basic fundamental reform was implemented: capital was deleted from the business property tax base and the municipalities received corresponding compensation revenue. Since the compensation controls for the budgetary effect, we expect, from our theoretical model, a rise in the business property tax rate caused by the change in the composition of its tax base (less mobile now). The spike in the business property tax rate observed in the data is consistent with this prediction. The absence of a similar pattern in the evolution of the housing tax rate which remained stable in 2010 seems to confirm that the pure budgetary effect was controlled for by the compensation. However, we observe no significant reversal in the increasing trend of the housing tax rate. The preliminary descriptive statistics provide no evidence of a clear rebalancing of the tax burden from residents to firms. To test this theoretical prediction more thoroughly, we need to compare the change in the housing tax rate among municipalities with different business property tax base composition (see [section 6](#)).

In 2011, the housing tax rate increased sharply. Its stability between 2009 and 2010 indicates that this hike had little to do with the compensated removal of the capital tax base. The most plausible explanation for it lies in the new institutional changes that occurred in 2011. As described in [section 3](#), the housing tax rate voted for by the counties in 2010 (around 8%) has been transferred to the municipalities from 2011. [Table 3.2](#) shows that almost all of this county tax was internalized by the post-reform municipal housing tax rates (which jumped by some 7 points). Note also that the rise in the municipal housing tax rate is about 1 point lower than might have been expected as a result of the transfer of the county tax rate. This might be a positive sign in relation to the rebalancing of taxation from firms to residents but further investigation is needed to understand the underlying mechanisms.

## 6. Results

### 6.1. *Effect of the capital share removal*

Panel A of [Table 3.3](#) reports the baseline estimates of equation (3.12) for the effect of the removal of the capital share from the business property tax base, compensated by national grants, on voted tax rates for business (columns 1 to 3) and housing (columns 4 to 6). All the estimations below use the full set of 11,896 municipalities from 2006 to 2012. Panel A presents the results of the regression including the two-period indicator variable *Post* which gathers the post-reform period year 2010-2012. Columns 1 and 4 report a parsimonious specification including only the *Ratio* main effect, the *Ratio*  $\times$  *Post* interaction, the *Post* indicator, and a set of municipality specific time trends which allow the tax rates to follow different overall apprecia-

tion across municipalities. Columns 2 and 5 include the control variables described in [section 5](#), and thus absorbs cross-municipality sociodemographic economic and political differences. Columns 3 and 6 refine the precision of the estimation by including year-specific EPCI and county effects, which negate the effects on the municipal tax rates of changes affecting higher local government levels (EPCIs, counties and regions).

In the business property tax rate regression, in the most demanding specification in column 3 of panel A the coefficient of *Post* shows that the business property tax rate (in municipalities with no capital tax base in the pre-treatment period) appreciated significantly (by about 7.6 points) between the pre and post-reform periods, which is consistent with the observation in [section 5](#).<sup>49</sup> It appears also that prior to the removal of the capital tax base, municipalities with a higher capital share of the business property tax base had lower average business property tax rates. Specifically, the point estimate of  $-0.02$  on the *Ratio* measure indicates that a municipality at the mean capital share level of 80.2% in 2009 (see [Table 3.2](#)) voted on a tax rate that was approximately 1.6 points lower than the tax rate voted for a municipality without capital, ie. around 16.7 % of its tax rate of 9.6%. We do not consider this tax differential as causal mostly because tax rate and tax base affect one other: while higher tax bases may allow lower tax rates, a rise in the tax rate can discourage tax payers and shrink the related tax base. Moreover this coefficient does not allow to disentangle budgetary and capital-mobility effects. Conversely, the coefficient of 0.007 on the *Ratio*  $\times$  *Post* interaction implies that 34% of this tax rate differential was erased in the years after the capital share was eliminated. Under our identifying assumption of no anticipation of the reform, the coefficient of the *Ratio*  $\times$  *Post* indicator can be considered as a causal estimate of the effect on the business property tax rate of the pre-reform capital share removal. That is, a municipality that lost a larger pre-reform capital share responded by imposing a higher business property tax increase. Columns 1 to 3 show that this effect is robust and stable across all specifications, although is reduced by the introduction of controls.

This result is in line with the prediction of our theoretical model that removing the capital share from the business property tax base spurs municipalities with higher share to increase their business property tax rate relative to those with lower

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<sup>49</sup> It might be tempting to interpret this rise as an effect of a decrease in the degree of mobility of the business property tax base, but the coefficient on *Post* picks up all macroeconomic factors arising between the two periods. Moreover, the presence of the *Ratio*  $\times$  *Post* coefficient in the regression also limits the scope of interpretation *Post* since its coefficient only captures the tax rate appreciation in municipalities without capital before the reform.

**Table 3.3.** Regression results: before/after estimates.

	DEPENDENT VARIABLE: BUSINESS PROPERTY TAX			DEPENDENT VARIABLE: HOUSING TAX		
	(1)	(2)	(3)	(4)	(5)	(6)
A. Continuous treatment						
<i>Ratio</i> × <i>Post</i>	.00817** (.00257)	.00704** (.00256)	.00686** (.00250)	-.00412*** (.00011)	-.00549*** (.00012)	-.00553*** (.00012)
<i>Post</i>	.07683*** (.00226)	.07617*** (.00227)	.07625*** (.00223)	.04695*** (.00094)	.05238*** (.00109)	.04726*** (.00103)
<i>Ratio</i>	-.00891*** (.00096)	-.01917*** (.00283)	-.02000*** (.00282)	-.02392*** (.00024)	-.02912*** (.00046)	-.02912*** (.00047)
<i>R</i> <sup>2</sup>	.989	.989	.996	.964	.968	.971
Observations	83272	83272	83272	83272	83272	83272
B. Discrete treatment						
<i>High</i> × <i>Post</i>	.00414* (.00199)	.00420* (.00197)	.00399* (.00190)	-.00206** (.00066)	-.00210** (.00075)	-.00211** (.00074)
<i>Post</i>	.08306*** (.00072)	.08161*** (.00078)	.08169*** (.00076)	.04762*** (.00025)	.04460*** (.00034)	.04434*** (.00033)
<i>High</i>	-.00629 (.00429)	-.01086* (.00493)	-.01179* (.00478)	-.01375*** (.00341)	-.01355** (.00420)	-.01350** (.00418)
<i>R</i> <sup>2</sup>	.989	.989	.991	.959	.962	.964
Observations	83272	83272	83272	83272	83272	83272
Controls	No	Yes	Yes	No	Yes	Yes
EPCI & County by year effects	No	No	Yes	No	No	Yes

NOTE.—The sample includes all 11,896 municipalities from 2006 to 2012. *Ratio* is the 2009 share of the removed capital tax base in the business property tax base consisting of capital and land. *High* is an indicator equal to 1 if the municipality had a capital share in 2009 above the sample median (around 86.76%), and zero otherwise. *Post* is an indicator of the post-reform years 2010-2012. Individual time trends are included in all the regressions. The controls are all the socio-demographic, political and economic variables described in the data section. Robust standard errors clustered by 2009 EPCI are reported in parentheses. \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

capital share.<sup>50</sup> Moreover, controlling for all other relevant factors, this relative rise

<sup>50</sup> See conditions (3.9b) and (3.11b).

in the business property tax rate may result from two effects working potentially in combination. The budgetary effect implies that to maintain (at least in part) their tax revenues, municipalities with more capital before the reform, which suffered a greater loss, respond by a bigger rise in their tax rates. The capital-mobility effect means that municipalities hosting more-capital intensive firms before the reform have been relieved from a stronger pressure exerted by capital mobility. This allows them to raise their business property tax rate which now only rely on business land, since it is much less mobile than capital. However, the compensation mechanism implemented from 2010 (section 3) ensures that central government reimburses each municipality for the amount of the tax revenue lost due to the removal of its capital tax base. Therefore, the budgetary effect being controlled for by this grant scheme, our most demanding estimate ( $Ratio \times Post$  in column 3) suggests that the average capital-mobility effect of the capital share removal on the business property tax rate is 0.55 points.<sup>51</sup> That is, a municipality with an average pre-reform capital share of 80.02% increased its business property tax rate (which was 9.6% in 2009) by 5.7% due to the capital-mobility effect.

Turning now to the two-period estimates of the housing tax regression reported in columns 4 to 6 in panel A of Table 3.3, our most demanding specification in column 6 shows that consistent with the data description of section 5, municipalities with no capital tax base before the reform raised their housing tax rates by 4.7 points between the pre and post-reform periods. Additionally, the point estimate of  $-0.029$  on the  $Ratio$  measure indicates that the pre-reform housing tax rate was lower in more capital-intensive municipalities which likely reflects the higher tax revenue potential of these municipalities. The coefficient of  $-0.006$  of the key interaction term  $Ratio \times Post$  reveals that the housing tax gap between municipalities with higher and lower capital intensity widened by 19% after elimination of the capital tax base. Then, since the budgetary effect of this tax base elimination is controlled for by the central grant, we can infer that the average capital-mobility effect entailed by the reform is a 0.44 points cut in the housing tax rate which represents 5.4% of the 8.2% mean housing tax rate of 2009.

This housing tax rate cut by municipalities hosting more capital intensive firms relative to those hosting less capital intensive firms is consistent with the theoretical predictions in section 2.<sup>52</sup> Indeed, as expected, more capital-intensive municipalities where removal of capital base taxation resulted in less downward pressure from

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<sup>51</sup> As standard, the average treatment effect 0.55 points is obtained by multiplying the estimate of 0.686% on  $Ratio \times Post$  by the average pre-reform capital share of 80.02% (ie. the average treatment level).

<sup>52</sup> See condition (3.11a).

capital mobility on their business property tax rates, were driven to impose a higher business tax rate. This allowed them to further alleviate the tax burden on their residents. Interestingly, our negative estimates on  $Ratio \times Post$  suggest that we can reject the hypothesis of a budgetary effect on housing tax rates outweighing or exactly compensating the capital-mobility effect, which would have showed a positive or non-significant coefficient on  $Ratio \times Post$ . This can be regarded as further evidence that the central grant is perceived by municipalities as proper revenue compensation, and that a capital-mobility effect is present.

Our continuous treatment measure of the removed pre-reform capital intensity  $Ratio$  exploits the entire range of capital intensity in 2009, and allows comparison among municipalities with very close  $Ratio$  levels. It might be informative to consider a more aggregated treatment measure to check whether our results hold in a larger perspective. Panel B of [Table 3.3](#) reports the estimates of equation (3.12) where the  $Ratio$  variable is replaced by an indicator variable  $High$  which takes the value 1 if the municipality's capital intensity in 2009 was above the median (around 86.76%), and is equal to zero otherwise.<sup>53</sup> Not surprisingly, this more aggregated treatment measure reduces the precision of the estimation. However, the main results derived in the continuous case appear to be qualitatively robust to this alternative measure. Specifically, considering our most demanding specification in columns 3 and 6, we see that the group of municipalities hosting more capital-intensive firms set an average pre-reform business property tax rate 1.2 points below that set by municipalities with less capital-intensive firms. This gap closes by 0.4 point following the removal of the capital tax base. Additionally, these more capital-intensive municipalities charge an average pre-reform housing tax rate that is 1.4 points lower than that set by less capital-intensive municipalities, and the gap widens by 0.2 point following the reform.

### 6.2. Time path of the capital-mobility effect

To complete this picture of the effect of the removal of capital from the business property tax base, we take advantage of the panel dimension of our dataset to investigate the dynamic impact of the reform. Panel A of [Table 3.4](#) reports the estimates of equation (3.13) which allow for year-specific treatment effects. We report only the interaction terms capturing the treatment effects, ie. the interaction of the heterogeneity terms between municipalities of different capital intensity and over time. Regardless of the specification, the most striking new insight obtained is that the effect of the reform is concentrated on the first treatment year, since

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<sup>53</sup> See [Table A.4](#) in [Appendix C](#) for descriptive statistics on these two categories of municipalities.

only the  $Ratio \times Post^{10}$  the treatment effect is significant. In subsequent years, the point estimate decreases sharply — business property tax regressions, columns 1 to 3 — or the precision of the estimation is considerably reduced — housing tax regressions, columns 4 to 6. This suggests that the differential tax behavior between municipalities with different capital intensity prior to the reform occurs mainly in the first year of the reform. As described in [section 3](#), in 2010, only the core of the reform was implemented since the capital tax base was eliminated and replaced by a grant equal to the revenue collected from capital by the municipality in 2009. All other institutional changes were implemented only from 2011. Thus, year 2010 perfectly fits with the theoretical framework developed in [section 2](#) and local government responses in this first treatment year can even more convincingly be interpreted as a consequence of the capital-mobility effect.

Let us examine this in greater depth. First, in the case of the business property tax regression, the point estimate in column 3 of 0.017 on the  $Ratio \times Post^{10}$  interaction term, implies a differential appreciation of 1.4 points for a municipality at the mean level of the pre-reform capital intensity of 80.2% relative to a municipality with a zero pre-reform capital tax base. Our most demanding estimate implies that municipalities, which have been removed a higher capital share relatively increased their business tax rate. This differential appreciation represents a 14% rise compared to the 9.6% average business property tax rate in 2009. This capital-mobility effect of the capital tax base on the business property tax rate for the year 2010 is much more important than the 5.7% in [subsection 6.1](#) with the merged post-treatment period. The coefficients on the interaction terms for years 2011 and 2012, although non-significant may explain this difference. Since the capital-mobility effect on business property tax rates appears to be very low or non-existent from 2011, merging the post-treatment period hides part of the strong effect observed in 2010. This strong positive effect confirms the theoretical predictions of [subsection 2.4](#) and is further evidence of the capital-mobility effect.

Similarly, the point estimate of  $-0.0013$  on  $Ratio \times Post^{10}$  in column 6, confirms the theoretical prediction that more capital-intensive municipalities will decrease their housing tax rate relative to others, since they benefit from more scope to increasing their business property tax rates. More precisely, it follows from this point estimate that the average capital-mobility effect of the reform induced a 1.3% decrease in the housing tax rate. This decline is 4 points lower than the one estimated in the before/after regression in the previous subsection. Again, the (non-significant) point estimates on the interaction terms for the years 2011 and 2012 may provide an explanation. Contrary to the business property tax case, the capital-mobility effect of the reform on the housing tax rate although non-significant after 2010 seems more persistent. This might explain the larger effect in the estimations merging the post-

**Table 3.4.** Regression results: year-specific estimates.

	DEPENDENT VARIABLE: BUSINESS PROPERTY TAX			DEPENDENT VARIABLE: HOUSING TAX		
	(1)	(2)	(3)	(4)	(5)	(6)
A. Continuous treatment						
<i>Ratio</i> × <i>Post</i> <sup>10</sup>	.01802*** (.00300)	.01682*** (.00296)	.01714*** (.00291)	-.00105*** (.00026)	-.00120*** (.00036)	-.00125** (.00039)
<i>Ratio</i> × <i>Post</i> <sup>11</sup>	.00483 (.00286)	.00485 (.00287)	.00430 (.00283)	-.00151 (.00151)	-.00069 (.00157)	-.00136 (.00155)
<i>Ratio</i> × <i>Post</i> <sup>12</sup>	.00186 (.00272)	.00161 (.00278)	.00094 (.00273)	-.00179 (.00151)	-.00096 (.00160)	-.00155 (.00157)
<i>R</i> <sup>2</sup>	.989	.989	.996	.991	.991	.996
Observations	83272	83272	83272	83272	83272	83272
B. Discrete treatment						
<i>High</i> × <i>Post</i> <sup>10</sup>	.00126* (.00056)	.00132* (.00058)	.00134* (.00067)	-.00142*** (.00039)	-.00056** (.00019)	-.00061** (.00021)
<i>High</i> × <i>Post</i> <sup>11</sup>	-.00091 (.00062)	-.00048 (.00065)	-.00062 (.00071)	-.00227* (.00099)	-.00087 (.00045)	-.00105 (.00057)
<i>High</i> × <i>Post</i> <sup>12</sup>	-.00135* (.00066)	-.00089 (.00071)	-.00033 (.00074)	-.00269** (.00102)	-.00095* (.00048)	-.00106 (.00060)
<i>R</i> <sup>2</sup>	.989	.989	.996	.991	.991	.994
Observations	83272	83272	83272	83272	83272	83272
Controls	No	Yes	Yes	No	Yes	Yes
EPCI & County by year effects	No	No	Yes	No	No	Yes

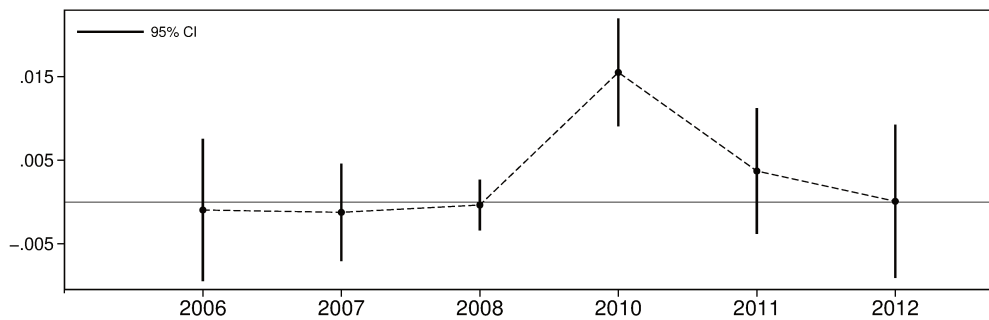
NOTE.—The sample is all 11,896 municipalities from 2006 to 2012. *Ratio* is the 2009 share of the eliminated capital tax base in the business property tax base consisting in capital and land. *High* is an indicator equal to 1 if a municipality has a 2009 capital share above the sample median, and zero otherwise. *Post*<sup>*j*</sup> is a year dummy which equals 1 for year 20*j*, and zero otherwise. Individual time trends are included in all the regressions. The controls are all the socio-demographic, political and economic variables described in the data section. Robust standard errors clustered by 2009 EPCI are reported in parentheses. \* *p* < .05, \*\* *p* < .01, \*\*\* *p* < .001.

treatment years. This negative effect the year of the reform is in line also with the theoretical predictions.

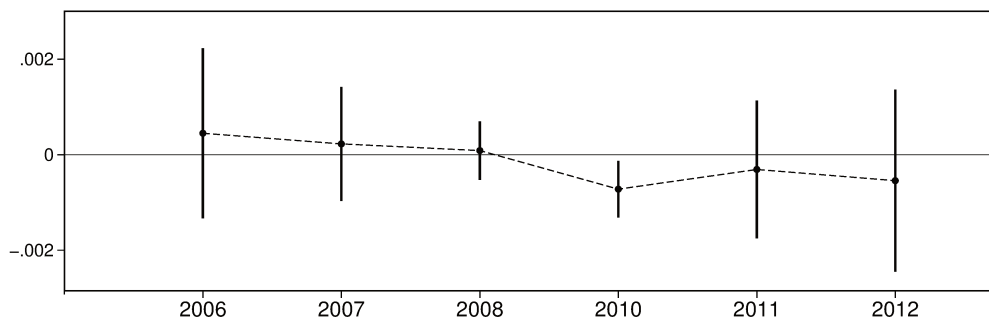
As in the before/after regression, we check the robustness of the above results



replacing the continuous treatment measure *Ratio* with the binary variable *High* indicating municipalities with a capital share above the median in 2009. The results are reported in panel B of Table 3.4. Again, the main results for the continuous-treatment case appear to be confirmed by the discrete specification. As can be seen from the most conservative specifications in columns 3 and 6, the effect of the reform is observed only in the first treatment year. Also, the coefficients have the expected signs: more capital-intensive municipalities increased their business property tax rate by 0.13 and decreased their housing tax rate by 0.06 points relative to less capital-intensive ones.



(a) Business property tax regression



(b) Housing tax regression

**Figure 3.3.** Event study for the effect of the capital-share elimination on tax rates, 2006-2012. The figure plots, for the sample of all 11,896 municipalities, the coefficients on  $Ratio \times Post^j$ , where  $Post^j$  is a time dummy for the year  $20j$ ,  $j = 06, 08, 10, 11, 12$ . *Ratio* is the 2009 share of the eliminated capital tax base in the business property tax base consisting of capital and land. The regression also includes all the socio-demographic, political and economic variables described in the data section, individual time trends, and EPCI and county by year effects. Robust standard errors are clustered by 2009 EPCI.

Exploiting the panel dimension of our dataset even further, we can use an event study to investigate potential anticipation of the reform by municipalities. This requires to slightly transform equation (3.13) replacing the *POST* vector by

$\widetilde{POST}' = (Post^{06} \ Post^{07} \ Post^{08} \ Post^{10} \ Post^{11} \ Post^{12})$ , where  $Post^j$  is a dummy for the year  $20j$ . Including pre-reform year indicators in the  $POST$  vector slightly changes the interpretation of the coefficients on the interaction terms  $Ratio \times Post^j$ . Whereas, with the  $POST$  vector, each post-reform year 2010-2012 is compared to all the pre-reform years 2006-2009, with the  $\widetilde{POST}$  vector, the single reference year is 2009. This allows us to estimate the effect of the treatment not only for the post-reform years 2010-2012 as above, but also for the pre-reform years 2006-2008 in order to investigate potential anticipation of the reform. [Figure 3.3](#) plots the key coefficient estimates associated to the interaction terms  $Ratio \times Post^j$  from the modified equation (3.13) for our most demanding specification with controls and EPCI and county by year effects.<sup>54</sup> It corresponds to year estimates of the tax rate differential between municipalities with high and low capital intensity measured relative to the omitted reference year of 2009.

[Figure 3.3a](#) indicates that more capital-intensive municipalities relative to less capital-intensive municipalities increased non-significantly their business property tax rate by roughly 0.01 points (resp. 0.1 and 0.04) between 2006 (resp. 2007 and 2008) and 2009. This strongly non-significant increase suggests that we can dismiss spurious anticipation of the reform, as expected from the timing of its implementation. However, the more capital-intensive municipalities significantly increased their relative business property tax rate in 2010 by 1.5 points. This is close to the 1.7 points relative increase reported in column 3 of [Table 3.4](#). This relative rise quickly falls to become a non-significant relative increase of 0.004 point in 2011 and around 0 point in 2012 compared to 2009.

The evolution of the housing tax rate in more capital-intensive municipalities relative to less capital-intensive ones is fairly symmetric. It decreases non-significantly by less than 0.045 points between 2006 (resp. 2007 and 2008) and 2009. It knows a slightly significant decrease of 0.07 points in 2010 (a bit lower than the 0.12 points in [Table 3.4](#)). At the end of the sample period in 2011 and 2012 the relative housing tax rate decreases are non-significant. The most important evidence from the [Figure 3.3](#) is that the event-study estimates reject significant effects of the reform prior to its implementation. Thus, the reform can be regarded as unanticipated by municipalities, which reinforces our DD identifying assumption.

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<sup>54</sup> [Table A.6](#) in [Appendix D](#) reports the point estimates and the 95% confidence interval both for the continuous specification ( $Ratio$  treatment variable) and for the discrete specification ( $High$  treatment variable).

### 6.3. Variation across municipality types

By aggregating the full sample of municipalities, the results presented above potentially hide heterogeneous effects of removal of the capital tax base on municipal tax rates. Table 3.5 explores this possible heterogeneity in treatment effect across three municipal characteristics: (non-)metropolitan, ideology and high/low new business tax revenue. It reports the baseline estimates of equation (3.12) for the most demanding specification comprising controls and EPCI and county by year effects, for six municipality sub-samples. Columns 1 and 2 present the estimates for metropolitan and non-metropolitan municipalities. Columns 3 and 4 report the respective results for municipalities where the majority voted for a left-wing candidate and a right-wing candidate in the 2007 presidential election. Columns 5 and 6 distinguish between municipalities collecting higher (above the 2011 median) and lower (below the 2011 median) new business tax revenues per capita after 2011. For each of these sub-samples, we report the treatment effect estimates on the interaction  $Ratio \times Post$  when the dependent variable is business property tax and when it is the housing tax. We also report the sub-sample means for these two tax rates and the capital share in the business property tax base in 2009. For easier comparison of the treatment effect among sub-samples, we report each sub-sample average treatment effect (ATE) relative to the mean related tax rate of 2009.<sup>55</sup>

A first look at the estimated treatment effects in Table 3.5 shows that the coefficients (although not all significant) have the expected signs. That is, in each sub-sample, municipalities which had larger capital share of their pre-reform business property tax base removed, responded by increasing their business property tax rate and decreasing their housing tax rate relative to less capital-intensive municipalities. However, we observe substantial differences among sub-groups which call for further discussion. Columns 1 and 2 indicate that the treatment effect on the business property tax rate is much lower for municipalities located in a metropolitan area compared to non-metropolitan municipalities: it represents only 2.3% of the tax rate of 2009 for the former and 16.7% for the latter. This suggests that capital mobility exerts a weaker downward pressure on business tax rates in metropolitan areas. This result supports one of the main results in the agglomeration economies literature which suggests that the existence of agglomeration rents in metropolitan areas tends to mitigate the tax competition result that capital mobility spurs local governments to lower their business tax rate.<sup>56</sup> The treatment effect of capital

<sup>55</sup> As usual, the ATE is computed by multiplying the point estimates on  $Post \times Ratio$  by the sub-sample average capital share in 2009.

<sup>56</sup> See the seminal theoretical paper by Baldwin and Krugman (2004). Contributions providing

share removal is also lower (and non-significant) in the housing tax rate regression for municipalities in metropolitan areas compared to others: respectively  $-2\%$  and  $-4.3\%$  of the 2009 tax rate for the first and second sub-samples. This suggests that comparison of higher and lower capital-intensive municipalities reveals a weaker re-balancing of the tax burden from businesses to residents following the decrease in capital mobility in metropolitan areas.

**Table 3.5.** Business property tax and housing tax regressions with two-period treatment.

	METROPOLITAN		IDEOLOGY		NEW REVENUE	
	YES (1)	NO (2)	LEFT (3)	RIGHT (4)	HIGH (5)	LOW (6)
A. Business property tax regression						
<i>Ratio</i> $\times$ <i>Post</i>	0.00271* (0.00115)	0.02110*** (0.00490)	0.00411 (0.00216)	0.00990*** (0.00278)	0.00082* (0.00035)	0.00849** (0.00278)
Mean tax rate 2009	.0951	.0986	.1138	.0905	.1036	.0883
ATE relative to tax rate 2009	.0231	.1674	.0285	.0881	.0065	.0743
B. Housing tax regression						
<i>Ratio</i> $\times$ <i>Post</i>	-0.00209 (0.00118)	-0.00418* (0.00181)	-0.00444* (0.00174)	-0.00409*** (0.00116)	-0.00398 (0.00234)	-0.00419*** (0.00114)
Mean tax rate 2009	.0844	.076	.086	.0812	.0904	.0743
ATE relative to tax rate tax rate 2009	-.02	-.0431	-.0408	-.0406	-.0365	-.0436
Capital share 2009	.808	.7824	.7906	.8052	.83	.7736
Municipalities	9001	2895	2786	9110	5948	5948

NOTE.—Each pair of sub-samples comprises all 11,896 municipalities from 2006 to 2012. *Ratio* is the 2009 share of the eliminated capital tax base in the business property tax base consisting in capital and land. *Post* is an indicator for post-reform years 2010-2012. The regressions also include all the socio-demographic, political and economic variables described in the data section, individual time trends, and EPCI and county by year effects. Sub-samples high and low new revenue are municipalities collecting per capita new business tax revenue — CVAE + IFER + TASCOS — above and below the sample median. Robust standard errors clustered by 2009 EPCI are reported in parentheses. \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

Columns 3 and 4 in Table 3.5 show that municipalities with higher capital shares

empirical evidence are, e.g., Charlot and Paty (2010), Luthi and Schmidheiny (2013) and Fréret and Maguain (2017).

increased their business property tax rate relatively less if they included a majority of left-wing voters. Indeed, the (non-significant) estimate of 0.004 on  $Ratio \times Post$  for left-wing jurisdictions is lower than the strongly significant estimate of 0.01 for right-wing ones. This difference is reflected also in the ATE relative to the tax rate voted in 2009 (2.9% for left wing municipalities against 8.8% for right wing ones). This finding suggests that ideology matters for the response of voted business tax rate to capital mobility. Left-leaning municipalities appear to be less sensitive to the downward pressure exerted by mobile capital. The treatment effect on housing is also interesting since in contrast to what we observed for the business property tax rate, left-wing municipalities with a more capital-intensive tax base prior to reform appear to reduce their tax rate to the same extent as their right-wing counterparts. Indeed, the ATE represents  $-4.08\%$  of their 2009 tax rate and  $-4.06\%$  of right-wing municipalities. This result can be interpreted as a sign that left-wing municipalities are *ceteris paribus* more prone (compared to right-wing ones) to alleviate the tax burden on households.<sup>57</sup>

Finally, columns 5 and 6 in [Table 3.5](#) distinguish municipalities collecting per capita new business tax revenues in 2011 above the sample median and those whose new business tax revenues are below the median.<sup>58</sup> Since municipalities have no decision power on the vote for these new business taxes which rely on the value-added generated by local firms (CVAE) and their size and sector (IFER and TASCOM), they receive high or low new business tax revenues depending on their economic structure. Comparison of the last two columns in [Table 3.5](#) reveals that more capital-intensive municipalities (relative to less capital intensive ones) collecting high tax revenues from the new business taxes after the reform are able to raise their business property tax rates much less than their counterparts that collected lower new tax revenues. Indeed, the respective ATE relative to the 2009 tax rate of 0.65% and 7.43% indicates that municipalities with important new tax revenues responded substantially less to the reduced downward pressure induced by elimination of the mobile capital tax base. This result makes economic sense. While capital now does not figure in the business property tax base, these municipalities cannot charge overly high taxes on

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<sup>57</sup> Although these preliminary findings call for deeper analysis, they are informative in regard of the contrasting results obtained in the political economy studies dealing with the link between ideology and local taxation. Indeed, while e.g. [Pettersson-Lidbom \(2008\)](#) finds empirical evidence of the impact of ideology on local tax level in the case of Swedish municipalities, [Ferreira and Gyourko \(2009\)](#) point out the “striking lack of partisan impact at the local level” in a study of American municipalities.

<sup>58</sup> The new business tax revenues are the sum of the CVAE, the IFER and the TASCOM (see [section 3](#) for definitions). We divide these revenues by the municipal population for the sake of comparability.

business land since this might cause firms to move and have important negative effects on the revenues from the new business taxes.<sup>59</sup> Finally, we see that removing the capital share gave these municipalities with higher new business tax revenues less latitude to cut their housing tax rate: their ATE relative to the 2009 tax rate is of  $-3.65\%$  compared to  $-4.36\%$  for the other municipalities. This can be viewed as a sign that their lower ability of increasing business property tax rates in response to the reform allow lower leeway to reduce the tax burden on residents.

## 7. Conclusion

This chapter examined the relationship between tax base mobility and local taxation through theoretical and empirical analyses. The theoretical model derived local tax setting equations, which showed that decreasing the capital intensity of the business property tax base increases the business property tax rates and decreases the tax on residents. We tested this result using a French reform implemented in 2010 which changed the composition of the main local business tax base to reliance on a much less mobile tax base and implemented compensation for the tax base loss. The results of the empirical analysis are consistent with the theoretical predictions, and suggest that reducing the mobility of the tax base results in higher business property tax rates. Also, housing tax rates are negatively affected by the reform.

In terms of public policy implications, we show that the composition of the local tax base has a clear impact on the related tax decisions. Although exact compensation was paid to the municipalities after the reform, local governments seized the opportunity to increase their tax rates on a less mobile tax base. However, since we do not know whether local business tax rates were initially lower or higher than the optimal level, we cannot draw conclusions as to the efficiency of the reform.

Our analysis points to the need for more theoretical and empirical investigations of tax base reforms. A similar reform of the French national tax system is currently being discussed in France. Indeed, in the Draft Budget Bill for 2018, government proposed removing the most mobile part (based on capital) of the solidarity tax base on wealth ISF (initially based on capital and real property). We can expect this reform to produce a higher tax rate on the immobile tax base of the new ISF (real property), called tax on real property wealth (IFI). Unlike the business property tax reform studied in this chapter, this increase would be due to both a capital-mobility effect and a budgetary effect since the draft budget bill does not stipulate complete

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<sup>59</sup> Recall that the new business taxes (CVAE, IFR and TASCOT) are not voted for by the municipalities. They only depend on the type and size of firms they host.

budget compensation.

# Chapter 4

## Taxes in the Metropolis: City versus Towns

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### Abstract

Who, the central city or the suburban towns, sets the highest taxes in a metropolitan area and why? To address this issue, we develop a new sub-metropolitan tax competition model which contributes to fill the gap between local public economics and urban economics. It involves an asymmetric metropolitan area with a central municipality surrounded by satellite municipalities linked by mobile capital and mobile residents who can commute to work; both households and firms compete for local land markets. A new feature is that workers benefit from local public goods provided at their workplace and generate congestion. Several new results are provided. First, agglomeration forces lead the city, where firms are usually more capital intensive, to set higher (lower) capital tax rates than the towns when capital is a gross substitute (complement) for other inputs. Second, taxes on residents are higher (lower) in the city than in the suburb when a sufficiently high (low) share of workers are employed in the CBD. Third, the unavailability of local labor taxes drives the city to decrease (increase) its tax on residents (capital) relative to that of the towns. Fourth, the absence of local labor taxes entails an under-provision of local public goods.

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## 1. Introduction

The basic purpose of this chapter is to investigate the following question: who, the central city or the suburban towns, set the highest taxes on capital<sup>1</sup> and residents in a metropolitan area (MA) and why? Observing that central municipalities usually have a bigger population than the suburban ones, the traditional tax competition literature provides an unambiguous answer to this question: the central municipality charges higher tax rates than suburban municipalities. The capital tax competition literature argues that, having more market power on the capital market due to its relatively higher endowment of labor, the central city is intended to raise a higher capital tax rate (Bucovetsky, 1991; Wilson, 1991; Bucovetsky, 2009). Similarly, in the literature considering residential taxation, a central result is that since largest municipalities have more market power on the housing market than smaller ones, a city should set higher tax rates on residents (absent other taxes) than small towns (Epple and Zelenitz, 1981; Hoyt, 1992). This clear-cut theoretical result does not always coincide with basic empirical facts. Indeed, in a given metropolitan area, there are usually a non-negligible share of suburban towns charging higher tax rates on capital and/or on residents than the central city. For instance, in 2009 among the ten most populated French MAs, 54% of the suburban towns set a higher tax rate on capital than the city of their MA and 41% set a higher housing tax rate (see Table 4.1). Regarding the existing theoretical literature, this fact is hardly understandable.

The scope of the present chapter is to provide insights into the possible reasons why suburban towns may or may not set higher tax rates on capital and/or residents than a central city. To this end, the model developed hereafter needs to enrich the existing frameworks in several extents. There is still a knowledge gap in understanding local governments' behavior of sub-metropolitan jurisdictions, as noted in Brühart et al. (2015). Most existing models in the traditional tax competition literature ignore three features of these low-level jurisdictions which are key to compare tax rates in the central city to those chosen by suburban municipalities: household mobility, core-periphery structure and agglomeration economies. There are however several recent contributions which have started to fill this gap.

