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# ESSAYS ON URBAN SPRAWL AND LOCAL PUBLIC FINANCE
(Ensayos sobre la expansión urbana y finanzas públicas locales)

TESIS DOCTORAL DE:

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# ESSAYS ON URBAN SPRAWL AND LOCAL PUBLIC FINANCE

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**PhD Dissertation**

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# INTRODUCTION

This PhD Dissertation is divided in three closely related essays, each of them having its own structure and methodological framework. The three essays are mainly empirical and address some relevant issues from urban sprawl and local public finance. The first two chapters analyse the impact of this growth development pattern on municipal budgets, accounting for both the revenue and the expenditure side. The third paper makes a contribution to the understanding of a closely related phenomenon to urban sprawl, the urban decay of central cities, and the role played by urban containment programs as a possible public policy remedy. Overall, the three essays are aimed at orientating local government behaviour and public policies in terms of land-use decision making.

In recent years Europe has been involved in a far-reaching process of land use change. Its former compact, vertical pattern of urban growth has been replaced by a horizontal pattern, characterized by a rapid, low-density outward expansion, known as urban sprawl. This new urban development model, exclusive to U.S. cities since the beginning of the 20$^{th}$ century, has now become part of the European landscape. A recent report published by the European Environment Agency (EEA, 2006) asserts that the urbanized land consumed per person during the last 20 years has more than doubled. During this period the extent of built-up areas has increased by 20%, while the population has grown by only 6%. Besides, as available data show, the process is particularly intense in the southern regions of the continent, with Spain being no exception.

According to data from the Spanish Ministry of Housing, some 600,000 dwellings per year were initiated between 1996 and 2005, a figure that almost doubled annual domestic demand for new homes.

Moreover, most of this building activity took the form of scattered, spatially-expansive urban growth. Consequently, data provided by the aerial photographs of the *Corine Land Cover* project (Ministerio de Fomento, 2006) shows that between 1987 and 2005 the proportion of artificial land rose by 54.86%, reflecting primarily the expansion in land for new infrastructure and developments located at the urban fringe. Similarly, data

from the Spanish Property Assessment Office reveal that developed land increased by an additional 11.5% during the period 2000-2004. Most of this development took the form of low density urban growth (up by 30% during the 1987-2000 period) and scattered growth (up by 26%), while the area undergoing compact development increased by a meagre 4.1%. Yet, marked differences are evident in the spatial distribution of this growth across the country, with it being particularly intense in Mediterranean coastal areas (i.e., in the tourist zones of Catalonia, Valencia, Murcia, Andalusia and the Balearic Islands that had not been developed in the 80s, which grew, on average, by 50% during this period) and within the urban area of Madrid, where dispersed residential land grew, on average, by 25%.

Several benefits have been attributed to urban sprawl in terms of the fulfilment of residents' preferences for larger, single-family detached housing, greater proximity to open spaces, and segregation from some of the problems suffered by the inner city such as pollution, crime and congestion. Nonetheless, these benefits can be offset by a wide variety of costs. An increase in commuting due to the more scattered nature of urban areas also exacerbates traffic congestion and, in turn, air pollution (Sierra Club, 1998; Brueckner 2001; Glaeser and Khan, 2003). Excessive land conversion to urban use diminishes the extent of farmland and forests, which represents a loss of the amenity benefits from open space (Sierra Club, 1998). The claim is also made that urban sprawl reduces social interaction and contributes to socioeconomic segregation and income inequality between the rich of the suburbs and the poor of the inner cities (Downs, 1999; Brueckner, 2000, 2001; Glaeser and Khan, 2003; Wheeler, 2008; Pendall and Carruthers, 2003). Then, several poverty-related problems arise in low-income neighbourhoods, such as increasing crime rates, poor-quality public services and lack of fiscal resources.

Consequently, urban sprawl has become a matter for concern and a contentious and widely-debated topic among academics, urban planners and the general public, not only because of the intensity of the process but also because of its great environmental, social and economic impact. However, among the many consequences already mentioned the impact on municipal finances is perhaps the most relevant. Although many factors have an influence on the amount, allocation and distribution of local public spending, there is a growing conviction that urban spatial structure is gaining in importance. Low-density expansion increases the costs of providing local public services. Major investments are required to extend the highway network, and water, electricity or sewer lines to a

relatively small number of residents (Carruthers, 2002). Likewise, as a result of the greater dispersion of population in the municipality, such districts fail to capitalize on economies of scale and optimise on facility location of several public services, including public education, police protection or public transportation (Carruthers and Ulfarsson, 2008). Without question, all these issues have an important impact on public policies and, consequently, on public budgets.

The three essays presented in this PhD Dissertation address this growing concern on urban sprawl and its strong connection to local public finance.

