Differentiated property tax and urban sprawl in Italian urbanized areas

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Abstract

City's core and suburbans tax differentials can affect sprawl within an urban area. We empirically address this issue by analyzing the pattern of growth of 72 Italian urbanized areas. As a novelty, we investigate the causes of the emerging land development pattern. Our results show that density of urban area declines in response to an increase in the city's core property tax rate. We find that this effect is due to changes in dwelling size. By contrast, density of urban area significantly rises when suburbans property tax rates increase, making the urban area more compact. This effect is attributable to changes in the improvement effect of property taxation.

Keywords: differentiated property tax, urban sprawl, functional urban area
JEL Classification: H3, H71, R10, R14

1 Literature background

Excessive soil consumption and the social desirability of a smart pattern of urban growth have directed increasing attention to the urban sprawl dimension of cities' spatial development. Urban sprawl connotes an excessive spread of buildings, activities and infrastructures, with the result of a low and scattered density pattern of physical urban expansion. A more comprehensive definition of sprawl is provided by the European Environment Agency (EEA). In 2006, it defined urban sprawl as "unplanned incremental urban development, characterized by a low density mix of land uses on the urban fringe" where "Development is patchy, scattered and strung out, with a tendency for discontinuity. It leap-frogs over areas, leaving agricultural enclaves. Sprawling cities are the opposite of compact cities - full of empty spaces that indicate the inefficiencies in development and highlight the consequences of uncontrolled growth" (European Environment Agency, 2006, 5-6). Negative externalities are usually associated with sprawl: long commutes in terms of distance and time, traffic congestion, rapid conversion of agricultural land and increasing costs of providing local public services and infrastructures and, eventually, social segregation (Brueckner, 2000; Glaeser and Kahn, 2004; Hortas-Rico and Solé-Ollé, 2010). Consequently, handling sprawl is a primary concern of urban growth planners.

Several economists have sought to counter the widespread criticism that considers sprawl as a phenomenon of a process of urban growth gone awry by demonstrating that urban spatial size is a result of an orderly market process which economically allocates land between urban and non urban - predominantly, agricultural - uses. Brueckner and Fansler (1983) first addressed this issue by demonstrating

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that the built-up area of a city can be predicted by an economic model - whose fundamentals are socio-economic factors such as population, income and agricultural land value among others - which directs resources to their highest and best use. Similar conclusions are reached in the paper by Mieszkowski and Mills (1993), which includes investments in freeways and other transportation infrastructures among factors of urban spatial growth. However, Brueckner (2000) admits that several market failures can occur: failure to account for the social value of open space, for the social costs of freeway congestion and for the infrastructure costs of new development.[1] The author indicates policy measures - development taxes, congestion tolls and impact fees- that can be implemented to restrict urban expansion to socially desirable levels in order to maximize aggregate economic well-being yet he also recognizes that such instruments are often disregarded because they are either unpopular or difficult to calibrate.[2]

Urban sprawl is also rising high on local policy makers' agendas. When they design tax policy, they not only assess local council revenues, but also contribute to shaping city growth. On the one hand, property taxation is frequently the basis of the annual local budget process and the main municipal financial resource. Accordingly, in order to raise revenue, local governments have two substitute strategic instruments. They can raise the tax rate on properties or increase the tax base by relaxing land use regulation and selling building permits, that is, they adapt urban growth policy.[3]

On the other hand, it can be shown that the property tax influences urban development and the way a city grows. Indeed, it can be shown that it affects the spread of edifices, the height of buildings and the size of dwellings in an urban area. In an influential theoretical article, Brueckner and Kim (2003) investigated the relation between property tax and urban sprawl in a monocentric city. They considered that a property tax, as a tax levied at equal rates on both the land and capital embodied in structures, can reduce the intensity of land development in comparison to a pure land tax, where the rate on improvements is set at zero and is proved to be not distortionary (George, 1879). The theoretical model identifies an improvement effect which denotes the impact of the property tax in lowering the equilibrium level of housing capital chosen by the developer, i.e. the capital/land ratio. The lower level of improvement per acre implies a reduction in the intensity of land development, and this lower density associated with property tax appears to encourage urban sprawl. The model also highlights the possibility of a countervailing effect of the property tax, denoted as the dwelling size effect. The property tax affects the consumer's choice of dwelling size given that the tax on land and structures is partly shifted forward to consumers. A higher cost of housing floor space is associated with a reduction in dwelling size. Consequently, an increase in population density ensues and thus a decrease in the city's spatial extent. Which effect is likely to dominate is not clear. Brueckner and Kim (2003) show that, under CES preferences, the dwelling size effect prevails over the improvement effect when the elasticity of substitution between housing and the non-housing commodity is equal to or greater than one. On the other hand, the effect of tax on urban sprawl is ambiguous when the elasticity of substitution is lower than one. This implies that the improvement effect can prevail on the dwelling size effect or *vice versa*. Building on the model of Brueckner and Kim (2003), but using a log-linear utility function with a variable elasticity of substitution greater than one, Song and Zenou (2006) develop a theoretical model which shows that the dwelling size always prevails over the improvement effect, leading to a smaller monocentric city.

Few studies have tested the above theoretical predictions. Song and Zenou (2006) regress the size of 448 US urbanized area on property tax rate and other control variables such as population, income, agricultural land, and transportation expenditure. Using the two-stage least squares method, they find that increasing the average property tax rate by 1% reduces the city size by about 0.4%. This evidence

[1] Brueckner (2000) lists also the impulse for fiscal segregation of high income households to separate themselves from low income counterparts among the causes of misguided urban expansion policies. Richer citizens have incentives to form separate communities on the suburban fringe to enjoy the preferred mix of tax-public goods available.

[2] For example, policy makers often rely on urban growth boundary that, however, has great potential for misuse. Cities may end up with draconian attack on urban sprawl that needlessly shrinks the spatial dimension of a city.

[3] Ermini et al. (2013) and Bimonte and Stabile (2013) show that the latter option has been adopted in Italy over recent years affecting the total number of buildings across territories.

supports the theoretical implications put forward in their paper. However, they do not investigate whether the dwelling size or the improvement effect drives this result. This task is performed in the paper by Banzhaf and Lavery (2010) which, however, investigates the impact on sprawl of the split-rate tax, a specific structure of property tax rate that taxes land and improvement at differing rates. As estimation procedure they adopt an original approach which makes it possible to distinguish whether changes in the improvement effect are the result of the dwelling rather than the density effect. They find that an increase in the split-rate tax in an urbanized area of Pennsylvania increases the capital/land ratio, making city density smaller because the dwelling size effect is less important. This result contrasts with the theoretical predictions set out in the model of Song and Zenou (2006).

Extending the above theories to a duocentric city model, it emerges different equilibria with regard to the distribution of taxes and citizens within the city's center and between the center and its surrounding urban areas, usually smaller municipalities. This topic has been addressed by Song and Zenou (2009), who develop a theoretical model where dwelling size and improvement effect work together with competition in the housing market between the city's center and suburbs workers. They show that changes in the ratio between property tax rates in the suburbs and in the city's center have an ambiguous effect on city urban expansion, except when workers' income is lower in suburbs than in the center. In this specific circumstance, an increase in the ratio turns into a reduction of the city fringe. Their empirical investigation of 445 US urbanized areas shows that a higher property tax rate in the suburbs as compared to the center is associated with less urban growth and lower level of population and employment decentralization.

Given that the literature on the impact of the city core-suburban property tax differentials on the spread of urbanized area is scarce, this topic turns out to be a fruitful area of research. The present paper will focus on this issue. Some features distinguish our contribution from the other few, but relevant, articles on the topic. First, assuming an urban area with a core municipality that plays a preeminent role over the surrounding interdependent jurisdictions, we study the impact of differentiated property taxes over the spatial expansion of the entire urbanized areas. To our knowledge only the paper written by Song and Zenou (2009) investigates, under a theoretical and empirical profile, this issue. Yet our paper differs from that by Song and Zenou (2009). Here, we empirically contribute to disentangle specific features of an urban area growth - i.e. improvement, dwelling and density effects - produced by differentiated property taxes within an urban area. Specifically, we distinguish whether variation in density of an urban area in response to changes in property tax rate of both core and hinterland is prevalently due to the improvement effect, that is the capital/land ratio, rather than the dwelling size effect, measured as the amount of capital per housing units.