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<sup>1</sup> In all this paper, "capital" denotes the business capital used by firms, ie. the machinery and equipment employed in the production process.

The first major feature necessary to characterize the tax rate levels in a MA is household mobility, both as workers and as residents. Workers' mobility plays an important role in the determination of the capital tax rates of municipalities. Labor flows typically follow capital flows so that a jurisdiction aiming at attracting more capital must pay attention to labor mobility. This point is studied in [Kächelein \(2014\)](#) which develops a two-jurisdiction tax competition model with commuting in which jurisdictions differ in the exogenous number of inhabitants. The analysis shows that due to labor limited geographic mobility, the largest jurisdiction sets a higher tax rate than the smallest one. This result confirms the traditional tax competition ordering of the capital tax rates between larger and smaller jurisdictions. Workers' mobility is probably also regarded as important by sub-metropolitan jurisdictions when determining their residential tax policy. A jurisdiction which is attractive to workers is also attractive to residents since commuting might be particularly costly. Thus, a link between the degree of workers' mobility (intensity of commuting costs) and local taxes on residents certainly exists in practice, which should affect the respective levels of the city's and towns' tax rates on residents. However, to our knowledge, no study casts light on this link to date.

Considering residential mobility is also key in the determination of local tax rate levels. When local taxes on capital and residents are available to jurisdictions, they have to deal with the mobility of both tax bases. Assuming that residents are immobile not only does not fit with empirical facts at the local level, but it also raises a theoretical issue. If residents are immobile and residential taxes are available (as is often the case in practice), then no use of capital taxation would be made; city and towns would only charge households (the immobile tax base). One of the main results of the tax competition literature with residents' mobility (see e.g. [Wilson, 1995](#); [Richter and Wellisch, 1996](#); [Ly, 2018](#)) is that jurisdictions using multiple tax instruments relying on mobile tax bases choose the relative level of their different tax rates depending of the relative mobility the tax bases. This is, for instance, captured in the modified Ramsey rule derived in [Wellisch and Hulshorst \(2000\)](#). Also, [Wilson \(1995\)](#) shows that introducing residents' mobility in a traditional tax competition framework raises the capital tax from zero to a positive level. The existing literature has paid little attention to the respective level of the tax rates of city and towns in a context with multiple tax instruments and multiple mobile tax bases. It might however be not satisfactory to explain capital tax rates differentials between the city and the towns by exogenous population size differences if residential tax are available.<sup>2</sup>

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<sup>2</sup> If a residential tax is available, the city and the towns set identically a zero capital tax rate.

The second key feature that needs to be considered in a comparison of the tax rates raised by central cities and towns is the core-periphery structure. The first models drawing the conclusion that a larger jurisdiction is expected to charge higher tax rates on households and capital actually did not focus on the proper case of cities and suburban towns. Instead, they accounted for population size differences between jurisdictions which are otherwise similar. However, the tax competition context in which city and towns choose their tax rates is very specific to MAs. The central city has an inherited market power which entails that its behavior is driven by factors that are not present in suburban towns. Tax competition models including features characterizing this asymmetric relationship have recently been developed. [Janeba and Osterloh \(2013\)](#) propose a capital tax competition model in which the city is able to compete not only with the towns of its MA, but also with the cities of other MAs. Towns however have a more restricted tax competition environment since they only compete with the other towns of their own MA. Interestingly, the authors find that the capital tax rate of the central city needs not be higher than the capital tax rate of the suburban municipalities. The argument is the following: since city and suburb face different degrees of competition, when the number of MA is large enough, competition incurred by central municipalities is so important compared to that faced by suburban ones that the former set lower tax rates on capital.

Another tax competition model including a core-periphery structure is the contribution by [Gagné et al. \(2016\)](#), which is the closest study to the present chapter. To study the economic structure and performance of MAs, the authors build an important bridge between the tax competition and the urban economics literature by including in their *urban tax competition model* several important features of MAs: commuting and agglomeration economies. Also, while municipalities' population is fixed, residents are mobile within jurisdictions. The authors find that the central city sets a higher business tax rate than suburban municipalities. This result is due "to the central position of the CBD in the transportation network". The intuition behind this result is that, due to commuting costs, the city attracts more workers (the single production factor) than the towns so that it faces a weaker competition than towns. It can therefore set a higher business tax rate.

The third characteristics which characterizes the tax competition environment within MAs is the existence of agglomeration economies.<sup>3</sup> The main strand of the

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<sup>3</sup> Noticeably, the main forces driving the city's business tax rate to be above that of towns in [Gagné et al.](#) is not the presence of agglomeration economies as seen above. Indeed, the authors find that the central city's tax rate on firms is higher than that of the suburban towns even when agglomeration economies are absent. This is one of the main differences with the present chapter

tax competition literature which highlights the role of agglomeration economies in the comparison of the capital tax rate levels of cities and towns is the new economic geography (NEG) literature (Baldwin and Krugman, 2004, see e.g.). An important result of these inter-country tax competition models is that agglomeration economies entail that mobile capital is locked in a given country which, benefiting from this agglomeration rent, can levy a high tax rate on this quasi-fixed tax base. Transposed to the context of inter-municipality tax competition, this result implies that the city is expected to concentrate capital and set a higher capital tax than the suburban towns. However, empirical evidence of the existence of a taxable agglomeration rent are mitigated. While e.g. Charlot et al. (2008) obtain results in favor of this result for French municipalities, e.g. Luthi and Schmidheiny (2013) find no evidence of a positive impact of agglomeration forces on capital tax rates, using panel data from Swiss municipalities. Further theoretical investigation could help understanding such mitigated results.

From the above discussion of the literature, it follows that our investigation of the tax rates raised by cities and towns needs to account for capital, residents' and workers' mobility, for a core-periphery framework and for agglomeration economies. The model we propose in this chapter accounts for all these features. Specifically, we introduce a new sub-metropolitan tax competition model which considers a MA consisting in a central city and surrounding small towns. The city, which has market power, acts as a Stackelberg leader, while towns (followers) have no market power. Municipalities provide a local public good financed by taxes on capital, residents, workers and land. Firms produce a private good using labor, capital and land under increasing returns to scale which capture agglomeration economies. Capital and residents can freely choose their location in the MA. Once they have chosen a jurisdiction of residence, households can choose to commute to the city (for suburbanites) or work in their home municipality. Households and firms both consume land, so they compete for local land.<sup>4</sup> Moreover, the urban structure of the model allows to integrate a new feature. Households consume public goods not only as residents but also as workers. Specifically, workers benefit from the congestible public good in the jurisdiction where they work.

Our analysis provides several new results. First, agglomeration forces lead the city, where firms are usually more capital intensive, to set higher (lower) capital tax rates than the towns when capital is a gross substitute (complement) for other inputs. Second, taxes on residents are higher (lower) in the city than in the suburb

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(see footnote 6).

<sup>4</sup> In a tax competition model with capital, labor and resident mobility involving atomistic jurisdictions Ly (2018) also considers competition among firms and households for local land.

when a sufficiently high (low) share of workers are employed in the CBD. Third, the unavailability of local labor taxes drives the city to decrease (increase) its tax on residents (capital) relative to that of the towns. Fourth, the absence of local labor taxes entails an under-provision of local public goods.

This chapter contributes to the existing literature in several ways. First, it provides new insights to understand why, in practice, tax rates are not systematically observed at a higher level in cities than in suburban towns. Second, the chapter highlights the ambiguous role of agglomeration economies in this ordering of the level of the capital tax rate between the center and the suburb. Since this ordering depends on the substitutability of capital to other production factors, it suggests that further empirical investigation could lead to distinguish MAs according to their sectoral composition. Third, the chapter emphasizes a new link between local taxes on residents and job accessibility. While we might have expected *a priori* that the role of controlling for job accessibility should be assigned to labor taxes, our analysis shows that taxes on residents are the optimal instrument for it. Fourth, the chapter points out the key role of labor taxes in MAs. While, in practice, they are often the missing tool in the tax instrument set of municipalities (see e.g. [Blöchliger and Rabesona, 2009](#)), our analysis shows that this might entail important inefficient distortion in the policy setting of municipalities. In this regard, our analysis reveals a new distortion in local public good provision generated by the public good consumption of mobile and costly workers.<sup>5</sup> The absence of labor taxes could ultimately harm residents of municipalities. This result might be viewed as a plea for the availability of labor taxes to municipalities.

Finally, this chapter more generally contributes to fill the gap between the tax competition literature and the urban economics literature, as started by [Gaigné et al. \(2016\)](#).<sup>6</sup> This task is, in our view, essential for local public economics. Recent models

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<sup>5</sup> This new result shows up because the urban workers' consumption of the public good is explicitly modeled in the present chapter. This is allowed by the urban structure of the model. It aims at capturing the fact that workers partly benefit from public services and amenities at their workplace. It provides a new motive for the widely studied public good spillovers from one jurisdiction to others. In this chapter, the motive for which residents can benefit from public services of another municipality is specifically commuting.

<sup>6</sup> The urban structure in this chapter is closely related to that developed in [Gaigné et al. \(2016\)](#). Three main features distinguish the present framework from this recent contribution. First, our framework considers the traditionally studied capital taxes (in addition to labor taxes), while [Gaigné et al.](#) only consider taxes on labor which is the only input used by firms. Second, public goods are hereafter endogenously chosen by local governments while they are exogenous in [Gaigné et al. \(2016\)](#). Efficiency of the local public good is therefore discussed in the present chapter. Third, while municipalities' population is fixed in [Gaigné et al. \(2016\)](#), we consider residents who are mobile across municipalities and compete with firms for local land. This allows us to consider,

of urban economics capture a considerable amount of real-life features of MAs (e.g. agglomeration economies, unemployment, sorting, trade...) which could profitably be introduced into local public economics model to study how local governments can address a bunch of issues. Empirical literature could also benefit from this strengthened link between local public economics and urban economics, in view of the considerable amount of data available at the municipal level.

The remainder of the chapter is organized as follows. [Section 2](#) provides some motivations. [Section 3](#) introduces the model. [Section 4](#) describes the game played by the agents. [Section 5](#) and [Section 6](#) present the optimal taxation rules of the central and satellite municipalities with and without access to a labor tax. [Section 7](#) contains numeric simulations. [Section 8](#) concludes.

## 2. Motivation

A widespread theoretical expectation from the theoretical literature is that tax rates on capital and residents are higher in the central municipality (city) than in the suburban municipalities (towns) of the MA. In order to confront this clear-cut theoretical result, with real-world stylized facts, we consider the two main local tax rates in France. The first is the business tax rate ( $\tau^K$  in [Table 4.1](#) and [Figure 4.1](#)) which is levied on a mixed tax base: business capital investment and business real property. The second tax rate is the housing tax rate ( $\tau^R$  in [Table 4.1](#) and [Figure 4.1](#)).

[Table 4.1](#) indicates, for the ten most populated French central municipalities, the number of suburban municipalities with higher (business or housing) tax rate than the central city relative to the total number of municipalities in the urban area. One observes that in several urban areas, more than one third of the suburban municipalities set a higher business tax rate than the central city (e.g. 35 % in the urban area of Marseille). Concerning the housing tax rate, the amount of suburban municipalities with higher tax rates is more limited (except for Paris) but non-zero either. This last result appears as a sign that congestion costs (included in the following model), which are much higher in the center, must play an important role in the resident tax setting.

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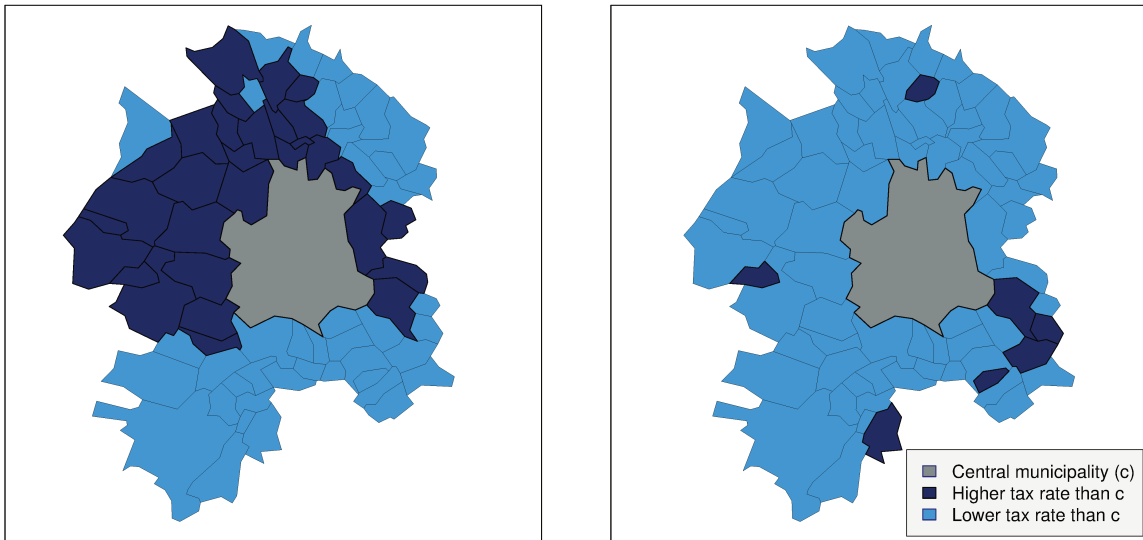
in addition to business (capital) taxation, residential taxes.

**Table 4.1.** Share of towns with a higher tax rate than the city's one, in French MAs.

	(1)	(2)
	Business tax	Housing tax
	$\tau_{s_i}^K > \tau_c^K$	$\tau_{s_i}^R > \tau_c^R$
Paris	0.79	0.84
Marseille	0.35	0.02
Lyon	0.00	0.04
Toulouse	0.42	0.10
Nice	0.33	0.00
Nantes	0.00	0.08
Strasbourg	0.96	0.04
Montpellier	0.00	0.05
Bordeaux	0.39	0.05
Lille	0.00	0.14
All	0.54	0.41

NOTE.— Column (1) reports the share of towns in the 10 French most populated MAs which voted a higher business property tax rate (on capital and business land)  $\tau_{s_i}^K$  than that of the city  $\tau_c^K$  in 2009. Column (2) reports the share of these towns which voted a higher housing tax rate  $\tau_{s_i}^R$  than that of the city  $\tau_c^R$  in 2009. The MA definition uses the National Institute of Statistics and Economic Studies (INSEE) of the center of urban poles: all municipalities belonging to a continuously built-up area with more than 2000 inhabitants and 1500 jobs.

Figure 4.1 represents the case of Toulouse. It shows some evidence that municipalities setting a higher residential tax rate than the central municipality do not necessarily coincide with those levying a higher business tax rate than the central municipality. From Table 4.1 and Figure 4.1, the question arises as to which forces drive suburban municipalities to set higher tax rates on capital and/or residents than the city. This is the purpose of the following investigation.

(a) Tax rate on businesses ( $\tau^K$ )(b) Tax rate on residents ( $\tau^R$ )

**Figure 4.1.** Comparison of tax rates of the city and the towns in the MA of Toulouse (2009). The definitions the MA,  $\tau^K$  and  $\tau^R$  are the same as in Table 4.1.

### 3. The model

#### 3.1. Metropolis structure

We consider a metropolitan area (MA) composed of  $n + 1$  sub-metropolitan jurisdictions which can be interpreted as municipalities: one central municipality  $c$  - referred to as *city* - and  $n$  symmetric atomistic suburban municipalities  $s_i$  with  $i = 1, \dots, n$  - referred to as *towns*.<sup>7</sup> Business capital and residents are mobile across all municipalities of the MA. Regarding labor, the MA is endowed with a *hub-and-spoke* commuting transportation network, which means that the  $n$  towns  $s_i$  are connected only to the city  $c$ , while the city has a direct access to all towns of the MA.<sup>8</sup> In other words, once she has chosen her location of residence, an individual living in town  $s_i$  can work in her home town or in the city  $c$ . However, all residents living in  $c$  are assumed to work in  $c$ . This MA structure aims at capturing the fact that suburbanites usually hesitate between working either in the city or in their home town. Commuting from the city to the suburb or from a suburban town to another

<sup>7</sup> In practice, most MAs are composed of a central municipality, which has a sufficient size to have market power, surrounded by many small municipalities whose market power is much more limited. This is why  $c$  is assumed to have market power contrary to municipalities  $s_i$ .

<sup>8</sup>Our hub-and-spoke MA structure is similar to that developed in Gaigné et al. (2016).



similar one is less frequent.<sup>9</sup>

In the remainder of the chapter, we adopt the following notations, for each municipality  $j, j' \in \{c, s_i\}_{i \in \llbracket 1, n \rrbracket}$ :

- $R_j$  is the number of residents living in  $j$ ,
- $W_j$  is the number of workers employed in  $j$ ,
- $W_{jj'}$  is the number of residents living in  $j$  and working in  $j'$ ,
- $K_j$  is the amount of business capital used in  $j$ ,
- $L_j$  is the business land used in  $j$ ,
- $\mathcal{L}_j$  is the total land endowment of municipality  $j$ ,

where  $R_j, W_j, W_{j,j'}, K_j$  and  $L_j$  are endogenous variables of the model, while  $\mathcal{L}_j$  is exogenously fixed. Recalling that part of the residents of  $s_i$  work in  $c$ , while no resident of  $c$  work in  $s_i$ , we have:

$$R_{s_i} = W_{s_i c} + W_{s_i s_i}, \quad W_{s_i} = W_{s_i s_i}. \quad (4.1)$$

Each individual is assumed to consume a single unit of land, so that local land market clearing requires, for each municipality  $j \in \{c, s_i\}_{i \in \llbracket 1, n \rrbracket}$ :

$$\mathcal{L}_j = R_j + L_j. \quad (4.2)$$

The number of residents and workers do not necessarily coincide within a municipality, but they do at the level of the MA since each individual choose a workplace within the MA. Denoting  $\mathcal{P}$  the exogenous population of the MA, we have:

$$\mathcal{P} = R_c + \sum_{i=1}^n R_{s_i} \quad (4.3a) \quad \mathcal{P} = W_c + \sum_{i=1}^n W_{s_i} \quad (4.3b)$$

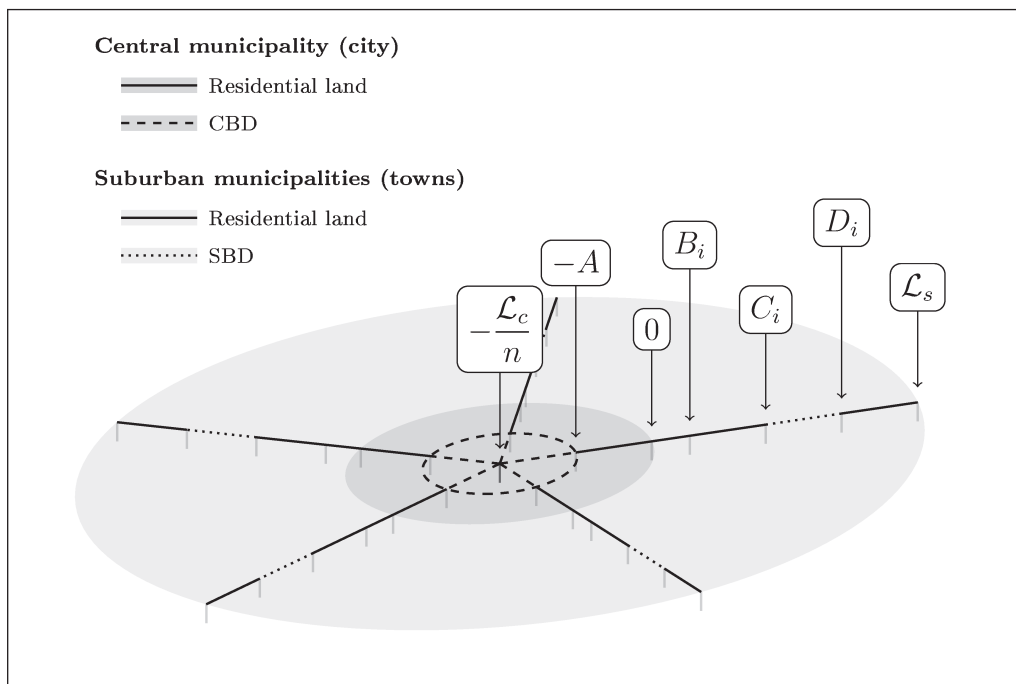
And, equilibrium on capital market requires:

$$\mathcal{K} = K_c + \sum_{i=1}^n K_{s_i} \quad (4.4)$$

where  $\mathcal{K}$  is the exogenous total capital endowment of the MA. Let us now describe the spatial structure of the MA which is illustrated in [Figure 4.2](#) for convenience.

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<sup>9</sup> An interesting development of this model would be to include inter-town commuting. However, it is beyond the scope of the present study.



**Figure 4.2.** Graphical representation of the MA, with  $n = 5$ . Each strip (ray) represents a part of the city  $c$  and a town  $s_i$ . The intervals  $[-\mathcal{L}_c/n, 0]$  and  $[0, \mathcal{L}_s]$  respectively represent one  $n^{\text{th}}$  of the city  $c$  and town  $s_i$ . Specifically,  $[-\mathcal{L}_c/n, -A]$  is one  $n^{\text{th}}$  the CBD;  $[-A, 0]$  is one  $n^{\text{th}}$  of the population of the city;  $[0, B_i]$  are commuters from town  $s_i$  to  $c$ ;  $[B_i, C_i]$  and  $[D_i, \mathcal{L}_s]$  each represents half of the residents of  $s_i$ ; and  $[C_i, D_i]$  is the SBD of  $s_i$ .

The MA is composed of  $n$  strips of 1 space unit width and  $\mathcal{L}_c/n + \mathcal{L}_s$  space units length. The total space of the MA is therefore  $\mathcal{L}_c + n\mathcal{L}_s$ , that is the sum of the land endowments of the city and the  $n$  towns. Each strip is an interval  $[-\mathcal{L}_c/n, \mathcal{L}_s]$  which links the center of the city,  $-\mathcal{L}_c/n$ , to the extremity of one of the  $n$  towns,  $\mathcal{L}_s$ . The city is spatially represented by the union of the  $n$  intervals  $[-\mathcal{L}_c/n, 0]$ . Each of these intervals is divided between business land  $[-\mathcal{L}_c/n, -A]$  and residential land  $[-A, 0]$ . Since each household consumes one unit of land, we have:

$$A = \frac{R_c}{n}. \quad (4.5)$$

Notice that  $A$  does not depend on  $i$ , which means that the amount of business land used by firms is the same on each strip of the MA. This stems from the fact that firms in the SBD pay the same land rent per business land unit whatever the strip they are located on (see [subsection 3.2](#)). The central business district (CBD) is the union of the intervals  $[-\mathcal{L}_c/n, -A]$ . It represents business land used by firms located in the city whose total length is  $L_c = \mathcal{L}_c - R_c$ .

Each town is spatially represented by the interval  $]0, \mathcal{L}_s]$ . For each town  $s_i$ , this interval is divided into four subintervals:

- $]0, B_i]$  of length  $W_{s_i c}$ , is occupied by residents of  $s_i$  who commute to work in the CBD.
- $]B_i, C_i]$  of length  $W_{s_i s_i}/2$ , is occupied by half of the residents of  $s_i$  who work in  $s_i$ .
- $]C_i, D_i]$  of length  $L_{s_i}$ , is the secondary business district of  $s_i$  (SBD $_i$ ).
- $]D_i, \mathcal{L}_s]$  of length  $W_{s_i s_i}/2$ , is occupied by half of the residents of  $s_i$  who work in  $s_i$ .

Using (4.1) and (4.2), the following explicit expressions for  $B_i$ ,  $C_i$  and  $D_i$  result:

$$B_i \equiv W_{s_i c} = R_{s_i} - W_{s_i}, \quad (4.6)$$

$$C_i \equiv W_{s_i c} + \frac{W_{s_i s_i}}{2} = R_{s_i} - \frac{W_{s_i}}{2}, \quad (4.7)$$

$$D_i \equiv W_{s_i c} + \frac{W_{s_i s_i}}{2} + L_{s_i} = \mathcal{L}_s - \frac{W_{s_i}}{2}. \quad (4.8)$$

Several observations can be made about this MA structure. The first is that the SBD location is such that suburbanites working in their home town distribute themselves symmetrically around their SBD. This assumption is similar to [Gaigné et al. \(2016\)](#).<sup>10</sup> Alternatively, we could assume that the SBDs are located at the extremity of the towns, which would not substantially change our results. The second observation is that the above MA structure ignores agricultural land and considers the boundaries of the MA as fixed. This modeling relies on several grounds.

First, agricultural land is not technically required in the present framework. Contrary to traditional urban economic models (see e.g. [Fujita, 1989](#)) which require agricultural land to allow the MA population to vary, our framework does not require an endogenous urban fringe to allow residential mobility among municipalities. Here, a municipality's population can vary not because of a trade-off between agricultural land and urban land, but because of a trade-off between residential land and business land.<sup>11</sup> Since agricultural land is not technically required, ignoring it can be regarded as a parsimony hypothesis.

Second, the focus of this chapter is on urban municipalities. In practice, most of the suburban municipalities surrounding contiguously the central city do not have agricultural land, contrary to more remote municipalities which are not considered in the present model.

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<sup>10</sup> [Gaigné et al. \(2016\)](#) also assume that workers are symmetrically distributed around the SBD. The authors argue that if towns choose non-cooperatively the location of their SBDs, they choose this location such that the distribution of workers around it is symmetric.

<sup>11</sup> A similar trade-off is considered in [Ly \(2018\)](#).

Third, a major distinction between urban economics (UE) models and local public economics (LPE) ones must be pointed out. While UE models consider MAs as a whole entity with potentially endogenous boundaries and, usually, do not explicitly model jurisdictions, LPE models regard MAs as a set of jurisdictions whose boundaries are fixed and which are endowed with their own public policy instruments. Thus, our framework which stands in the tradition of LPE models considers fixed municipal boundaries and a set of local public policy instruments assigned to each municipality. In this context, introducing agricultural land would require to introduce more remote municipalities comprising an additional business sector or another class of households (farmers) submitted to the local public policy instruments of their municipality. It would be much more tedious — and fairly distracting — than introducing a ‘no-man’s land’ agricultural area as done in traditional UE models.<sup>12</sup>

### 3.2. *Firms*

The same private good numeraire is produced in each municipality by local firms which regard its price  $p = 1$  as given. In municipality  $j \in \{c, s_i\}_{i \in [1, n]}$ , the private good is produced combining labor  $W_j$ , capital  $K_j$  and business land  $L_j$  according to the production function  $F^j \equiv F(W_j, K_j, L_j)$ . The production function  $F^j$  represents all local firms in municipality  $j$ .<sup>13</sup> As common, we assume that  $F_X^j > 0$ ,  $F_{XX}^j < 0$  and  $F_{XY}^j > 0$  for all  $X, Y \in \{K_j, W_j, L_j\}$ , which means that  $F^j$  exhibits positive but decreasing marginal returns with respect to each factor, and that factors are technological complement. Moreover,  $F^j$  is homogeneous of degree  $\psi + 1$ ,  $\psi > 0$ . Thus, the production technology exhibits internal increasing returns to scale, which captures agglomeration economies.<sup>14, 15</sup> The profit of the firms in municipality  $j$  is:

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<sup>12</sup> However, introducing more remote municipalities with an agricultural sector or a class of farmers could be an interesting extension of the present framework, in the context of tax competition among suburban municipalities. Notice that [Gagné et al. \(2016\)](#) do not consider business land and then introduce agricultural land in the tradition of UE models.

<sup>13</sup> Explicitly modeling the number of firms as in e.g. [Matsumoto \(1998\)](#) would be an alternative specification, but we do not introduce this refinement for simplicity.

<sup>14</sup> Our modeling of agglomeration economies is similar to [Burbidge and Cuff \(2005\)](#). An alternative modeling is proposed in [Fernandez \(2005\)](#) and [Krogstrup \(2008\)](#). In these studies, which assume external returns to scale, increasing returns are due to an externality: when demanding capital, each firm of a municipality increases the output of other firms but does not account for this external effect. Using this alternative specification would not qualitatively change the results derived in this chapter.

<sup>15</sup> Note that every municipality  $j$  has the same production technology  $F(\cdot)$ : differences in outputs can only result from differences in input amounts and mix.

$$\Pi^j = F(W_j, K_j, L_j) - (w_j + \tau_j^W)W_j - (r + \tau_j^K)K_j - \rho_j^L L_j, \quad (4.9)$$

where  $w_j$  is the wage prevailing in municipality  $j$ ,  $r$  is the MA return to capital,  $\rho_j^L$  is the municipal business land rent,  $\tau_j^W$  is the tax rate on labor levied by municipality  $j$ ,<sup>16</sup> and  $\tau_j^K$  is its capital tax rate. In the CBD, the cost of a unit of business land  $\rho_c^L$  does not depend on the strip it is located on (CBD-SBD <sub>$i$</sub> ). Then, when choosing the amount of land input, firms located in the CBD consider each strip as being equivalent. It follows that business land used by firms located in the city is equal to  $L_c/n$  on each strip. And since the land endowment of the city on each strip is identically equal to  $\mathcal{L}_c/n$ , population of the city is also evenly distributed on each strip: there are  $R_c/n = \mathcal{L}_c/n - L_c/n$  residents of the city on each strip.

Due to increasing returns to scale (IRS), if all production factors were paid at the level of their marginal productivity, profits would be negative.<sup>17</sup> Therefore, as noticed in [Burbidge and Cuff \(2005\)](#), modeling IRS in the standard tax competition framework requires to make an additional assumption about which factor owners hire the other production factors. In the sequel, we assume that capital owners hire labor and business land. Thus profits accrue to capital owners, while labor and business land are chosen competitively. This assumption may not be very far from what happens in practice, where managers are left the responsibility to maximize the firm's profit choosing optimally the production factors, while shareholders receive the remaining profit as dividends. Hence, the optimal demands for inputs are, for each municipality  $j \in \{c, s_i\}_{i \in [1, n]}$ :

$$F_W^j = w_j + \tau_j^W, \quad (4.10a) \quad F_L^j = \rho_j^L, \quad (4.10b) \quad F_K^j - \psi \frac{F^j}{K_j} = r + \tau_j^K, \quad (4.10c)$$

where  $F^j$ 's subscripts stand for derivatives. Conditions (4.10a) and (4.10b) are the first-order conditions of the maximization of (4.9). They state, as usual, that the marginal outputs of labor and land are equal to their marginal costs. Condition

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<sup>16</sup> Notice that assuming alternatively that  $\tau_j^W$  is directly paid by workers would lead to strictly identical results. It is however simpler from a modeling viewpoint, to introduce  $\tau_j^W$  in firms' profit.

<sup>17</sup> Indeed, under IRS, the average cost of production is decreasing so its marginal cost is below the average cost. Thus marginal cost pricing, which results from competitiveness of the output good market, induces negative profits. Notice that this is not the case in NEG models ([Baldwin and Krugman, 2004](#), see e.g.) in which the output good is produced under the condition of a monopolistic competition. Instead, we follow the tax competition literature and assume that the output good is produced under competitive conditions. This assumption is more plausible for municipalities than it is for countries as is the focus of the NEG literature. It allows to ignore cross-municipality good trade issues which are outside the scope of this chapter.

(4.10c), which is proved and graphically represented in [Appendix A](#) expresses the zero-profit statement  $\Pi^j = 0$  which stems from the perfect mobility of capital across municipalities. Importantly, notice that in the presence of agglomeration economies ( $\psi > 0$ ), firms choose a lower level of capital than the competitive level. That is, firms behavior entails a socially inefficiently low use of capital. Indeed, the marginal private benefit of capital use  $F_K^j - \psi F^j/K_j$  is lower than its marginal social benefit which is the marginal productivity of capital  $F_K^j$ . Capital owners who control firms ignore agglomeration rents  $\psi F^j$ . Instead, they care about obtaining non-negative returns to capital — formally, they are constrained by the zero-profit condition. It follows that a way for municipalities to achieve an efficient allocation of capital is to use their capital tax as a subsidy to spur capital owners to increase their local capital supply.

### 3.3. Households

Each household is composed of one individual. The preferences of the residents of municipality  $j \in \{c, s_i\}$  who work in municipality  $j' \in \{c, s_i\}$  are described by:

$$x_j + u(G_j) + v(G_{j'}) \equiv x_j + U^j + U^{jj'}$$

where  $x_j$  is a private numeraire good,  $G_j$  is the local public good provided by the government  $j$  in its municipality. Utility derived from public good consumption is increasing and concave, so that  $u'(\cdot)$  and  $v'(\cdot)$  are positive, while  $u''(\cdot)$  and  $v''(\cdot)$  are negative. The function  $v(\cdot)$  captures the fact that workers benefit from the local public services and amenities (security, public cleanliness, state of roads, etc.) provided at their workplace; and local authorities can make their municipality more attractive to workers by improving these services and amenities.<sup>18</sup> A household consumes one unit of land, say at location  $l \in [-\mathcal{L}_c/n, \mathcal{L}_s]$ , paying the land rent  $\rho(l)$ . She supplies inelastically one unit of labor in the city  $c$  or in her home town  $s_j$  (if she is a suburbanite) of the MA depending on which of these offers the highest wage net of commuting costs. Thus, wages net of commuting costs are equated within the MA. Each worker incurs a commuting cost  $t$  per unit of distance to the business district she works in: if an individual lives at location  $l$  and works at location  $l_0$ , she incurs the commuting cost  $T(l) = t|l - l_0|$ . A resident of  $j$  is charged the local head tax  $\tau_j^R$ , chosen by government  $j$ . Each household of the economy owns an equal share of the total capital endowment of the economy  $k = \mathcal{K}/\mathcal{P}$ . Since

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<sup>18</sup> To our knowledge, there exists no other model in the literature accounting for spillovers enabled by individuals' commuting to their workplace. Notice that local public goods limited to residents, such as local public schools, are obviously not captured by  $G_j$ .

a household invests its capital endowment in the municipality which provides the highest return to capital, the capital return  $r$  is identical in all municipalities of the MA.