*Chapter I* focuses on the impact of this process of rapid, low-density urban expansion on the costs of providing local public services. Specifically, we estimate a per capita local public spending equation both for aggregate spending and for six disaggregated spending categories that intuitively should be more markedly influenced by urban sprawl. A set of variables are introduced in measuring urban sprawl to account for its spatial dimension and, thus, to capture the full extent of this growth pattern. Given that little is known about the exact nature of the relationship between this variable and the costs of providing public services, we adopt a highly flexible approach that allows the data to determine the functional form. Using a *piecewise linear function* (Ladd 1992), the relationship between urban sprawl and local costs is estimated as a series of linear connected segments. Further, we also introduce a number of control variables in the expenditure function so as to take into account the effect of different potential users, other cost factors and fiscal capacity on expenditure. Having controlled for these effects, we are then in a position to identify the specific impact of urban sprawl on local costs. In other words, we can determine whether among municipalities with the same characteristics the more sprawled ones have to deal with extra costs in providing certain local services. Should the results suggest that urban sprawl is more expensive to maintain than a more compact development, this would then be a starting point for discussing the role that local and regional governments should play in regulating the outcome of this pattern of growth. In this sense, the increasing provision costs of public goods and services, as well as additional consequences related to urban sprawl, have been used by critics of this phenomenon to justify the use of growth control programs and cooperation policies among jurisdictions that promote more compact urban areas (Katz, 2002; Carruthers, 2002; Carruthers and Ulfarsson, 2003).

This new urban development pattern represents also a source of potential funds for local governments, in terms of increased grants from upper tiers of governments and revenues associated with building activity, including planning permissions, construction taxes, taxes on land value improvements, revenues from the sales of public land and asset revenues. In the light of the above, it might be concluded that as land-use changes occur, the balance of municipal revenues and expenditures changes as well.

*Chapter II* takes into account the results obtained in Chapter I and expands the analysis so as to get a picture of the net fiscal impact of urban sprawl on local public finance, accounting for both the expenditure and the revenue side. Given the relationships between expenditures and revenues, local authorities need to be aware of the long-term financial implications of their land-use decisions and the need to re-examine the role played by state and regional governments in regulating the outcome of this growth pattern. The empirical treatment of this relationship has typically focused on purely cross-sectional or static panel data analysis. The dynamic links between local budgets and urban sprawl have not been previously addressed in the literature. Yet, it is by explicitly analysing the time dimension that could allow for a direct statement on what may happen over time if cities continue to spread out. Thus, the purpose of this study is to shift the focus more explicitly to the time-series dimension of the panel data. We seek to provide evidence regarding the time profile of the fiscal adjustment to a sprawl shock and, therefore, to determine the net fiscal impact of this growth pattern on local public finance. The typical way to proceed involves examining the intertemporal linkages between the variables of interest. The availability of disaggregated budget data at the local level for a representative sample of Spanish municipalities for the period 1994-2005 allows a novel dynamic analysis to be undertaken, based on the estimation of a panel vector autoregressive model (PVAR).

We first explore how sprawl interacts with local budgets by breaking the non-financial deficit down into several components: current spending, tax revenues, current transfers, capital spending, capital transfers and development revenues. This breaking down of local budgets allows us to clearly identify the costs and benefits of urban sprawl (in terms of the impact on expenditures and revenues, respectively). Unobserved individual effects and a set of time dummies are included in all the regressions. The estimation procedure relies on the application of Generalised Method of Moments (GMM) techniques in order to ensure consistent and efficient estimates. Having been correctly specified, the model allows the Generalised Impulse Response Functions (GIRFs) to be computed, so as to

determine the way in which municipal budgets adjust to an urban sprawl shock and the role that is played by upper tiers of government in this process. Overall, with these findings we seek to contribute to the existing empirical literature on the consequences of sprawl, as well as orienting public policy in terms of its local land-use decision-making.

So far, Chapters I and II have analyzed the impact of sprawl on local public finance. Nonetheless, urban sprawl is also responsible for many other challenges we face today with evident applications in terms of public policy. Sprawl induces the movement of large shares of population and employment to suburban communities contributing to socioeconomic segregation between the rich of the suburbs and the poor of the inner cities. This primarily "white and middle- and upper-income-class flight" makes several poverty-related problems arise in downtown neighbourhoods, such as increasing crime rates, poor-quality public services, lack of fiscal resources and lack of reinvestment and maintenance in existing building structures, leading to the deterioration and decay of central cities (urban blight). These inner-city problems induce even further population shift toward the suburbs, reinforcing the process of suburban growth and urban decay (Bradford and Kelejian, 1973; Mills and Price, 1984; Mieskowski and Mills, 1993).

*Chapter III* analyses the relationship between sprawl and blight, focusing on the role played by urban containment programs as a public policy remedy. Given that the problem of central city urban decay has become a matter for concern especially throughout US metropolitan areas, the empirical study focuses on that country.