Finally, this is the first paper to use Italy as a case study to examine the nexus between urban sprawl and property taxation, given that previous empirical studies have focused on US urbanized areas. Since land is scarce in Italy and the property tax is a major source of revenue for Italian municipalities[4], it is interesting to analyze the role played by this form of taxation on land consume. Moreover, the focus on local government is of interest because the devolution reforms in Italy have assigned limited fiscal autonomy to this tier of government. While central government transfers have been progressively reduced, local government could have coped with funds shrinkage by strategic use of the property tax rate and property tax base regulations. Since the possibility of abolishing this tax in Italy is much debated, it is important to have a clear idea of the implications of this tax in an urban context.

In our empirical analysis, we investigate the urban growth pattern of 72 Italian functional urban areas (hereafter FUA) across census years from 1991 to 2001. Our results show that density of urban area declines in response to an increase in the city's core property tax rate. The density effect is caused by an increase in the dwelling size due to higher property tax rates in core municipalities. By contrast, city becomes more compact when the property tax rate of hinterland rises. This effect can be ascribed to the improvement effect of property taxation.

The remainder of the paper is as follows. Section 2 depicts the Italian context in terms of land use,

[4] About 48% of the total tax revenue in year 2010 (Ires et al., 2012).

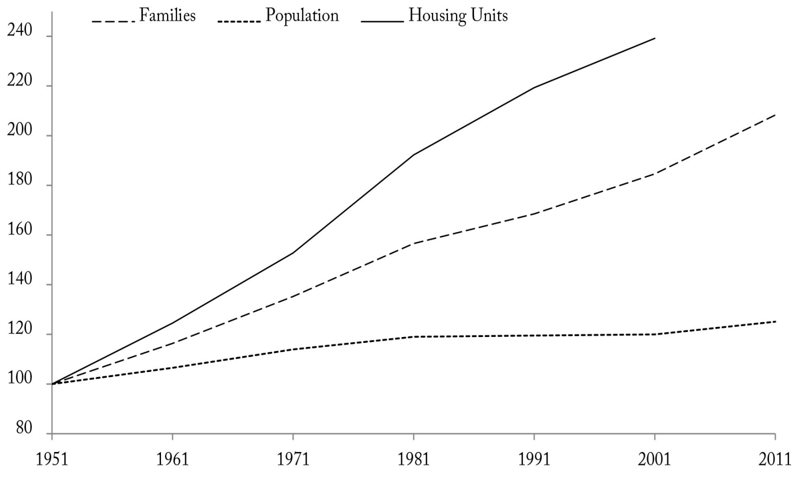
urban development and property tax design. The econometric approach is introduced in section 3. The following section is devoted to the data and variables description, while the results of the empirical model are discussed in section 5. Section 6 makes some final remarks and suggests ideas for future research.

2 Urban growth and property taxation in Italy

In 2006, the European Environment Agency (2006) observed that more than a quarter of the EU territory was already directly affected by urban land use. By 2020 approximately 80% of European citizens will be living in cities or other built-up areas. Given this projection, it is crucial to plan the use of soil and to govern the way in which cities sprawl to achieve a sustainable urban growth. This issue is exacerbated in a country like Italy where morphological fragility and poor soil conservation and protection are contingent problems, and where 60% of urbanization is concentrated in lowlands which represent only 20% of the Italian territory (Castrignanò and Pieretti, 2010b). In recent decades, soil consumption and urban development nationwide has grown faster than the increase in the overall population, a trend already registered for the whole of Europe, especially with regard to the expansion of towns and cities outwards into rural areas (Commission of the European Communities, 2004).

As underlined by Castrignanò and Pieretti (2010a), in Italy 75% of the housing stock, which in year 2001 amounted to more than 27.3 million housing units, had been built in the previous 60 years. Furthermore, as evident in figure 1, even if the housing stock increases at a far greater pace than the population and number of families, municipalities keep on urbanizing.

Figure 1: Families, population and urban growth in Italy over the census years 1951-2011 (Index:1951=100)



Source: Authors' elaboration on Istat (Italian National Institute of Statistics), *Censimento Generale della Popolazione e delle Abitazioni*, various census years.

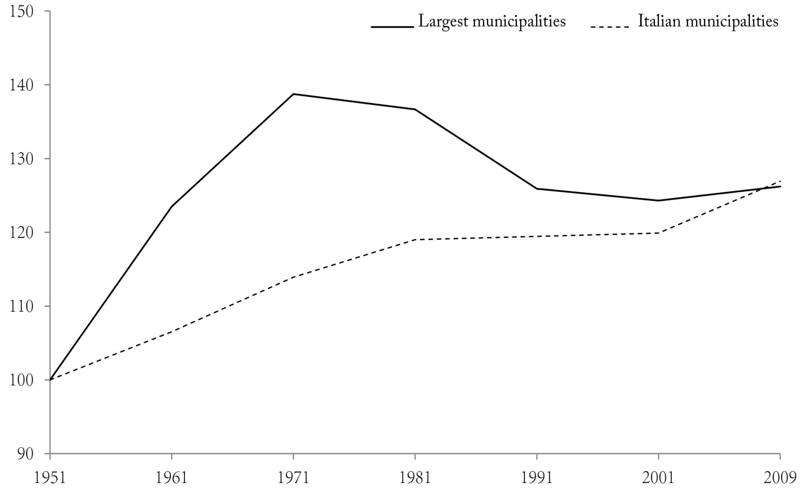
The finding that urbanization in Italy is no longer a phenomenon connected to demographic increase is also clearly confirmed by the 2009 World Wide Fund for Nature Italian Report which focuses on major Italian cities (WWF Italia, 2009). It shows that all cities decreased in population from 1971 to 2001 but they did not register a decrease in urbanization.[5] Differently from traditional urban expansion, in recent

[5] The only exceptions are Palermo and Messina in the Sicily region.

years, this pattern is the result of migration flows no longer directed from rural to urban areas. In fact, they are orientated from the core - more densely populated - towards the periphery of urban settlements, and beyond. That is, cities sprawl. Figure 2 clearly shows that, since the 1970s, this phenomenon has predominantly concerned the largest Italian cities, which have been characterized by a more marked decrease in population density compared with Italian municipalities in general.

Also Munafò et al. (2010), in a study on soil sealing, remark that the increase of sealed soil is disproportionate to that of the population, suggesting that, in more recent times, peri-urban development is achieved through settlements with low population density and high intensity infrastructure. The net effect on soil consumption is even more marked than the development generated by the compact urban growth and high density typical of the early post-World War II decades.

Figure 2: Population per square kilometer in the largest Italian cities over 1951-2009 (Index: 1951=100)



Note: The largest cities are: Bari, Bologna, Cagliari, Catania, Firenze, Genova, Messina, Milano, Napoli, Palermo, Roma, Torino, Trieste, Venezia,Verona.
Source: Authors' elaboration on Istat,*The Italian Statistics Archive*, various census years.

In Italy, the drawbacks of this low density urban growth have been acknowledged since the beginning of the twentieth century, with especial emphasis on issues concerning the sustainability of development, social segregation and increasing private mobility costs (Camagni, 1996; Camagni et al., 2002; Gibelli and Salzano, 2006). Apart from analysis of population dynamics and urban growth trajectories, the economic causes of sprawl have been less debated (Mazzeo, 2010). Moreover, to our knowledge, linkages between fiscal policy and urban sprawl have not yet received attention. Indeed, a preeminent instrument with which to influence urban development is the property tax. During the '1990s Italy began a process of fiscal decentralization, including the power to levy taxes, to local governments. Beside a reduction in State transfers, municipalities have been assigned growing fiscal autonomy. In terms of own-source revenue, local governments benefit most from "Imposta Comunale sugli Immobili" (ICI), i.e. the property tax. The ICI tax was introduced in 1993 and charged on owners, according to their percentage of ownership, of buildings, building land and agricultural land.[6] ICI tax is calculated according to the re-evaluated cadastral property value and it is collected by the municipality in which the property is located.[7] The tax

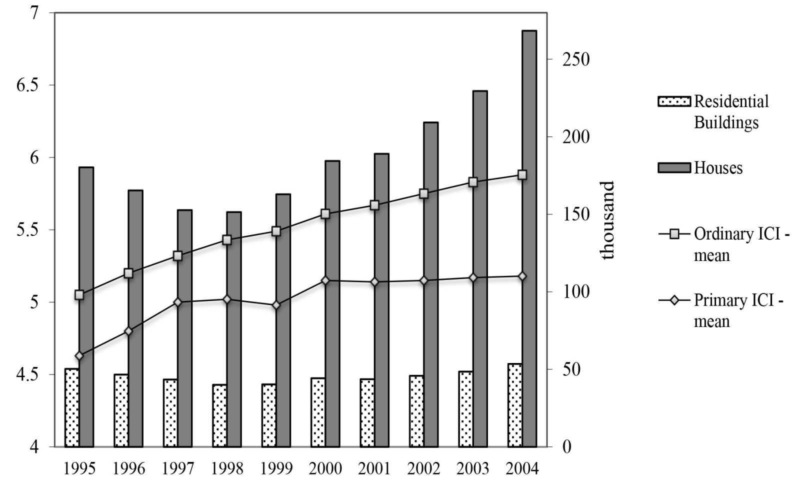
[6]ICI tax was not charged on properties owned by the State, Regions, Provinces, Municipalities, Mountain Communities, local health units, the Holy See and other Public Organizations if they are intended exclusively for institutional tasks and, finally, for those intended for cultural purposes or the exercise of worship.