Each municipality  $j \in \{c, s_i\}$  levies a land tax  $\tau_j^{\mathcal{L}}$  on owners of its land endowment; it is chosen by government  $j$ . Since, land is assumed evenly distributed among all households of the economy, the land income of an individual is:

$$\Gamma = \mathcal{P}^{-1} \sum_{i=1}^n \left[ \int_{-\mathcal{L}_c/2n}^0 [\rho(l) - \tau_c^{\mathcal{L}}] dl + \int_0^{\mathcal{L}_{s_i}} [\rho(l) - \tau_{s_i}^{\mathcal{L}}] dl \right] \quad (4.11)$$

The budget constraint of a household who lives in  $j$  and works in  $j'$  is:

$$x_j + \rho(l) = w_{j'} - T(l) - \tau_j^R + rk + \Gamma$$

It follows that the indirect utility of a household residing in  $j$  who pays the rent  $\rho(l)$  and receives the wage  $w_{j'}$  is:

$$V_j[\rho(l), w_{j'}] \equiv w_{j'} - \rho(l) - T(l) - \tau_j^R + rk + \Gamma + U^j + U^{jj'} \quad (4.12)$$

Perfect residential mobility of households implies that every resident in the MA obtains the same level of utility  $u$  at equilibrium. Equating the indirect utility function of each type of resident to the prevailing utility level  $u$  allows to determine the bid land rent function as a function of  $l$ . The residential land rent function in the center  $c$  is:<sup>19</sup>

$$\rho(l) = w_c - t(A + l) + \Lambda^{cc}, \quad l \in ]-A, 0] \quad (4.13)$$

where  $\Lambda^{jj'} \equiv -\tau_j^R + rk + \Gamma + U^j + U^{jj'} - u$ , with  $j, j' \in \{c, s_i\}$ . Notice that, we assume that there are no commuting costs for workers within connected firms — ie. within the CBD or within a SBD.<sup>20</sup> It is apparent in (4.13): the individual only pays for commuting from  $l$ , her residence location, to  $-A$ , the entrance of the CBD. This simplifying assumption could be relaxed without affecting the main results of the chapter by assuming that workers have the same commuting cost whenever they enter a business district: a fixed cost times the average size of the business district interval. The residential land rent function in town  $s_i$  is as follows:

$$\rho(l) = w_c - t(A + l) + \Lambda^{s_i c}, \quad l \in ]0, B_i], \quad (4.14)$$

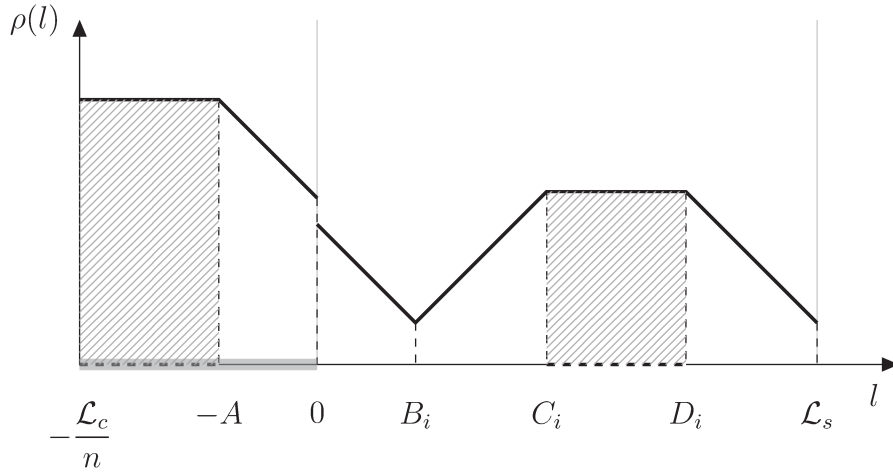
$$\rho(l) = w_{s_i} - t(C_i - l) + \Lambda^{s_i s_i}, \quad l \in ]B_i, C_i], \quad (4.15)$$

$$\rho(l) = w_{s_i} - t(l - D_i) + \Lambda^{s_i s_i}, \quad l \in ]D_i, \mathcal{L}_s]. \quad (4.16)$$

<sup>19</sup>From Fujita (1989),  $\rho(l) \equiv \max_{(x)} \{w + rk + \Gamma - \tau^R - T(l) - x \mid x + u(G) + v(G') \geq u\}$ . Then,  $\rho(l) = w - \tau^R - T(l) + u(G) + v(G') + rk + \Gamma - u$ .

<sup>20</sup> The same is assumed in Zenou (2009, chap. vi).

Figure 4.3 represents the land rent function, defined by (4.13)–(4.16), along a location strip linking the central municipality to a town  $s_i$ .



**Figure 4.3.** Bid land rent function over a strip linking the city  $c$  to the town  $s_i$ . The intervals have the same definitions as in Figure 4.2.

The marginal resident of town  $s_i$  who is indifferent between working in the CBD and working in the SBD $_i$  resides at  $l = B_i$ , and is characterized by:

$$V_{s_i}[\rho(B_i), w_c] = V_{s_i}[\rho(B_i), w_{s_i}],$$

which, from the expression of the indirect utility (4.12) and that of the the land rent (4.14) and (4.15) implies:

$$w_c - t(A + B_i) + U^{s_i c} = w_{s_i} - t(C_i - B_i) + U^{s_i s_i}.$$

and, inserting in this equation the definitions of  $A$ ,  $B_i$  and  $C_i$ , (4.5)–(4.7), and the optimal condition for labor input demand (4.10a), we obtain:

$$F_W^c - \tau_c^W - F_W^{s_i} + \tau_{s_i}^W + U^{s_i c} - U^{s_i s_i} = t \left( \frac{R_c}{n} + R_{s_i} - \frac{3}{2} W_{s_i} \right) \quad (4.17)$$

Moreover, in each municipality the business land rent is equal to the residential land rent paid by the resident who lives the closest from the business district. Thus:

$$F_L^c = \rho(-A), \quad F_L^{s_i} = \rho(C_i) = \rho(D_i),$$

which, using (4.13) and (4.15) (or (4.16)), can be written for each  $j \in \{c, s_i\}$  as:

$$F_L^j = w_j + \Lambda^{jj}.$$

which can be explicitly written for each  $j \in \{c, s_i\}$  as:

$$F_W^j - \tau_j^W - F_L^j + U^j + U^{jj} - \tau_j^R + rk + \Gamma - u = 0 \quad (4.18)$$

where the definition of  $\Lambda^{jj}$  and the optimal condition for labor input demand (4.10a) have been inserted.



### 3.4. Assumptions

To complete the description of the model, we now introduce and discuss the main assumption which will be used in the derivation of some results or in their interpretation. Notice that most of the results of this chapter do not require all the following assumptions to be verified. Each specific assumption will be mentioned when it is necessary to derive a given result.

**Assumption 4.1 (Public goods).** *In the equilibrium, the public good provision is such that  $G_c \geq G_{s_i}$ .*

Assumption 4.1 states that in the equilibrium, the center provides a higher amount of local public good than each single town. This assumption reflects the significant difference of size between these two types of municipalities.

**Assumption 4.2 (Weak separability).** *Assume that  $F(W_j, K_j, L_j) = F(K_j, X(W_j, L_j))$ , where  $F^j$  is homogenous of degree  $\psi + 1$  in  $K_j$  and  $X^j \equiv X(W_j, L_j)$ , and  $X^j$  exhibits constant returns to scale.*

Assumption 4.2 allows to deal with the substitutability of capital to the other production factors considered as a whole. The mixed input  $X^j$  is interpreted as land augmented labor so that,  $F^j$  should be regarded, in this case, as the traditional two-factor production function with capital and labor inputs. This assumption is satisfied by most of the usual functional forms — e.g. Cobb Douglas and nested CES functions.

**Assumption 4.3 (Third order effects).** *The production function  $F(\cdot)$  is such that:*

$$F_{XYZ}^s = 0, \quad \text{for each } X, Y, Z \in \{K_s, W_s, L_s\}$$

Assumption 4.3 is a simplifying assumption used in the derivation of results involving a large number of effects. It states that the third-order effects on the production function  $F^s$  are negligible.

## 4. The Game

To characterize optimal public policy of the municipalities, we consider the following four-stage game. In the *first stage*, the government of the central municipality (Stackelberg leader) chooses its public policy instruments so as to maximize the utility of its residents. Due to its non negligible size, the city has a market power so that its decisions have effects on the return to capital  $r$  and on all local variables in the towns. In the *second stage*, residents, workers and capital choose their location

within the metropolis. In the *third stage*, the suburban governments (Stackelberg followers) choose their public policy instruments so as to maximize the utility of their residents. Since each town is atomistic, its government decision affects neither the return to capital nor the variables in the other municipalities (city and towns). However, when making its decision a suburban government takes into account the reactions of local capital, residents and workers. Finally, in the *fourth stage*, residents, workers and capital adapt their location.<sup>21</sup> To solve this sequential game, we proceed, as common, by backward induction. First, we characterize the behavior of towns which account for the location reaction of capital, workers and residents (stages three and four). Second, we characterize the policy choices of the central municipality which accounts for the reactions of towns and for the location choices of capital, residents and workers.<sup>22</sup>

In this game, each local government  $j \in \{c, s_i\}$  maximizes the utility of its constituents by providing the local public good  $G_j$  financed by a head tax on its residents  $\tau_i^R$ , a unit tax on capital  $\tau_i^K$  and a unit tax on land property  $\tau_i^L$ . Due to residents' mobility, all residents of  $j$  (and more generally in the MA) have the same utility level in equilibrium. Thus, the objective of government  $j$  boils down to maximize the utility of a representative resident. We assume that this representative resident is the one who lives the closest from municipality  $j$ 's business district, that is at  $l = -A$  for the center and at  $l = C_i$  (or  $l = D_i$ ) for town  $s_i$ . Local government  $j$ 's budget constraint is:

$$\tau_j^R R_j + \tau_j^K K_j + \tau_j^W W_j + \tau_j^L \mathcal{L}_j = C(G_j, R_j, W_j), \quad (4.19)$$

where  $C^j \equiv C(G_j, R_j, W_j)$  is the cost function of public good provision. It is increasing in the public good provision, so that  $C_G^j$  is positive. Residents and workers generate congestion so that  $C_R^j$  and  $C_W^j$  are also positive.<sup>23</sup> It is also assumed that congestion entails that it is more costly to provide additional local public good when

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<sup>21</sup>Janeba and Osterloh (2013) also consider a closely related four-stage game. Aside from differences in the framework, the main difference with the present game is that in the first stage of Janeba and Osterloh (2013), the city competes for capital with cities of other MAs, while in the third stage, as assumed in the present chapter, the towns compete with the city of their own MA.

<sup>22</sup>In line with most of the literature on tax competition (see Wilson (1999)), our purpose is to determine general behavioral rules underlying the choices of local governments, by shedding light on equilibrium relations between key variables of the model. We keep all functional forms as general as possible and do not derive reduced forms contrary to Janeba and Osterloh (2013) and Gagné et al. (2016). Our approach should then be viewed as complementary to this rising literature on sub-metropolitan tax competition.

<sup>23</sup>While resident congestion is a widespread feature in tax competition models dealing with household mobility (see e.g. Wilson, 1995; Richter and Wellisch, 1996; Wellisch and Hulshorst, 2000), congestion induced by workers' consumption of the local public good is new to the literature.

its beneficiaries are more numerous, so that  $C_{GR}$  and  $C_{GW}$  are positive as well. In the remainder of the chapter, we assume that local governments account for (4.19) by adjusting the land tax  $\tau_j^{\mathcal{L}}$  so as to clear their local budget. Formally,  $\tau_j^{\mathcal{L}}$  is replaced in the definition of the aggregate land rent  $\Gamma$  (4.11), whose explicit form is derived in [Appendix B](#).

Local governments do not directly control the location of capital, residents and workers in the MA. However a rational government must take into account the location responses of economic agents to its policy decisions. To this aim, each local government accounts for the private behavior described in [section 3](#), and more specifically, for the fact that the center's and towns' population ( $R_c$  and  $R_{s_i}$ ), workforce ( $W_c$  and  $W_{s_i}$ ) and capital ( $K_c$  and  $K_{s_i}$ ) are implicitly defined as functions of the municipal policy instruments  $\{\tau_c^R, \tau_{s_i}^R, \tau_c^K, \tau_{s_i}^K, \tau_c^W, \tau_{s_i}^W, G_c, G_{s_i}\}_{i \in \llbracket 1, n \rrbracket}$  by the following location equation system:

$$F_K^c - \psi \frac{F^c}{K_c} - \tau_c^K = F_K^{s_i} - \psi \frac{F^{s_i}}{K_{s_i}} - \tau_{s_i}^K \quad i \in \llbracket 1, n \rrbracket \quad (4.20)$$

$$F_W^c - \tau_c^W - F_L^c + U^c + U^{cc} - \tau_c^R = F_W^{s_i} - \tau_{s_i}^W - F_L^{s_i} + U^{s_i} + U^{s_i s_i} - \tau_{s_i}^R \quad i \in \llbracket 1, n \rrbracket \quad (4.21)$$

$$F_W^c - \tau_c^W - F_W^{s_i} + \tau_{s_i}^W + U^{s_i c} - U^{s_i s_i} = t \left( \frac{R_c}{n} + R_{s_i} - \frac{3}{2} W_{s_i} \right) \quad i \in \llbracket 1, n \rrbracket \quad (4.22)$$

$$\mathcal{K} = K_c + \sum_{i=1}^n K_{s_i} \quad (4.23)$$

$$\mathcal{P} = R_c + \sum_{i=1}^n R_{s_i} \quad (4.24)$$

$$\mathcal{P} = W_c + \sum_{i=1}^n W_{s_i} \quad (4.25)$$

where  $L_j$  has been substituted in the production function using (4.2),  $F^j = F(W_j, K_j, \mathcal{L}_j - R_j)$ . Condition (4.20), which restates (4.10c), determines the amount of capital  $K_{s_i}$  used in each the towns  $s_i$ . Condition (4.21), which restates (4.18), determines the population  $R_{s_i}$  in each town  $s_i$ . Condition (4.22), which restates (4.17), determines the number of workers  $W_{s_i}$  in each town  $s_i$ . Condition (4.23),

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Their integration is allowed by the urban structure of the present model, in which commuters are well identified households. This should be distinguished from previous tax competition models with commuting (see e.g. [Braid, 1996, 2000](#); [Ly, 2018](#)) where workers are only modeled as a production factor without utility function.

which restates (4.4), determines the amount of capital  $K_c$  in the city. Condition (4.24), which restates (4.3a), determines the population  $R_c$  in the city. Condition (4.25), which restates (4.3b), determines the number of workers  $W_c$  in the city.

## 5. Optimal local public policies with labor taxes

### 5.1. Public policy of the towns

The optimal local public policy rules governing the behavior of the central municipality  $c$  and the towns  $s_i$  can now be established. In this section, we consider the case where the tax instrument set of municipalities contains labor taxes  $\tau_j^W$ . Since all towns  $s_i$  are identical, we drop index  $i$  in the remainder of the chapter. To derive the optimal behavior of town  $s$ , we must solve the third stage of the game — accounting for the fourth stage. Local authorities of town  $s$  maximize the utility of their representative resident who lives at location  $l = C$  (or  $l = D$ ), by choosing  $\tau_s^R$ ,  $\tau_s^K$ ,  $\tau_s^W$ , and  $G_s$ , while adjusting  $\tau_s^L$  so as to satisfy (4.19). When making its policy choices, government  $s$  considers the choice of all other governments as given. However, as explained in section 4, government  $s$  accounts for the responses of economic agents to its policy decisions. Since town  $s$  is atomistic, it regards its decisions as having no effect on variables in the city and the other towns. Its program is therefore to maximize:<sup>24</sup>

$$V_s[\rho(C), w_s] = -F_L^s + F_W^s - \tau_s^W + rk + \Gamma + U^s + U^{ss} - \tau_s^R, \quad (4.26)$$

choosing  $\tau_s^R$ ,  $\tau_s^K$ ,  $\tau_s^W$  and  $G_s$ , and subject to:

$$F_K^s - \psi \frac{F^s}{K_s} - \tau_s^K = F_K^c - \psi \frac{F^c}{K_c} - \tau_c^K, \quad (4.27)$$

$$F_W^s - \tau_s^W - F_L^s + U^s + U^{ss} - \tau_s^R = F_W^c - \tau_c^W - F_L^c + U^c + U^{cc} - \tau_c^R, \quad (4.28)$$

$$F_W^s - \tau_s^W + U^{ss} + t \left( R_s - \frac{3}{2} W_s \right) = F_W^c - \tau_c^W + U^{sc} - t \frac{R_c}{n}, \quad (4.29)$$

which restates conditions (4.20)–(4.22), and where all variables and functions on the right hand side of the equalities are exogenous from the viewpoint of municipality  $s$ . Specifically, constraints (4.27)–(4.29) state that government  $s$  accounts for the responses of  $K_s$ ,  $R_s$  and  $W_s$  to its policy choices. Solving the above maximization problem, the following result can be derived:

**Result 4.1.** *The optimal public policy rules followed by the benevolent local government of a town  $s$  when financing its public good provision  $G_s$  using the tax instrument*

<sup>24</sup> The explicit form of  $\Gamma$  is derived in Appendix B.

set  $\{\tau_s^R, \tau_s^K, \tau_s^W, \tau_s^L\}$  are:

$$R_s U_G^s + W_s U_G^{ss} = C_G^s, \quad (4.30)$$

$$\tau_s^R = C_R^s + t \frac{W_s}{2}, \quad (4.31)$$

$$\tau_s^K = -\frac{\psi F^s}{K_s}, \quad (4.32)$$

$$\tau_s^W = C_W^s, \quad (4.33)$$

and  $\tau_s^L$  allows to clear the budget constraint (4.19).

*Proof.* See Appendix C. □

Condition (4.30), which characterizes the public good provision rule of  $s$ , reveals that the towns efficiently provide local public goods. Indeed, (4.30) is a modified Samuelson rule extended to an economy in which workers also benefit from the local public good provision. It states that the sum of the marginal willingness to pay for the local public good of residents  $R_s U_G^s$  and workers  $W_s U_G^{ss}$  of town  $s$  is equal to the marginal cost of the local public good provision  $C_G^s$ . This rule extends an important result derived in tax competition models with residents' mobility (Wilson, 1995; Wellisch and Hulshorst, 2000) stating that when residents are mobile and a head tax is available to internalize the costs entailed by residential mobility, public goods are efficiently provided. Condition (4.30) states that when residents and workers are mobile, and taxes on residents and workers are available to internalize their mobility costs, municipalities are provided with the right incentive to internalize not only the preferences of their residents but also these of the workers consuming the local public good.

Condition (4.31), which characterizes the resident taxation rule of  $s$ , indicates that  $\tau_s^R$  — the fiscal benefit of a new resident in  $s$  — internalizes two different costs. The first,  $C_R^s$ , represents the marginal congestion costs induced by new residents whose additional consumption increases the cost of the public good. While this first cost is standard in this literature, the second cost reveals a new role of residential taxes in a MA. The cost  $tW_s/2$  represents the commuting cost incurred by a new resident of  $s$  if she works in her new home town, since  $W_s/2$  is the distance she would have to cover to work in the SBD.<sup>25</sup> In other words, a new resident in  $s$  makes its

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<sup>25</sup> For simplicity, we assume in this interpretation that the new resident locates at the extremity of the town and work in the SBD. Actually, she can choose to reside anywhere in  $s$  (and potentially work in the CBD).  $tW_s/2$  must be regarded as an average cost of the accessibility of the SBD of  $s$  for all its residents. Wherever a new resident chooses to locate in  $s$ , she increases the average accessibility cost of the SBD by  $tW_s/2 + \varepsilon$ .

SBD less accessible by increasing the average commuting cost to work in  $s$ . Thus, in order to safeguard an optimal level of access to its SBD by limiting its population size, the local government of  $s$  is spurred to rise its residential tax  $\tau_s^R$  above the congestion cost  $C_R^s$ . Then, condition (4.36) points out a new possible reason for the high residential tax rate raised by municipalities in practice.<sup>26</sup>

Condition (4.32), which characterizes the capital taxation rule of  $s$ , indicates that town  $s$  is provided with the right incentive to internalize the positive externality entailed by agglomeration economies. As discussed in 3, the benefit of agglomeration economies is not accounted for by capital owners who only care about making non negative profits. With a zero capital tax, this behavior entails an efficiently low level of capital in  $s$ . Condition (4.32) indicates that town  $s$  subsidizes capital to provide capital owners with the incentive to internalize the positive externality resulting from agglomeration economies. The level of this externality,  $\psi F^s/K_s$ , is the additional output per capital unit ignored by investors in the absence of a capital subsidy.

Finally, condition (4.33), states that the labor tax is used as a congestion tax to internalize the costs of workers mobility, just as the residential tax in traditional tax competition model with household mobility. Interestingly, we can notice from the observation of conditions (4.31) and (4.33) that the role of the residential tax to control the level accessibility of the SBD is not due to an absence of labor tax.

## 5.2. Public policy of the city

Let us now turn to the policy decisions of the central municipality  $c$ , that is the first stage of the game — accounting for the three subsequent stages. The local authorities of the city maximize the utility of their representative resident who lives at location  $l = -A$ , by choosing  $\tau_c^R$ ,  $\tau_c^K$ ,  $\tau_c^W$ , and  $G_c$ , while adjusting  $\tau_c^L$  so as to satisfy (4.19). Contrary to the towns, the center has market power and therefore accounts for the responses of all economic agents of the MA to its policy decisions. Moreover, as a Stackelberg leader it also accounts for the optimal policy behavior of suburban municipalities (third stage of the game). Its program is therefore to maximize:

$$V_c[\rho(-A), w_c] = -F_L^c + F_W^c - \tau_c^W + rk + \Gamma + U^c + U^{cc} - \tau_c^R, \quad (4.34)$$

choosing  $\tau_c^R$ ,  $\tau_c^K$ ,  $\tau_c^W$  and  $G_c$ , and subject to the full location system (4.20)–(4.25) and the suburban governments' policy rules (4.30)–(4.33). Thus, the central city

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<sup>26</sup> To our knowledge, there exists no other previous contribution showing that taxes on residents are used to internalize accessibility costs to the business district in a MA. This new result shows up because of the urban structure of the present tax competition model including residential mobility.

accounts for the effects of its decisions on the location choices of all agents in the economy — that is on variables  $R_c$ ,  $R_s$ ,  $K_c$ ,  $K_s$ ,  $W_c$  and  $W_s$  — and it also accounts for the policy responses of suburban governments — that is, changes in  $\tau_s^R$ ,  $\tau_s^K$ ,  $\tau_s^W$ ,  $\tau_s^L$  and  $G_s$ . Solving its maximization problem, the following result can be derived:

**Result 4.2.** *The optimal public policy rules followed by the benevolent local government of the city  $c$  when financing its public good provision  $G_c$  using the tax instrument set  $\{\tau_c^R, \tau_c^K, \tau_c^W, \tau_c^L\}$  are:*

$$R_c U_G^c + R_c U_G^{cc} + (W_c - R_c) U_G^{sc} = C_G^c, \quad (4.35)$$

$$\tau_c^R = C_R^c + t \frac{W_c}{n}, \quad (4.36)$$

$$\tau_c^K = -\psi \frac{F_c^c}{K_c}, \quad (4.37)$$

$$\tau_c^W = C_W^c, \quad (4.38)$$

and  $\tau_c^L$  allows to clear the budget constraint (4.19).

*Proof.* See Appendix D. □

According to conditions (4.35)–(4.38), the central city’s behavior is similar to that of towns. Condition (4.35) is the extended Samuelson rule for the city. It states that the provision of  $G_c$  is such that the sum of the marginal willingness to pay for the central city’s public good of the residents of  $c$ ,  $R_c U_G^c$ , its workers-residents,  $R_c U_G^{cc}$  and commuters from the suburb  $(W_c - R_c) U_G^{sc}$  is equal to the marginal cost of the public good provision  $C_G^c$ . This rule reveals that the city does not only account for the benefits of its own residents, but it also internalize the spillovers induced by workers’ mobility from the suburb to the city. Conditions (4.36)–(4.38) are qualitatively identical to conditions (4.31)–(4.33) described above.

### 5.3. Comparison of the tax rates

From the taxation rules of the towns (4.31)–(4.33) and those of the city (4.36)–(4.38), it is now possible to compare the level of the center and suburban tax rates. The following result characterizes the tax rate differentials:

**Result 4.3.** *The optimal local public policy rules are:*

$$\tau_c^R - \tau_s^R = C_R^c - C_R^s + \frac{3t}{2n} \left( W_c - \frac{\mathcal{P}}{3} \right) \quad (4.39)$$

$$\tau_c^K - \tau_s^K = \psi \left( \frac{1}{\varepsilon_s} - \frac{1}{\varepsilon_c} \right) F_K^s \quad (4.40)$$

$$\tau_c^W - \tau_s^W = C_W^c - C_W^s \quad (4.41)$$

where  $\varepsilon_j \equiv F_K^j K_j / F^j$  is the output elasticity with respect to capital.

*Proof.* See [Appendix E](#). □

Condition (4.39) indicates that two motives explain the resident tax rate differential between the city and a town: congestion and accessibility costs. The term  $C_R^c - C_R^s$  indicates that, *ceteris paribus*, the city set a higher resident tax if residents entail more congestion in the center than in the suburb. This term suggests that a higher tax rate would be observed in the city. Indeed, since public good provision is usually higher in the city than in the suburb,  $G_c > G_s$  (admitting [Assumption 4.1](#)), providing additional public services in the center tends to be more costly (since  $C_{RG} > 0$ ).<sup>27</sup> This goes in the same direction as the tax rate ordering predicted in the existing literature: the center taxes more than the suburb. The argument here is more basic and does not rely on the stronger market power of the center: providing public goods in the center is more costly. The second term of (4.39),  $3t/(2n)(W_c - \mathcal{P}/3)$ , implies a more mitigated tax rate ordering. This term stems from the objective of controlling accessibility to their business district of municipalities, using their tax on residents (see previous subsections). It implies that if the city employs a sufficiently low (resp. large) share of the population of the MA — ie. less (resp. more) than one third<sup>28</sup> — it taxes, *ceteris paribus*, less (resp. more) residents than towns. In other words, if jobs are not accessible enough in the suburb compared to the city, towns are driven to rise their tax rate on residents relative to the city. Tax rates in a town can even be higher than that of the city if the accessibility cost is sufficiently important ( $t$  large) and/or its SBD is sufficiently little accessible (large  $W_s$  relative to  $\mathcal{P}$ ) to outweigh the congestion effect described above. Formally, it can be written as:

$$\tau_s^R \begin{matrix} \geq \\ < \end{matrix} \tau_c^R, \quad \text{if} \quad \frac{3t}{2n} \left( \frac{\mathcal{P}}{3} - W_c \right) \begin{matrix} \geq \\ < \end{matrix} C_R^c - C_R^s \quad (4.42)$$

This result provides new motive for potentially lower tax rates in the suburb than in the center. The attractiveness of the center might in this regard play a central role. For instance, in a MA where the city attracts less jobs relative to suburban municipalities, more towns could be driven to set higher tax rates than the city. Our

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<sup>27</sup> A convexity argument could also be used. Assuming that  $C_{RR} > 0$  (cost conver in population) and reasonably admitting  $R_c > R_s$  population of the city is higher than that of a town, we would also have  $C_R^c > C_R^s$ . However, we do not impose convexity.

<sup>28</sup> While the threshold of  $\mathcal{P}/3$  obviously results from the assumptions of our stylized framework, notice that condition  $W_c > \mathcal{P}/3$  does not necessarily hold for all MA in real life. For example, in 2014 Paris has concentrated 1 801 866 of the 5 787 865, that is around 30% workers of its MA. Similar figures are observed in Lyon. However, Marseille has concentrated 49% of its MA employed workers. (Source: <https://www.insee.fr/fr/statistiques/1405599?geo=DEP-75+AU2010-001>).



result also shows that the importance of congestion costs, in practice, can hide this effect of accessibility on the resident tax rate differential. This could partly explain why we observe on [Figure 4.1](#) that few towns raise a higher resident tax than the center.<sup>29</sup> This result can be summarized in the following proposition:

**Proposition 4.1.** *If commuting is costly and if the CBD employs a sufficiently low (high) share the workers of the MA, then the city chooses a lower (higher) tax rate on residents than the towns.*

According to condition (4.40), the ordering of the capital tax rates is apparently less ambiguous than that of the residents tax rates. In the presence of agglomeration economies ( $\psi > 0$ ), the city sets a higher (resp. lower) capital tax rate<sup>30</sup> than towns if its output elasticity of capital is higher (resp. lower) than that of towns. Formally, it can be written as:

$$\tau_c^K \begin{matrix} > \\ < \end{matrix} \tau_s^K \quad \text{if} \quad \varepsilon_c \begin{matrix} > \\ < \end{matrix} \varepsilon_s \quad (4.43)$$

In other words, if capital contributes more to production in the center than in the suburb, the city has a lower incentive to reduce its capital tax rate than towns. From condition (4.43), it might be difficult to figure out whether, in practice, capital tax rates are higher or lower in the center than in the suburb. Indeed, the amount of capital employed in a city is usually (much) more important than the amount of capital used in a town, ie.  $K_c > K_s$ . Then, ceteris paribus, the marginal product of capital should be lower in the center than in the suburb, ie.  $F_K^c < F_K^s$ ,<sup>31</sup> which decreases the contribution of capital to the production in the center relative to the suburb. However, since  $K_c > K_s$ , even if each unit of capital contributes less to the production, due to a size effect, the overall contribution of capital to the production could be higher. This observation calls for further investigation of condition (4.43). To this aim, we introduce the following lemma:

**Lemma 4.1.** *Suppose that  $F(\cdot)$  is weakly separable according to [Assumption 4.2](#), so that  $F^j = F(K_j, X(W_j, L_j))$  for all  $j \in \{c, s\}$ . If the city is more capital intensive than towns, ie.  $K_c/W_c > K_s/W_s$  and  $K_c/L_c > K_s/L_s$ , then:*

$$\varepsilon_c \begin{matrix} > \\ < \end{matrix} \varepsilon_s \quad \text{if} \quad \sigma_{KX} \begin{matrix} > \\ < \end{matrix} 1$$

<sup>29</sup> Our result calls for further empirical investigation of the link between accessibility and the tax rate gap between city and towns. It suggests, estimating this link would require to control for the congestion effect.

<sup>30</sup> In this section,  $\tau^K$  being negative,  $\tau^K$  should be more properly call a capital subsidy rate rather than a capital tax rate. But for simplicity,  $\tau^K$  is qualified as tax rate whatever its sign.

<sup>31</sup> This inequality is itself mitigated by the fact that the center usually also employs more of the other factors, ie.  $W_c > W_s$  and  $L_c > L_s$ , which by the factor technological complementarity, ie.  $F_{XY} > 0$ , should increase  $F_K^c$  relative to  $F_K^s$ .

where  $\sigma_{KX}$  denotes the elasticity of substitution between capital  $K$  and land augmented labor  $X$ .

*Proof.* See [Appendix F](#).<sup>32</sup>

□

[Lemma 4.1](#) assumes that the ratios of capital to labor and capital to business land are both higher in the city than in the towns. This assumption is grounded on the empirical fact that the cities usually concentrate highly capital-intensive firms. Under this sufficient (but not necessary) condition, [Lemma 4.1](#) implies that, in the presence of agglomeration economies (ie.  $\psi > 0$ ), the city  $c$  sets a higher (resp. lower) capital tax than the towns,  $\tau_c^K > \tau_s^K$  (resp.  $\tau_c^K < \tau_s^K$ ), if capital is a gross substitute to (resp. complement for) the other factors,  $\sigma_{KX} > 1$  (resp.  $\sigma_{KX} < 1$ ). This result can be summarized in the following proposition:

**Proposition 4.2.** *Suppose that [Assumption 4.2](#) holds. In the presence of agglomeration economies, if the city is more capital intensive than towns, then the city sets a higher (resp. lower) capital tax than the towns if capital is a gross substitute to (resp. complement for) the other factors.*

[Proposition 4.2](#) highlights the key role of the substitutability of capital for other factors to know whether the city or the towns tax more capital. The intuition behind this central role is the following. If capital is highly substitutable for other factors, the high amount of capital in the center does not imply a too low marginal product of capital (ie. if  $\sigma_{KX} > 1$ ,  $F_K$  decreases less with  $K$ ), so that the contribution of capital to output is more important in the center than in the suburb which concentrates less capital. On the contrary, if capital is highly complementary to other factors, the high amount of capital in the center entails a particularly low marginal product of capital (ie. if  $\sigma_{KX} < 1$ ,  $F_K$  decreases more with  $K$ ), so that the contribution of capital to output is lower in the center than in the suburb.

[Proposition 4.2](#) suggests that the higher capital tax rate in the center relative to the suburb predicted by the literature is not the unique outcome which should be observed in practice, as also suggested by [Figure 4.1](#). More specifically, in MAs where sectors with a high capital complementarity to other factors (tertiary sectors such as office jobs) dominate, more towns would have higher capital tax than the city. This should comparatively be less so in MAs where sectors such as the industrial sector (in which machineries can more easily replace workers) dominate.

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<sup>32</sup> [Appendix F](#) also illustrates [Lemma 4.1](#) for the case of the nested CES production function. Notice that, for a Cobb-Douglas production function,  $\sigma_{KX} = 1$  so that  $\tau_c^K = \tau_s^K$ .

Finally, condition (4.41) indicates that the labor tax, whose role is specifically to control for worker congestion, is more likely to be higher in the center where congestion is more significant. The same argument as discussed for the resident tax holds here too: providing additional local public good in the city which usually employs more worker than a town, ie.  $W_c > W_s$ , is more costly — since  $C_{WG} > 0$ .<sup>33</sup>

## 6. Optimal local public policies absent labor taxes

The above analysis assumes that the local tax instrument set includes a labor tax. Municipalities are therefore able, by using it as a pigouvian tax, to internalize congestion induced by workers' consumption of local public goods. It results a socially efficient behavior of municipalities which provide public goods according to the extended Samuelson rule. However, labor taxes are rarely available at the local level in OECD countries.<sup>34</sup> In this section we study municipalities' behavior when no labor tax is available, so that they are deprived from the ability to directly control for worker congestion. Formally, municipality  $j \in \{c, s\}$  has now to satisfy the budget constraint:

$$\tau_j^R R_j + \tau_j^K K_j + \tau_j^L \mathcal{L}_j = C^j, \quad (4.44)$$

and  $\tau_c^W = \tau_s^W = 0$  in framework described in section 3.

### 6.1. Public policy of the towns

The program of town  $s$  is still defined by (4.26)–(4.29), where the tax instruments available to finance the local public good provision  $G_s$  are now  $\tau_s^R$ ,  $\tau_s^K$  and  $\tau_s^L$ . The following result can be derived:

**Result 4.4.** *The optimal public policy rules followed by the benevolent local government of a town  $s$  when financing its public good provision  $G_s$  using the tax instrument set  $\{\tau_s^R, \tau_s^K, \tau_s^L\}$  are:*

$$R_s U_G^s + W_s U_G^{ss} = C_G^s + d_s^G, \quad (4.45)$$

$$\tau_s^R = C_R^s + \frac{tW_s}{2} + d_s^R, \quad (4.46)$$

$$\tau_s^K = -\frac{\psi F^s}{K_s} + d_s^K, \quad (4.47)$$

<sup>33</sup> A convexity argument could also hold here. See footnote 27.