[7]The cadastral value is determined by the Italian land registry; it depends on factors such as location and floor space and is

rate ranges between 0.4 per cent and a maximum of 0.7; the rate, which varies from one local government to another, is established locally, each year, by a resolution of the municipality. Besides the "ordinary" ICI tax rate, which applies to the generality of the tax base, a primary residence tax rate was introduced for the principal house owners with a rate set autonomously by each municipalities within the same range as the ordinary tax.

In a study on the evolution of ICI taxation, Pellegrino (2007) showed that in 1995 the differentiated tax on buildings and primary houses was introduced by only 135 of more than 8,000 Italian local governments. This author also observed that the mean value of this tax had been growing constantly over time, being 4.63% in 1995 and 5.18% in 2004, with a trend, however, lower than the growth of the ordinary ICI tax rate, which was 5.05% in 1995 and 5.88% in 2004. In 2008, the ICI tax rate on the primary residence was eliminated.[8] In 2012 a slightly different version of ICI, called "Imposta Municipale Unica" (IMU), was reintroduced. Clearly, since buildings represent the tax base of ICI, local governments may be tempted to leverage on the tax rate to increase their revenues but, at the same time, the tax rate may impact on future construction activity, which definitely shapes the quantity and quality of urban growth. Figure 3 plots the series of the ICI tax rates and indicators of construction activity over the period 1995-2004. One observes an acceleration in the construction of housing units from 1998 which appears correlated with the ordinary tax rate rather than with the primary residence tax rate, which is almost stable over the more recent years. Estimation of the correlation among these data will be the focus of the econometric analysis developed in the next section.

Figure 3: ICI tax rates and construction activity in Italy over the period 1995-2004



Source: Authors' elaboration on Istat and Anci data.

3 Econometric approach

Building on the empirical strategy of Banzhaf and Lavery (2010), we investigate the effects produced by differentiated property tax rates on the pattern of urban spatial extension. Their strategy is based on decomposition of the improvement effect into the dwelling size and the density effect, built on the

usually less than half the purchase price.

[8] Notable exceptions are castles, villas, mansions, or historic buildings as primary homes.

fundamental relationship suggested by the theoretical model of Brueckner and Kim (2003): $S = q \cdot D$, where S is the improvement, measured as the ratio between capital and land, q is the dwelling size, measured as the share of the capital on housing units, and D is the density corresponding to the ratio between housing units and land area. The density effect reflects the intensity of land use. In other words, more density indicates less land consumed and more compact cities, while low density connotes urban sprawl. Taking this basic relationship in logarithmic form, the total improvement effect δ^S can be approximated by the sum of the dwelling size δ^q and density δ^D effect as follows: $\delta^S \approx \delta^q + \delta^D$. This approximation makes it possible to disentangle the sources of sprawl: variation in density can be easily ascribed to the improvement effect or to the dwelling size effect.

We estimate these effects by means of three separate equations (1)-(3), where the dependent variable corresponds respectively to the percentage change in S, q and D in urban area *i*. The dependent variable is computed in percentage change over the two census years 1991 and 2001 by means of the midpoint formula, where the beginning value in the denominator is replaced by the average of the beginning and ending value. The use of percentage change allows to decompose density effect into the improvement and dwelling size effect as described above (Banzhaf and Lavery, 2010).

$$\%\Delta S_i = c + \delta^S tax_i^{core} + \rho^S tax_i^{sub} + \beta x_i^{'} + \epsilon_i \tag{1}$$

$$\%\Delta q_i = c + \delta^q tax_i^{core} + \rho^q tax_i^{sub} + \beta_1 x_i^{'} + \xi_i \tag{2}$$

$$\%\Delta D_i = c + \delta^D tax_i^{core} + \rho^D tax_i^{sub} + \beta_2 x_i^{'} + \zeta_i \tag{3}$$

The level of improvement S is proxied by the total number of rooms (R) per square kilometer (L). The dwelling size q is measured by the total number of rooms per housing unit (HU), while the density D is computed as the housing units per square kilometer. The use of these proxies implies that the basic relationship $S = q \cdot D$ can be rewritten in the form of equation (4):

$$\frac{R}{L} = \frac{R}{HU} \cdot \frac{HU}{L} \tag{4}$$

As a robustness check, we consider a second model derived by replacing HU with the number of residents P. Accordingly, equation (4) can be rewritten as follows:

$$\frac{R}{L} = \frac{R}{P} \cdot \frac{P}{L} \tag{5}$$

The dwelling size is now measured as rooms per person and can be also interpreted in terms of the quality of the housing conditions of residents. More rooms per person indicate a better quality of life since more personal space can be devoted to privacy from the rest of family. Finally, to have more confidence in our results, we adopt different proxies for measuring the improvement and the dwelling size effect. Thus, in equations (4) and (5), we replace the total number of rooms R with the housing floor space (HFS), as shown by the two equations below:

$$\frac{HFS}{L} = \frac{HFS}{HU} \cdot \frac{HU}{L} \tag{6}$$

$$\frac{HFS}{L} = \frac{HFS}{P} \cdot \frac{P}{L} \tag{7}$$

A detailed summary of all proxies used in the regression analysis is illustrated in Table 1.

We includes, on the right-side of equations (1)-(3), the property tax rate of core (tax^{core}) and hinterland (tax^{sub}). Both the primary residence and the ordinary property tax rate are considered given the tax

Table 1: Effects and proxies

Effect	*Proxy*	*Symbol proxy*
S= improvement	Rooms per Km^2	R/L
	Housing floor space per Km^2	HFS/L
q= dwelling size	Rooms per housing unit	R/HU
	Rooms per capita	R/P
	Housing floor space per housing unit	HFS/HU
	Housing floor space per capita	HFS/P
D= density	Housing units per Km^2	HU/L
	People per Km^2	P/L

base of the two taxes are different and, theoretically, they can impact differently on building activity and, thus, on land consume. Tax rates are computed as average value over the period 1993-2001. The coefficient δ^S associated to the core property taxation in equation (1) measures the improvement effect and approximates the sum of the two coefficients δ^q and δ^D i.e., respectively, the dwelling size and density effect generated by the city's core tax policies. Analogous notation is adopted to denote the improvement effect of the hinterland property taxation. The right-side of each equation also includes a $1 \times K$ vector $x_i^{'} = (x_i^1, ..., x_i^K)$ of control variables, a constant term c and normally distributed error with zero mean and constant variance.

The empirical models are estimated with the Ordinary Least Squares (OLS) estimator. However, we also take endogeneity problems into account considering that the property tax rate may anticipate and reflect forecasts about future urban development (Banzhaf and Lavery, 2010). We try to overcome this issue by estimating the equations with the Two-Stage Least Squares (2SLS) estimator.[9] This approach requires a set of instrumental variables correlated with the property tax rate but not correlated with the urban size proxies. Since they are not affected by reverse causality, we use as instruments the initial period values of both the city's core and hinterland property tax rate. They are computed as average over years 1993 and 1994. As a further instrumental variable, we employ the ratio between the number of non-profit institutions in core municipalities and non-profit institutions in hinterland. We employ its average value computed over the two census years 1991 and 2001. Italian law (art. 7 of Legislative Decree 504/1992) excludes non-profit activities from the property tax base. Thus, these institutions are excluded from the strategic management of land area and construction activity for local budget revenue purposes.

4 Data and variables

4.1 Unit of analysis

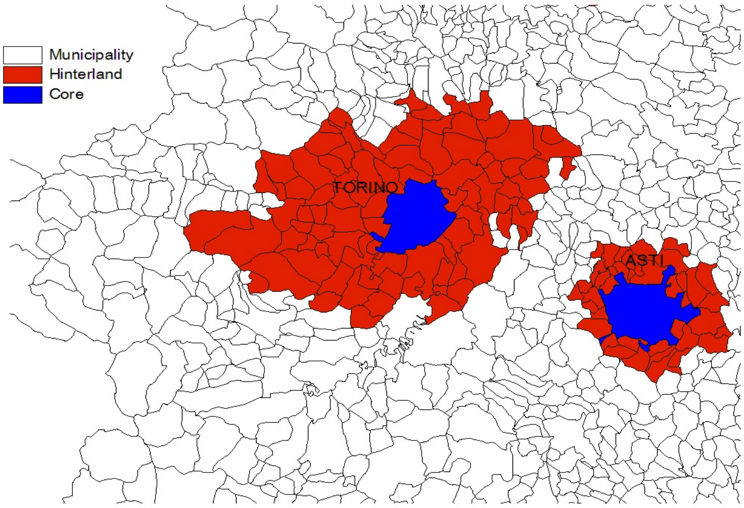
There is no unanimous consensus on the most appropriate extent of space for measuring urban sprawl development (Hortas-Rico, 2013; Torrens and Alberti, 2000) so that metropolitan area, municipality or neighborhood have been used as the research domain. Here, we consider urbanized areas jointly defined by European Commission (Eurostat and EC-DG Regio) and the Organization for Economic Co-operation and Development (OECD) as functional economic units (OECD, 2012). They are composed of densely adjacent inhabited urban core municipalities and hinterland. The urban core is identified by using gridded population data. For European countries, it consists of cluster of contiguous grid cells of 1 square

[9] On performing the Breusch-Pagan/Godfrey/Cook-Weisberg (BP-G-CW) test, we do not detect the presence of heteroskedasticity (see Tables 2 and 3 for the BP-G-CW test results). Thus, we adopt the 2SLS estimator because it is more efficient than the Two-Step Feasible Generalized Method of Moment when the variance of the error term is constant (Baum et al., 2003).

kilometer with a population density of at least 1,500 inhabitants per square kilometer and a minimum population of 50,000. A municipality becomes a part of a urban core if at least 50% of its population lives within the urban cluster (OECD, 2013). An urban area can have a monocentric structure, with a unique core, or a polycentric structure, with physically separated cores, but economically integrated.[10]

Urban hinterland is defined by travel-to-work flows as contiguous municipalities that have a high degree of labor market integration with the city's core. The hinterland includes all municipalities with at least 15% of their employed residents working in an urban core. Figure 4 gives an illustrative example of core and hinterland for the Italian functional urban areas of Torino and Asti located in the Piedmont northern region.

Figure 4: Functional urbanized areas of Torino and Asti



Source: Authors' elaboration on OECD (2013) data.

In our empirical analysis the effects of property taxation on spatial extension of urban areas are estimated on 72 Italian urban areas as above defined.[11] Figure 5 informs about the geographical distribution of FUA in Italy. Municipalities belonging to the same urban area enjoy autonomy to set their own property tax rate.

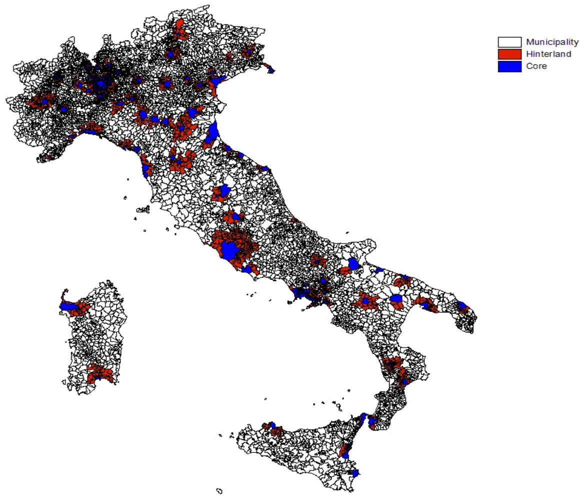
4.2 Control variables

According to Brueckner and Fansler's (1983) model, urban growth is influenced by population size (*pop*), per capita income (*income*), the commuting costs (*commuting*) and the agricultural land rent per acre (*rent*). The model predicts that an increase in population size leads to a less compact city because people must be housed. An increase in disposable income produces the same effect by raising the housing demand. Higher commuting costs reduce disposable income and consequently the housing demand, with the consequence of a more compact city. Finally, agricultural land rent increases the opportunity cost of urban land, making the city smaller. All these control variables enter our regression analysis. Unfortunately, data on disposable income are not available for Italian municipalities. We, therefore, employ the

[10]"Two urban cores are considered integrated, and thus part of the same polycentric metropolitan area, if more than 15% of the residence population of any of the cores commutes to work in the other core" (OECD, 2013, p. 13).

[11]We exclude Acireale and Barletta from our sample because we can not compute the average property tax rate of their hinterland, respectively, since they have none.

Figure 5: Italian functional urbanized areas



Source: Authors' elaboration on OECD (2013) data.

taxable income as its proxy. Agricultural land rent is measured as the rent of the agricultural area utilized per square kilometer, computed at the provincial level and according to the territorial morphology of municipalities. Commuting costs are proxied by the number of motor vehicles per square kilometer. According to Brueckner and Fansler (1983), an increase in commuting costs leads to a reduction in housing demand making a city more compact.

To these traditional controls, in each regression, we add the stock of housing built before year 1919 per square kilometer, the percentage of elderly people over 64 years old ($\%pop65+$) and young people under 15 years old ($\%pop0-14$). As recently shown by Takáts (2012), a large share of elderly households in the population depresses house prices. Lower prices can stimulate the demand for bigger or second houses, leading to lower buildings and a significant reduction in population density, with a consequent expansion of the city's borders. By contrast, more dense cities should be associated to younger people who keep house prices higher. Additional controls related to population structure can influence the spatial dimension of a city. According to Brueckner and Fansler (1983)'s model, immigrants contribute to population growth, which may cause a more dense city. Cities with more educated inhabitants and workers tend to growth faster than cities with less educated inhabitants and workers because skilled cities are better at adapting to economic shocks (Glaeser and Saiz, 2003). In our empirical analysis, we proxy these aspects by the percentage of *foreign residents* and people with *high school* diplomas in the total population. Moreover, we include the *labor force* rate participation, measured as the percentage of the population employed and unemployed job-seekers in the total population.

Since the territory of many Italian municipalities is included in national parks and natural reserves, which are subjected to stiffer rules for building construction, a dummy variable named *park* is used. It assumes value 1 if the territory (or a part of it) of a municipality is included in a national park area, and zero otherwise.

We also control for the geographical configuration of Italian municipalities with variables related to *latitude* and *longitude* of municipalities. In each cross-sectional regression we introduce a dummy variable *SSRs* that assumes value 1 if the municipality pertains to a Region with a Special Statute and zero otherwise[12], and two dummies *Centre* and *South* for, respectively, municipalities located in central

[12]The Italian Special Statute Regions are: Friuli-Venezia-Giulia, Sicily, Sardinia, Trentino-Alto Adige, Valle D'Aosta.

and southern regions.

These controls are mainly dated 1996 since this year corresponds to the midpoint of the two census years 1991 and 2001. Years before 1996 are also used when data are not available for this year. The descriptive statistics of the variables are reported in Table 2, while all details on variables definition and data sources are in appendix.