<sup>34</sup> See e.g. Blöchliger and King (2006) and Blöchliger and Rabesona (2009).

and  $\tau_s^L$  allows to clear the budget constraint (4.44). And:

$$d_s^G = \frac{U_G^{ss}}{3t/2 - F_{WW}^s} C_W^s > 0, \quad d_s^R = \frac{(t - F_{WL}^s)}{3t/2 - F_{WW}^s} C_W^s, \quad d_s^K = \frac{F_{WK}^s}{3t/2 - F_{WW}^s} C_W^s > 0. \quad (4.48)$$

*Proof.* See Appendix C. □

The first observation which can be made by comparing conditions (4.45)–(4.47) to the conditions derived in the presence of labor taxes (4.30)–(4.32) is that towns distort their behavior — as apparent from the distortion terms  $d_s^G$ ,  $d_s^R$  and  $d_s^K$  — in order to deal with worker congestion which cannot anymore be controlled for by the labor tax. Indeed, if  $C_W^s = 0$ , the above conditions boil down to the optimal behavior rule derived when a labor tax is available. Further understanding of these distortions is of interest since they are specific to the urban framework developed in this chapter where workers do not coincide with residents but are not a simple production factor since they consume public good at their workplace.<sup>36</sup> Condition (4.45) shows that since it cannot directly internalize worker congestion costs, town  $s$  harms all its residents by under-providing public goods ( $R_s U_G^s + W_s U_G^{ss} > C_G^s$ ) compared to the efficient extended Samuelson rule (4.30). Notice that this strategy makes sense only if the municipality knows that, by reducing its public good provision, it is able to discourage individuals to work in their SBD. Indeed, public goods are efficiently provided if workers do not benefit from local public services ( $U_G^{ss} = 0$ ) which would be the case if congestion were not related to public good consumption.

Condition (4.46) depicts how town  $s$  distorts its tax on residents to tackle the absence of labor tax.<sup>37</sup> The sign of this distortion is ambiguous as can be seen from the expression of  $d_s^R$ . To see this, let us consider separately the two separate effects at stake. Let us examine the first effect by supposing that  $t > 0$  and  $F_{WL}^s = 0$ . In this

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<sup>35</sup> The signs are obtained recalling that  $C_W > 0$ ,  $F_{XX} < 0$  and  $F_{XY} > 0$  for all  $X, Y \in \{K, W, L\}$ .

<sup>36</sup> Richter and Wellisch (1996) and Wellisch and Hulshorst (2000) study the effect of depriving local jurisdictions of taxes on mobile residents generating congestion at their residence place which is also their workplace. The distortion on the business tax and that on public goods they find goes in the same direction as (4.45) and (4.47) and reflects the same idea: the impossibility to directly internalize congestion costs drives jurisdictions to try to indirectly control it using the remaining instruments. However, condition (4.46) has no counterpart in the above paper since removing the tax on labor implies that there is no tax on residents as well in a model where workers and residents coincide.

<sup>37</sup> To our knowledge, there exists no previous contribution presenting the distortion of local resident taxes in response to a lack of local labor taxes. The main reason is that the existing models these two taxes are a single tax on resident-worker.

case, the town over-taxes its residents compared to (4.31). The reason is that since the municipality accounts for imperfect workers' mobility, it uses its tax on residents to discourage residents to settle in its jurisdiction and thus reduces the number of workers generating congestion in the town. Let us now consider the second effect by assuming that  $t = 0$  and  $F_{WL}^s > 0$  (input technological complementarity). In this case, local authorities know that their population size is not linked to its workforce through imperfect workers' mobility since  $t = 0$ . However it knows that it can still discourage households to work in its SBD by reducing the amount of land available to firms. Indeed,  $F_{WL}^s > 0$  implies that additional business land increases the local wage and therefore allows to attract workers. To reduce the land size of its SBD, the municipality decides to under-tax residents — compared to (4.31) — in order to attract new residents and then crowd-off business land.<sup>38</sup>

Finally, condition (4.47) reveals that the town non ambiguously over-taxes capital compared to (4.32). The intuition is straightforward. Due to technological complementarity between capital and labor, local authorities increase their capital tax to discourage capital, and thus indirectly costly workers, to locate in their town.<sup>39</sup>

## 6.2. Public policy of the center

The program of the city  $c$  is still to maximize (4.34) subject to the location system (4.20)–(4.25), accounting for towns' policy characterized by (4.45)–(4.47) and choosing  $G_c$ ,  $\tau_c^R$ ,  $\tau_c^K$  and  $\tau_c^L$ . In all this subsection and the following one, we assume that [Assumption 4.3](#) holds, and therefore ignore third-order effects on  $F^s$ . The following result can be derived:

**Result 4.5.** *Suppose that [Assumption 4.3](#) holds. The optimal public policy rules followed by the benevolent local government of a town  $c$  when financing its public*

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<sup>38</sup> Recall that the total land endowment of a municipality is fixed. Then, the town, when choosing its policy, arbitrate between hosting residents and hosting businesses. This mechanisms is similar to that identified in [Ly \(2018\)](#). Which of the two opposite effects described just above dominates, so that the municipality over-taxes or under-taxes its residents, depends on the relative importance of commuting costs and technological complementarity between labor and business land.

<sup>39</sup> This result echoes [Richter and Wellisch \(1996\)](#). See [footnote 36](#).

good provision  $G_c$  using the tax instrument set  $\{\tau_c^R, \tau_c^K, \tau_c^L\}$  are:

$$R_c U_G^c + R_c U_G^{cc} + (W_c - R_c) = C_G^c + d_c^G \quad (4.49)$$

$$\tau_c^R = C_R^c + \frac{tW_c}{2n} + d_s^R + d_c^R \quad (4.50)$$

$$\tau_c^K = -\frac{\psi F^c}{K_c} + d_s^K + d_c^K \quad (4.51)$$

and  $\tau_c^L$  allows to clear the budget constraint (4.44). And:

$$d_c^G = d_c n U_G^{sc}, \quad d_c^R = -d_c (n F_{WL}^c + F_{WL}^s) + \lambda \frac{\partial \Delta^{G_s}}{\partial R_s}, \quad d_c^K = d_c (n F_{WK}^c + F_{WK}^s), \quad (4.52)$$

where  $d_c = \left( C_W^c - C_W^s + \lambda \frac{\partial \Delta^{G_s}}{\partial W_s} \right) / \left( \frac{3t}{2} - n F_{WW}^c - F_{WW}^s \right)$ ,  $\Delta^{G_s} \equiv R_s U_G^s + W_s U_G^{ss} - C_G^s - d_s^G$  and  $\lambda$  is the Lagrange multiplier of constraint (4.45).<sup>40</sup>

*Proof.* See Appendix D. □

Two preliminary observations need to be made about conditions (4.49)–(4.51). First, they indicate that, absent labor taxes, the city distorts its behavior — compared to conditions (4.35)–(4.37) — not only by accounting for the distortion in the policy instruments of the towns ( $d_s^R$ ,  $d_s^K$  and  $d_s^G$ ), but also by adding its own distortions ( $d_c^R$ ,  $d_c^K$  and  $d_c^G$ ). Thus, the city tries to internalize the distortion of the towns, since residents' mobility entails that if residents of the suburb are worse-off, residents of the city will also be negatively affected.<sup>41</sup> Second, although less obvious than in the case of towns, the basic reason why the city need to distort its policy is the impossibility to control worker congestion using labor taxation. The following lemma states this result:

**Lemma 4.2.** *Suppose that Assumption 4.3 holds. If  $C_W^c = C_W^s = 0$ , then  $d_s^G = d_s^R = d_s^K = 0$  and  $d_c^G = d_c^R = d_c^K = 0$ .*

*Proof.* See Appendix F. □

Lemma 4.2 indicates that were congestion absent, the government of the city would not distort its policy instruments. This lemma confirms that making the labor tax available for the municipalities would ensure a ‘first-best’ allocation of residents, workers and capital in the MA, and municipalities would be able to provide an efficient level of public good.

<sup>40</sup> More rigorously,  $\lambda = \mathcal{P}\mu_7/n$ ,  $\mu_7$  in the Lagrange multiplier of constraint (4.45).

<sup>41</sup> Recall that all households have the same level of utility at equilibrium.

Let us now examine the way in which the city specifically distorts its policy instruments through  $d_c^R$ ,  $d_c^K$  and  $d_c^G$ . Notice that as a Stackelberg leader, the city accounts for the reactions of towns to its decisions. Specifically, the city's policy further distorts the public good provision of towns. This effect is captured by the  $\lambda$  term. Since this Stackelberg effect might not be of prime importance in practice, let us first examine condition (4.49)–(4.51) in the case where  $\lambda = 0$ .<sup>42</sup> In this case the distortions of the city become:

$$d_c^G = d_c n U_G^{sc}, \quad d_c^R = -d_c (n F_{WL}^c + F_{WL}^s), \quad d_c^K = d_c (n F_{WK}^c + F_{WK}^s), \quad (4.53)$$

where  $d_c = (C_W^c - C_W^s) / (\frac{3t}{2} - n F_{WW}^c - F_{WW}^s)$ . Recalling that  $C_{WG} > 0$ ,  $F_{XX} < 0$  and  $F_{XY}$  for all  $X, Y \in \{K, W, L\}$ , and assuming that  $G_c > G_s$  (Assumption 4.1), it follows that the signs of the distortions (4.53) have non ambiguous signs:  $d_c^G > 0$ ,  $d_c^R < 0$  and  $d_c^K > 0$ . These signs are similar to those observed for towns and have the same interpretation. Since the city cannot internalize worker congestion directly through labor taxation, it under-provides its public good to discourage suburbanite to commute to its CBD. For the same reason, it cuts its resident tax to attract new households and then limit the land size of the CBD. And, it increases its capital tax to limit its attractiveness on capital and then on workers. Notice that contrary to  $d_s^R$ ,  $d_c^R$  is non ambiguously negative. The reason is that, as explained above, residents' mobility forces the authorities of the city to account for the welfare of suburbanites. Then, they know that attracting new residents while making the CBD less accessible, improve the accessibility of the SBD. The accessibility of the CBD being already controlled for (term  $tW_c/n$  in (4.50)), the city does not further distort its residential taxation. The same is not true for atomistic towns which do not account for the effect of their policy on residents of the city.

We now turn to the case where  $\lambda \neq 0$ . Since the sign of  $\lambda$ ,  $\partial \Delta^{G_s} / \partial W_s$  and  $\partial \Delta^{G_s} / \partial R_s$  need not be positive, the sign of the distortions  $d_c^G > 0$ ,  $d_c^R < 0$  and  $d_c^K > 0$  may now be ambiguous. In other words, knowing that it affects the public good provision in towns, the city can potentially choose to distort its instruments differently from the manner described above. To see this, let us introduce the following lemma:

**Lemma 4.3.** *Suppose that Assumption 4.3 holds. We have:*

$$\begin{cases} d_c > 0 & \text{if } LL < \frac{\partial G_s}{\partial W_s} < LU, \\ d_c < 0 & \text{otherwise.} \end{cases}$$

---

<sup>42</sup> Notice that, solving the present model in the case where the city has no Stackelberg leadership — that is, a Nash game where the city takes as given the policy of the towns — the essential difference in results is that  $\lambda = 0$ .

with  $LL = -(3t/2 - nF_{WW}^c - F_{WW}^s)/U_G^{ss}$  and  $LU = (C_W^c - C_W^s)/d_s^G$ .

*Proof.* See [Appendix F](#). □

[Lemma 4.3](#) combined with (4.52) indicates that the distortions on the public good provision,  $d_c^G$ , and the capital tax,  $d_c^K$ , of the city depends on the extent to which workers' mobility affects the public good provision in the towns. Specifically, if the towns' public good provision is moderately sensitive to workers flows, the prediction viewed in the case where  $\lambda = 0$  are confirmed. That is, the city reduces its provision of public good and increases its capital tax (compared to the situation where a labor tax is available) in order to limit the workforce in the CBD. However, this behavior is reversed if the towns' public good provision is significantly sensitive to labor mobility. The intuition behind this reversal is the following. The government of the city accounts for the distortion of public good provision in the suburb and knows that rejecting its workers towards the suburb spurs the towns to further distort their public good provision to discourage new workers. Since residents' mobility forces the city to care about the welfare of suburbanites, it chooses not to push its workers towards the suburb if the resulting distortion is too significant in the suburb (high  $\partial G_s/\partial W_s$ ). In this case, it accepts to bear a higher burden of costly (due to congestion) workers in its CBD, by increasing its public good provision and cutting its capital tax, to relieve the SBDs.

As visible from (4.52), the distortion on the resident tax,  $d_c^R$ , is more ambiguous, because of the term  $\lambda\partial\Delta^{G_s}/\partial R_s$ . In fact, there is no clear condition to sign  $d_c^R$ . The intuition behind the term  $d_c(nF_{WL}^c + F_{WL}^s)$  is however transparent. According to [Lemma 4.3](#), we can state from this term that if the distortion in the public good provision of towns caused by labor mobility is low, then the city, as above, chooses to decrease its tax on residents to limit the size of its CBD and by this way the amount of costly workers it hosts. On the contrary, if the distortion caused to towns becomes too important, then the city increases its tax on residents to alleviate the SBDs from a too large amount of costly workers. However, the term  $\lambda\partial\Delta^{G_s}/\partial R_s$  has an ambiguous sign. The essential reason is the same as that explaining the ambiguous sign of  $d_s^R$  in (4.48). In order to tackle the issue of costly workers, the towns can wish either to attract new residents (to reduce the size of their SBD) or to push out their current residents (to increase the accessibility to their SBD). This entails that their response to the city's policy to attract (for instance) new residents in the center is by nature difficult to predict. However, notice that, in practice, it appears rather unlikely that the Stackelberg effect is so important that it outweighs the main distortion. It seems more plausible that the policy of the city is firstly driven by its own interest, so that the lack of labor tax drives it to reduce its tax on residents.



### 6.3. Comparison of tax rates

We now turn to the comparison of the tax rates of the city and the towns. The following result can be derived:

**Result 4.6.** *Suppose that Assumption 4.3 holds. The optimal local public policy rules are:*

$$\tau_c^R - \tau_s^R = C_R^c - C_R^s + \frac{3t}{2n} \left( W_c - \frac{\mathcal{P}}{3} \right) + d_c^R \quad (4.54)$$

$$\tau_c^K - \tau_s^K = \psi \left( \frac{1}{\varepsilon_s} - \frac{1}{\varepsilon_c} \right) F_K^s + \left( 1 - \frac{\psi}{\varepsilon_c} \right) d_c^K \quad (4.55)$$

where  $\varepsilon_j \equiv F_K^j K_j / F^j$  is the output elasticity with respect to capital.

*Proof.* See Appendix E. □

Result 4.6 shows that the ordering of tax rates is driven by the same forces as in the case where labor taxes are available stated in Result 4.3.<sup>43</sup> However, an additional element appears: the policy distortion of the center. As expected, the policy distortion of the towns are not present since they are internalized by the city which accounts for the welfare of suburbanite due to residents' mobility. To interpret condition (4.54) suppose — certainly the most plausible case in practice — that the Stackelberg distortion of the city's policy is dominated by the direct distortion viewed in the previous subsection. In this case ( $d_c^R < 0$ ), the resident tax rate of the city decreases relative to that of towns due to the unavailability of labor taxes. In other words, the government of the city makes use of its market power to set relatively lower tax rates on residents to reduce the size of the CBD and then limit worker congestion in its municipality. This effect goes in the opposite direction of the literature which mainly predicts that tax rates on residents of cities should be above those of towns.

According to condition (4.55), the opposite behavior is expected concerning the tax on capital. Assuming once again that the Stackelberg effect is not excessively strong, we have  $d_c^K > 0$  and  $1 - \psi/\varepsilon_c > 0$ ,<sup>44</sup> then in response to the absence of labor taxes, the government of the city makes use of its market power to increase its tax rate relative to that of the towns, in order to discourage new investments and

<sup>43</sup> If  $d_c^R = d_c^K = 0$ , (4.54) and (4.55) boil down to (4.39) and (4.40).

<sup>44</sup> Rigorously, a sufficient condition for  $1 - \psi/\varepsilon_c$  to be positive is  $r + \tau_c^K > 0$  (see Appendix E). It is not a too demanding assumption since, from (4.51),  $\tau_c^K$  needs not be negative (since  $d_c^K$  and  $d_s^K$  are positive) as in the case without labor tax. Moreover, we may assume that the production function  $F^c$  is such that the demand for capital is sufficiently high relative to the fixed capital supply  $\mathcal{K}$  for  $r$  to be high enough to cover a possible capital subsidy.

therefore limit the congestion of workers in its municipality. This effect goes in the same direction as the literature which mainly predicts that capital tax rates in the city should be higher than in the towns. However, two nuances can be given. First, the above distortion might not be important enough to compensate lower capital tax rate of cities in MAs where capital is highly complementary to other factors (see [Proposition 4.2](#)). Second, recall that the Stackelberg effect can push the capital tax rate of the city down. Even if this effect might be low in practice, it can mitigate the incentive of the city to set higher tax on capital when missing the power to tax labor. The above results can be summarized in the following proposition:

**Proposition 4.3.** *If the Stackelberg effect is not too high, owing to its market power,<sup>45</sup>*

- (i) the city increases its tax rate on residents relative to the towns in response to the absence of a labor tax,*
- (ii) the city decreases its tax rate on residents relative to the towns in response to the absence of a labor tax.*

## 7. Numerical simulation

[Section 5](#) showed that different reasons can explain that suburban municipalities charge higher taxes on capital and residents than the city. Towns can charge a higher tax on residents if their SBD is insufficiently accessible relative to the CBD. Besides, their tax on capital can be higher than that of the city if capital is a gross complement to other inputs. To obtain further insights about these results, this section provides numerical simulations. The elasticity of substitution of capital to land-augmented labor,  $\sigma_{kx}$  appears as the most important underlying parameter of the analysis conducted in the chapter. While  $\sigma_{kx}$  is a key parameter to compare the capital tax of the city and that of the towns, it also plays an interesting role for all other variables of the model. The simulations below shed a light on this role.

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<sup>45</sup> The policy of the city in the absence of labor taxes is a so-called NIMBY (not-in-my-backyard) behavior. That is, the government of the city uses its policy instruments to prevent too many costly workers to pour into the city.

**Table 4.2.** Calibration for the simulations.

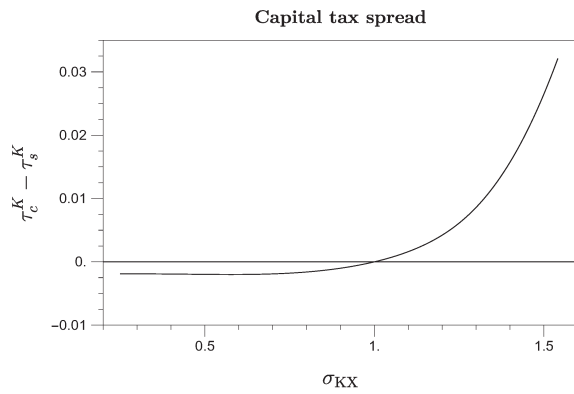
Parameter	$n$	$\mathcal{K}$	$\mathcal{P}$	$\mathcal{L}$	$t$	$\gamma$	$a$	$b$	$\sigma_{\text{WL}}$	$\psi$	$\theta$
Value	20	100000	7000	10000	0.001	-0.5	0.5	0.7	0.75	0.1	0.1

NOTE.— The table presents the parameter values for the simulations.  $n$  denotes the number of towns,  $\mathcal{K}$  the capital endowment of the MA,  $\mathcal{P}$  the population of the MA,  $\mathcal{L}$  the land endowment of the MA,  $t$  the linear commuting cost per distance unit,  $\gamma$  the elasticity of the utility with respect to public good consumption,  $a$  and  $b$  the share parameters of the production function,  $\sigma_{\text{WL}}$  the elasticity of substitution between labor and business land,  $\psi$  the agglomeration economy parameter, and  $\theta$  the share of land of the city.

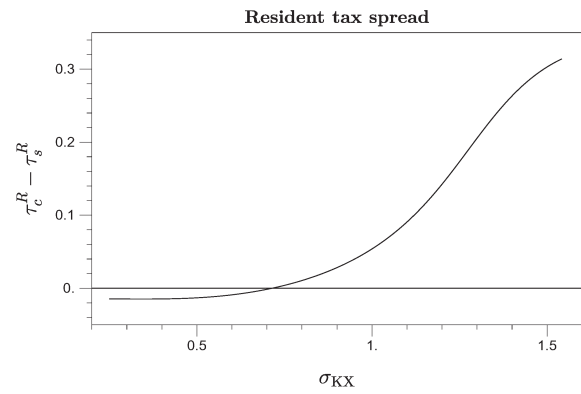
To focus on the main effects recalled just above, we assume that congestion is absent so that  $C(G) = G$  and we ignore spillovers by considering the utility function  $u(G) = \frac{1}{\gamma+1}G^{\gamma+1}$ . The absence of congestion also allows to ignore labor taxes. The production is carried out using a nested CES function:

$$F(W, K, L) = [aK^\delta + (1-a)(bW^\eta + (1-b)L^\eta)^{\frac{\delta}{\eta}}]^{\frac{\psi+1}{\delta}}.$$

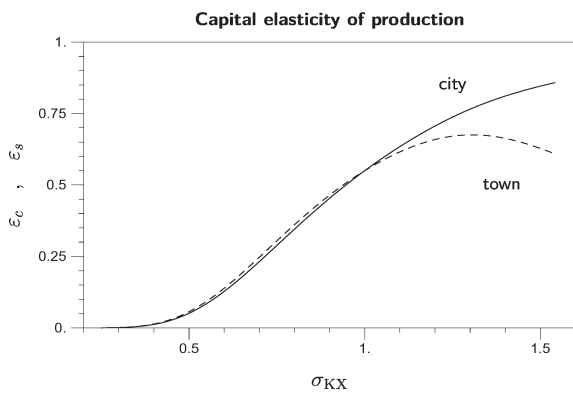
The total land endowment of the economy,  $\mathcal{L}$ , is assumed to be distributed between the city and the town according to the concentration parameter  $\theta$  so that  $\mathcal{L}_c = \theta\mathcal{L}/n$  and  $\mathcal{L}_s = (1-\theta)\mathcal{L}/n$ . [Table 4.2](#) summarizes the value of the parameters used for the simulation.



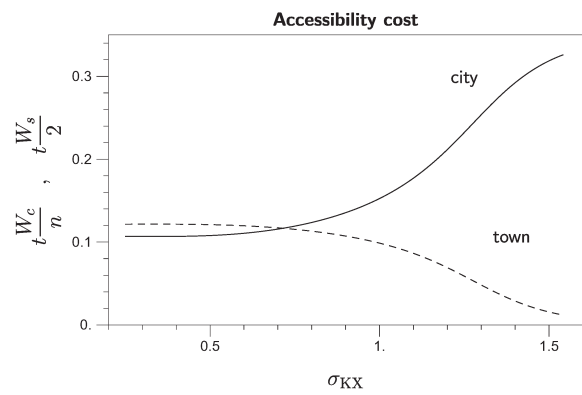
(a) Capital tax rate gap as a function of  $\sigma_{KX}$ .



(b) Resident tax rate gap as a function of  $\sigma_{KX}$ .



(c) Capital elasticity of output as a function of  $\sigma_{KX}$ .



(d) Accessibility costs as a function of  $\sigma_{KX}$ .

**Figure 4.4.** Tax spreads between the city and a town as a function of  $\sigma_{KX}$ . The indexes  $c$  and  $s$  respectively denote the city and the representative town.  $\sigma_{KX}$  denotes the elasticity of substitution between capital and land-augmented labor,  $\tau_j^K$  the capital tax rates of municipality  $j$ ,  $\tau_j^R$  the tax rate on residents;  $\varepsilon_j$  the capital elasticity of output,  $W_j$  the amount of workers,  $t$  the linear commuting cost, and  $n$  the number of towns.

Figure 4.4 plots the capital tax rate and the resident tax rate differentials between the city and the representative town as a function of the elasticity of substitution of capital to land-augmented labor. In order to figure out the forces which drive these tax rate differentials, the capital elasticity of output and the accessibility costs are also plotted.<sup>46</sup> As expected, panel (a) shows that the city, which is mainly more capital intensive than towns (see Figure A.2), charges lower (resp. higher) taxes on

<sup>46</sup> To complete the picture, Figure A.2 in Appendix G represents the capital externality and the capital intensities with respect to other inputs for the city and the representative town. Figure A.3 plots the level of capital, labor, population and business land for the city and the representative town.

capital when capital is a gross complement (resp. substitute) for land-augmented labor, that is when  $\sigma_{kx} < 1$  (resp.  $\sigma_{kx} > 1$ ). However, an increasing pattern of the capital tax rate gap, which was not apparent before, shows up when  $\sigma_{kx} > 1$ . From condition (4.40), we know that this pattern must be due to an increase in the output elasticity of capital of the city relative to that of towns, which is confirmed by panel (c). It shows that the output elasticity of capital increases in both types of municipalities when  $\sigma_{kx}$  rises but at a higher rate in the city when  $\sigma_{kx} > 1$ .

The question arises as to why the output elasticity of capital increases more in the city than in the suburb when  $\sigma_{kx} > 1$ . When  $\sigma_{kx}$  increases, capital investments become more profitable since the marginal productivity decreases less when capital increases. Agglomeration economies imply that this effect is stronger in the city which concentrates more capital when  $\sigma_{kx} > 1$ . This relatively higher profitability of capital investments in the city increases (resp. decreases) the amount of capital in the city (resp. in the towns) — see Figure A.3. Thus, the intensity of capital among the other factors increases in the city relative to that of towns. This concentration of capital in the city explains the increase of  $\varepsilon_c$  relative to  $\varepsilon_s$  when  $\sigma_{kx} > 1$  (Lemma 4.1).<sup>47</sup> This explains the diverging trend of the capital tax rates for  $\sigma_{kx} > 1$ .

The resident tax rate gap depicted on panel (b) of Figure 4.4 follows an increasing pattern when  $\sigma_{kx}$  rises. As visible on panel (d), this pattern is due to an increase (resp. decrease) of the accessibility cost in the city (resp. towns). The basic reason for this trend is that increasing capital substitutability with other factors improves the profitability of additional capital investments in the city which is more capital intensive. The attraction of more capital investments in the city is accompanied by worker flows from the suburb to the city, which makes the CBD (resp. SBDs) less (resp. more) accessible and spurs authorities of the city (resp. towns) to rise (resp. cut) their tax on residents to control the accessibility level of their business district. Notice that for low levels of  $\sigma_{kx}$ , the CBD is sufficiently accessible relative to SBDs for the city to levy a lower tax on residents than the towns.<sup>48</sup>

In sum, the simulations depicted in Figure 4.4 confirm and illustrate the main predictions in section 5: (1) towns can charge a higher capital tax than the city if capital is a gross complement to other inputs; (2) towns can charge a higher tax on

<sup>47</sup> See Appendix F for a general statement.

<sup>48</sup> On panel (b), the tax rate gap is only slightly higher in towns than in the city for low values of  $\sigma_{kx}$ . This gap actually highly depends on the number of towns  $n$  and on the concentration of land of the central municipality  $\theta$ . Increasing one or both of these parameters can imply a significant tax rate differential  $\tau_s^R - \tau_c^R$  for low values of  $\sigma_{kx}$ . The relatively low values of  $n$  and  $\theta$  have been chosen for expositional reasons.

residents than the city if their SBD is insufficiently accessible relative to the CBD. Additionally, the simulations reveal that in the presence of agglomeration economies, the elasticity of substitution of capital to land-augmented labor plays the role of a concentration parameter: the higher  $\sigma_{kx}$ , the more productive activities concentrate in the city, and the more likely it charges higher taxes on both residents and capital than towns.

## 8. Conclusion

In this chapter, we have investigated tax competition between sub-metropolitan municipalities when capital, residents and workers are mobile, and both households and firms compete for local land markets. We have considered asymmetric MAs with a city surrounded by satellite municipalities. This model is the first contribution to consider tax competition among asymmetric municipalities linked by resident, worker and capital mobility across sub-metropolitan jurisdictions.

We have provided several new results. First, agglomeration forces lead the city, where firms are usually more capital intensive, to set higher (lower) capital tax rates than the towns when capital is a gross substitute (complement) for other inputs. Second, taxes on residents are higher (lower) in the city than in the suburb when a sufficiently high (low) share of workers are employed in the CBD. Third, the unavailability of local labor taxes drives the city to decrease (increase) its tax on residents (capital) relative to that of the towns. Fourth, the absence of local labor taxes entails an under-provision of local public goods.

This chapter contributes to fill the gap between the local public economics literature and the urban economics literature as initiated by [Gaigné et al. \(2016\)](#). The urban structure of the model opens several directions for future research. By integrating unemployed households to the model as in [Zenou \(2009\)](#), one could analyze how tax competition among municipalities can affect local unemployment and investigate the possibility of new local policy to address the unemployment issue. Moreover, integrating more remote suburban municipalities to the model would provide new insights on competition between suburban municipalities. Indeed, while some municipalities have access to the CBD, more remote ones do not. This could provide a certain market power to municipalities which are the closest to the CBD. It could be informative to study how this asymmetry affects their respective policy and that of the central city. Many features from urban economics, whose recent models capture an impressive amount of real-life features (e.g. sorting, trade, monopolistic competition...) of MAs could also be studied in the context of urban tax competition.



# Conclusion

## 1. Main results and contribution

This section briefly recalls the main results of the thesis and its main contributions.<sup>49</sup>

### 1.1. Main results

Chapter 1 investigated the efficiency properties of tax competition between sub-metropolitan jurisdictions when capital, residents and workers are mobile, and both households and firms compete for local land markets. We analyzed two decentralized equilibria: (1) with a local tax on residents and two separate local taxes on capital and land inputs, efficiency is achieved and the existence of a *marginal fiscal cost* due to residents' mobility is revealed; (2) combination of the taxes on capital and land inputs into a single business property tax leads local authorities to charge inefficiently high taxation on capital. We showed that capital mobility induces a reduction in the business land taxation and local public inputs are used to offset the distorting effects of the business property tax, accounting for the distorting impact of workers' mobility.

Chapter 2 presented a discussion around the model introduced in Chapter 1. First, we discussed two types of limited household mobility. Workers' limited mobility is addressed by introducing commuting costs in the baseline framework. We showed that for jurisdictions with low or high local labor demand, the baseline results remain. However, for jurisdictions with intermediate-level labor demand, residents work where they live contrary to the baseline model; the resulting departures from the baseline results have been described. Residents' limited mobility is addressed by introducing immobile landowners. We showed that a single business property tax constraint leads local governments to provide an inefficiently high level of public good when immobile residents have a greater marginal willingness to pay for the local public good than mobile residents. Second, we discussed how policies

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<sup>49</sup> See section 4 in the [Introduction](#) for a more detailed summary.



can correct the distortions entailed by the single business property tax constraint. Three types of policies have been addressed: dissociation of business property tax bases, vertical transfers and land-use restrictions.

Chapter 3 investigated the impact of tax base mobility on local taxation. We first developed a theoretical model in order to examine the connection between local business property taxation and tax base mobility within a metropolitan area. We found that, in the presence of a budget compensation, decreasing capital intensity in the business property tax base, composed of capital and land, increases the business property tax rates and decreases the tax rates on residents. We then tested this result using a French reform, which changed the composition of the main local business tax base in 2010. Estimations using difference-in-differences showed that the reduction in the mobility of the tax base indeed results in a 14% rise in the business property tax rates and a reduction of housing tax rates by 1.3% in 2010 compared to their pre-reform average level.

Chapter 4 focused on the following question: who, the central city or the suburban towns, sets the highest taxes in a metropolitan area and why? To address this issue, we developed a new sub-metropolitan tax competition model which contributes to fill the gap between local public economics and urban economics. It involves an asymmetric metropolitan area with a central municipality surrounded by satellite municipalities linked by mobile capital and mobile residents who can commute to work; both households and firms compete for local land markets. A new feature is that workers benefit from local public goods provided at their workplace and generate congestion. Several new results have been derived. First, agglomeration forces lead the city, where firms are usually more capital intensive, to set higher (lower) capital tax rates than the towns when capital is a gross substitute (complement) for other inputs. Second, taxes on residents are higher (lower) in the city than in the suburb when a sufficiently high (low) share of workers are employed in the CBD. Third, the unavailability of local labor taxes drives the city to decrease (increase) its tax on residents (capital) relative to that of the towns. Fourth, the absence of local labor taxes entails an under-provision of local public goods.

## 1.2. *Main contribution*

The overall main contribution of our thesis is to provide a better knowledge of local governments in a tax competition environment occurring within a metropolitan area where capital, residents and workers are highly mobile. Each chapter brought its own contribution to this overall objective.

Chapter 1 proposes the first sub-metropolitan tax competition model with capital, residents' and workers' mobility. We believe that previous models in the litera-

ture did not allow to properly describe the choices made by governments of low-level jurisdictions such as municipalities when they are endowed with policy instruments, as is the case in practice. This chapter addresses this shortcoming and proposes a new model to analyze sub-metropolitan jurisdictions.

This chapter also contributes to the literature by shedding light on tax instrument a commonly used in practice but often overlooked in the theoretical literature: the single business property taxation on capital investments and real property. [Chapter 1](#) showed that this tax leads to an inefficiently low taxation of firms and can drive local governments to engage in an inefficient subsidy competition to attract mobile capital. In this regard, this chapter shows that considering the single business property tax on capital and land sheds a new light on the effect of capital mobility on local governments' choices.

We believe that studying this type of taxes is a major concern not only because it is common in practice that considering business capital and business land are taxed together. But, beyond the case of the business property tax studied in this chapter, all real property taxes can be viewed as taxes on both mobile capital (e.g. investments in housing, buildings and infrastructure) and immobile land (e.g. land plots on which these building are constructed and pure vacant land).

[Chapter 2](#) contributes to two strands of the tax competition literature. First, by deriving an optimal grant scheme allowing to tackle the inefficiency issue raised by the single business property taxation, it contributes to the literature on efficiency-enhancing grants in distorting tax competition contexts e.g. (e.g. [Wildasin, 1989](#); [DePater and Myers, 1994](#)). The main contribution of the chapter, in this regard, is to show that an optimal grant policy scheme allowing to compensate the downward pressure exerted by capital mobility on the business property tax rate is "U-shaped": municipalities with extreme population sizes shall receive a higher grant.

The second and main contribution of [Chapter 2](#) is to highlight the key role of land-use restriction policies in at the sub-metropolitan level. To our knowledge, [Chapter 2](#) is the first study to investigate the role of land-use restriction policies when households and firms compete for land. Our analysis not only show that land-use policies can solve the inefficiency problem caused by the single business property tax, but it also reveals the original location pattern of the economic agents when these policy instruments are used.

[Chapter 3](#) contributes to the tax competition literature both theoretically and empirically. First, theoretically, it is the first contribution to show that based on a sub-metropolitan tax competition framework, a new way of identifying the effect of capital mobility on business tax rates emerges. Indeed, this chapter originally shows that the removal of capital from a business property tax base relying both on capital and land allows to identify the effect of capital mobility on local tax rates

if this removal is accompanied with a perfect budgetary compensation provided by the central government.