Table 2: Descriptive statistics

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
%ΔRooms per Km2	72	6.72	4.52	-6.54	18.68
%ΔHousing floor space per Km2	72	12.18	4.76	-0.59	20.59
%ΔRooms per housing unit	72	-2.64	2.41	-7.87	3.61
%ΔRooms per capita	72	6.52	3.45	-1.08	17.07
%ΔHousing floor space per housing unit	72	2.83	2.63	-5.42	9.94
%ΔHousing floor space per capita	72	11.98	3.54	0.60	20.77
%ΔHousing unit per Km2	72	9.36	4.49	-0.76	18.34
%ΔPeople per Km2	72	0.21	3.87	-9.33	8.07
Primary tax core	72	4.96	0.51	4.00	5.91
Primary tax sub	72	5.07	0.37	4.00	5.80
Ordinary tax core	72	5.57	0.57	4.22	6.80
Ordinary tax sub	72	5.41	0.40	4.22	6.28
Income	72	7232.10	1857.06	3476.65	10644.60
Rent	72	18.32	11.28	4.23	53.63
Pop	72	403370	734832	73857	3846136
%Pop 0-14	72	13.51	2.90	8.77	20.71
%Pop 65+	72	17.93	3.39	11.01	24.69
%High school	72	19.99	2.12	14.81	24.67
%Foreign people	72	0.60	0.34	0.12	1.47
%Labor force	72	42.70	2.88	36.80	48.74
Commuting	72	308.40	243.51	44.09	1420.27
Houses 1919	72	29.56	25.29	2.77	141.59
Longitude	72	11.498	2.684	7	18
Latitude	72	42.785	2.443	37	46
Park	72	0.125	0.333	0	1
Centre	72	0.181	0.387	0	1
South	72	0.306	0.464	0	1
SSRs	72	0.153	0.362	0	1

5 Results

The regression results of models (1)-(3) using OLS are presented in Tables 3 and 4, while the 2SLS results are illustrated in Tables 5 and 6. Each column reports results of separate regressions with proxies for the improvement, dwelling size and density effect used as the dependent variables in (1)-(3).

The OLS estimates show that an increase in the core property tax rate does not significantly change the density of the urban area. By contrast, the property tax rates set by suburban municipalities play a more incisive role in transforming the spatial urban area extension. We find that an increase in suburbans ICI tax rates, both primary residence and ordinary, makes the urban area more densely populated, preventing urban sprawl (see columns 7-8 of Tables 3-4). The greater city compactness resulting from changes in the hinterland property taxation is mainly ascribed to the improvement effect, since only the two related proxies, the percentage change in rooms and housing floor space per square kilometer, are significantly affected by changes in the surrounding municipalities' property tax.

Taking the endogeneity problem of taxation into account, we instrument the property tax rate of the core and hinterland with their lagged values computed as average over the initial period 1993-1994 and the percentage of non-profit institutions in core municipalities on non-profit institutions in hinterland. To verify that our set of instrumental variables are weakly or not correlated with the urban growth proxies, we perform both the weak-identification test and the under-identification test (Baum et al., 2007). The under-identification test makes it possible to verify if the instruments are correlated with the endogenous variable. Rejection of the null-hypothesis suggests that the model is adequately identified. In the absence of heteroskedasticity, we use the Anderson canonical correlations LM-statistic (Anderson, 1984) to test the under-identification hypothesis. This test rejects the null at 1% level in our 2SLS estimates, suggesting that the instruments are correlated with the property taxes of the city's core and its surrounding municipalities. We then run the weak-identification test of Stock and Yogo (2005) that uses Cragg-Donald (CD) F statistic (Cragg and Donald, 1993). This statistic exceeds the Stock-Yogo threshold for 10% and 15% maximal size, as reported in Tables 5 aand 6, pointing out that our instruments are valid. Finally, the Sargan (1958) test for over-identification is run to have more confidence that our instruments are appropriate. With only one exception (see column 5, Table 6), the Sargan test accepts the null-hypothesis, showing the validity of the instruments used in our regressions.

Focusing on results of the second-stage of the 2SLS estimation procedure[13], column 8 of Tables 5 and 6 shows that an urban area sprawls when the core property tax rate increases. The positive and significant correlation detected between the core primary residence tax rate and the proxies used for dwelling size (see columns 3, 5 and 6 of Table 5) denotes that urban sprawl can be ascribed to the dwelling size effect. Our 2SLS results confirm that the property taxes of suburban are crucial in determining the city's spatial extension, inducing a greater spatial housing units concentration and population density. Again, this result is mainly due to the improvement effect, since its proxy (see column 2 of Tables 5 and 6) is positively and significantly affected by property tax rates of surrounding municipalities. Overall, we do not find any significant change in the dwelling size that can be attributed to variation in the hinterland property taxation.

As to the controls, the cross-sectional regressions show that changes in population size reduces significantly the density of urban area. Moreover, higher rent extracted from agricultural land turns into smaller dwelling size, making the urban area more compact. As expected, we find an increase in city density when the commuting costs, proxied by the number of motor vehicles per square kilometer, increase. In contrast to our expectations, on the income side, we observe that more affluent people demand for new buildings with rooms of smaller size, leading to a smaller urban area. With regards to the demographic structure of the population, we find that urban areas become more compact when a large share of the population is young. Dwelling size becomes smaller in cities with a large share of young people. Cities attractive to elderly people prove to have more rooms per housing unit that take up less housing floor space. Finally, cities with higher rates of labor force participation and less educated inhabitants are more dense. They tend to growth faster because they are more resilient to negative economic shocks (Glaeser and Saiz, 2003).

6 Concluding remarks

Linkages between fiscal policy and urban sprawl have received attention only in recent years. The seminal paper by Brueckner and Kim (2003) demonstrates that a preeminent instrument with which to influence development of an urban area is the property tax. They identify two countervailing effects of property taxation on urban sprawl: improvement and the dwelling size, which, in combination, determine the spatial expansion of cities. Which effect is likley to prevail is not clear. Drawing inspiration from model of Brueckner and Kim (2003), but making different assumptions on the functional form of utility

[13] The first-stage regression results are available from the authors' upon request.

function and elasticity of substitution, Song and Zenou (2006) shows that the dwelling size effect prevails over the improvement effect, leading to a smaller city. From an empirical point of view, identifying which effect prevails in the urban growth pattern is a challenging issue. To our knowledge, only the paper of Banzhaf and Lavery (2010) succeeds in this task.

The paper of Song and Zenou (2009) contributes to explore how differences in property tax rates within an urban area affect its spatial expansion. They find a more expansive urban growth when the property tax rate in suburbs is lower than the central city's property tax rate. However, their empirical analysis do not disentangle for the specific features of improvement, dwelling and density effects produced by differentiated property taxes. Our paper fills this gap by analyzing these effects on the Italian urban growth. The Italian scenario is an interesting case study to explore the topic, given that the property tax revenue is one of the preeminent sources of local budget financing and local governments may be tempted to set the property tax rate or property tax base strategically so as to increase their revenues. However, land is scarce in Italy, and it is important to evaluate if a strategic use of the property tax impacts on the spatial pattern of city growth. Moreover, particular attention has been paid to considering if property tax sprawls Italian cities, a crucial issue for urban planners and policy makers.

Our econometric analysis shows that differences in property tax across the city's core and hinterland significantly affect the size of Italian urbanized areas. After an increase in the core property tax, urban area sprawls by reducing its density. By contrast, urban area becomes more compact when the property tax rate of hinterland rises. As original contribution of the paper, we effectively disentangle the causes of this pattern of urban growth. We find that an increase in density is mainly driven by the improvement effect of the hinterland property taxation, while the dwelling size effect appears to play a major role in sprawling the spatial dimension of urban area in response to an increase in the core property tax rate.

Our results assess that tax setting decisions of core and hinterland affect spatial expansion of the entire urban area in opposite directions: urban area sprawls in response to an increase in the core property taxation, while it shrinks when the hinterland property taxation rises. Policy makers should be aware of these mechanisms. When they pursue land planning, they should coordinate tax policies at the level of the entire urban area. It could allow to internalize the opposite effects on urban sprawl exerted by fiscal decisions taken by core and surrounding municipalities. In absence of this coordination, autonomous fiscal policies can fail to achieve policy makers' desired goals in terms of land development.

Given that property tax is a widely adopted instrument of local fiscal policies, it is extremely important to gain insight over its interconnections with urban land development. This topic should receive greater attention in future researches.

Table 3: The OLS estimation results with the primary residence tax rate

	Improv.	*Improv.*	*Dwelling*	*Dwelling*	*Dwelling*	*Dwelling*	*Density*	*Density*
	%ΔRooms per Km^2	%ΔHousing floor space per Km^2	%ΔRooms per housing unit	%ΔRooms per capita	%ΔHousing floor space per housing unit	%ΔHousing floor space per capita	%ΔHousing units per Km^2	%ΔPeople per Km^2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Primary tax^{core}	-0.566	0.426	0.081	-0.111	1.074	0.879	-0.646	-0.457
	(-0.60)	(0.35)	(0.14)	(-0.15)	(1.47)	(0.95)	(-0.60)	(-0.56)
Primary tax rate^{sub}	3.166**	4.180**	-0.517	-0.222	0.510	0.800	3.679**	3.397**
	(1.97)	(2.03)	(-0.51)	(-0.17)	(0.41)	(0.51)	(2.02)	(2.44)
Pop	-8.8e-07	-1.9e-06**	8.2e-07**	3.2e-07	-2.0e-07	-7.0e-07	-1.7e-06**	-1.2e-06**
	(-1.44)	(-2.42)	(2.14)	(0.66)	(-0.43)	(-1.17)	(-2.45)	(-2.26)
%Pop 0-14	0.336	-0.498	0.382	-1.080***	-0.455	-1.912***	-0.044	1.418***
	(0.75)	(-0.87)	(1.36)	(-3.05)	(-1.31)	(-4.36)	(-0.09)	(3.65)
%Pop 65+	-0.631**	-0.906**	0.330*	-0.402*	0.052	-0.679**	-0.959***	-0.228
	(-2.07)	(-2.32)	(1.73)	(-1.66)	(0.22)	(-2.27)	(-2.77)	(-0.86)
Income	0.001	0.000	0.000	0.000	-0.001	-0.001	0.001	0.001*
	(1.59)	(0.20)	(0.51)	(0.08)	(-1.31)	(-1.29)	(1.12)	(1.76)
Rent	-0.002	0.031	-0.091***	-0.047	-0.057*	-0.014	0.088*	0.045
	(-0.05)	(0.60)	(-3.56)	(-1.47)	(-1.80)	(-0.34)	(1.91)	(1.28)
Commuting	0.003	0.004	0.001	-0.001	0.002	-0.000	0.002	0.004*
	(1.23)	(1.22)	(0.80)	(-0.43)	(1.07)	(-0.01)	(0.64)	(1.81)
%High school	0.075	-0.099	-0.169	-0.006	-0.343**	-0.179	0.244	0.081
	(0.37)	(-0.38)	(-1.35)	(-0.04)	(-2.21)	(-0.91)	(1.07)	(0.46)
%Foreign residents	-1.356	0.795	-0.229	-0.586	1.924	1.563	-1.130	-0.777
	(-0.83)	(0.38)	(-0.22)	(-0.45)	(1.53)	(0.98)	(-0.61)	(-0.55)
%Labor force	0.111	0.241	-0.367**	-0.157	-0.236	-0.027	0.478	0.269
	(0.41)	(0.70)	(-2.16)	(-0.73)	(-1.13)	(-0.10)	(1.55)	(1.14)
Houses 1919	-0.054*	-0.058	-0.009	0.005	-0.013	0.001	-0.045	-0.059**
	(-1.89)	(-1.58)	(-0.49)	(0.22)	(-0.58)	(0.04)	(-1.39)	(-2.38)
Park	0.047	-1.940	-0.264	2.072**	-2.258**	0.079	0.310	-2.030*
	(0.04)	(-1.27)	(-0.35)	(2.18)	(-2.44)	(0.07)	(0.23)	(-1.95)
SSRs	1.301	1.342	-0.908	-0.538	-0.866	-0.499	2.207	1.845
	(0.99)	(0.80)	(-1.10)	(-0.52)	(-0.85)	(-0.39)	(1.48)	(1.61)
Centre	2.016	3.690**	-0.992	-0.721	0.694	0.962	3.003*	2.741**
	(1.43)	(2.04)	(-1.12)	(-0.64)	(0.63)	(0.69)	(1.87)	(2.23)
South	1.578	5.297	0.069	5.065**	3.807*	8.776***	1.502	-3.493
	(0.53)	(1.40)	(0.04)	(2.16)	(1.66)	(3.02)	(0.45)	(-1.36)
Longitude	0.388*	0.491*	0.213	0.262	0.316*	0.364*	0.176	0.126
	(1.73)	(1.71)	(1.51)	(1.47)	(1.81)	(1.65)	(0.69)	(0.65)
Latitude	-0.044	0.767	0.094	-0.333	0.907**	0.477	-0.138	0.288
	(-0.09)	(1.24)	(0.31)	(-0.87)	(2.43)	(1.01)	(-0.25)	(0.69)
R^2	0.700	0.556	0.587	0.676	0.468	0.530	0.609	0.691
BP-G-CW test	0.226	0.583	0.475	0.356	0.332	0.271	0.485	0.412
F-test	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000
Obs. No.	72	72	72	72	72	72	72	72

Note: A constant term is included in each regression. t-value in parenthesis. Significant at level ***1%, **5%, *10%.

Table 4: The OLS estimation results with the ordinary tax rate

	Improv.	*Improv.*	*Dwelling*	*Dwelling*	*Dwelling*	*Dwelling*	*Density*	*Density*
	%ΔRooms per Km^2	%ΔHousing floor space per Km^2	%ΔRooms per housing unit	%ΔRooms per capita	%ΔHousing floor space per housing unit	%ΔHousing floor space per capita	%ΔHousing units per Km^2	%ΔPeople per Km^2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ordinary tax^{core}	0.579	0.831	0.329	0.226	0.583	0.479	0.250	0.353
	(0.620)	(0.690)	(0.569)	(0.307)	(0.791)	(0.521)	(0.237)	(0.430)
Ordinary tax^{sub}	1.968	3.108*	-0.833	-0.220	0.317	0.927	2.798*	2.193*
	(1.374)	(1.683)	(-0.940)	(-0.194)	(0.281)	(0.658)	(1.728)	(1.742)
Pop	-6.3e-07	-1.4e-06*	7.3e-07**	2.4e-07	-1.6e-08	-5.1e-07	-1.4e-06**	-8.8e-07*
	(-1.084)	(-1.827)	(2.026)	(0.525)	(-0.034)	(-0.880)	(-2.063)	(-1.706)
%Pop 0-14	0.498	-0.239	0.360	-1.089***	-0.377	-1.822***	0.139	1.589***
	(1.113)	(-0.414)	(1.303)	(-3.089)	(-1.070)	(-4.144)	(0.275)	(4.043)
%Pop 65+	-0.471	-0.736*	0.349*	-0.393*	0.083	-0.658**	-0.818**	-0.077
	(-1.569)	(-1.901)	(1.882)	(-1.663)	(0.349)	(-2.232)	(-2.413)	(-0.293)
Income	0.001	0.000	0.000	0.000	-0.001	-0.001	0.001	0.001*
	(1.595)	(0.297)	(0.551)	(0.128)	(-1.103)	(-1.125)	(1.108)	(1.705)
Rent	-0.003	0.019	-0.088***	-0.044	-0.065**	-0.021	0.085*	0.041
	(-0.074)	(0.373)	(-3.516)	(-1.386)	(-2.048)	(-0.540)	(1.853)	(1.162)
Commuting	0.003	0.003	0.002	-0.000	0.002	-0.000	0.001	0.003
	(0.917)	(0.693)	(1.148)	(-0.186)	(0.872)	(-0.170)	(0.184)	(1.210)
%High school	0.046	-0.116	-0.197	-0.024	-0.359**	-0.186	0.242	0.070
	(0.216)	(-0.426)	(-1.502)	(-0.147)	(-2.149)	(-0.894)	(1.012)	(0.379)
%Foreign residents	-1.074	0.821	-0.012	-0.422	1.884	1.472	-1.064	-0.659
	(-0.632)	(0.375)	(-0.012)	(-0.315)	(1.406)	(0.881)	(-0.554)	(-0.441)
%Labor force	0.156	0.275	-0.392**	-0.171	-0.273	-0.052	0.547*	0.328
	(0.574)	(0.783)	(-2.332)	(-0.800)	(-1.272)	(-0.195)	(1.780)	(1.371)
Houses 1919	-0.061*	-0.062	-0.013	0.001	-0.015	-0.001	-0.048	-0.062**
	(-1.960)	(-1.555)	(-0.686)	(0.042)	(-0.601)	(-0.017)	(-1.358)	(-2.266)
Park	0.171	-1.566	-0.249	2.057**	-1.991**	0.315	0.418	-1.892*
	(0.143)	(-1.015)	(-0.337)	(2.182)	(-2.110)	(0.268)	(0.309)	(-1.799)
SSRs	1.554	1.336	-0.959	-0.368	-1.176	-0.587	2.510	1.927
	(1.142)	(0.761)	(-1.138)	(-0.343)	(-1.095)	(-0.439)	(1.632)	(1.612)
Centre	1.132	2.278	-0.694	-0.585	0.460	0.567	1.822	1.719
	(0.794)	(1.239)	(-0.786)	(-0.520)	(0.409)	(0.405)	(1.130)	(1.372)
South	1.867	5.239	0.391	5.425**	3.780	8.789***	1.470	-3.565
	(0.604)	(1.314)	(0.204)	(2.226)	(1.549)	(2.891)	(0.421)	(-1.312)
Longitude	0.468**	0.572**	0.206	0.255	0.311*	0.360*	0.262	0.212
	(2.155)	(2.044)	(1.534)	(1.493)	(1.817)	(1.685)	(1.068)	(1.114)
Latitude	0.067	0.866	0.128	-0.273	0.931**	0.526	-0.061	0.338
	(0.130)	(1.307)	(0.404)	(-0.673)	(2.295)	(1.041)	(-0.106)	(0.749)
R^2	0.696	0.544	0.592	0.676	0.442	0.521	0.606	0.680
BP-G-CW test	0.120	0.772	0.376	0.331	0.513	0.424	0.385	0.209
F-test	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Obs. No.	72	72	72	72	72	72	72	72