Second, empirically, [Chapter 3](#) is one of the first contribution to go back to the early tax competition literature finding stating that capital mobility exerts a downward pressure on business tax rates.<sup>50</sup> To date, this result is widely admitted in most empirical studies as an underlying mechanism which, for instance, links local business tax rates among jurisdictions. Moreover, this result is an intermediate underlying mechanism in the great majority of theoretical studies involving capital tax competition. However, this important result has almost never been called into question empirically at the local level.<sup>51</sup> Then, the main contribution of [Chapter 3](#) is to go back to the initial tax competition story and provide one of the first empirical evidence of the existence of a downward pressure exerted by capital mobility on local business tax rates.

Additionally, the original methodology used in [Chapter 3](#) shows that a multiple-tax-instrument approach can reinforce the theoretical and empirical evidence. Indeed, we show that contrary to the business tax rate, the tax rate on residents decreased in response to the compensated removal of capital from the business property tax base. This can be interpreted as further evidence that the business property tax rate increased because of a capital-mobility effect and not because of a pure budgetary effect — which is neutralized by the budgetary compensation.

[Chapter 4](#) contributes to the existing literature in several ways. First, it provides new insights to understand why, in practice, tax rates are not systematically observed at a higher level in cities than in suburban towns. Second, the chapter highlights the ambiguous role of agglomeration economies in this ordering of the level of the capital tax rate between the center and the suburb. Since this ordering depends on the substitutability of capital with other production factors, it suggests that further empirical investigation could be lead to differentiate MAs according to

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<sup>50</sup> Only one contribution precedes our study, [Carlsen et al. \(2005\)](#). This other contribution uses as a theoretical background the early tax competition model developed in [Zodrow and Mieszkowski \(1986\)](#) whose limits to study municipalities have been discussed in [subsection 2.1](#) of the [Introduction](#). Moreover, the empirical approach in this paper is radically different from the one followed in [Chapter 2](#).

<sup>51</sup> Notice a strand of the empirical literature on international tax competition (e.g. [Quinn, 1997](#); [Bretschger and Hettich, 2002](#); [Slemrod, 2004](#); [Kenny and Winer, 2006](#)) addresses a related question. This literature addresses the following question: how mobility driven by openness, integration, globalization affects tax policy? The logic goes back to the well-known [Hettich and Winer \(1988\)](#) approach of the optimal mix of tax instruments with several constraints of various nature on governments. However, contrary to [Chapter 3](#), to our knowledge, none of these empirical studies specifically focuses on the effect of capital mobility on tax rates.

their sectoral composition.

Third, [Chapter 4](#) emphasizes a new link between local taxes on residents and job accessibility. While we might have expected *a priori* that the role of controlling for job accessibility should be assigned to labor taxes, our analysis shows that taxes on residents are the optimal instrument for it. Fourth, the chapter points to the key role of labor taxes in MAs. While, in practice, they are often the missing tool in the tax instrument set of municipalities (see e.g. [Blöchlinger and Rabesona, 2009](#)), our analysis shows that this might entail important inefficient distortion in the policy setting of municipalities. In this regard, our analysis reveals a new distortion in local public good provision entailed by the public good consumption of mobile and costly workers. The absence of labor taxes could ultimately harm residents of municipalities. This result might be viewed as a plea for the availability of labor taxes to municipalities.

Finally, [Chapter 4](#) more generally contributes to fill the gap between the tax competition literature and the urban economics literature, as started by [Gaigné et al. \(2016\)](#). This task is, in our view, essential for local public economics. Recent models of urban economics capture a considerable amount of real-life features of MAs (e.g. agglomeration economies, unemployment, sorting, trade...) which could profitably be introduced into local public economics model to study how local governments can address a bunch of issues. Empirical literature could also benefit from strengthened link between local public economics and urban economics, in view of the considerable amount of data available at the municipal level.

## 2. Policy implications

Several policy implications follow from the study of sub-metropolitan governments conducted in this thesis. They can broadly be divided into two categories. First, our analysis gives a clearer view of the policy instrument set which should be made available to municipalities and lower-level jurisdictions. Second, our thesis suggests that reforming the local institutional context requires to account for the specific responses of local governments.

### 2.1. *A proper policy instrument set*

Decentralization — especially at the sub-metropolitan level — has several advantages. Probably the most admitted one is that it induces a better match between the policy decision making and the needs of individuals. This argues in favor of providing a sufficient amount of policy instruments to municipalities. Beyond this broad statement, our analysis suggests that one should pay particular attention to

the composition of the policy instrument set made available to municipalities. Our policy recommendations in view of building an ‘optimal’ policy instrument set are the following.

First, throughout this thesis it has appeared that residential taxes are a key policy instrument for municipalities. They not only allow local governments to internalize the well-known congestion costs entailed by households, but our analysis in [Chapter 4](#) also reveals another key of role residential taxes. It appears that they also allow local authorities to internalize the costs entailed by a too large number of residents in terms of accessibility to their business district.

Second, our analysis shows that in view of the high mobility of capital, local taxes on capital seem to be rather useless since they lead to a potentially inefficient competition and tend to be chosen at a particularly low level so that they do not bring much local tax revenue.<sup>52</sup> From our analysis, it appears that a special type of capital taxation is particularly detrimental: capital taxes which also include an immobile part such as land. Our study of combined business taxation of capital and land in [Chapter 1](#), [2](#) and [3](#) reveals that these taxes not only constrain local governments to charge inefficiently low taxes on businesses due to capital mobility, but also force them to tax capital too much. This last constraint can drive local governments to engage in an inefficient subsidy competition for mobile capital ([Chapter 1](#)). We therefore recommend reforms such as the business property tax reform implemented in France in 2010 ([Chapter 3](#)).

Third, while they are often missing in local tax instrument sets, based on the analysis conducted in [Chapter 4](#) we recommend a more systematic availability of local labor taxes. Previous literature either considered labor as a simple production factor so that there was no reason to tax it (just as capital) or did not disentangle residents and workers so that residential tax and labor tax were indistinct. Therefore it did not point out the key role of these taxes at the local level. In [Chapter 4](#) we have shown that since workers entail congestion costs at their workplace, a policy instrument is needed to internalize these costs. Otherwise the other instruments are distorted to compensate this lack.

Finally, from [Chapter 2](#), it appears that in the presence of a limited tax instrument set — as is probably always the case in practice — local land-use restriction policies can play a key role for local jurisdictions. These policies are not exces-

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<sup>52</sup> This claim might be tempered by the fact that some capital investments, such as factories or plants, can entail negative externalities, such pollution. However, these negative effects are often perceived by people as minor compared to the benefits induced by capital (e.g. production and employment). Moreover, for externalities such as pollution, it seems that upper-government layers can be more adapted to internalize them.

sively costly. They also allow local governments to have a better control over their budgetary revenue and provide the other policy instruments with more latitude to play their own specific role. So our last recommendation is to further develop local land-use restriction policies.

## *2.2. National objectives and local reforms*

Our investigation of the French business property tax reform of 2010 in [Chapter 3](#) ended up with a rather striking conclusion. While the initial objective of the President of the French Republic, through this reform, was to attract businesses in France,<sup>53</sup> our empirical analysis showed that municipalities responded to the reform by an important increase of their business tax rate. This reaction goes into the opposite direction to the initial objective of the reform. We might even wonder if the attractiveness of France increased following this reform.

It seems that the objective of the national government would have been met more easily if the reform had concerned a national business tax instead of a local one. The central government has indeed much more control over the level of national taxes.

This paradoxical case illustrates the last policy implication of our thesis. It seems that many reforms of the local tax instrument set pursue national objective and do not properly account for the responses of local governments.<sup>54</sup> However, such reforms can entail unexpected distortions at the local level and also generate reactions from local governments mitigating their initial purpose as in [Chapter 3](#).

Our last policy recommendation is to pay more attention to the effect of local reforms with national objectives on local governments choices. In the best-case scenario, it would even be better to only implement local reforms with local objectives. We believe that one of the main reason why policy makers do not account for the local impact of local reforms is that local tax systems are usually complex and it is difficult to have clear expectations about the multiple effects of local reforms. Through this thesis, we have tried to provide more insights into a number of mechanisms at stake at the local level. We believe that it could contribute to clarify these complex mechanisms and provide some guidance for future reforms.

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<sup>53</sup> See the introduction of in [Chapter 3](#).

<sup>54</sup> An other example is the ongoing French reform consisting in the removal of the local housing tax which is officially implemented to better-off the purchasing power of French people. Little care seems to be given to the reaction of local governments to this reform.

### 3. Limitations and direction for future research

This thesis is a tiny step towards the immense and fascinating objective to provide an overall and coherent understanding of local governments at the sub-metropolitan level. In this regard, the analysis conducted in this thesis suffers from several limitations. We mention some of them hereafter. However, we see this thesis as a first step to prepare the groundwork for many further studies. Some of the directions that we view for future research are also reported hereafter.

#### 3.1. *Theory*

In our view, the theoretical models developed in this thesis suffer from four main limitations.

First, one of the main contributions of the thesis is to study, from different perspectives, the often misunderstood single taxation of capital and business land. Our main claim is that this tax is inappropriate since it does not allow enough flexibility for local governments' decisions. However, these taxes are a commonly used instrument. One of the main reason why they are used is probably due to the relief in terms of administrative costs and complexity that they allow. These costs are absent from our analysis so that it is a bit difficult to understand the relevance of such instruments. We believe that an explicit modeling of these administrative costs would make the results derived in this thesis more relevant. A strand of the taxation literature initiated by [Hettich and Winer \(1988\)](#) is more specifically interested in these types of administrative and political costs. It could represent an interesting ground to integrate these costs in future models dealing with single business property taxation.

Second, while in [Chapter 1](#), [2](#) and [Chapter 3](#) we consider competition among atomistic municipalities and ignore the existence of the central city, in [Chapter 4](#) we only consider competition between a city and its atomistic surrounding towns. This provides an incomplete view of the full picture. A promising direction for future research could be to develop a model including competition both between city and towns and among towns. For such a framework to be relevant, it seems that a rethinking of the spatial space of the metropolitan area needs to be engaged. Especially, adding competition among towns in the model of [Chapter 4](#) seems *a priori* tedious. However, we see two possibilities. First, the spatial limits of towns could be linked in pairs. This connection could be interpreted as the presence of a train station located at the limit of towns. Second, we could also connect another metropolitan area at the extremity of each town.

Third, as most tax competition models to the exception of few recent contribu-

tions (e.g. Wildasin, 2003, 2011), our framework suffers from the lack of dynamics. It is indeed not satisfactory to regard capital as a flow while capital accumulation certainly plays an important role for capital tax competition. Indeed, our modeling assumes that a jurisdiction can instantaneously loose all its capital if it increases its tax rate above that of its neighbors. However, it is more plausible that, in this case, while new investments will be made in more attractive jurisdictions, the capital stock accumulated in previous periods stays in the jurisdictions and progressively depreciates. This would imply a kind of imperfect capital mobility which could justify a positive taxation of capital. Additionally, by ignoring dynamics, our framework cannot account for a major policy instrument widely used by local governments: the local debt. To our knowledge, very few tax competition models address the issue of local debt (see chapter 9 in Wellisch, 2006, for preliminary proposal and a review of the limited related literature).

Finally, a direction for future research is to integrate more urban economic features in sub-metropolitan tax competition models. We believe that the framework developed in Chapter 4 could be a relevant starting point for this purpose. One of the most interesting direction, in our view, could be to integrate unemployment in a sub-metropolitan tax competition framework. To our knowledge, there exists no contribution on the effects of tax competition on unemployment. However, this could provide very informative insights for public policy makers. We believe that the models developed in Zenou (2009) could help building this new model.

### 3.2. *Empirics*

We see two main limits to the empirical analysis conducted in Chapter 2.

The first limit of our empirical study is that in order to focus on municipalities which have the power to vote their own tax rates, we ignored municipalities involved in an inter-municipal cooperation (EPCI) imposing a single business property tax (SBT) regime for all its member municipalities. In these municipalities, a single business property tax rate is voted by the EPCI, while municipalities can levy their own housing tax rate. Two main reasons explain why we did not include these municipalities with SBT regime in our sample.

First, aggregating the data at the level of the EPCI for these municipalities and including them in the sample would induce a strong heterogeneity in the sample due to the different nature of the observation units. The empirical analysis would need to account for this heterogeneity. However, a study of cooperations among French municipalities raises many issues which are beyond the scope of our analysis. Second, in our multiple-tax-instrument analysis, EPCIs do not appear as a homogeneous unit since municipalities, even in a EPCI with SBT regime, vote their own tax rate.



However, ignoring municipalities with SBT regime limits the external validity of our study since these municipalities comprise a majority of urban municipalities of relatively large size. These municipalities certainly have relatively more market power and then the effect of capital mobility on local tax rates could be lower for these municipalities.

The second limit of our empirical study is that it brings exclusively positive results and ignore normative aspects. We know from [Chapter 1](#) that the pre-reform business tax rate which was based on capital and land was theoretically inefficiently low compared to the post-reform business tax rate. However, in our empirical investigation of [Chapter 3](#) we do not measure the efficient level of the business tax rate. Then, we are not able to know whether the reform significantly allowed to bring the business tax rate closer to its efficient level. In this regard, a direction for future research would be to use more structural approaches.

Finally, we see the theoretical investigation of [Chapter 4](#) as opening two directions for future empirical investigations. First, our theoretical investigation showed that the ordering of the tax rate between city and towns depends on the degree of substitutability between capital and the other factors. Many empirical studies have estimated the elasticity of substitution of capital with various production factors in different sectors (e.g. [Kemfert, 1998](#)). They could be a starting point to test whether the metropolitan areas where the dominating sectors with high (resp. low) elasticity of substitution are coincide with the metropolitan areas where the city set higher (resp. lower) capital tax rates than suburban towns.

The second direction for future research suggested by [Chapter 4](#) is to investigate empirically whether metropolitan areas in which the CBD is highly (resp. little) accessible compared to the SBDs coincide with metropolitan areas where the city set a higher (resp. lower) tax rate on residents than the towns. A preliminary step in this direction would be to find an appropriate measure of accessibility.

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# Appendix for Chapter 1

## Appendix A

The basic purpose of this appendix is to prove Result 1.1.<sup>55</sup> To this end, we assume that the economy is characterized by the resource constraints (1.1)-(1.3) and that the agents behave according to (1.4)-(1.11). Let us prove that a necessary and sufficient condition for implementing the efficient allocation - defined by the constraints (1.1)-(1.4) and (1.12), and the optimal conditions (1.13)-(1.17) - is that the instruments  $\{\tau_i^R, \tau_i^K, \tau_i^L, g_i, z_i\}$  satisfy conditions (1.18)-(1.21).<sup>56</sup>

First, observe that in a decentralized economy households migrate at no cost and all markets are first-order condiiing. Hence, the constraints (1.1)-(1.4) are satisfied. Besides, from the resident's budget constraint (1.6) and the zero-profit condition (1.10), it follows that

$$\sum_{i=1}^n [F^i - R_i x_i - C^i] = \sum_{i=1}^n [wW_i + (r + \tau_i^K)K_i + (\rho_i + \tau_i^L)L_i - R_i(y - \rho_i - \tau_i^R) - C^i] = 0$$

where the last equality is obtained using the definition of the individual income (1.5) and the local government budget constraint (1.11). Therefore, the feasibility constraint of the economy (1.12) is satisfied. Also, noting that the wage rate  $w$  is the same in the whole federation, it follows from (1.7) that condition (1.15) is ensured in equilibrium.

Let us now turn to the tax system. Inserting (1.6) for  $x_i$  and (1.9) for  $\rho_i$  into both sides of the condition for efficient allocation of residents (1.13) yields condition (1.18). This proves that conditions (1.13) and (1.18) are equivalent when allowing for private behaviors. And, inserting (1.8) for  $F_K^i$  into (1.14) proves that the condition for efficient capital allocation (1.14) and (1.19) are equivalent.

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<sup>55</sup>The proof follows the methological approach in Wellisch (2006) (Chapter 2).

<sup>56</sup>Note that, conditions (1.4), (1.13), (1.14) and (1.15) constitute  $4 \times (n - 1)$  equations. Thus, if the problem is well-behaved, the  $7n$  variables  $x_i, g_i, z_i, R_i, W_i, K_i$  and  $L_i$  are uniquely determined by the  $7n$  conditions (1.1)-(1.4) and (1.12)-(1.17).

Finally, noting that the public service provision rules (1.16) and (1.17) are respectively identical to (1.20) and (1.21) allows us to complete the proof.

## Appendix B

Consider the impact of a small local policy change on the representative resident's utility. Inserting the budget constraint (1.6) into the utility function and accounting for the free mobility condition (1.23), total differentiation of  $U^i$  yields:

$$dU^i = U_x^i dy + dU(\bar{y} - \rho_i - \tau_i^R, g_i, R_i) = U_x^i dy + d\bar{u} = U_x^i dy,$$

since  $d\bar{u} = 0$ . That is, the only channel through which policy can increase utility is income variations; residents mobility compensates for any other effect. Using the income definition (1.5), the marginal utility change can be written as:

$$dU^i = U_x^i \frac{\mathcal{L}^i}{\mathcal{P}} d\rho_i.$$

Thus, any utility gain resulting from the incremental policy is due to an increase in the return to domestic landowners.

## Appendix C

### *Necessary conditions*

This paragraph derives the first-order conditions of the local government (1.30). Differentiating the local government's objective (1.29) with respect to  $t \in \{\tau; \tau^K; g; z\}$  and the conditions for the optimal inputs demand (1.7)-(1.9), it follows that

$$\frac{d\Omega}{dt} = \tau R_t + \tau^K K_t - C_g g_t + (F_z - C_z) z_t + R(F_{Lt} + \tau_t) = 0 \quad (\text{A.1})$$

where subscripts stand for derivatives.<sup>57</sup> Besides, differentiating the migration equilibrium (1.26), we have

$$F_{Lt} + \tau_t = \frac{U_R}{U_x} R_t + \frac{U_g}{U_x} g_t \quad (\text{A.2})$$

Inserting (A.2) into (A.1), the first-order conditions (1.30) result.

### *Location responses*

We now derive the location responses of residents, workers and capital to local policy changes. First, note that since  $F$  exhibits constant returns to scale in the private

<sup>57</sup>In the following appendices, the jurisdiction index  $i$  is dropped for notational convenience.

factors, Euler's theorem requires that  $F = WF_W + KF_K + LF_L$ . Differentiating this condition with respect to  $W$ ,  $K$ ,  $L$  and  $z$  yields

$$WF_{WW} + KF_{WK} + LF_{WL} = 0 \quad (\text{A.3})$$

$$WF_{KW} + KF_{KK} + LF_{KL} = 0 \quad (\text{A.4})$$

$$WF_{LW} + KF_{LK} + LF_{LL} = 0 \quad (\text{A.5})$$

$$WF_{zW} + KF_{zK} + LF_{zL} = F_z \quad (\text{A.6})$$

Differentiating the equilibrium conditions (1.24)-(1.26) with respect to  $t \in \{\tau, \tau^K, g, z\}$ , it follows that

$$\begin{pmatrix} F_{WW} & -F_{WL} & F_{WK} \\ F_{KW} & -F_{KL} & F_{KK} \\ F_{LW} & -F_{LL} - \frac{U_R}{U_x} & F_{LK} \end{pmatrix} \begin{pmatrix} W_t \\ R_t \\ K_t \end{pmatrix} = \begin{pmatrix} -F_{Wz}z_t \\ \tau_t^K - F_{Kz}z_t \\ -\tau_t + \frac{U_g}{U_x}g_t - F_{Lz}z_t \end{pmatrix} \quad (\text{A.7})$$

Let  $A$  denote the first matrix on the LHS of (A.7).<sup>58</sup> Performing the row operation

$$r_3 \leftarrow Wr_1 + Kr_2 + Lr_3 \quad (\text{A.8})$$

on the third row of  $|A|$ , and using (A.3)-(A.5) yields

$$|A| = \frac{U_R}{U_x} D$$

where  $D = \begin{vmatrix} F_{WW} & F_{WK} \\ F_{KW} & F_{KK} \end{vmatrix}$ .<sup>59</sup> It will prove useful in the sequel to notice that

$$D = -\frac{L}{W} \begin{vmatrix} F_{WL} & F_{WK} \\ F_{KL} & F_{KK} \end{vmatrix} = -\frac{L}{K} \begin{vmatrix} F_{WW} & F_{WL} \\ F_{KW} & F_{KL} \end{vmatrix} > 0 \quad (\text{A.9})$$

The first (second) equality of (A.9) is obtained applying the column operation  $c_1(c_2) \leftarrow \frac{W}{L}c_1 + \frac{K}{L}c_2$  to the first (second) column of  $D$ .<sup>60</sup>

Let us now derive the migration responses of residents. Applying Cramer's rule to (A.7), it comes

$$R_t = \frac{U_x}{U_R D} \begin{vmatrix} F_{WW} & -F_{Wz}z_t & F_{WK} \\ F_{KW} & \tau_t^K - F_{Kz}z_t & F_{KK} \\ F_{LW} & -\tau_t + \frac{U_g}{U_x}g_t - F_{Lz}z_t & F_{LK} \end{vmatrix}$$

<sup>58</sup>Notice that from Schwarz's theorem,  $\forall X, Y \in \{W; K; L\}$ ,  $F_{XY} = F_{YX}$ .

<sup>59</sup>To solve (A.7) for  $W_t$ ,  $R_t$  and  $K_t$ , the determinant  $|A|$  must be nonzero which is the case since  $U_R < 0$  due to congestion, and  $D > 0$  (see below).

<sup>60</sup>The derivations make extensive use of the following calculation rule for determinants:  $|c_1 \dots c_j \dots c_p| = \frac{1}{\alpha_j} |c_1 \dots \sum_{k=1}^p \alpha_k c_k \dots c_p|$ , where  $c_j$  is the  $j^{\text{th}}$  column vector. Since  $|{}^t A| = |A|$ , the same rule applies to row operations.



Using the row operation (A.8) and equalities (A.3),(A.4) and (A.6), we obtain

$$R_t = G_t \frac{U_x}{U_R} \quad (\text{A.10})$$

where  $G_t \equiv \tau_t - \frac{K}{L} \tau_t^K - \frac{U_g}{U_x} g_t + \frac{F_z}{L} z_t$ . It follows that

$$R_\tau = \frac{U_x}{U_R}, \quad R_{\tau^K} = -\frac{K}{L} \frac{U_x}{U_R}, \quad R_g = -\frac{U_g}{U_R}, \quad R_z = \frac{U_x}{U_R} \frac{F_z}{L}. \quad (\text{A.11})$$

which proves the signs of the responses  $R_t$ ,  $t \in \{\tau; \tau^K; g; z\}$  in Lemma 1.2.<sup>61</sup>

Identically,

$$W_t = \frac{U_x}{U_R D} \left[ G_t \begin{vmatrix} F_{WL} & F_{WK} \\ F_{KL} & F_{KK} \end{vmatrix} + \frac{U_R}{U_x} \begin{vmatrix} -F_{Wz} z_t & F_{WK} \\ \tau_t^K - F_{Kz} z_t & F_{KK} \end{vmatrix} \right] \quad (\text{A.12})$$

Inserting (A.9) into (A.12) yields

$$W_t = -G_t \frac{W}{L} \frac{U_x}{U_R} + \frac{1}{D} \begin{vmatrix} -F_{Wz} z_t & F_{WK} \\ \tau_t^K - F_{Kz} z_t & F_{KK} \end{vmatrix}$$

The location responses of workers are thus given by

$$\begin{aligned} W_\tau &= -\frac{W}{L} \frac{U_x}{U_R}, & W_{\tau^K} &= \frac{KW}{L^2} \frac{U_x}{U_R} - \frac{F_{WK}}{D}, \\ W_g &= \frac{W}{L} \frac{U_g}{U_R}, & W_z &= -\frac{W}{L^2} F_z \frac{U_x}{U_R} + \frac{F_{WK} F_{Kz} - F_{KK} F_{Wz}}{D}. \end{aligned} \quad (\text{A.13})$$

which proves the signs of the responses  $W_t$ ,  $t \in \{\tau; \tau^K; g; z\}$  in Lemma 1.2. Notice that the signs of the responses (A.13) are unambiguous, since  $D > 0$  from (A.9).

Finally, the same calculations give

$$K_t = -G_t \frac{K}{L} \frac{U_x}{U_R} + \frac{1}{D} \begin{vmatrix} F_{WW} & -F_{Wz} z_t \\ F_{KW} & \tau_t^K - F_{Kz} z_t \end{vmatrix}$$

so that,

$$\begin{aligned} K_\tau &= -\frac{K}{L} \frac{U_x}{U_R}, & K_{\tau^K} &= \left( \frac{K}{L} \right)^2 \frac{U_x}{U_R} + \frac{F_{WW}}{D}, \\ K_g &= \frac{K}{L} \frac{U_g}{U_R}, & K_z &= -\frac{K}{L^2} F_z \frac{U_x}{U_R} + \frac{F_{KW} F_{Wz} - F_{WW} F_{Kz}}{D}. \end{aligned} \quad (\text{A.14})$$

which proves the signs of the responses  $K_t$ ,  $t \in \{\tau; \tau^K; g; z\}$  in Lemma 1.2.

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<sup>61</sup>To establish the signs of the location responses, recall that:  $U_x > 0$ ,  $U_g > 0$ ,  $U_R < 0$ ,  $F_X > 0$ ,  $F_{XX} < 0$  and  $F_{XY} > 0$  for all  $X$  and  $Y$  in  $\{W; K; L; z\}$ .

## Appendix D

The basic purpose of this appendix is to prove Result 1.2. From the first-order condition (1.30),

$$\left(\tau + R\frac{U_R}{U_x}\right) R_\tau + \tau^K K_\tau = 0 \quad (\text{A.15})$$

$$\left(\tau + R\frac{U_R}{U_x}\right) R_{\tau^K} + \tau^K K_{\tau^K} = 0 \quad (\text{A.16})$$

$$\left(\tau + R\frac{U_R}{U_x}\right) R_g + \tau^K K_g + R\frac{U_g}{U_x} - C_g = 0 \quad (\text{A.17})$$

$$\left(\tau + R\frac{U_R}{U_x}\right) R_z + \tau^K K_z + F_z - C_z = 0 \quad (\text{A.18})$$

Yet, using (A.11) and (A.14) yields

$$\begin{vmatrix} R_\tau & K_\tau \\ R_{\tau^K} & K_{\tau^K} \end{vmatrix} = \frac{U_x F_{WW}}{U_R D} \neq 0$$

Then, equations (A.15) and (A.16) imply

$$\tau + R\frac{U_R}{U_x} = 0 \quad (\text{A.19})$$

$$\tau^K = 0 \quad (\text{A.20})$$

which proves the optimal taxation rules (1.31) and (1.32), recalling that  $\tau = \tau^R - \tau^L$ . Inserting (A.19) and (A.20) into (A.17) and (A.18), the Samuelson rules (1.33) and (1.34) follow.

Finally, using (A.19) and (A.20) to substitute  $\tau$  and  $\tau^K$  into the local budget constraint (1.27) yields the optimal condition for  $\tau^L$  (1.35).

## Appendix E

### *Locational system*

The basic purpose of this appendix is to prove Result 1.3. Using (1.36) to substitute for  $\tau^P$  into (1.25), the location system becomes

$$F_W(W, K, \mathcal{L} - R, z) - w = 0 \quad (\text{A.21})$$

$$F_K(W, K, \mathcal{L} - R, z) + \frac{\tau R - C}{K + \mathcal{L}} - r = 0 \quad (\text{A.22})$$

$$U[\bar{y} - F_L(W, K, \mathcal{L} - R, z) - \tau, g, R] - \bar{u} = 0 \quad (\text{A.23})$$

Differentiating (A.21)-(A.23) with respect to  $t \in \{\tau, g, z\}$ , it follows that

$$\begin{aligned} & \begin{pmatrix} F_{WW} & -F_{WL} & F_{WK} \\ F_{KW} & -F_{KL} + \frac{\tau}{K+\mathcal{L}} & F_{KK} + \frac{\tau^P}{K+\mathcal{L}} \\ F_{LW} & -F_{LL} - \frac{U_R}{U_x} & F_{LK} \end{pmatrix} \begin{pmatrix} W_t \\ R_t \\ K_t \end{pmatrix} \\ &= \begin{pmatrix} -F_{Wz}z_t \\ -\frac{R}{K+\mathcal{L}}\tau_t + \frac{C_g}{K+\mathcal{L}}g_t + \left(\frac{C_z}{K+\mathcal{L}} - F_{Kz}\right)z_t \\ -\tau_t + \frac{U_g}{U_x}g_t - F_{Lz}z_t \end{pmatrix} \end{aligned} \quad (\text{A.24})$$

Let  $B$  denote the first matrix on the LHS of (A.24).

### *Household taxation rule*

Let us start with the choice of  $\tau$  whose second-best value is determined by the necessary condition (1.30), where  $\tau^P$  replaces  $\tau^K$ :

$$\left(\tau + R\frac{U_R}{U_x}\right)R_\tau + \tau^P K_\tau = 0 \quad (\text{A.25})$$

As in the first-best case, Cramer's rule is used to solve for  $R_\tau$  and  $K_\tau$  from (A.24). Inserting these expressions into (A.25), the first-order condition becomes

$$\begin{aligned} & \left(\tau + R\frac{U_R}{U_x}\right) \begin{vmatrix} F_{WW} & 0 & F_{WK} \\ F_{KW} & -\frac{R}{K+\mathcal{L}} & F_{KK} + \frac{\tau^P}{K+\mathcal{L}} \\ F_{LW} & -1 & F_{LK} \end{vmatrix} \\ & + \tau^P \begin{vmatrix} F_{WW} & -F_{WL} & 0 \\ F_{KW} & -F_{KL} + \frac{1}{K+\mathcal{L}}\left(\tau + R\frac{U_R}{U_x}\right) - \frac{R}{K+\mathcal{L}}\frac{U_R}{U_x} & -\frac{R}{K+\mathcal{L}} \\ F_{LW} & -F_{LL} - \frac{U_R}{U_x} & -1 \end{vmatrix} = 0 \end{aligned}$$

Noting that the terms  $\frac{\tau^P}{K+\mathcal{L}}$  and  $\frac{1}{K+\mathcal{L}}\left(\tau + R\frac{U_R}{U_x}\right)$  cancel each other and applying the row operation (A.8) to both determinants, it follows that

$$\begin{aligned} & \left(\tau + R\frac{U_R}{U_x}\right) \begin{vmatrix} F_{WW} & 0 & F_{WK} \\ F_{KW} & -\frac{R}{K+\mathcal{L}} & F_{KK} \\ 0 & \alpha & 0 \end{vmatrix} \\ & + \tau^P \begin{vmatrix} F_{WW} & -F_{WL} & 0 \\ F_{KW} & -F_{KL} - \frac{R}{K+\mathcal{L}}\frac{U_R}{U_x} & -\frac{R}{K+\mathcal{L}} \\ 0 & \alpha\frac{U_R}{U_x} & \alpha \end{vmatrix} = 0 \end{aligned}$$

where  $\alpha = \frac{KR}{K+\mathcal{L}} + L$ . Operating  $r_2 \leftarrow r_2 + \frac{1}{\alpha}\frac{R}{K+\mathcal{L}}r_3$  on the right determinant, and developing the resulting determinants yields

$$\left(\tau + R\frac{U_R}{U_x}\right)D + \tau^P \begin{vmatrix} F_{WW} & F_{WL} \\ F_{KW} & F_{KL} \end{vmatrix} = 0 \quad (\text{A.26})$$

Dividing (A.26) by  $D$  and using (A.9), it comes

$$\tau + R \frac{U_R}{U_x} - \frac{K}{L} \tau^P = 0 \quad (\text{A.27})$$

which proves the second-best taxation rule (1.37).

Finally, using (A.27) to substitute  $\tau$  into the local budget constraint (1.36) yields the optimal condition for  $\tau^P$  (1.40).

### *Public good provision rule*

Consider now the choice of  $g$ . Replacing  $\tau + R \frac{U_R}{U_x}$  from the second-best taxation rule (A.27) into (1.30), it follows that

$$\tau^P \left( \frac{K}{L} R_g + K_g \right) + R \frac{U_g}{U_x} - C_g = 0 \quad (\text{A.28})$$

Using again Cramer's rule and inverting the last two columns in the expression of  $R_g$ , it comes

$$R_g = -|B|^{-1} \begin{vmatrix} F_{WW} & F_{WK} & 0 \\ F_{KW} & F_{KK} + \frac{\tau^P}{K+\mathcal{L}} & \frac{C_g}{K+\mathcal{L}} \\ F_{LW} & F_{LK} & \frac{U_g}{U_x} \end{vmatrix},$$

$$K_g = -|B|^{-1} \begin{vmatrix} F_{WW} & F_{WL} & 0 \\ F_{KW} & F_{KL} - \frac{\tau}{K+\mathcal{L}} & \frac{C_g}{K+\mathcal{L}} \\ F_{LW} & F_{LL} + \frac{U_R}{U_x} & \frac{U_g}{U_x} \end{vmatrix}$$

and operating  $c_2 \leftarrow -c_2 + \frac{K}{L} c_3$  on the second column of  $|B|$ , we obtain

$$|B| = - \begin{vmatrix} F_{WW} & \gamma^W & F_{WK} \\ F_{KW} & \gamma^K - \frac{1}{K+\mathcal{L}} \left( \tau - \frac{K}{L} \tau^P \right) & F_{KK} + \frac{\tau^P}{K+\mathcal{L}} \\ F_{LW} & \gamma^L + \frac{U_R}{U_x} & F_{LK} \end{vmatrix}$$

where  $\gamma^W \equiv \frac{K}{L} F_{WK} + F_{WL}$ ,  $\gamma^K \equiv \frac{K}{L} F_{KK} + F_{KL}$  and  $\gamma^L \equiv \frac{K}{L} F_{LK} + F_{LL}$ . Multiplying (A.28) by  $-|B|$ , introducing the explicit forms of  $R_g$ ,  $K_g$  and  $|B|$ , and adding determinants yields

$$\begin{vmatrix} F_{WW} & \gamma^W & \Gamma F_{WK} \\ F_{KW} & \gamma^K - \frac{1}{K+\mathcal{L}} \left( \tau - \frac{K}{L} \tau^P \right) & \Gamma \left( F_{KK} + \frac{\tau^P}{K+\mathcal{L}} \right) + \tau^P \frac{C_g}{K+\mathcal{L}} \\ F_{LW} & \gamma^L + \frac{U_R}{U_x} & \Gamma F_{LK} + \tau^P \frac{U_g}{U_x} \end{vmatrix} = 0$$

where  $\Gamma \equiv R\frac{U_g}{U_x} - C_g$  has been introduced for convenience. Operating  $c_2 \leftarrow c_2 + \frac{W}{L}c_1$ , using Euler's expressions (A.3)-(A.5) and condition (A.27) to simplify terms, it follows that

$$\begin{vmatrix} F_{WW} & 0 & \Gamma F_{WK} \\ F_{KW} & \frac{R}{K+\mathcal{L}} \frac{U_R}{U_x} & \Gamma F_{KK} + \frac{\tau^P}{K+\mathcal{L}} R \frac{U_g}{U_x} \\ F_{LW} & \frac{U_R}{U_x} & \Gamma F_{LK} + \tau^P \frac{U_g}{U_x} \end{vmatrix} = 0 \quad (\text{A.29})$$

Performing  $r_2 \leftarrow W r_1 + (K + \mathcal{L}) r_2 - R r_3$ , simplifying from (A.3)-(A.5) and collecting terms, we obtain

$$\left( R \frac{U_g}{U_x} - C_g \right) \begin{vmatrix} F_{WW} & F_{WK} \\ F_{KW} - F_{LW} & F_{KK} - F_{LK} \end{vmatrix} = 0 \quad (\text{A.30})$$

It is straightforward to derive from (A.9) that the determinant in (A.30) equals  $\frac{K+\mathcal{L}}{L}D \neq 0$ . This proves the Samuelson rule (1.38).