Note: A constant term is included in each regression. t-value in parenthesis. Significant at level ***1%, **5%, *10%.

Table 5: The 2SLS estimation results with the primary residence tax rate

	Improv.	*Improv.*	*Dwelling*	*Dwelling*	*Dwelling*	*Dwelling*	*Density*	*Density*
	%ΔRooms per Km^2	%ΔHousing floor space per Km^2	%ΔRooms per housing unit	%ΔRooms per capita	%ΔHousing floor space per housing unit	%ΔHousing floor space per capita	%ΔHousing units per Km^2	%ΔPeople per Km^2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Primary tax^{core}	-0.992	-0.247	1.303*	1.411	2.043**	2.147*	-2.290	-2.407**
	(-0.82)	(-0.16)	(1.66)	(1.42)	(2.15)	(1.78)	(-1.64)	(-2.18)
Primary tax^{sub}	2.736	3.917*	-1.411	-1.855	-0.212	-0.657	4.138**	4.601***
	(1.59)	(1.78)	(-1.26)	(-1.31)	(-0.16)	(-0.38)	(2.08)	(2.93)
Pop	-7.4e-07	-1.7e-06**	7.3e-07**	2.8e-07	-2.7e-07	-7.2e-07	-1.5e-06**	-1.0e-06**
	(-1.38)	(-2.52)	(2.09)	(0.64)	(-0.64)	(-1.34)	(-2.36)	(-2.09)
%Pop 0-14	0.366	-0.468	0.381	-1.061***	-0.455	-1.892***	-0.013	1.429***
	(0.95)	(-0.95)	(1.52)	(-3.35)	(-1.50)	(-4.93)	(-0.03)	(4.06)
%Pop 65+	-0.610**	-0.901**	0.411**	-0.268	0.117	-0.560**	-1.019***	-0.343
	(-2.22)	(-2.56)	(2.31)	(-1.19)	(0.54)	(-2.05)	(-3.20)	(-1.37)
Income	0.001*	0.000	0.000	-0.000	-0.001	-0.001*	0.001	0.001**
	(1.79)	(0.22)	(0.36)	(-0.18)	(-1.62)	(-1.66)	(1.34)	(2.14)
Rent	-0.008	0.024	-0.082***	-0.038	-0.050*	-0.006	0.074*	0.030
	(-0.22)	(0.52)	(-3.53)	(-1.30)	(-1.78)	(-0.18)	(1.78)	(0.94)
Commuting	0.003	0.004	0.002	-0.001	0.003	0.000	0.001	0.004*
	(1.21)	(1.21)	(1.13)	(-0.35)	(1.37)	(0.05)	(0.41)	(1.65)
%High school	0.083	-0.087	-0.190*	-0.031	-0.360***	-0.200	0.273	0.114
	(0.48)	(-0.39)	(-1.69)	(-0.22)	(-2.65)	(-1.16)	(1.36)	(0.72)
%Foreign residents	-1.476	0.604	0.122	-0.147	2.202**	1.929	-1.599	-1.336
	(-1.04)	(0.33)	(0.13)	(-0.13)	(1.97)	(1.36)	(-0.97)	(-1.03)
%Labor force	0.116	0.238	-0.325**	-0.091	-0.203	0.031	0.440	0.207
	(0.49)	(0.78)	(-2.12)	(-0.47)	(-1.09)	(0.13)	(1.61)	(0.96)
Houses 1919	-0.051**	-0.054*	-0.013	0.000	-0.016	-0.003	-0.037	-0.051**
	(-2.04)	(-1.69)	(-0.84)	(0.02)	(-0.84)	(-0.11)	(-1.30)	(-2.26)
Park	0.151	-1.803	-0.428	1.901**	-2.386***	-0.058	0.576	-1.755*
	(0.14)	(-1.36)	(-0.64)	(2.23)	(-2.93)	(-0.06)	(0.48)	(-1.86)
SSRs	0.895	0.874	-0.632	-0.412	-0.653	-0.435	1.526	1.312
	(0.76)	(0.58)	(-0.82)	(-0.42)	(-0.70)	(-0.37)	(1.11)	(1.22)
Centre	1.863	3.539**	-1.018	-0.866	0.671	0.819	2.875**	2.733**
	(1.52)	(2.25)	(-1.28)	(-0.86)	(0.70)	(0.67)	(2.02)	(2.44)
South	1.166	4.812	0.400	5.269**	4.063**	8.906***	0.760	-4.110*
	(0.45)	(1.46)	(0.24)	(2.49)	(2.01)	(3.48)	(0.26)	(-1.75)
Longitude	0.402**	0.496*	0.260**	0.342**	0.354**	0.435**	0.143	0.060
	(2.02)	(1.94)	(2.01)	(2.09)	(2.26)	(2.19)	(0.62)	(0.33)
Latitude	-0.117	0.684	0.135	-0.322	0.939***	0.478	-0.253	0.204
	(-0.28)	(1.27)	(0.50)	(-0.94)	(2.85)	(1.14)	(-0.52)	(0.53)
Centered R^2	0.697	0.552	0.553	0.650	0.451	0.512	0.589	0.658
F-test	0.000	0.000	0.000	0.000	0.004	0.001	0.000	0.000
Sargan test	0.831	0.333	0.803	0.510	0.269	0.625	0.746	0.407
Anderson-LM stat.	0.000							
CD-Wald F test	14.7							

Note: Instruments: the average core primary tax rate over years 1993-1994, the average hinterland primary tax rate over years 1993-1994, non-profit institutions in core (% of non-profit institutions in hinterland). Stock-Yogo weak-identification test critical values: 10% maximal IV size 13.43; 15% maximal IV size 8.18. A constant term is included in each regression. t-value in parenthesis. Significant at level ***1%, **5%, *10%.