### *Public input provision rule*

Finally, let us prove the second-best public choice rule for  $z$ . This proof follows rigorously the same computation steps as in the derivation of the second-best public good provision rule. Therefore, we provide only the main steps of the proof. As, above, we start with replacing  $\tau + R\frac{U_R}{U_x}$  from (A.27) into (1.30), which yields

$$\tau^P \left( \frac{K}{L} R_z + K_z \right) + F_z - C_z = 0 \quad (\text{A.31})$$

Then, applying Cramer's rule to get explicit forms for  $R_z$  and  $K_z$ , integrating them into (A.31) and operating  $c_2 \leftarrow c_2 + \frac{W}{L}c_1$ , it follows that

$$\begin{vmatrix} F_{WW} & 0 & \Lambda F_{WK} - \tau^P F_{Wz} \\ F_{KW} & \frac{R}{K+\mathcal{L}} \frac{U_R}{U_x} & \Lambda F_{KK} + \tau^P \left( \frac{F_z}{K+\mathcal{L}} - F_{Kz} \right) \\ F_{LW} & \frac{U_R}{U_x} & \Lambda F_{LK} + \tau^P F_{Lz} \end{vmatrix} = 0$$

where  $\Lambda \equiv F_z - C_z$ . Performing  $r_2 \leftarrow W r_1 + (K + \mathcal{L}) r_2 + R r_3$ , simplifying terms using (A.3)-(A.6) and collecting terms, we obtain

$$(F_z - C_z) \begin{vmatrix} F_{WW} & F_{WK} \\ F_{KW} - F_{LW} & F_{KK} - F_{LK} \end{vmatrix} - \tau^P \begin{vmatrix} F_{WW} & F_{Wz} \\ F_{KW} - F_{LW} & F_{Kz} - F_{Lz} \end{vmatrix} = 0$$

Since the first determinant in (A.30) equals  $\frac{K+\mathcal{L}}{L}D \neq 0$  from (A.9). Straightforward manipulations yield

$$\frac{F_z - C_z}{K} = \frac{1}{K} \tau^P \frac{L}{K + L} \frac{F_{WW}}{D} \left[ F_{Kz} - F_{Lz} - \frac{F_{Wz}}{F_{WW}} (F_{KW} - F_{LW}) \right] \quad (\text{A.32})$$

Notice that differentiating (A.21), given the equilibrium values  $\bar{K}$  and  $\bar{L}$ , yields

$$\left. \frac{\partial W}{\partial z} \right|_{(\bar{K}, \bar{L})} = -\frac{F_{Wz}}{F_{WW}} > 0 \quad (\text{A.33})$$

Besides, the elasticity of the capital share in the overall business property with respect to property tax changes writes

$$\varepsilon = \tau^P \frac{K+L}{K} \left( \frac{K}{K+L} \right)_{\tau^P} = \frac{1}{K} \tau^P \frac{L}{K+L} \left( K_{\tau^P} + \frac{K}{L} R_{\tau^P} \right) \quad (\text{A.34})$$

where the second equality is obtained by recalling that  $L_{\tau^P} = -R_{\tau^P}$  from the land market first-order condition (1.3). And, replacing  $\tau^K$  by  $\tau^P$  and  $\tau$  by  $\tau^R - \tau^P$  into the location system (1.24)-(1.26) allows to derive by differentiation,

$$R_{\tau^P} = -\frac{K+L}{L} \frac{U_x}{U_R} \quad \text{and} \quad K_{\tau^P} = \frac{F_{WW}}{D} + \frac{K(K+L)}{L^2} \frac{U_x}{U_R}$$

Integrating these expressions into (A.34) yields

$$\varepsilon = \frac{1}{K} \tau^P \frac{L}{K+L} \frac{F_{WW}}{D} < 0 \quad (\text{A.35})$$

Finally, inserting (A.33) and (A.35) into (A.32), the optimal second-best condition (1.39) follows.



# Appendix for Chapter 2

## Appendix A Commuting costs

First-best public policy rules

Let us prove Result 2.4. The location system (2.19)-(2.20) implicitly defines  $R(\tau, \tau^K, g, z)$  and  $K(\tau, \tau^K, g, z)$ . Differentiating the location system (2.19)-(2.20) with respect to  $\tau$  and  $\tau^K$ , and using Cramer's rule, it follows that:

$$\begin{aligned} R_\tau &= -|A|^{-1}F_{KK} & R_{\tau^K} &= |A|^{-1}(F_{WK} - F_{LK}) \\ K_\tau &= |A|^{-1}(F_{KW} - F_{KL}) & K_{\tau^K} &= -|A|^{-1}(F_{WW} - F_{WL} - F_{LW} + F_{LL} + \frac{U_R}{U_x}) \end{aligned}$$

where

$$A \equiv \begin{pmatrix} F_{KW} - F_{KL} & F_{KK} \\ F_{WW} - F_{WL} - F_{LW} + F_{LL} + \frac{U_R}{U_x} & F_{WK} - F_{LK} \end{pmatrix}$$

Since

$$\begin{vmatrix} R_\tau & R_{\tau^K} \\ K_\tau & K_{\tau^K} \end{vmatrix} \neq 0$$

it is straightforward to show that (2.3)-(2.6) follow.<sup>62</sup>

Second-best public policy rules

In this section we prove 2.5. Replacing  $\tau_i^K$  by  $\frac{\tau_i R_i - C_i}{K_i + \mathcal{L}_i}$  in the location system (2.27)-(2.29), differentiating with respect to  $\{\tau, g, z\}$ , and using Cramer's rule, it follows that:

$$R_t = |B|^{-1} \begin{vmatrix} -\frac{R}{K+\mathcal{L}}\tau_t + \frac{C_g}{K+\mathcal{L}}g_t + (-F_{Kz} + \frac{C_z}{K+\mathcal{L}})z_t & F_{KK} + \frac{\tau^P}{K+\mathcal{L}} \\ \tau_t - \frac{U_g}{U_x}g_t + (-F_{Wz} + F_{Lz})z_t & F_{WK} - F_{LK} \end{vmatrix} \quad (\text{A.36})$$

$$K_t = |B|^{-1} \begin{vmatrix} F_{KW} - F_{KL} + \frac{\tau}{K+\mathcal{L}} & -\frac{R}{K+\mathcal{L}}\tau_t + \frac{C_g}{K+\mathcal{L}}g_t + (-F_{Kz} + \frac{C_z}{K+\mathcal{L}})z_t \\ F_{WW} - F_{WL} - F_{LW} + F_{LL} + \frac{U_R}{U_x} & \tau_t - \frac{U_g}{U_x}g_t + (-F_{Wz} + F_{Lz})z_t \end{vmatrix} \quad (\text{A.37})$$

<sup>62</sup>Note that since  $(F_{WK} - F_{LK})$  and  $|A|^{-1}$  can be either positive or negative, Lemma 1.2 in SMTC does not hold anymore.



where

$$B \equiv \begin{pmatrix} F_{KW} - F_{KL} + \frac{\tau}{K+\mathcal{L}} & F_{KK} + \frac{\tau^P}{K+\mathcal{L}} \\ F_{WW} - F_{WL} - F_{LW} + F_{LL} + \frac{U_R}{U_x} & F_{WK} - F_{LK} \end{pmatrix}$$

FOC with respect to  $\tau$

Inserting (A.36) and (A.37) into (1.30), it follows that:

$$\left( \tau + R \frac{U_R}{U_x} \right) \begin{vmatrix} -\frac{R}{K+\mathcal{L}} & F_{KK} + \frac{\tau^P}{K+\mathcal{L}} \\ 1 & F_{WK} - F_{LK} \end{vmatrix} + \tau^P \begin{vmatrix} F_{KW} - F_{KL} + \frac{\tau}{K+\mathcal{L}} & -\frac{R}{K+\mathcal{L}} \\ F_{WW} - F_{WL} - F_{LW} + F_{LL} + \frac{U_R}{U_x} & 1 \end{vmatrix} = 0$$

Achieving  $r_1 \leftarrow r_1 + \frac{R}{K+\mathcal{L}} r_2$ , we obtain:

$$\begin{aligned} & \left( \tau + R \frac{U_R}{U_x} \right) \begin{vmatrix} 0 & F_{KK} + \frac{\tau^P}{K+\mathcal{L}} + \frac{R}{K+\mathcal{L}}(F_{WK} - F_{LK}) \\ 1 & F_{WK} - F_{LK} \end{vmatrix} \\ & + \tau^P \begin{vmatrix} F_{KW} - F_{KL} + \frac{\tau}{K+\mathcal{L}} + \frac{R}{K+\mathcal{L}} \left( F_{WW} - F_{WL} - F_{LW} + F_{LL} + \frac{U_R}{U_x} \right) & 0 \\ F_{WW} - F_{WL} - F_{LW} + F_{LL} + \frac{U_R}{U_x} & 1 \end{vmatrix} = 0 \end{aligned}$$

Note that the terms  $\frac{\tau^P}{K+\mathcal{L}}$  and  $\frac{\tau+RU_R/U_x}{K+\mathcal{L}}$  cancel each other. Finally, from the land market clearing condition and Euler's formula,<sup>63</sup> we obtain:

$$\tau^R = R \frac{|U_R|}{U_x} + \left[ 1 + \frac{F_{KW} - F_{LW} - (F_{KL} - F_{LL})}{F_{KK} - F_{LK}} \right] \tau^P$$

and using once again Euler's formula,

$$\tau^R = R \frac{|U_R|}{U_x} + \left[ 1 + \frac{K}{L} + \frac{F_{KW} - F_{LW}}{F_{KK} - F_{LK}} \frac{\mathcal{L}}{L} \right] \tau^P \quad (\text{A.38})$$

follows.

*Optimal level of  $\tau^R$  and  $\tau^P$*

Using the optimal decision rule (A.38) and the local budget constraint the budget restriction (2.9), we obtain:

$$\tau^R = \frac{L}{\mathcal{L}} \left( \frac{C}{L} + R \frac{|U_R|}{U_x} \right) + \frac{F_{KW} - F_{LW}}{F_{KK} - F_{LK}} \tau^P \quad (\text{A.39})$$

$$\tau^P = \frac{L(F_{KK} - F_{KL})}{(K+L)(F_{KK} - F_{KL}) + R(F_{KW} - F_{LW})} \frac{R}{\mathcal{L}} \left( \frac{C}{R} - R \frac{|U_R|}{U_x} \right) \quad (\text{A.40})$$

<sup>63</sup>It can easily be shown that:

$$\begin{aligned} (K+\mathcal{L})F_{KK} + L(F_{WK} - F_{LK}) &= \mathcal{L}(F_{KK} - F_{LK}) \\ (K+\mathcal{L})F_{KW} + L(F_{WW} - F_{LW}) &= \mathcal{L}(F_{KW} - F_{LW}) \\ (K+\mathcal{L})F_{KL} + L(F_{WL} - F_{LL}) &= \mathcal{L}(F_{KL} - F_{LL}) \end{aligned}$$

and from Euler's formula, we can write (A.40) as:

$$\tau^P = \frac{1}{1 + \frac{F_{LK} - F_{LL}}{F_{KL} - F_{KK}}} \frac{R}{\mathcal{L}} \left( \frac{C}{R} - R \frac{|U_R|}{U_x} \right) \quad (\text{A.41})$$

Finally, recalling that second (cross) derivatives of  $F$  are negative (resp. positive), (2.21) and (2.22) directly follow from (A.39) and (A.41).

*FOC with respect to  $g$*

We have:

$$R_g = |B|^{-1} \begin{vmatrix} \frac{C_g}{K+\mathcal{L}} & F_{KK} + \frac{\tau^P}{K+\mathcal{L}} \\ -\frac{U_g}{U_x} & F_{WK} - F_{LK} \end{vmatrix}, \quad K_g = |B|^{-1} \begin{vmatrix} F_{KW} - F_{KL} + \frac{\tau}{K+\mathcal{L}} & \frac{C_g}{K+\mathcal{L}} \\ F_{WW} - F_{WL} - F_{LW} + F_{LL} + \frac{U_R}{U_x} & -\frac{U_g}{U_x} \end{vmatrix}$$

Inserting these location responses into (1.30), it follows that:

$$\begin{aligned} & \left( \tau + R \frac{U_R}{U_x} \right) \begin{vmatrix} \frac{C_g}{K+\mathcal{L}} & F_{KK} + \frac{\tau^P}{K+\mathcal{L}} \\ -\frac{U_g}{U_x} & F_{WK} - F_{LK} \end{vmatrix} \\ & + \tau^P \begin{vmatrix} F_{KW} - F_{KL} + \frac{\tau}{K+\mathcal{L}} + \frac{1}{K+\mathcal{L}} R \frac{U_R}{U_x} - \frac{1}{K+\mathcal{L}} R \frac{U_R}{U_x} & \frac{C_g}{K+\mathcal{L}} \\ F_{WW} - F_{WL} - F_{LW} + F_{LL} + \frac{U_R}{U_x} & -\frac{U_g}{U_x} \end{vmatrix} + |B| \Gamma = 0 \end{aligned}$$

where  $\Gamma \equiv +R \frac{U_g}{U_x} - C_g$ . Since the terms  $\frac{\tau^P}{K+\mathcal{L}}$  and  $\frac{1}{K+\mathcal{L}} \left( \tau + R \frac{U_R}{U_x} \right)$  in the determinants cancel each other, we obtain:

$$\Pi \tau^P \begin{vmatrix} \frac{C_g}{K+\mathcal{L}} & F_{KK} \\ -\frac{U_g}{U_x} & F_{WK} - F_{LK} \end{vmatrix} + \tau^P \begin{vmatrix} F_{KW} - F_{KL} - \frac{1}{K+\mathcal{L}} R \frac{U_R}{U_x} & \frac{C_g}{K+\mathcal{L}} \\ F_{WW} - F_{WL} - F_{LW} + F_{LL} + \frac{U_R}{U_x} & -\frac{U_g}{U_x} \end{vmatrix} + |B| \Gamma = 0$$

where  $\tau + R \frac{U_R}{U_x}$  in front of the first determinant has been replaced by  $\Pi \tau^P$  using (2.21) and  $\Pi \equiv 1 + \frac{F_{KW} - F_{LW} - (F_{KL}^i - F_{LL}^i)}{F_{KK}^i - F_{LK}^i}$ . Performing  $c_1 \leftarrow c_1 + \Pi c_2$  (and using (2.21) again) in  $|B|$  and collecting terms, we get:

$$\begin{vmatrix} F_{KW} - F_{KL} - \frac{1}{K+\mathcal{L}} R \frac{U_R}{U_x} - \Pi F_{KK} & \tau^P \frac{C_g}{K+\mathcal{L}} + \Gamma \left( F_{KK} + \frac{\tau^P}{K+\mathcal{L}} \right) \\ F_{WW} - F_{WL} - F_{LW} + F_{LL} + \frac{U_R}{U_x} - \Pi (F_{WK} - F_{LK}) & -\tau^P \frac{U_g}{U_x} + \Gamma (F_{WK} - F_{LK}) \end{vmatrix} = 0$$

Operating  $r1 \leftarrow r1 + \frac{R}{K+\mathcal{L}} r2$ , we obtain:

$$\begin{vmatrix} 0 & \Gamma \left( F_{KK} + \frac{R}{K+\mathcal{L}} (F_{WK} - F_{LK}) \right) \\ F_{WW} - F_{WL} - F_{LW} + F_{LL} + \frac{U_R}{U_x} - \Pi (F_{WK} - F_{LK}) & \tau^P \frac{U_g}{U_x} + \Gamma (F_{WK} - F_{LK}) \end{vmatrix} = 0 \quad (\text{A.42})$$

Then  $\Gamma = 0$ , which means that (2.23) is satisfied.

FOC with respect to  $z$

We have:

$$R_z = |B|^{-1} \begin{vmatrix} \frac{C_z}{K+\mathcal{L}} - F_{Kz} & F_{KK} + \frac{\tau^P}{K+\mathcal{L}} \\ F_{Lz} - F_{Wz} & F_{WK} - F_{LK} \end{vmatrix},$$

$$K_z = |B|^{-1} \begin{vmatrix} F_{KW} - F_{KL} + \frac{\tau}{K+\mathcal{L}} & \frac{C_z}{K+\mathcal{L}} - F_{Kz} \\ F_{WW} - F_{WL} - F_{LW} + F_{LL} + \frac{U_R}{U_x} & F_{Lz} - F_{Wz} \end{vmatrix}$$

Inserting these location responses into (1.30), and using exactly the same computation steps as for deriving (A.42), it follows that:

$$\tau^P \left[ \frac{F_z}{K+\mathcal{L}} - F_{Kz} + \frac{R}{K+\mathcal{L}}(F_{Lz} - F_{Wz}) \right] + \Lambda \left( F_{KK} + \frac{R}{K+\mathcal{L}}(F_{WK} - F_{LK}) \right) = 0 \quad (\text{A.43})$$

where  $\Lambda \equiv +R\frac{U_g}{U_x} - C_g$ . Yet, from Euler's formulas, we have:

$$F_{KK} + \frac{R}{K+\mathcal{L}}(F_{WK} - F_{LK}) = \frac{\mathcal{L}}{K+\mathcal{L}}(F_{KK} - F_{LK})$$

$$\frac{F_z}{K+\mathcal{L}} - F_{Kz} + \frac{R}{K+\mathcal{L}}(F_{Lz} - F_{Wz}) = \frac{\mathcal{L}}{K+\mathcal{L}}(F_{Lz} - F_{Kz})$$

which inserted in (A.43) leads

$$F_z^i - C_z^i = \frac{F_{Kz}^i - F_{Lz}^i}{F_{KK}^i - F_{LK}^i} \tau_i^P$$

from which condition (2.24) directly follows.

## Appendix B Mobile and immobile households

First-best public policy rules

Differentiating the location system (2.27)-(2.29) with respect to  $t \in \{\tau, \tau^K, g, z\}$ , it follows that:<sup>64</sup>

$$\begin{pmatrix} F_{WW} & -F_{WL} & F_{WK} \\ F_{KW} & -F_{KL} & F_{KK} \\ F_{LW} & -F_{LL} - \frac{U_R^M}{U_x^M} & F_{LK} \end{pmatrix} \begin{pmatrix} W_t \\ R_t^M \\ K_t \end{pmatrix} = \begin{pmatrix} -F_{Wz}z_t \\ \tau_t^K - F_{Kz}z_t \\ -\tau_t + \frac{U_g^M}{U_x^M}g_t - F_{Lz}z_t \end{pmatrix} \quad (\text{A.44})$$

which is identical to system (SMTCA.7). Then, the first-best location responses are the same as in the baseline model (SMTCA.11)-(SMTCA.14). It follows that conditions (2.30)-(2.33) can be derived following exactly the same steps as for deriving the baseline first-best conditions (2.3)-(2.6).<sup>65</sup>

<sup>64</sup>In the following appendices, we drop index  $i$  for convenience.

<sup>65</sup>See Appendix D in SMTCA.

Second-best public policy rules

Using the local government's budget constraint to substitute for  $\tau^P$  into (2.28) and differentiating the location system (2.27)-(2.29) with respect to  $t \in \{\tau, g, z\}$ , it follows that:

$$\begin{pmatrix} F_{WW} & -F_{WL} & F_{WK} \\ F_{KW} & -F_{KL} + \frac{\tau}{K+\mathcal{L}} & F_{KK} + \frac{\tau^P}{K+\mathcal{L}} \\ F_{LW} & -F_{LL} - \frac{U_R^M}{U_x^M} & F_{LK} \end{pmatrix} \begin{pmatrix} W_t \\ R_t \\ K_t \end{pmatrix} = \begin{pmatrix} -F_{Wz}z_t \\ -\frac{R^I+R^M}{K+\mathcal{L}}\tau_t + \frac{C_g}{K+\mathcal{L}}g_t + \left(\frac{C_z}{K+\mathcal{L}} - F_{Kz}\right)z_t \\ -\tau_t + \frac{U_g^M}{U_x^M}g_t - F_{Lz}z_t \end{pmatrix} \quad (\text{A.45})$$

It follows that conditions (2.35) and (2.37) can be derived following exactly the same steps as for deriving the baseline first-best conditions (2.10) and (2.12).<sup>66</sup> Besides, following the same steps as for deriving (SMTc.A.29), we obtain:

$$\begin{vmatrix} F_{WW} & 0 & \Gamma F_{WK} \\ F_{KW} & \frac{R^I+R^M}{K+\mathcal{L}} \frac{U_R^M}{U_x^M} & \Gamma F_{KK} + \frac{\tau^P}{K+\mathcal{L}} \left( R^M \frac{U_g^M}{U_x^M} + R^I \frac{U_g^I}{U_x^I} \right) \\ F_{LW} & \frac{U_R^M}{U_x^M} & \Gamma F_{LK} + \tau^P \frac{U_g^M}{U_x^M} \end{vmatrix} = 0$$

where  $\Gamma \equiv R^M \frac{U_g^M}{U_x^M} + R^I \frac{U_g^I}{U_x^I} - C_g$ . Performing  $r_2 \leftarrow W r_1 + (K + \mathcal{L}) r_2 - (R^I + R^M) r_3$ , simplifying from Euler's expressions (SMTc.A.3)-(SMTc.A.5) and collecting terms, we obtain:

$$\begin{vmatrix} F_{WW} & 0 & \Gamma F_{WK} \\ \mathcal{L}(F_{KW} - F_{LW}) & 0 & \Gamma \mathcal{L}(F_{KK} - F_{LK}) + \tau^P R^I \left( \frac{U_g^I}{U_x^I} - \frac{U_g^M}{U_x^M} \right) \\ F_{LW} & \frac{U_R}{U_x} & \Gamma F_{LK} + \tau^P \frac{U_g^M}{U_x^M} \end{vmatrix} = 0$$

It follows that:

$$R^M \frac{U_g^M}{U_x^M} + R^I \frac{U_g^I}{U_x^I} - C_g = \frac{L}{K+L} \frac{F_{WW}}{D} \tau^P R^I \left( \frac{U_g^I}{U_x^I} - \frac{U_g^M}{U_x^M} \right), \quad 67 \quad (\text{A.46})$$

since it is straightforward to derive from (SMTc.A.9) that

$$\begin{vmatrix} F_{WW} & F_{WK} \\ F_{KW} - F_{LW} & F_{KK} - F_{LK} \end{vmatrix} = \frac{K+L}{L} \begin{vmatrix} F_{WW} & F_{WK} \\ F_{KW} & F_{KK} \end{vmatrix} \equiv \frac{K+L}{L} D.$$

<sup>66</sup>See Appendix E in SMTc.

<sup>67</sup>Note that using the expression of  $\varepsilon$  in (SMTc.A.35), we obtain:

$$\frac{R^M \frac{U_g^M}{U_x^M} + R^I \frac{U_g^I}{U_x^I} - C_g}{K} = \varepsilon R^I \left( \frac{U_g^I}{U_x^I} - \frac{U_g^M}{U_x^M} \right).$$

Since condition (2.38) and scale economies (see Assumption 1.2 in SMTc) imply  $\tau^P > 0$ , and second (resp. cross) derivatives of  $F$  are negative (resp. positive), condition (2.36) follows.

## Appendix C Vertical transfers

Assume the following functional forms:

$$U(x, g, R) = x + v\left(\frac{g}{R^\gamma}\right) \quad (\text{A.47})$$

$$C(g, z) = g + z + FC \quad (\text{A.48})$$

Note that in the main text  $v(\cdot) = 1/\alpha(\cdot)^\alpha$ , but for exposition reasons, we keep the general form of  $v(\cdot)$  in the following derivations. Differentiating (A.47), condition (2.43) can be written as

$$\frac{v'(g/R^\gamma)}{R^{\gamma-1}} = 1 \quad (\text{A.49})$$

and differentiating (A.47), we obtain:

$$R|U_R| = R \frac{\gamma g v'(g/R^\gamma)}{R^{\gamma+1}} = \frac{\gamma g}{R}$$

From (2.40) and (A.48):

$$\frac{S}{R} = \frac{(1-\gamma)g + z + FC}{R} \quad (\text{A.50})$$

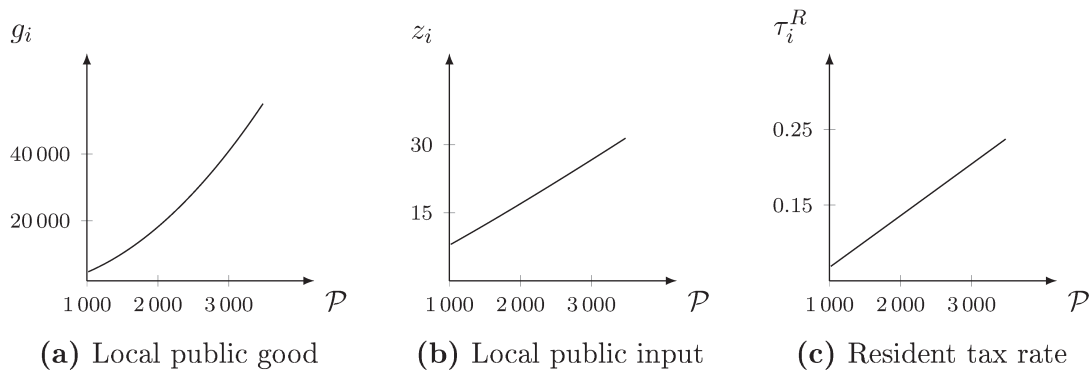
and condition (2.44) becomes:

$$F_z(K, W, L, z) = 1 \quad (\text{A.51})$$

Finally, symmetry implies that:

$$K = \frac{\mathcal{K}}{n} \quad R = W = \frac{\mathcal{P}}{n} \quad L = \mathcal{L} - \frac{\mathcal{P}}{n} \quad (\text{A.52})$$

Then,  $S/R$ ,  $g$  and  $z$  are fully determined by (A.49), (A.50) and (A.51), which allows to draw Figure 2.2 and Figure 5 hereafter:



**Figure 5.** Public policy instrument choices with respect to the metropolis size  $\mathcal{P}$ .

## Appendix D Land use restrictions

### *First-order conditions*

Differentiating equations (2.48)-(2.50) and performing  $r_3 \leftarrow Wr_1 + Kr_2 + Lr_3$ , we obtain:

$$A \equiv \begin{pmatrix} F_{WW} & F_{WK} & 0 & 0 & -F_{WL} \\ F_{KW} & F_{KK} & 0 & 0 & -F_{KL} \\ 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 & -\frac{U_R}{U_x} \\ 0 & \tau^P & 0 & 0 & \tau^R - \tau^P \end{pmatrix} \begin{pmatrix} W_t \\ K_t \\ \rho_t^L \\ \rho_t^R \\ R_t \end{pmatrix} = \begin{pmatrix} -F_{Wz}z_t \\ -F_{Kz}z_t + \tau_t^P \\ -F_z z_t + (K+L)\tau_t^P \\ -\tau_t^R + \frac{U_g}{U_x}g_t \\ C_g g_t + C_z z_t - R\tau_t^R - (K+L)\tau_t^P \end{pmatrix} \quad (\text{A.53})$$

Then:

$$\begin{aligned} R_{\tau^P} &= \frac{K+L}{R}R_{\tau^R} + |A|^{-1}F_{WW}\tau^P & K_{\tau^P} &= \frac{K+L}{R}K_{\tau^R} + |A|^{-1}F_{WW}(\tau^P - \tau^R) \\ R_{\tau^R} &= |A|^{-1}R(F_{KK}F_{WW} - F_{WK}^2) & K_{\tau^R} &= |A|^{-1}R(F_{KL}F_{WW} - F_{KW}F_{WL}) \end{aligned}$$

Inserting these responses into the first-order conditions (2.51) with respect to  $\tau_i^R$  and  $\tau_i^P$ , we obtain after simplification:

$$\begin{aligned} \left( \tau^R + R\frac{U_R}{U_x} - \tau^P + \rho^R - \rho^L \right) (F_{KK}F_{WW} - F_{WK}^2) + \tau^P (F_{KL}F_{WW} - F_{KW}F_{WL}) &= 0 \\ \left( R\frac{U_R}{U_x} + \rho^R - \rho^L \right) \tau^P &= 0 \end{aligned}$$

Yet  $\left( R\frac{U_R}{U_x} + \rho^R - \rho^L \right) \neq 0$  and  $(F_{KK}F_{WW} - F_{WK}^2) \neq 0$ . Then, conditions (2.54)-(2.57) follow.

### *Equilibrium location responses*

Note that we have from Euler's formula:

$$|A| = -\tau^R(F_{WW}F_{KK} - F_{WK}^2) = \tau^R \frac{L}{K}(F_{KL}F_{WW} - F_{WL}F_{WK}) < 0$$

And from (A.53) and using  $\tau^P$ , we obtain:

$$\begin{aligned}
R_{\tau^R} &= -\frac{R}{\tau^R} < 0, & R_{\tau^P} &= -\frac{K+L}{\tau^R} < 0, \\
R_g &= \frac{C_g}{\tau^R} > 0, & R_z &= \frac{C_z}{\tau^R} > 0, \\
W_{\tau^R} &= -\frac{W}{L}R_{\tau^R} > 0, & W_{\tau^P} &= -\frac{W}{L}R_{\tau^P} - \frac{F_{WK}}{F_{KK}F_{WW} - F_{WK}^2} > 0 \text{ or } < 0, \\
W_g &= -\frac{W}{L}R_g < 0, & W_z &= -\frac{W}{L}R_z - \frac{F_{KK}F_{Wz} - F_{Kz}F_{WK}}{F_{KK}F_{WW} - F_{WK}^2} > 0 \text{ or } < 0, \\
K_{\tau^R} &= -\frac{K}{L}R_{\tau^R} > 0, & K_{\tau^P} &= -\frac{K}{L}R_{\tau^P} + \frac{F_{WW}}{F_{KK}F_{WW} - F_{WK}^2} > 0 \text{ or } < 0, \\
K_g &= -\frac{K}{L}R_g < 0, & K_z &= -\frac{K}{L}R_z - \frac{F_{Kz}F_{WW} - F_{WK}F_{Wz}}{F_{KK}F_{WW} - F_{WK}^2} > 0 \text{ or } < 0.
\end{aligned}$$

since  $F_{XX} < 0$  and  $F_{XY} > 0$  for  $X, Y \in \{K, W, L\}$ .

# Appendix for Chapter 3

## Appendix A Derivation of the local public policy rules

The purpose of this appendix section is, first, to derive the optimal tax conditions ( $\text{TR}^0$ ), ( $\text{BC}^0$ ), ( $\text{TR}^0$ ) and ( $\text{TR}^1$ ) (Public policy rules),<sup>68</sup> which requires to characterize the first-order conditions of the local government (First-order conditions), as well as the location responses of resident and capital to local policy changes (Location responses). The second objective of this appendix section is to derive the tax rate change conditions (3.10a) and (3.10b) in the presence of a perfect revenue compensation (Tax rate evolution in the presence of a revenue compensation). We focus on the representative jurisdiction  $i$  in all this appendix. We drop index  $i$  for notational convenience.

### *First-order conditions*

The benevolent local government maximizes the utility of its residents  $U \equiv U(x, G, R) = x + \alpha \log(G/R)$  which, by substituting  $x$  using (1.6), can be written as:

$$U = \frac{r\mathcal{K} + \rho\ell + (n-1)\bar{\rho}\ell}{\mathcal{P}} + \alpha \log\left(\frac{G}{R}\right) - \rho - \tau^R,$$

where  $\bar{\rho} \equiv \rho_j$  with  $j \neq i$  denotes the other municipalities' land rent. Using respectively (3.2) and (3.4) to substitute  $\tau^R$  and  $\ell$ , we obtain:

$$U = \frac{r\mathcal{K} + \rho R + \rho L + (n-1)\bar{\rho}\bar{\ell}}{\mathcal{P}} + u. \quad (\text{A.54})$$

Since  $F$  is homogeneous of degree 1, Euler's theorem requires that  $F = KF_K + LF_L$ , where subscripts stand for derivatives. Inserting (3.3) into this condition implies the zero-profit condition  $F^i(K_i, L_i) - [r + (1-\theta)\tau_i^P]K_i - (\rho_i + \tau_i^P)L_i = 0$ . Replacing  $\rho R$  and  $\rho L$  into (A.54) using respectively (3.2) and the zero-profit condition yields:

$$U = \frac{[\alpha \log\left(\frac{G}{R}\right) - \tau^R - u]R + F - [\bar{r} + \tau^P(1-\theta)]K - \tau^P L + r\mathcal{K} + (n-1)\bar{\rho}\bar{\ell}}{\mathcal{P}} + u$$

---

<sup>68</sup> To this aim, we follow standard computational steps. See e.g. Wellisch (2006).



From the household budget constraint (1.6), it follows that the local government objective can be written as:

$$U = \frac{F(K, \ell - R) - \bar{r}K + [\alpha \log\left(\frac{G}{R}\right) - u]R - G - f + \theta\Lambda + r\mathcal{K} + (n-1)\bar{\rho}\bar{\ell}}{\mathcal{P}} + u \quad (\text{A.55})$$

where  $L$  has been substituted in the production function using (1.6).

In the sequel, we assume without loss of generality that the local government freely chooses  $\tau^R$  and  $G$  while adjusting  $\tau^P$  to clear its budget constraint (1.11).<sup>69</sup> Since household and capital locations are not under the direct control of the local government, a rational government must take account of location responses to its policy. The responses of residents ( $\partial R/\partial\tau^R$  and  $\partial R/\partial G$ ) and capital ( $\partial K/\partial\tau^R$  and  $\partial K/\partial G$ ) to changes in the local government's policy instruments can be derived from the migration equilibrium condition (3.2) and the necessary conditions for the optimal demand for capital (1.8) from local firms. Inserting (3.4) and (1.9) into (3.2) and (1.8) and substituting  $\tau^P$  using the budget constraint (1.11) the following two-equation system results:

$$F_K(K, \ell - R) - \frac{G + f - \theta\Lambda - \tau^R R}{(1 - \theta)K + \ell - R}(1 - \theta) - r = 0 \quad (\text{A.56})$$

$$\alpha \log\left(\frac{G}{R}\right) - F_L(K, \ell - R) - \tau^R + \frac{G + f - \theta\Lambda - \tau^R R}{(1 - \theta)K + \ell - R} - u = 0 \quad (\text{A.57})$$

The location system allows to derive  $R$  and  $K$  as implicit functions of  $\tau^R$  and  $G$ .

Let us now determine the first-order conditions of the local government. Differentiating (A.55) with respect to  $t \in \{\tau^R, G\}$ , we have  $\partial U/\partial t = 0$  is equivalent to:

$$[F_K - r] \frac{\partial K}{\partial t} + \left[ \alpha \log\left(\frac{G}{R}\right) - u - F_L - \alpha \right] \frac{\partial R}{\partial t} + \left( \alpha \frac{R}{G} - 1 \right) \frac{\partial G}{\partial t} = 0.$$

Replacing  $u$ ,  $F_K$  and  $F_L$  using (3.2), (1.8) and (1.9) and collecting terms, the following first-order conditions result:

$$(\tau^R - \tau^P - \alpha) \frac{\partial R}{\partial \tau^R} + \tau^P(1 - \theta) \frac{\partial K}{\partial \tau^R} = 0 \quad (\text{A.58})$$

$$(\tau^R - \tau^P - \alpha) \frac{\partial R}{\partial G} + \tau^P(1 - \theta) \frac{\partial K}{\partial G} + \alpha \frac{R}{G} - 1 = 0 \quad (\text{A.59})$$

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<sup>69</sup> This assumption allows to solve the model without introducing a Lagrange multiplier for the budget constraint of the local government. Note that whatever the instrument chosen to clear the budget ( $\tau^R$ ,  $\tau^P$  or  $G$ ), the results are strictly identical.

### Location responses

We now determine the location responses of residents and capital. To this aim, we differentiate (A.56) and (A.57) with respect to  $t \in \{\tau^R; \tau^P\}$ , which yields in matrix form:

$$A \begin{pmatrix} \frac{\partial R}{\partial t} \\ \frac{\partial K}{\partial t} \end{pmatrix} = B$$

where

$$A \equiv \begin{pmatrix} \frac{(1-\theta)(\tau^R - \tau^P)}{(1-\theta)K + \ell - R} - F_{KL} & F_{KK} + \frac{\tau^P(1-\theta)^2}{(1-\theta)K + \ell - R} \\ -\frac{\alpha}{R} + F_{LL} - \frac{\tau^R - \tau^P}{(1-\theta)K + \ell - R} & -\frac{\tau^P(1-\theta)}{(1-\theta)K + \ell - R} - F_{LK} \end{pmatrix} \quad (\text{A.60})$$

and

$$B \equiv \begin{pmatrix} \frac{(1-\theta)}{(1-\theta)K + \ell - R} \left[ \frac{\partial G}{\partial t} - R \frac{\partial \tau^R}{\partial t} \right] \\ \left[ 1 + \frac{R}{(1-\theta)K + \ell - R} \right] \frac{\partial \tau^R}{\partial t} - \left[ \frac{1}{(1-\theta)K + \ell - R} + \frac{\alpha}{G} \right] \frac{\partial G}{\partial t} \end{pmatrix} \quad (\text{A.61})$$

Then, from Cramer's rule:

$$\frac{\partial R}{\partial t} = |A|^{-1} \begin{vmatrix} \frac{(1-\theta)}{(1-\theta)K + \ell - R} \left[ \frac{\partial G}{\partial t} - R \frac{\partial \tau^R}{\partial t} \right] & F_{KK} + \frac{\tau^P(1-\theta)^2}{(1-\theta)K + \ell - R} \\ \left[ 1 + \frac{R}{(1-\theta)K + \ell - R} \right] \frac{\partial \tau^R}{\partial t} - \left[ \frac{1}{(1-\theta)K + \ell - R} + \frac{\alpha}{G} \right] \frac{\partial G}{\partial t} & -\frac{\tau^P(1-\theta)}{(1-\theta)K + \ell - R} - F_{LK} \end{vmatrix}, \quad (\text{A.62})$$

$$\frac{\partial K}{\partial t} = |A|^{-1} \begin{vmatrix} \frac{(1-\theta)(\tau^R - \tau^P)}{(1-\theta)K + \ell - R} - F_{KL} & \frac{(1-\theta)}{(1-\theta)K + \ell - R} \left[ \frac{\partial G}{\partial t} - R \frac{\partial \tau^R}{\partial t} \right] \\ -\frac{\alpha}{R} + F_{LL} - \frac{\tau^R - \tau^P}{(1-\theta)K + \ell - R} & \left[ 1 + \frac{R}{(1-\theta)K + \ell - R} \right] \frac{\partial \tau^R}{\partial t} - \left[ \frac{1}{(1-\theta)K + \ell - R} + \frac{\alpha}{G} \right] \frac{\partial G}{\partial t} \end{vmatrix} \quad (\text{A.63})$$

where  $|A|$  is the determinant of  $A$ , and for all  $t \in \{\tau^R; G\}$ ,  $\partial t / \partial t'$  is 1 if  $t = t'$  and 0 otherwise.

### Public policy rules

We can now determine the public policy rules by inserting the location responses (A.62) and (A.63) into the first-order conditions (A.58) and (A.59). Let us start with the taxation rules (TR<sup>0</sup>) and (TR<sup>1</sup>). Replacing  $t$  by  $\tau^R$  in the location responses and inserting them into (A.58), we obtain:<sup>70</sup>

<sup>70</sup> Recall that from usual determinant computation rules, we have:

$$\alpha \begin{vmatrix} a & c \\ b & d \end{vmatrix} + \beta \alpha \begin{vmatrix} e & a \\ f & b \end{vmatrix} = \alpha \begin{vmatrix} a & \alpha c - \beta e \\ b & \alpha b - \beta f \end{vmatrix}.$$

$$\left| \begin{array}{cc} -\frac{(1-\theta)R}{(1-\theta)K+\ell-R} & F_{KK} \left[ (\tau^R - \tau^P - \alpha) + \frac{F_{KL}}{F_{KK}} \tau^P (1-\theta) \right] - \alpha \frac{\tau^P (1-\theta)^2}{(1-\theta)K+\ell-R} \\ 1 + \frac{R}{(1-\theta)K+\ell-R} & -F_{LK} \left[ (\tau^R - \tau^P - \alpha) + \frac{F_{LL}}{F_{LK}} \tau^P (1-\theta) \right] + \left[ 1 + \frac{R}{(1-\theta)K+\ell-R} \right] \frac{\alpha}{R} \tau^P (1-\theta) \end{array} \right| = 0.$$

Applying the column operation  $C2 \leftarrow C2 - \frac{\alpha}{R} \tau^P (1-\theta) \times C1$  and noticing  $\frac{F_{KL}}{F_{KK}} = \frac{F_{LL}}{F_{LK}} = -\frac{K}{L}$  the derivative of  $F$  are homogeneous of degree 0, we obtain:

$$\left| \begin{array}{cc} -\frac{(1-\theta)R}{(1-\theta)K+\ell-R} & F_{KK} \\ \frac{(1-\theta)K+\ell}{(1-\theta)K+\ell-R} & -F_{LK} \end{array} \right| \left[ \tau^R - \tau^P - \alpha - \frac{K}{L} \tau^P (1-\theta) \right] = 0.$$

The determinant is negative due to the standard assumption  $F_{KK} < 0$  (which implies  $F_{KL} > 0$  by homogeneity  $F$ ) so that:

$$\tau^R - \tau^P - \alpha - \frac{K}{L} \tau^P (1-\theta) = 0 \quad (\text{A.64})$$

which is precisely the taxation rule ( $\text{TR}^0$ ), for  $\theta = 0$  and ( $\text{TR}^1$ ), for  $\theta = 1$ .

We now derive the local public good provision rule.<sup>71</sup> Replacing  $t$  by  $G$  in the location responses and inserting them into (A.59), and following the same computation step as above, it follows that:

$$\left| \begin{array}{cc} \frac{1-\theta}{(1-\theta)K+\ell-R} & F_{KK} \left[ (\tau^R - \tau^P - \alpha) - \frac{K}{L} \tau^P (1-\theta) \right] - \alpha \frac{\tau^P (1-\theta)^2}{(1-\theta)K+\ell-R} \\ -\frac{1}{(1-\theta)K+\ell-R} - \frac{\alpha}{G} & -F_{LK} \left[ (\tau^R - \tau^P - \alpha) - \frac{K}{L} \tau^P (1-\theta) \right] + \left[ 1 + \frac{R}{(1-\theta)K+\ell-R} \right] \frac{\alpha}{R} \tau^P (1-\theta) \end{array} \right| + \left( \alpha \frac{R}{G} - 1 \right) |A| = 0$$

Using (A.64) to simplify and applying the column operation  $C2 \leftarrow C2 + \frac{G}{R} \tau^P (1-\theta) \times C1$ , we obtain:

$$\left| \begin{array}{cc} \frac{1-\theta}{(1-\theta)K+\ell-R} & -\frac{\tau^P (1-\theta)^2}{(1-\theta)K+\ell-R} \left( \alpha - \frac{G}{R} \right) \\ -\frac{1}{(1-\theta)K+\ell-R} - \frac{\alpha}{G} & \frac{\tau^P (1-\theta)}{(1-\theta)K+\ell-R} \left( \alpha - \frac{G}{R} \right) \end{array} \right| + \left( \alpha \frac{R}{G} - 1 \right) |A| = 0$$

which gives:

$$\left( \alpha \frac{R}{G} - 1 \right) \left[ |A| - \frac{\alpha}{R} \frac{\tau^P (1-\theta)^2}{(1-\theta)K+\ell-R} \right] = 0 \quad (\text{A.65})$$

Yet, replacing replacing  $\tau^R$  from (A.64) in  $A$  as defined by (A.60) and developing its determinant, we obtain after some simple manipulations:

$$|A| = \frac{\alpha}{R} \frac{\tau^P (1-\theta)^2}{(1-\theta)K+\ell-R} + \frac{\alpha \ell}{RL} F_{KK} \quad (\text{A.66})$$

<sup>71</sup> Public good provision is rather peripheral in this paper, but deriving the public good provision rule is necessary to derive the tax reduced forms.

which shows that the term between square brackets (A.65) is non zero, so that the government public good policy is characterized by:

$$\alpha \frac{R}{G} = 1 \quad (\text{A.67})$$

which is the well-known Samuelson rule (see footnote 17).

We can now derive the budget constraint rules (BC<sup>0</sup>) and (BC<sup>1</sup>). Inserting (A.67) into the local government budget constraint (1.11) and solving for  $\tau^P$ , we obtain:

$$\tau^P = \frac{R}{(1-\theta)K + L} \left( \alpha - \tau^R + \frac{f - \Lambda}{R} \right)$$

which is precisely the taxation rule (BC<sup>0</sup>), for  $\theta = 0$  and (BC<sup>1</sup>), for  $\theta = 1$ .

### *Tax rate evolution in the presence of a revenue compensation*

In this last subsection, we derive the tax rate change equations (3.10a) and (3.10b). In the presence of a revenue compensation  $\Lambda = \tau^{P0}K^0$ , from (3.8b) and (3.8a), we have:

$$\tau^{P1} - \tau^{P0} = \frac{f}{\ell} - \frac{\tau^{P0}K^0}{\ell} - (1 - \kappa^0) \frac{f}{\ell}$$

Substituting  $\tau^{P0}$  and  $\ell$  using (3.8a) and (3.4), replacing  $\kappa^0$  by its definition (ie.  $K^0/(K^0 + L^0)$ ) we obtain:

$$\tau^{P1} - \tau^{P0} = \frac{(R^0 + L^0)(K^0 + L^0) - (R^0 + L^0 + K^0)L^0}{K^0 + L^0} \frac{f}{\ell^2} = R^0 \frac{f}{\ell^2} \frac{K^0}{K^0 + L^0} = \frac{\mathcal{P}}{\mathcal{L}} \frac{f}{\ell} \kappa^0, \quad (\text{A.68})$$

where the last equality is obtained using the definition of  $\kappa^0$ , recalling that  $R^0 = \mathcal{P}$  in the symmetric equilibrium and that by definition  $n\ell = \mathcal{L}$ . This proves the tax rate change equation (3.10a).

Let us now turn to evolution of the tax on resident. Replacing  $\tau^{P0}$  using (3.8a) into (3.7a), we have:

$$\tau^{R0} = \alpha + \tau^{P0} + \frac{f}{\ell} \kappa^0 \quad (\text{A.69})$$

Besides, using (A.68) so substitute  $\tau^{P1}$  into (3.7b) yields:

$$\tau^{R1} = \alpha + \tau^{P0} + \frac{\mathcal{P}}{\mathcal{L}} \frac{f}{\ell} \kappa^0 \quad (\text{A.70})$$

Finally, the difference between (A.70) and (A.69) gives the tax rate change equation (3.10b).

## Appendix B Institutional setting of the different government layers

**Table A.1.** Tax rate and EPCI's fiscal option before 2010.

EPCI option	SBT-FPU				SBT-FM				FA				No EPCI			
	TP	TH	TFB	TFNB	TP	TH	TFB	TFNB	TP	TH	TFB	TFNB	TP	TH	TFB	TFNB
Municipality	x	x	x		x	x	x		x	x	x	x	x	x	x	x
EPCI	x				x	x	x	x	x	x	x	x				

NOTE.—Crosses indicate that the jurisdiction — municipality or EPCI — has authority to vote its own tax rate. TP, TH, TFB and TFNB respectively stand for business property tax, housing tax, tax on developed property and tax on undeveloped property. FA stands for *fiscalité additionnelle* (additional taxation), FPU for *fiscalité professionnelle unique* (single professional taxation) and FM for *fiscalité mixed* (mixed taxation).

**Table A.2.** Indirect taxes available before and after the reform.

	$\leq 2009$					$\geq 2011$				
	TP	TP bis	TH	TFB	TFNB	CFE	CVAE	TH	TFB	TFNB
Mun./EPCI	x	x	x	x	x	x	x	x	x	x
County	x	x	x	x	x		x		x	
Region	x	x		x	x		x			

NOTE.—Crosses indicate that the jurisdiction — municipality, EPCI, county or region — has authority to vote its own tax rate. TP, TH, TFB and TFNB respectively stand for business property tax, housing tax, tax on developed property and tax on undeveloped property. CFE is the new business property tax relying exclusively on business land, and CVAE is the new business value added tax. The first line does not distinguish between municipalities and EPCIs, but the distribution of [Table A.1](#) actually applies. The same distribution of competences between municipalities and EPCIs apply for TP and CFE, while all EPCIs perceive a share of the CVAE.

## Appendix C Complementary descriptive statistics

**Table A.3.** Descriptive statistics on control variables in 2009.

	Mean	Standard deviation	Minimum	Maximum
<i>Municipal characteristics</i>				
Population (in thousands)	1.3	20.8	.009	2234
Density	0.1	0.7	3.5e-04	26
Number of firms per inhabitant	0.1	0.1	.012	.95
Metropolitan (dummy)	0.8	0.4	0	1
Median income ( <i>in 10,000 €</i> )	1.8	0.3	.91	5.4
Share of commuters (%)	74.7	14.6	3.7	100
Share of left-wing voters (%)	42.4	10.9	0	94
Share of population below 15 year old (%)	32.7	6.0	2.9	68
Schooling rate (%)	92.9	4.1	50	100
<i>Share of population per SPC (%)</i>				
Farmers	3.9	5.1	0	67
Craftsmen	4.2	3.2	0	50
Managers	5.0	4.3	0	57
Temporary workers	12.2	6.0	0	100
Employees	15.4	5.4	0	65
Blue color workers	16.4	7.0	0	67
Retirees	30.1	10.1	0	100
Unemployed	12.9	5.3	0	80
<i>Share of firms per sector (%)</i>				
Industry	44.3	20.6	0	98
Finance and real estate	2.2	3.1	0	50
Trade and retail	12.5	8.2	0	67
Other tertiary sector	26.7	13.2	1.4	100
<i>Share of firms per size (%)</i>				
No employee	70.4	12.5	0	100
Less than 10 employees	25.9	10.8	0	100
At least 10 employees	3.7	4.5	0	54

NOTE.—The sample includes all 11,896 municipalities for the year 2009. Density is the number of inhabitants (in thousands) per square kilometer. Share of left-wing voters is that of the presidential election of 2007. Schooling rate is the share of population below 17 year old enrolled in school.

**Table A.4.** Descriptive statistics per category of capital share intensity.

	2006	2007	2008	2009	2010	2011	2012
A. Capital share below the median							
Capital share	.6909 (.2243)	.6891 (.2253)	.6859 (.2288)	.6741 (.2364)			
Business property tax rate	.1007 (.0574)	.1007 (.0575)	.1011 (.0578)	.1013 (.0584)	.184 (.0683)	.1857 (.0665)	.1869 (.0665)
Housing tax rate	.0867 (.0374)	.0869 (.0374)	.0874 (.0376)	.0883 (.0379)	.089 (.0403)	.1578 (.0496)	.1584 (.0499)
Observations	5948	5948	5948	5948	5948	5948	5948
B. Capital share above the median							
Capital share	.9098 (.0675)	.9161 (.0582)	.9229 (.0448)	.9294 (.0354)			
Business property tax rate	.0897 (.0466)	.0897 (.0467)	.0901 (.0467)	.0906 (.0467)	.1749 (.0535)	.1746 (.0549)	.1756 (.0555)
Housing tax rate	.075 (.0347)	.0751 (.0347)	.0757 (.0349)	.0764 (.0351)	.0769 (.0373)	.1453 (.0477)	.146 (.0481)
Observations	5948	5948	5948	5948	5948	5948	5948

NOTE.—Each cell contains the variable mean and standard error in parentheses. Panel A (resp. Panel B) describe municipalities with a share of capital in the business property tax below (resp. above) the median. The sample median of the capital share in 2009 is 86.76%.

**Table A.5.** Correlation between net and gross business property tax base.

Year	Pearson's coefficient	Spearman's coefficient	Share of the net tax base in the gross tax base
2006	99.9949	99.3043	83.17
2007	99.9945	99.319	82.98
2008	99.9931	99.3118	83.2
2009	99.9928	99.2703	83.28
2010	99.981	97.2859	89.68
2011	99.9787	97.2934	89.39
2012	99.9836	97.5448	85.2

NOTE.—N=11,896. The table reports correlation coefficients between the gross tax base  $GB$  and the net tax base  $NB$  of the business property tax. In the pre-reform years 2006-2009,  $GB = K + L$  and  $NB = \alpha_K K + \alpha_L L$ , where  $K$  (resp.  $L$ ) is the capital (resp. business land) tax base, and  $\alpha_K$  (resp.  $\alpha_L$ ) is the share of the tax base not exempted from tax. In the post-reform years 2010-2012,  $GB = L$  and  $NB = \alpha_L L$ . The significance tests for all coefficients are below  $10^{-6}$ , so that they strongly reject non significance of the correlation.



## Appendix D Event study estimates

**Table A.6.** Event study coefficients for the continuous and discrete regressions.

	DEPENDENT VARIABLE: BUSINESS PROPERTY TAX		DEPENDENT VARIABLE: HOUSING TAX	
	Coef.	95%CI	Coef.	95%CI
A. Continuous treatment				
$Ratio \times Post^{06}$	-.00096	[-.00949 ; .00757]	.00045	[-.00133 ; .00223]
$Ratio \times Post^{07}$	-.00123	[-.00706 ; .0046]	.00023	[-.00097 ; .00142]
$Ratio \times Post^{08}$	-.00036	[-.00339 ; .00268]	.00009	[-.00053 ; .0007]
$Ratio \times Post^{10}$	.01552	[.00907 ; .02197]	-.00072	[-.00132 ; -.00013]
$Ratio \times Post^{11}$	.00371	[-.0038 ; .01123]	-.00031	[-.00175 ; .00113]
$Ratio \times Post^{12}$	.00009	[-.00909 ; .00926]	-.00054	[-.00245 ; .00136]
B. Discrete treatment				
$High \times Post^{06}$	.00045	[-.00027 ; .00116]	.00041	[-.00015 ; .00097]
$High \times Post^{07}$	.00016	[-.00038 ; .00069]	.00026	[-.00013 ; .00065]
$High \times Post^{08}$	-.00019	[-.00055 ; .00017]	.00021	[-.00002 ; .00044]
$High \times Post^{10}$	.00129	[.00027 ; .00231]	-.00031	[-.00053 ; -.00009]
$High \times Post^{11}$	-.00075	[-.00188 ; .00038]	-.00075	[-.00183 ; .00033]
$High \times Post^{12}$	-.00136	[-.00258 ; -.00014]	-.00086	[-.00201 ; .00028]

NOTE.—The sample is all 11,896 municipalities from 2006 to 2012. The table reports the coefficients on  $Ratio \times Post^j$  and  $High \times Post^j$  of respectively the continuous and discrete event-study regressions.  $Post^j$  is a time dummy for the year  $20j$ ,  $j = 06, 08, 10, 11, 12$ .  $Ratio$  is the 2009 share of the eliminated capital tax base in the business property tax base consisting in capital and land.  $High$  is an indicator equal to one if a municipality has a 2009 capital share above the sample median, and zero otherwise. The regression also includes all the socio-demographic, political and economic variables described in the data section, individual time trends, and EPCI and county by year effects. Robust standard errors are clustered by 2009 EPCI.

# Appendix for Chapter 4

## Appendix A Agglomeration economies and demand for capital

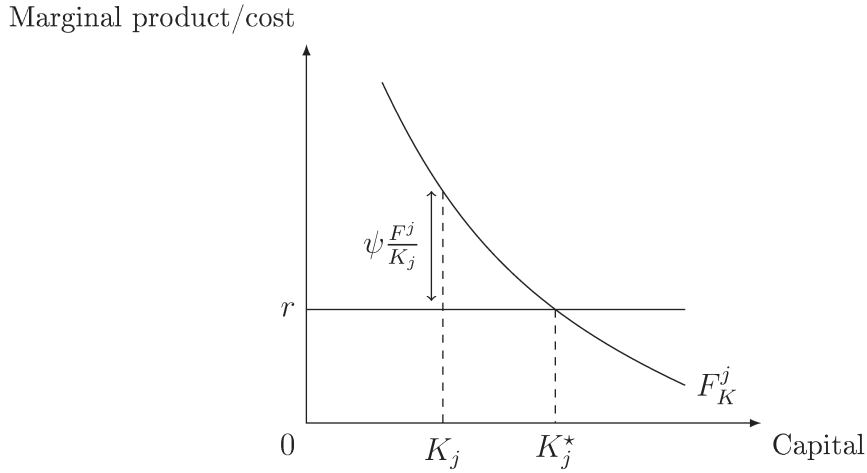
In this appendix we prove the condition for optimal capital input demand (4.10c) and present a graphical representation of it. Zero-profit requirement,  $F^j - w_j W_j - (r + \tau_j^K)K_j - \rho_j^L L_j = 0$ , implies:

$$r + \tau_j^K = \frac{F^j - F_W^j W_j - F_L^j L_j}{K_j} = \frac{F^j - (\psi + 1)F^j + F_K^j K_j}{K_j} = F_K^j - \psi \frac{F^j}{K_j}$$

where the first equality comes from simple manipulations of  $\Pi^c = 0$ , where input prices have been substituted using (4.10). The second equality uses Euler's formula resulting from linear homogeneity:  $(\psi + 1)F^c = F_K^c K_c + F_W^c W_c + F_L^c L_c$ . Notice that, as in [Burbidge and Cuff \(2005\)](#) and [Fernandez \(2005\)](#), we assume that the equilibrium on the capital market is stable, and therefore focus on interior solutions where both types of municipalities have a certain amount of capital at equilibrium. Formally, we assume the following:

$$\frac{\partial \left( F_K^j - \psi \frac{F^j}{K_j} \right)}{\partial K_j} = F_{KK}^j - \psi \frac{F_K^j - F^j/K_j}{K_j} < 0.$$

[Figure A.1](#) represents the equilibrium on the capital market for municipality  $j$  if it doesn't make use of its capital tax, ie.  $\tau_j^K = 0$ .



**Figure A.1.** Partial equilibrium on a local capital market when  $\tau_j^K = 0$ . The figure shows that due to the existence of agglomeration economies ( $\psi > 0$ ), the local amount of capital  $K_j$  demanded by firms is lower than the efficient amount  $K_j^*$ .

From Figure A.1, it appears that if they wish to reach the efficient level of local capital amount  $K_j^*$ , authorities of municipality  $j$  are spurred to introduce a capital subsidy  $\tau_j^K < 0$  to decrease the marginal cost of capital.

## Appendix B Aggregate land rent

Since land rent is constant within business districts and the land rent paid by suburban residents working where they live is symmetric on both side of the SBD (see Figure 4.3), we have::

$$\int_{-\frac{L_c}{n}}^0 [\rho(l) - \tau_c^L] dl = \int_{-\frac{R_c}{n}}^0 [\rho(l) - \tau_c^L] dl + [F_L^c - \tau_c^L] \frac{L_c}{n}$$

$$\int_0^{\mathcal{L}_s} [\rho(l) - \tau_{s_i}^L] dl = \int_0^{R_{s_i} - W_{s_i}} [\rho(l) - \tau_{s_i}^L] dl + 2 \int_{R_{s_i} - W_{s_i}}^{R_{s_i} - \frac{W_{s_i}}{2}} [\rho(l) - \tau_{s_i}^L] dl$$

Then, from the aggregate land rent definition (4.11), we obtain:

$$\Gamma = \mathcal{P}^{-1} \left[ n\mathcal{I}_c + \sum_{i=1}^n \mathcal{I}_{s_i} + F_L^c L_c - \tau_c^L \mathcal{L}_c + \sum_{i=1}^n (F_L^{s_1} L_{s_1} - \tau_{s_1}^L \mathcal{L}_s) \right] \quad (\text{A.1})$$

where

$$\mathcal{I}_c \equiv 2 \int_{-\frac{R_c}{2n}}^0 \rho(l) dl, \quad \mathcal{I}_{s_i} \equiv \int_0^{R_{s_i} - W_{s_i}} \rho(l) dl + 2 \int_{R_{s_i} - W_{s_i}}^{R_{s_i} - \frac{W_{s_i}}{2}} \rho(l) dl.$$

Inserting (4.17) and (3.3) into (4.13)–(4.16) leads to:

$$\begin{aligned}\rho(l) &= -t \left( \frac{R_c}{n} + l \right) + F_L^c, & l \in \left] -\frac{R_c}{n}, 0 \right] \\ \rho_{s_i}(l) &= -t \left( l - R_{s_i} + \frac{3}{2}W_{s_i} \right) + F_L^{s_i}, & l \in ]0, R_{s_i} - W_{s_i}], \\ \rho_{s_i}(l) &= -t \left( R_{s_i} - \frac{W_{s_i}}{2} - l \right) + F_L^{s_i}, & \forall l \in \left] R_{s_i} - W_{s_i}, R_{s_i} - \frac{W_{s_i}}{2} \right]\end{aligned}$$

Then, integrating over the appropriate intervals, we have:

$$\mathcal{I}_c = -\frac{t}{2} \left( \frac{R_c}{n} \right)^2 + F_L^c \frac{R_c}{n}, \quad \mathcal{I}_{s_i} = F_L^{s_i} R_{s_i} + \frac{t}{2} (R_{s_i}^2 - 3R_{s_i}W_{s_i} + \frac{3}{2}W_{s_i}^2). \quad (\text{A.2})$$

Then, inserting (A.2) into (A.1), replacing  $\tau_c^{\mathcal{L}}$  and  $\tau_{s_i}^{\mathcal{L}}$  from the local budget constraints (4.19), and replacing  $L_c$  and  $L_{s_i}$  from the land occupation condition (4.2), we obtain:

$$\begin{aligned}\Gamma &= \mathcal{P}^{-1} \sum_{i=1}^n \left[ \mathcal{A}_{s_i} + F_L^{s_i} \mathcal{L}_{s_i} + \tau_{s_i}^R R_{s_i} + \tau_{s_i}^K K_{s_i} + \tau_{s_i}^W W_{s_i} - C^{s_i} \right. \\ &\quad \left. + n^{-1} (F_L^c \mathcal{L}_c + \tau_c^R R_c + \tau_c^K K_c + \tau_c^W W_c - C^c) \right],\end{aligned}$$

with

$$\mathcal{A}_{s_i} = \frac{t}{2} \left[ R_{s_i}^2 + \frac{3}{2}W_{s_i}^2 - 3R_{s_i}W_{s_i} - \left( \frac{R_c}{n} \right)^2 \right].$$

## Appendix C First-order conditions of town $s$

The purpose of this appendix is to derive the suburban government  $s_i$ 's optimal policy rules when the tax instrument set comprises a tax on labor — that is, conditions (4.30)–(4.33) — and when the labor tax is absent — that is, conditions (4.45)–(4.47). Since each town  $s_i$  is atomistic and symmetric, in the sequel we can ignore index  $i$  for convenience.

### *Municipality's program*

Before proceeding, recall that since  $F^j$  is homogenous of degree  $\psi + 1 > 1$ , we have the following Euler's formulas for each  $X \in \{W; K, L\}$ :

$$(\psi + 1)F^j = F_W^j W + F_K^j K + F_L^j L, \quad (\text{A.3})$$

$$\psi F_X^j = F_{WX}^j W + F_{KX}^j K + F_{LX}^j L, \quad (\text{A.4})$$

The utility of the resident of  $s$  living the closest from her home town SBD is:

$$x_s + U^s + U^{ss},$$

and her budget constraint is:

$$x_s + \rho(C) = w_s + rk + \Gamma - \tau_s^R,$$

with  $\rho(C) = F_L^s$ . Replacing  $w_s$  using (4.10), it follows that the municipalities' program is to maximize:

$$-F_L^s + F_W^s - \tau_s^W + rk + \Gamma + U^s + U^{ss} - \tau_s^R,$$

choosing  $\tau_s^R, \tau_s^K, G_s, W_s, R_s, K_s$ , subject to

$$F_K^s - \psi \frac{F^s}{K_s} - \tau_s^K = F_K^c - \psi \frac{F^c}{K_c} - \tau_c^K \quad (\lambda_1)$$

$$F_W^c - \tau_c^W - F_W^s + \tau_s^W - t \left( \frac{R_c}{n} + R_s - \frac{3}{2}W_s \right) + U^{s_i c} - U^{ss} = 0 \quad (\lambda_2)$$

$$-F_L^s + F_W^s - \tau_s^W + U^s + U^{ss} - \tau_s^R = F_W^c - \tau_c^W - F_L^c + U^c + U^{cc} - \tau_c^R \quad (\lambda_3)$$

where  $\lambda_1, \lambda_2$  and  $\lambda_3$  denote the Lagrange multipliers of the program. The variables  $r, w_c, U, R_c$  and  $G_c$  are exogenous from the atomistic jurisdiction  $s_i$ 's viewpoint. Notice also that business land  $L_s$  has been replaced into the production function using the land occupation condition (4.2).

### *First-order conditions*

From the above program, we can derive the first-order conditions. The first-order conditions with respect to  $\tau_s^R, \tau_s^K, \tau_s^W$  and  $G_s$  are respectively:

$$\frac{R_s}{\mathcal{P}} - (\lambda_3 + 1) = 0, \quad (\text{A.5})$$

$$\frac{K_s}{\mathcal{P}} - \lambda_1 = 0, \quad (\text{A.6})$$

$$\frac{W_s}{\mathcal{P}} - (\lambda_3 - \lambda_2 + 1) = 0, \quad (\text{A.7})$$

$$(\lambda_3 + 1)U_G^s + (\lambda_3 - \lambda_2 + 1)U_G^{ss} - \frac{C_G^s}{\mathcal{P}} = 0. \quad (\text{A.8})$$

The first-order condition with respect to  $R_s$  is:

$$\begin{aligned} \frac{\tau_s^R - C_R^s}{\mathcal{P}} + \lambda_1 \left( \frac{\psi F_L^s}{K_s} - F_{KL}^s \right) - \left( \frac{\mathcal{L}_s}{\mathcal{P}} - \lambda_3 - 1 \right) F_{LL}^s - (\lambda_3 - \lambda_2 + 1) F_{WL}^s \\ - \lambda_2 t + \frac{t(2R_s - 3W_s)}{2\mathcal{P}} = 0. \end{aligned} \quad (\text{A.9})$$

The first-order condition with respect to  $K_s$  is:

$$\frac{\tau_s^K}{\mathcal{P}} + \lambda_1 \left( \frac{\psi(F^s - K_s F_K^s)}{K_s^2} + F_{KK}^s \right) + \left( \frac{\mathcal{L}_s}{\mathcal{P}} - \lambda_3 - 1 \right) F_{KL}^s + (\lambda_3 - \lambda_2 + 1) F_{WK}^s = 0. \quad (\text{A.10})$$

And, the first-order condition with respect to  $W_s$  is:

$$\begin{aligned} \frac{\tau_s^W - C_W^s}{\mathcal{P}} - \lambda_1 \left( \frac{\psi F_W^s}{K_s} - F_{WK}^s \right) + \left( \frac{\mathcal{L}_s}{\mathcal{P}} - \lambda_3 - 1 \right) F_{WL}^s + (\lambda_3 - \lambda_2 + 1) F_{WW}^s \\ + \frac{3t(W_s - R_s)}{2\mathcal{P}} + \frac{3t\lambda_2}{2} = 0. \end{aligned} \quad (\text{A.11})$$

### *Optimal policy rules with labor tax*

Inserting the first-order conditions with respect to the tax instruments (A.5)–(A.7) into the first-order conditions with respect to public good (A.8), population (A.9), capital (A.10) and labor (A.11), substituting  $\mathcal{L}_s$  from (4.2) and using Euler’s identities (A.4) entails the stated conditions (4.30)–(4.33).

### *Optimal policy rules without labor tax*

First of all, to derive the optimal conditions (4.45)–(4.47), the first-order condition with respect to the labor tax (A.7) must be ignored and  $\tau_s^W$  must be replaced by 0 in (A.11). Inserting the first-order conditions with respect to the tax instruments (A.5) and (A.6) into the first-order condition with respect to labor (A.11), substituting  $\mathcal{L}_s$  from (4.2) and using Euler’s theorem entails:

$$\frac{W_s}{\mathcal{P}} - (\lambda_3 - \lambda_2 + 1) - \frac{C_W^s/\mathcal{P}}{3t/2 - F_{WW}^s} = 0. \quad (\text{A.12})$$

Similarly, inserting (A.5), (A.6) and (A.12) into the first-order conditions with respect to public good (A.8), population (A.9), capital (A.10) and labor (A.11), substituting  $\mathcal{L}_s$  from (4.2) and using Euler’s identities (A.4) entails the stated conditions (4.45)–(4.47).