Table 6: The 2SLS estimation results with the ordinary tax rate

	Improv.	*Improv.*	*Dwelling*	*Dwelling*	*Dwelling*	*Dwelling*	*Density*	*Density*
	%ΔRooms per Km^2	%ΔHousing floor space per Km^2	%ΔRooms per housing unit	%ΔRooms per capita	%ΔHousing floor space per housing unit	%ΔHousing floor space per capita	%ΔHousing units per Km^2	%ΔPeople per Km^2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ordinary tax^{core}	-0.798	-0.596	1.255	1.570	1.453	1.765	-2.049	-2.371*
	(-0.59)	(-0.35)	(1.50)	(1.45)	(1.37)	(1.33)	(-1.32)	(-1.85)
Ordinary tax^{sub}	2.528	4.407**	-1.314	-2.000	0.580	-0.106	3.835*	4.538***
	(1.47)	(2.00)	(-1.23)	(-1.45)	(0.43)	(-0.06)	(1.93)	(2.78)
Pop	-4.7e-07	-1.2e-06*	6.3e-07*	1.1e-07	-1.3e-07	-6.5e-07	-1.1e-06*	-5.8e-07
	(-0.90)	(-1.82)	(1.92)	(0.26)	(-0.31)	(-1.25)	(-1.81)	(-1.17)
%Pop 0-14	0.462	-0.263	0.383	-1.075***	-0.344	-1.798***	0.081	1.540***
	(1.18)	(-0.52)	(1.57)	(-3.41)	(-1.12)	(-4.67)	(0.18)	(4.13)
%Pop 65+	-0.568**	-0.868**	0.419**	-0.243	0.116	-0.545**	-0.985***	-0.324
	(-2.02)	(-2.41)	(2.40)	(-1.08)	(0.53)	(-1.97)	(-3.03)	(-1.21)
Income	0.001	0.000	0.000	0.000	-0.000	-0.001	0.001	0.001
	(1.55)	(0.21)	(0.86)	(0.25)	(-0.95)	(-1.10)	(0.88)	(1.43)
Rent	-0.011	0.011	-0.082***	-0.037	-0.060**	-0.014	0.071*	0.025
	(-0.32)	(0.24)	(-3.69)	(-1.27)	(-2.11)	(-0.40)	(1.70)	(0.75)
Commuting	0.001	0.001	0.003*	0.002	0.003	0.001	-0.002	-0.001
	(0.29)	(0.16)	(1.81)	(0.64)	(1.32)	(0.44)	(-0.71)	(-0.24)
%High school	0.141	-0.012	-0.262**	-0.128	-0.414***	-0.279	0.402*	0.269
	(0.70)	(-0.05)	(-2.10)	(-0.79)	(-2.62)	(-1.42)	(1.73)	(1.41)
%Foreign residents	-1.816	-0.015	0.497	0.416	2.297*	2.211	-2.313	-2.241
	(-1.13)	(-0.01)	(0.50)	(0.32)	(1.81)	(1.40)	(-1.24)	(-1.46)
%Labor force	0.224	0.338	-0.437***	-0.227	-0.321*	-0.111	0.659**	0.450*
	(0.92)	(1.09)	(-2.89)	(-1.16)	(-1.68)	(-0.46)	(2.34)	(1.95)
Houses 1919	-0.042	-0.044	-0.026	-0.016	-0.027	-0.018	-0.016	-0.026
	(-1.37)	(-1.10)	(-1.35)	(-0.65)	(-1.13)	(-0.58)	(-0.46)	(-0.88)
Park	0.059	-1.688	-0.174	2.177***	-1.926**	0.424	0.231	-2.123**
	(0.06)	(-1.25)	(-0.27)	(2.58)	(-2.33)	(0.41)	(0.19)	(-2.13)
SSRs	1.068	1.182	-0.683	-0.495	-0.569	-0.382	1.750	1.569
	(0.84)	(0.73)	(-0.87)	(-0.49)	(-0.57)	(-0.31)	(1.19)	(1.30)
Centre	0.834	1.840	-0.474	-0.072	0.538	0.937	1.305	0.906
	(0.64)	(1.11)	(-0.59)	(-0.07)	(0.53)	(0.74)	(0.87)	(0.74)
South	0.382	3.901	1.359	6.528***	4.890**	10.031***	-0.979	-6.156**
	(0.13)	(1.05)	(0.75)	(2.79)	(2.14)	(3.51)	(-0.29)	(-2.23)
Longitude	0.474**	0.562**	0.204*	0.279*	0.292*	0.366*	0.271	0.196
	(2.48)	(2.29)	(1.72)	(1.82)	(1.94)	(1.95)	(1.23)	(1.08)
Latitude	-0.200	0.655	0.298	-0.124	1.154***	0.729	-0.497	-0.078
	(-0.41)	(1.05)	(0.99)	(-0.32)	(3.01)	(1.53)	(-0.88)	(-0.17)
Centered R^2	0.683	0.531	0.572	0.650	0.422	0.503	0.571	0.611
F-test	0.000	0.000	0.000	0.000	0.008	0.001	0.000	0.000
Sargan test	0.624	0.721	0.435	0.738	0.070	0.218	0.401	0.424
Anderson-LM stat.	0.000							
CD-Wald F test	10.05							

Note: Instruments: the average core ordinary tax rate over years 1993-1994, the average hinterland ordinary tax rate over years 1993-1994, non-profit institutions in core (% of non-profit institutions in hinterland). Stock-Yogo weak-identification test critical values: 10% maximal IV size 13.43; 15% maximal IV size 8.18. A constant term is included in each regression. t-value in parenthesis. Significant at level $^{***}1\%$, $^{**}5\%$, $^{*}10\%$.

Table 7: Appendix: Data sources and variable definitions

Variable	*Data description*	*Data year*	*Data source*
Δ%Rooms per Km^2	Rooms per square kilometer (Km) in urban area (% changes over the census years 1991 and 2001).	census year 1991, 2001	ISTAT, Atlante statistico dei comuni.
Δ%Housing floor space per Km^2	Housing floor space per square Km in urban area (% changes over the census years 1991 and 2001).	census year 1991, 2001	ISTAT, Atlante statistico dei comuni.
Δ%Rooms per housing unit	Rooms per housing units in urban area (% changes over the census years 1991 and 2001).	census year 1991, 2001	ISTAT, Atlante statistico dei comuni.
Δ%Rooms per capita	Rooms per capita in urban area (% changes over the census years 1991 and 2001).	census year 1991, 2001	ISTAT, Atlante statistico dei comuni.
Δ%Housing floor space per housing unit	Housing floor space per housing unit in urban area (% changes over the census years 1991 and 2001).	census year 1991, 2001	ISTAT, Atlante statistico dei comuni.
Δ%Housing floor space per capita	Housing floor space per capita in urban area (% changes over the census years 1991 and 2001).	census year 1991, 2001	ISTAT, Atlante statistico dei comuni.
Δ%Housing unit per Km^2	Housing unit per square Km in urban area (% changes over the census years 1991 and 2001).	census year 1991, 2001	ISTAT, Atlante statistico dei comuni.
Δ%People per Km^2	People per square Km in urban area (% changes over the census years 1991 and 2001).	census year 1991, 2001	ISTAT, Atlante statistico dei comuni.
Primary tax^{core}	Primary residence tax rate of the city's core municipalities, average value over 1993-2001.	1993-2001	ISFOL.
Ordinary tax^{core}	Ordinary tax rate of the city's core municipalities, average value over 1993-2001.	1993-2001	ISFOL.
Primary tax^{sub}	Primary residence tax rate of hinterland, average value over 1993-2001.	1993-2001	ISFOL.
Ordinary tax^{sub}	Ordinary tax rate of hinterland, average value over 1993-2001.	1993-2001	ISFOL.
Income	Taxable income in urban area (% of total population in urban area).	1995	MEF-Department of Finance.
Rent	Rent of the utilized agricultural area at provincial level.	1996	INEA.
Pop	Population in urban area, total.	1996	ISTAT, Atlante statistico dei comuni.
%Pop 0-14	Population age 0-15 in urban area (% of total population in urban area).	1996	ISTAT, Atlante statistico dei comuni.
%Pop 65+	Population aged 65 and over in urban area (% of total population in urban area).	1996	ISTAT, Atlante statistico dei comuni.
%High school	High school graduate in urban area (% of total population in urban area).	1991	ISTAT, Atlante statistico dei comuni.
%Foreign residents	Foreign residents in urban area (% of total population in urban area).	1991	ISTAT, Atlante statistico dei comuni.
%Labor force	Population employed and unemployed looking for new jobs in urban area (% of total population in urban area).	1991	ISTAT, Atlante statistico dei comuni.
Commuting	Number of motor vehicles per square kilometer in urban area.	1996	Automobile Club d'Italia.
Houses 1919	Housing built before year 1919 in urban area (% of land area in 1991).	1991	ISTAT, Atlante statistico dei comuni.
Longitude	Longitude.		ENEA.
Latitude	Latitude.		ENEA.
Park	1= territories of urban area are in national park and/or nature reserve; 0= otherwise.		
SSRs	1= municipalities of urban area are located in Special Statute Region; 0= otherwise.		
Centre	1= municipalities of urban area are located in central regions; 0= otherwise.		
South	1= municipalities of urban area are located in southern regions; 0= otherwise.		

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