## **Appendix D First-order conditions of the central municipality**

The purpose of this appendix is to derive the optimal policy rules of the government of the central municipality  $c$  when the tax instrument set comprises a tax on labor — that is, conditions (4.35)–(4.38) — and when the labor tax is absent — that is, conditions (4.49)–(4.51).

### *Municipality's program*

Since the central municipality regards all towns as symmetric, the aggregate land rent becomes:

$$\Gamma = \mathcal{P}^{-1} \left[ n(\mathcal{A}_s + F_L^s \mathcal{L}_s + \tau_s^R R_s + \tau_s^K K_s + \tau_s^W W_s - C^s) + F_L^c \mathcal{L}_c + \tau_c^R R_c + \tau_c^K K_c + \tau_c^W W_c - C^c \right],$$

with

$$\mathcal{A}_s = \frac{t}{2} \left[ R_s^2 + \frac{3}{2} W_s^2 - 3R_s W_s - \left( \frac{R_c}{n} \right)^2 \right].$$

As a Stackelberg leader, the city accounts for the reactions of towns to its policy choices. These reactions are given by:

$$R_s U_G^s + W_s U_G^{ss} = C_G^s + (1 - \theta) d_s^G, \quad (\text{A.13})$$

$$\tau_s^R = C_R^s + \frac{t W_s}{2} + (1 - \theta) d_s^R, \quad (\text{A.14})$$

$$\tau_s^K = -\frac{\psi F^s}{K_s} + (1 - \theta) d_s^K, \quad (\text{A.15})$$

$$\tau_s^W = C_W^s, \quad (\text{A.16})$$

where  $\theta \in \{0; 1\}$  is a parameter which is equal to 1 if labor taxes are available (case of [section 5](#)) and 0 if they are not (case of [section 6](#)). Let us denote:

$$d_s^{G0} = \frac{1}{3t/2 - F_{WW}^s}, \quad d_s^{R0} = \frac{t - F_{WL}^s}{3t/2 - F_{WW}^s}, \quad d_s^{K0} = \frac{F_{WK}^s}{3t/2 - F_{WW}^s}. \quad (\text{A.17})$$

so that  $d_s^G = d_s^{G0} U_G^{ss} C_W^s$ ,  $d_s^R = d_s^{R0} C_W^s$  and  $d_s^K = d_s^{K0} C_W^s$ . The utility of the resident of  $c$  living the closest from the CBD is:

$$x_c + U^c + U^{cc},$$

and her budget constraint is:

$$x_s + \rho(-A) = w_s + rk + \Gamma - \tau_c^R.$$

with  $\rho(-A) = F_L^c$ . Replacing  $w_c$  and  $r$  using [\(4.10\)](#), it follows that the municipalities' program is to maximize:

$$-F_L^c + F_W^c - \theta \cdot \tau_c^W + \left( F_K^c - \psi \frac{F^c}{K_c} - \tau_c^K \right) k + \Gamma + U^c + U^{cc} - \tau_c^R,$$

choosing  $\tau_c^R, \tau_c^K, G_c, G_s, W_j, R_j, K_j$ , where  $j \in \{c, s\}_{i \in [1, n]}$ , and subject to:

$$F_K^c - \psi \frac{F^c}{K_c} - \tau_c^K - \left( F_K^s - \psi \frac{F^s}{K_s} - \tau_s^K \right) = 0 \quad (\mu_1)$$

$$F_W^c - \theta \cdot \tau_c^W + U^{s_i c} - (F_W^s - \theta \cdot \tau_s^W + U^{ss}) - t \left( \frac{\mathcal{P}}{n} - \frac{3}{2} W_s \right) = 0 \quad (\mu_2)$$

$$F_W^c - \theta \cdot \tau_c^W - F_L^c + U^c + U^{cc} - \tau_c^R - (F_W^s - \theta \cdot \tau_s^W - F_L^s + U^s + U^{ss} - \tau_s^R) = 0 \quad (\mu_3)$$

$$\mathcal{P} = W_c + nW_s \quad (\mu_4)$$

$$\mathcal{P} = R_c + nR_s \quad (\mu_5)$$

$$\mathcal{K} = K_c + nK_s \quad (\mu_6)$$

$$R_s U_G^s + W_s U_G^{ss} = C_G^s + d_s^G \quad (\mu_7)$$

where  $R_c + nR_s$  has been replaced by  $\mathcal{P}$  in the second constraint (from fifth one), and  $\mu_i, i = 1, \dots, 8$  are the Lagrange multipliers. Moreover, business land  $L_c$  and  $L_s$  have been replaced into the production function using the land occupation condition (4.2), and  $\tau_s^R, \tau_s^K$  and  $\tau_s^W$  are respectively defined by (A.14), (A.15) and (A.16).

### First-order conditions

From the above program, we can derive the first-order conditions. To obtain more compact first-order conditions, we assume that [Assumption 4.3](#) is verified, that is  $F_{XYZ}^s = 0$ , for each  $X, Y, Z \in \{K_s, W_s, L_s\}$ . It is formally equivalent to assume that:

$$\frac{\partial d_s^{G0}}{\partial X} = \frac{\partial d_s^{R0}}{\partial X} = \frac{\partial d_s^{K0}}{\partial X} = 0, \quad \text{for each } X \in \{K_s, W_s, L_s\} \quad (\text{A.18})$$

where  $d_s^{G0}, d_s^{R0}$  and  $d_s^{K0}$  are defined by (A.17). Equalities (A.18) mean that the city deepens the distortion of the policy decisions of town  $s$  (A.13)–(A.15) only by affecting  $C_W^s$ ; third-order effects on  $F^s$  are neglected. This assumption only affects the solutions if the tax instrument set is deprived from labor taxes  $\tau^W$ . It is not necessary for the derivation of the solutions in the presence of labor taxes. The first-order conditions with respect to  $\tau_c^R, \tau_c^K, \tau_c^W$  and  $G_c$  are respectively:

$$\frac{R_c}{\mathcal{P}} - (\mu_3 + 1) = 0 \quad (\text{A.19})$$

$$\frac{K_c}{\mathcal{P}} - (\mu_1 + k) = 0 \quad (\text{A.20})$$

$$\theta \left[ \frac{W_c}{\mathcal{P}} - (\mu_2 + \mu_3 + 1) \right] = 0 \quad (\text{A.21})$$

$$(\mu_3 + 1) (U_G^c + U_G^{cc}) + \mu_2 U_G^{sc} - \frac{C_G^c}{\mathcal{P}} = 0 \quad (\text{A.22})$$

The first-order condition with respect to  $G_s$  is:



$$\begin{aligned}
& \mu_3(C_{GR}^s - U_G^s) + \mu_7(R_s U_{GG}^s + W_s U_{GG}^{ss}) + \frac{n(R_s C_{GR}^s - C_G^s)}{\mathcal{P}} - (\mu_2 + \mu_3)U_G^{ss} - \mu_7 C_{GG}^s \\
& + (1 - \theta) \left[ d_s^{K0} \left( \frac{nK_s}{\mathcal{P}} + \mu_1 \right) + d_s^{R0} \left( \frac{nR_s}{\mathcal{P}} + \mu_3 \right) - \mu_7 d_s^{G0} \left( \frac{C_W^s}{C_{GW}^s} U_{GG}^{ss} + U_G^{ss} \right) \right] C_{GW}^s \\
& + \theta \left( \frac{nW_s}{\mathcal{P}} + \mu_2 + \mu_3 \right) C_{GW}^s = 0 \tag{A.23}
\end{aligned}$$

The first-order condition with respect to  $R_c$  is:

$$\begin{aligned}
& \frac{\tau_c^R - C_R^c - tR_c/n}{\mathcal{P}} + \frac{\psi(k + \mu_1) F_L^c}{K_c} - (k + \mu_1) F_{KL}^c - (\mu_2 + \mu_3 + 1) F_{WL}^c + \left( \mu_3 + 1 - \frac{\mathcal{L}_c}{\mathcal{P}} \right) F_{LL}^c \\
& - \mu_5 = 0 \tag{A.24}
\end{aligned}$$

The first-order condition with respect to  $R_s$  is:

$$\begin{aligned}
& \frac{n\psi F_L^s}{\mathcal{P}} + \mu_1 F_{KL}^s + (\mu_2 + \mu_3) F_{WL}^s - \left( \frac{n\mathcal{L}_s}{\mathcal{P}} + \mu_3 \right) F_{LL}^s + \frac{n[t(R_s - W_s) + d_s^{R0}(1 - \theta)C_W^s]}{\mathcal{P}} \\
& + \Theta C_{RW}^s + \left( \mu_3 + \frac{nR_s}{\mathcal{P}} \right) C_{RR}^s + \mu_7(U_G^s - C_{GR}^s) - n\mu_5 = 0 \tag{A.25}
\end{aligned}$$

where  $\Theta$  is defined as:

$$\Theta = \theta \left( \mu_2 + \mu_3 + \frac{nW_s}{\mathcal{P}} \right) + (1 - \theta) \left( \frac{n(K_s d_s^{K0} + R_s d_s^{R0})}{\mathcal{P}} + \mu_1 d_s^{K0} + \mu_3 d_s^{R0} - \mu_7 d_s^{G0} U_G^{ss} \right)$$

The first-order condition with respect to  $K_c$  is:

$$\begin{aligned}
& \frac{\tau_c^K}{\mathcal{P}} + \frac{\psi(k + \mu_1)(F^c - K_c F_K^c)}{K_c^2} + (k + \mu_1) F_{KK}^c + (\mu_2 + \mu_3 + 1) F_{WK}^c - \left( \mu_3 + 1 - \frac{\mathcal{L}_c}{\mathcal{P}} \right) F_{KL}^c \\
& - \mu_6 = 0 \tag{A.26}
\end{aligned}$$

The first-order condition with respect to  $K_s$  is:

$$\begin{aligned}
& - \frac{n(\theta - 1)d_s^{K0} C_W^s}{\mathcal{P}} - \frac{n\psi F_K^s}{\mathcal{P}} - \mu_1 F_{KK}^s - (\mu_2 + \mu_3) F_{WK}^s + \left( \frac{n\mathcal{L}_s}{\mathcal{P}} + \mu_3 \right) F_{KL}^s - n\mu_6 = 0 \\
& \tag{A.27}
\end{aligned}$$

The first-order condition with respect to  $W_c$  is:

$$\begin{aligned}
& \frac{\theta\tau_c^W - C_W^c}{\mathcal{P}} - \frac{\psi(k + \mu_1) F_W^c}{K_c} + (k + \mu_1) F_{WK}^c + (\mu_2 + \mu_3 + 1) F_{WW}^c - \left( \mu_3 + 1 - \frac{\mathcal{L}_c}{\mathcal{P}} \right) F_{WL}^c \\
& - \mu_4 = 0 \tag{A.28}
\end{aligned}$$

The first-order condition with respect to  $W_s$  is:

$$\begin{aligned}
& - \frac{n\psi F_W^s}{\mathcal{P}} - \mu_1 F_{WK}^s - (\mu_2 + \mu_3) F_{WW}^s + \left( \frac{n\mathcal{L}_s}{\mathcal{P}} + \mu_3 \right) F_{WL}^s + \frac{n[t(3W_s/2 - R_s) - (1 - \theta)C_W^s]}{\mathcal{P}} \\
& + \Theta C_{WW}^s + \frac{t}{2}(3\mu_2 + \mu_3) + \mu_7(U_G^{ss} - C_{GW}^s) - n\mu_4 = 0 \tag{A.29}
\end{aligned}$$

### *Optimal policy rules with labor tax*

We can now prove the optimal behavior rules when labor taxes are available (4.35)–(4.38). By definition,  $\theta = 1$  must be imposed in (A.19)–(A.29). Inserting (A.19) and (A.21) into (A.22), the public good provision rule (4.35) directly follows. Moreover, inserting (A.19) and (A.21) into (A.23), replacing  $R_s$  and  $W_s$  from (4.3) and simplifying using the public provision rule of town  $s$  (4.30), we obtain:

$$\mu_7 = 0.$$

Then, inserting (A.19)–(A.21) into the first-order conditions with respect  $R_c$ ,  $K_c$  and  $W_c$ , (A.24), (A.26) and (A.28), substituting  $\mathcal{L}_c$  from (4.2), replacing and using Euler's identity (A.4), it follows that:

$$\tau_c^R = C_R^c + t \frac{R_c}{n} + \mu_5 \mathcal{P}, \quad (\text{A.30})$$

$$\tau_c^K = -\frac{\psi F_c}{K_c} - \mu_6 \mathcal{P}, \quad (\text{A.31})$$

$$\tau_c^W = C_W^c + \mu_4 \mathcal{P}. \quad (\text{A.32})$$

Inserting now (A.19)–(A.21) into the first-order conditions with respect  $R_s$ ,  $K_s$  and  $W_s$ , (A.25), (A.27) and (A.29), substituting  $\mathcal{L}_s$  from (4.2), replacing  $R_s$ ,  $W_s$  and  $K_s$  using (4.3) and (4.4), and using once again Euler's identities (A.4), it follows that:

$$tR_c + \mu_5 n \mathcal{P} = tW_c, \quad (\text{A.33})$$

$$\mu_6 = 0, \quad (\text{A.34})$$

$$\mu_4 = 0. \quad (\text{A.35})$$

Finally, inserting (A.33)–(A.35) into (A.30)–(A.32) proves conditions (4.36)–(4.38).

### *Optimal policy rules without labor tax*

We now turn to the proof of the optimal behavior rules when labor taxes are not available (4.49)–(4.51). By definition,  $\theta = 0$  must be imposed in (A.19)–(A.29), which directly implies that the first-order condition with respect to the labor tax (A.21) is ignored (it states that  $0 = 0$ ) and  $\tau_c^W$  and  $\tau_s^W$  are replaced everywhere they appear by 0. As above, by inserting (A.19) and (A.20) into the first-order conditions with respect  $G_c$ ,  $R_c$ ,  $K_c$  and  $W_c$ , (A.22), (A.24), (A.26) and (A.28), substituting  $\mathcal{L}_c$

from (4.2), replacing and using Euler's identities (A.4), we obtain:

$$R_c(U_G^c + U_G^{cc}) + (W_c - R_c - nd_c)U_G^{sc} = C_G^c \quad (\text{A.36})$$

$$\tau_c^R = C_R^c + \frac{tR_c}{n} + \mu_5\mathcal{P} - nd_cF_{WL}^c \quad (\text{A.37})$$

$$\tau_c^K = -\frac{\psi F^c}{K_c} + nd_cF_{WK}^c + \mu_6\mathcal{P} \quad (\text{A.38})$$

$$C_W^c + nd_cF_{WW}^c + \mu_4\mathcal{P} = 0 \quad (\text{A.39})$$

where  $d_c$  is defined as:

$$d_c = W_c - \mathcal{P}(1 + \mu_2 + \mu_3) \quad (\text{A.40})$$

Equation (A.36) proves the public good provision rule (4.49). Inserting now (A.19)–(A.21) into the first-order conditions with respect  $R_s$ ,  $K_s$ ,  $W_s$  and  $G_s$ , (A.25), (A.27), (A.29) and (A.23), substituting  $\mathcal{L}_s$  from (4.2), replacing  $R_s$ ,  $W_s$  and  $K_s$  using (4.3) and (4.4), and using once again Euler's identities (A.4), it follows that:

$$t(W_c - R_c) + nd_s^{R0}C_W^s + \mathcal{P}\mu_7(U_G^s - d_s^{G0}U_G^{ss}C_{RW}^s - C_{GR}^s) - nd_cF_{WL}^s - n\mathcal{P}\mu_5 = 0, \quad (\text{A.41})$$

$$d_s^{K0}C_W^s + d_cF_{WK}^s - \mathcal{P}\mu_6 = 0, \quad (\text{A.42})$$

$$n\mathcal{P}\mu_4 + nC_W^s + \mathcal{P}\mu_7[U_G^{ss}(d_s^{G0}C_{WW}^s - 1) + C_{GW}^s] + nd_c\left(\frac{3t}{2} - F_{WW}^s\right) = 0, \quad (\text{A.43})$$

$$\mu_7 = -\frac{nU_G^{ss}(d_c + d_s^{G0}C_W^s)}{\mathcal{P}(R_sU_{GG}^s + W_sU_{GG}^{ss} - d_s^{G0}U_{GG}^{ss}C_W^s - d_s^{G0}U_G^{ss}C_{GW}^s - C_{GG}^s)}. \quad (\text{A.44})$$

Denoting  $\Delta^{G_s} \equiv R_sU_G^s + W_sU_G^{ss} - C_G^s - d_s^G$  and  $\lambda \equiv \mathcal{P}\mu_7/n$ , (A.44) can be written as:

$$\lambda = -\frac{U_G^{ss}(d_c + d_s^G)}{\frac{\partial \Delta^{G_s}}{\partial G_s}}, \quad (\text{A.45})$$

where (A.13) has been used to simplify (A.44). Combining (A.37) and (A.41) to eliminate  $\mu_5$ , (A.38) and (A.42) to eliminate  $\mu_6$  and (A.39) and (A.43) to eliminate  $\mu_4$ , we obtain:

$$\tau_c^R = C_R^c + \frac{tW_c}{n} + d_s^R - d_c(nF_{WL}^c + F_{WL}^s) + \mu_7\frac{\mathcal{P}}{n}(U_G^s - C_{GR}^s - d_s^{G0}U_G^{ss}C_{RW}^s), \quad (\text{A.46})$$

$$\tau_c^K = -\frac{\psi F^c}{K_c} + d_s^K + d_c\left(F_{WK}^c + \frac{F_{WK}^s}{n}\right), \quad (\text{A.47})$$

$$d_c = \frac{C_W^c - C_W^s + \mu_7(\mathcal{P}/n)(U_G^{ss} - d_s^{G0}U_G^{ss}C_{WW}^s - C_{GW}^s)}{3t/2 - nF_{WW}^c - F_{WW}^s}, \quad (\text{A.48})$$

which can be re-written as:

$$\tau_c^R = C_R^c + \frac{tW_c}{n} + d_s^R - d_c(nF_{WL}^c + F_{WL}^s) + \lambda \frac{\partial \Delta^{G_s}}{\partial R_s}, \quad (\text{A.49})$$

$$\tau_c^K = -\frac{\psi F^c}{K_c} + d_s^K + d_c(nF_{WK}^c + F_{WK}^s), \quad (\text{A.50})$$

$$d_c = \frac{C_W^c - C_W^s + \lambda \frac{\partial \Delta^{G_s}}{\partial W_s}}{3t/2 - nF_{WW}^c - F_{WW}^s}. \quad (\text{A.51})$$

This proves conditions (4.50) and (4.51).

## Appendix E Comparison of tax rates

The purpose of this appendix is to prove [Result 4.3](#) and [Result 4.6](#). Conditions (4.39) and (4.54) are proved in [subsection 3.2](#) and conditions (4.40) and (4.55) are proved in [subsection 3.2](#).

### *Differential of the tax rates on residents*

Subtracting (4.36) from (4.31) and (4.50) from (4.46), we obtain:

$$\tau_c^R - \tau_s^R = C_R^c - C_R^s + t \left( \frac{W_c}{n} - \frac{W_s}{2} \right) + \lambda \frac{\partial \Delta^{G_s}}{\partial R_s} - d_c(nF_{WL}^c + F_{WL}^s) \quad (\text{A.52})$$

where  $\lambda = d_c = 0$  in the case where labor taxes are available. Replacing,  $W_s$  using (4.3b) in (A.52) proves conditions (4.39) and (4.54).

### *Differential of the tax rates on capital*

Subtracting (4.37) from (4.32) and (4.51) from (4.47), we obtain:

$$\tau_c^K - \tau_s^K = \psi \left( \frac{F^s}{K_s} - \frac{F^c}{K_c} \right) + d_c(nF_{WK}^c + F_{WK}^s), \quad (\text{A.53})$$

where  $d_c = 0$  in the case where labor taxes are available. Then, denoting  $\varepsilon_j = F_K^j K_j / F^j$ , we have:

$$\tau_c^K - \tau_s^K = \psi \left( \frac{1}{\varepsilon_s} - \frac{1}{\varepsilon_c} \frac{F_K^c}{F_K^s} \right) F_K^s + d_c(nF_{WK}^c + F_{WK}^s) \quad (\text{A.54})$$

which proves condition (4.40) since  $d_c = 0$  in the case where labor taxes are available.

Rewriting (A.54), we obtain:

$$\tau_c^K - \tau_s^K = \psi \left( \frac{1}{\varepsilon_s} - \frac{1}{\varepsilon_c} \right) F_K^s - \frac{\psi}{\varepsilon_c} (F_K^c - F_K^s) + d_c(nF_{WK}^c + F_{WK}^s) \quad (\text{A.55})$$

Yet combining the condition for optimal capital allocation (4.20) with (A.53) yields:

$$F_K^c - F_K^s = d_c(nF_{WK}^c + F_{WK}^s)$$

Then (A.55) can be written as:

$$\tau_c^K - \tau_s^K = \psi \left( \frac{1}{\varepsilon_s} - \frac{1}{\varepsilon_c} \right) F_K^s + \left( 1 - \frac{\psi}{\varepsilon_c} \right) (F_K^c - F_K^s)$$

Finally, notice that:

$$1 - \frac{\psi}{\varepsilon_c} > 0 \iff F_K^c - \psi \frac{F^c}{K_c} > 0 \iff r + \tau_c^K > 0,$$

where the second equivalence comes from condition (4.10c), which states the condition stated in footnote 44.

## Appendix F Proofs of Lemmas 4.1, 4.2 and 4.3

### *Proof of Lemma 4.1*

Suppose that Assumption 4.2 holds. In order to prove Lemma 4.1, let us first rewrite  $\varepsilon_j$ :

$$\varepsilon_j = K \frac{F_K^j(K_j, X_j)}{F(K_j, X_j)} = \frac{K_j}{X_j} \frac{F_K^j(K_j, X_j)/X^\psi}{F(K_j, X_j)/X^{\psi+1}} = \frac{K_j}{X_j} \frac{F_K^j(K_j/X_j, 1)}{F(K_j/X_j, 1)}$$

from which we can notice that  $\varepsilon_j$  only depends on  $K_j/X_j$ . Ignoring the argument of  $F$ , we have:

$$\varepsilon_j = \frac{K_j}{X_j} \frac{(\psi + 1) F_K^j}{\frac{K}{X} F_K^j + F_X^j} = \frac{\psi + 1}{1 + \frac{F_X^j/F_K^j}{K_j/X_j}} \quad (\text{A.56})$$

$$\begin{aligned} \frac{d \left( \frac{F_X^j/F_K^j}{K_j/X_j} \right)}{d(K_j/X_j)} &= \frac{\frac{d(F_X^j/F_K^j)}{d(K_j/X_j)} \frac{K_j}{X_j} - \frac{F_X^j}{F_K^j}}{(K_j/X_j)^2} = \left( \frac{X_j}{K_j} \right)^2 \frac{F_X^j}{F_K^j} \left( \frac{d(F_X^j/F_K^j)}{d(K_j/X_j)} \frac{K_j/X_j}{F_X^j/F_K^j} - 1 \right) \\ &= \left( \frac{X_j}{K_j} \right)^2 \frac{F_X^j}{F_K^j} \left( \frac{1}{\sigma_{KX}} - 1 \right) \end{aligned}$$

Then, from (A.56):

$$\frac{d\varepsilon_j}{d(K_j/X_j)} > 0 \iff \frac{d \left( \frac{F_X^j/F_K^j}{K_j/X_j} \right)}{d(K_j/X_j)} < 0 \iff \sigma_{KX} > 1$$

Moreover, since  $X(\cdot)$  exhibits constant returns to scale (Assumption 4.2), we have:

$$\frac{K}{X(W, L)} = \frac{1}{X \left( \frac{W}{K}, \frac{L}{K} \right)} \equiv f \left( \frac{K}{W}, \frac{K}{L} \right)$$

where  $f(K/W, K/L)$  is increasing in  $K/W$  and in  $K/L$ . Then, it follows that if  $K_c/X_c > K_s/X_s$ , then:

$$\tau_c^K - \tau_s^K = \psi \left( \frac{1}{\varepsilon_s} - \frac{1}{\varepsilon_c} \right) > 0 \quad \text{if and only if} \quad \varepsilon_c > \varepsilon_s \quad \text{if and only if} \quad \sigma_{KX} > 1$$

which proves [Lemma 4.1](#). This result can be illustrated with the following example:

**Example.** Assume  $F$  is a nested CES production function with increasing returns to scale, such that:

$$F(W, K, L) = [aK^\delta + (1-a)(bW^\eta + (1-b)L^\eta)^{\frac{\delta}{\eta}}]^{\frac{\psi+1}{\delta}} \quad (\text{A.57})$$

with  $a, b > 0$ ,  $\delta, \eta < 1$  and  $\delta, \eta \neq 0$ . Then, we have:<sup>72</sup>

$$\tau_c^K - \tau_{s_i}^K = \frac{\psi}{\psi+1} \left\{ \left[ c \left( \frac{W_{s_i}}{K_{s_i}} \right)^\eta + d \left( \frac{L_{s_i}}{K_{s_i}} \right)^\eta \right]^{\frac{\delta}{\eta}} - \left[ c \left( \frac{W_c}{K_c} \right)^\eta + d \left( \frac{L_c}{K_c} \right)^\eta \right]^{\frac{\delta}{\eta}} \right\} \quad (\text{A.58})$$

where  $c, d > 0$ . Note that the elasticity of substitution between capital and the nested labor-land input  $\sigma_{KX}$  is equal to  $1/(1-\delta)$ , and the elasticity of substitution between labor and land  $\sigma_{WL}$  is equal to  $1/(1-\eta)$ . Then equation (A.58) illustrates that for any value of  $\sigma_{WL}$ , if  $\sigma_{KX} > (<)1$  and the city  $c$  is more (less) capital-intensive than the suburb  $s_i$ , then  $\tau_c^K > (<)\tau_{s_i}^K$ .

### Proof of Lemma 4.2

The purpose of this appendix is to prove [Lemma 4.2](#). To this aim, we first provide the explicit forms of  $d_c$  and  $\lambda$  which allow us to derive the stated lemma. Equations (A.45) and (A.51) can be written as follows:

$$d_c = a_1\lambda + b_1, \quad \lambda = a_2d_c + b_2, \quad (\text{A.59})$$

with

$$a_1 = \frac{\frac{\partial \Delta^{G_s}}{\partial W_s}}{3t/2 - nF_{WW}^c - F_{WW}^s}, \quad a_2 = -\frac{U_G^{ss}}{\frac{\partial \Delta^{G_s}}{\partial G_s}}, \quad b_1 = \frac{C_W^c - C_W^s}{3t/2 - nF_{WW}^c - F_{WW}^s}, \quad b_2 = -\frac{U_G^{ss} d_s^G}{\frac{\partial \Delta^{G_s}}{\partial G_s}}.$$

<sup>72</sup>It is straightforward to show that:

$$\varepsilon = \frac{\psi+1}{\left[ c \left( \frac{W}{K} \right)^\eta + d \left( \frac{L}{K} \right)^\eta \right]^{\frac{\delta}{\eta}} + 1}$$

where  $c = b((1-a)/a)^{\frac{\delta}{\eta}}$  and  $d = (1-b)((1-a)/a)^{\frac{\delta}{\eta}}$ .

Solving (A.59) for  $d_c$  and  $\lambda$ , we obtain:

$$d_c = \frac{a_1 b_2 + b_1}{1 - a_1 a_2} \quad \lambda = \frac{a_2 b_1 + b_2}{1 - a_1 a_2} \quad (\text{A.60})$$

Assuming that  $C_W^c = C_W^s = 0$ , it follows from the definitions (4.48) that  $d_s^R = d_s^K = d_s^G = 0$ . It also follows that  $b_1 = b_2 = 0$ , which implies that  $d_c = \lambda = 0$  and  $d_c^R = d_c^K = d_c^G = 0$  from definitions (4.52). This completes the proof of Lemma 4.2.

### *Proof of Lemma 4.3*

To prove Lemma 4.3, let us study the sign of the numerator and denominator of  $d_c$  which is defined in (A.60). Recalling that  $d_s^G > 0$ , we have the following equivalence:

$$a_1 b_2 + b_1 > 0 \iff \frac{\partial \Delta^{G_s} / \partial W_s}{\partial \Delta^{G_s} / \partial G_s} < \frac{C_W^c - C_W^s}{d_s^G}, \quad (\text{A.61})$$

and recalling that  $3t/2 - nF_{WW}^c - F_{WW}^s > 0$  and  $U_G^{ss} > 0$ , we have the following equivalence:

$$1 - a_1 a_2 > 0 \iff \frac{\partial \Delta^{G_s} / \partial W_s}{\partial \Delta^{G_s} / \partial G_s} > -\frac{3t/2 - nF_{WW}^c - F_{WW}^s}{U_G^{ss}}. \quad (\text{A.62})$$

Since we know from constraint (4.45) that  $\Delta_s^G = 0$  at equilibrium, it appears that  $\frac{\partial \Delta^{G_s} / \partial W_s}{\partial \Delta^{G_s} / \partial G_s}$  is the marginal rate of substitution between workers of town  $s$ ,  $W_s$ , and public good provided in town  $s$ ,  $G_s$ . Denoting  $\partial G_s / \partial W_s$  this MRS allows to complete the proof of Lemma 4.3.

### Appendix G Numerical simulations

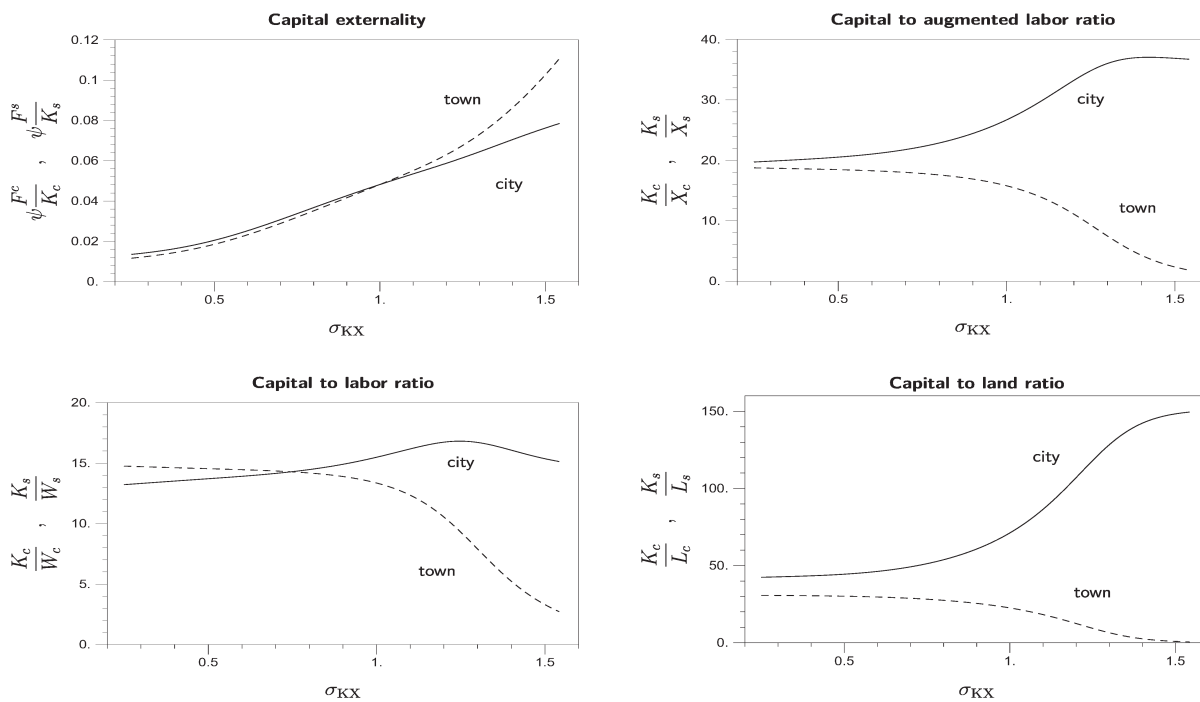


Figure A.2. Capital externality and capital intensity

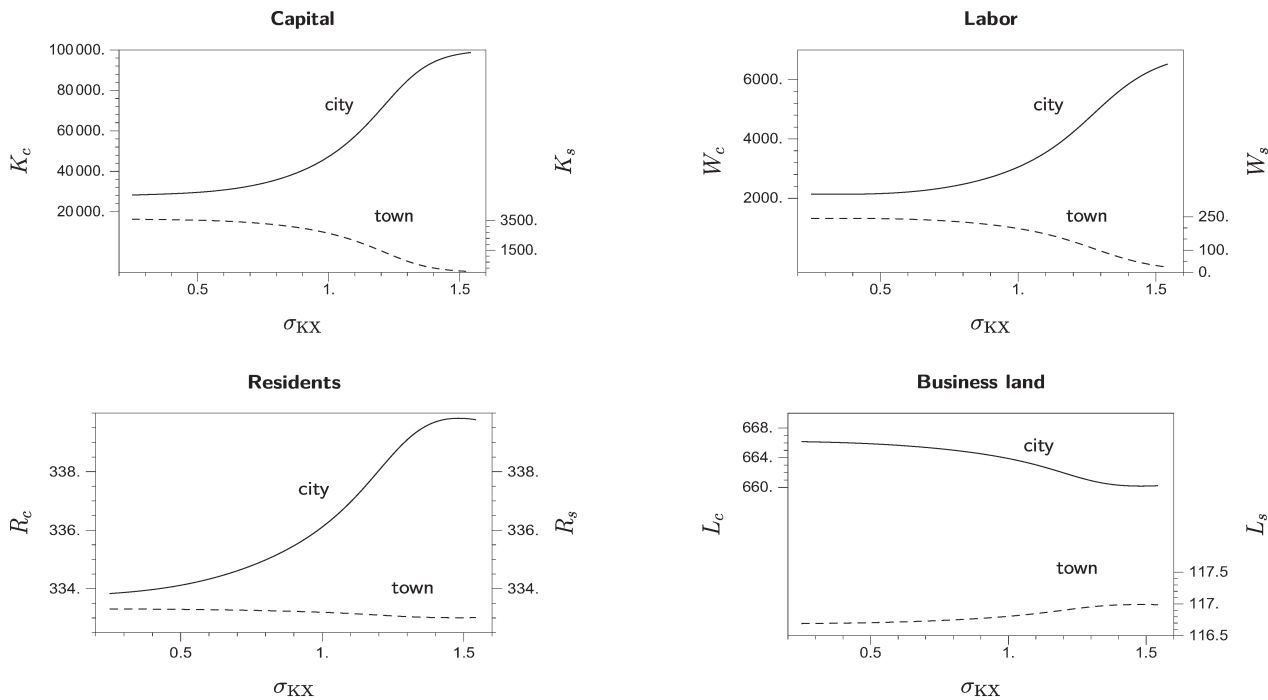


Figure A.3. Location of residents, capital, labor and business land.