Early writers on blight and urban renewal pointed out the complex relationships between central-city and suburban development (Fisher, 1942; Breger, 1967; Davis, 1960; Davis and Whinston, 1961; Bradbury, Downs and Small, 1980). The decline of central cities was clearly seen as a diseconomy of urbanization. More recently, Brueckner and Helsley (2011) developed a dynamic urban model to show that sprawl and urban blight can be considered the byproduct of the same underlying economic process, both being responses to fundamental market failures distorting the socially desired allocation of population and urban land within jurisdictions. Unpriced traffic congestion, open-space externalities, or unpriced suburban infrastructure make the cost of suburban living to be inefficiently low, drawing residents away from the central-city and resulting in excessive suburban population. This population shift in turn depresses housing prices in the centre, undermining incentives to maintain or reinvest in existing

downtown structures. In this context, the adoption of corrective growth management policies may help preventing sprawl and the decline of central cities as they raise reinvestment and reduce urban blight.

Traditionally, land-use regulations (such as zoning ordinances or minimum lot sizes) have been the tool most frequently used to limit the excessive growth of cities. Nonetheless, the undesired outcomes of such policies (increasing housing prices, unaffordability of housing and exclusionary problems, among others) have reduced their popularity in favour of more appropriate anti-sprawl measures. In this context, newly designed urban containment policies have emerged in response to the perverse consequences of restrictive land-use controls (Nelson et al, 2004). These policies combine regulations and incentives to guide and efficiently allocate new development as well as to balance the forces of decentralization and promote the revitalisation of inner core areas.

The analysis presented in the third chapter enlarges existing empirical literature on the relationship between central-city and suburban development and the role played by anti-sprawl policies. It is, therefore, a first attempt in the empirical literature to address blight reduction in U.S. central cities. Besides, conclusions derived from this analysis could help orienting public policy in terms of its regional and local land-use decision-making and central city revitalisation. The fiscal impact on public budgets could also benefit from evidence on effective corrective public policies. An early implementation of such policies could avoid additional local and regional expenditures aimed at solving central-city problems.

First, we develop an accurate measure of urban blight so that we might empirically test whether the adoption of corrective policies could help reducing urban decay.

Available micro data from the American Housing Survey on external conditions of buildings and neighborhoods reflecting a serious damage to the structure enables us to construct new detailed blight measures at the city level for a representative sample of Metropolitan Statistical Areas. These blight measures are summarized in two synthetic indexes with minimum loss of information by means of a Principal Components Analysis. We implement a novel empirical analysis on the correlation between city blight and the role of corrective urban containment policies. The empirical specification includes a number of control variables so as to take into account the effect of socioeconomic characteristics at the city level. Having controlled for these effects, we are then in a position to identify the specific impact of more stringent anti-sprawl

policies adopted at the metro-level on city blight. In other words, we can determine whether among metropolitan areas with the same characteristics the ones with urban containment programs in place face significant blight reductions in their central cities.

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# CHAPTER I.

# DOES URBAN SPRAWL INCREASE THE COSTS OF PROVIDING LOCAL PUBLIC SERVICES? EVIDENCE FROM SPANISH MUNICIPALITIES

## 1.1. Introduction

In recent years Europe has been involved in a far-reaching process of land use change. Its former compact, vertical pattern of urban growth has been replaced by a horizontal pattern, characterized by a rapid, low-density outward expansion, known as urban sprawl. This new urban development model, exclusive to U.S. cities since the beginning of the 20th century, has now become part of the European landscape. A recent report published by the European Environment Agency (EEA, 2006) asserts that the urbanized land consumed per person during the last 20 years has more than doubled. Specifically, during this period the extent of built-up areas has increased by 20%, while the population has grown by only 6%. Besides, as available data show, the situation acquires particular importance in the southern regions of the continent, with Spain being no exception. According to data provided by the aerial photographs of the *Corine Land Cover* project (Ministerio de Fomento, 2006), between 1987 and 2000 Spain's artificial land area grew by 29.5%, roughly one third of its overall historical record. Similarly, data from the Spanish Property Assessment Office reveal that developed land increased by an additional 11.5% during the period 2000-2004. Moreover, most of this development took the form of low density urban growth (up by 30% during the 1987-2000 period) and scattered growth (up by 26%), while the area undergoing compact development increased by a meagre 4.1%[1].

Urban sprawl has thus become a matter for concern, not only because of the intensity of the process but also because of its great environmental, social and economic impact. An increase in commuting due to the more scattered nature of urban areas also exacerbates traffic congestion and, in turn, air pollution (Sierra Club, 1998; Brueckner 2001; Glaeser and Khan, 2003). Excessive land conversion to urban use diminishes the extent of farmland and forests, which represents a loss of the amenity benefits from open space (Sierra Club, 1998). The claim is also made that urban sprawl reduces social interaction and contributes to socioeconomic segregation between the rich of the suburbs and the poor of the inner cities (Downs, 1999; Brueckner, 2000, 2001; Glaeser and Khan, 2003). Then, several poverty-related problems arise in low-income neighbourhoods, such as increasing crime rates, poor-quality public services and lack of

[1]The area devoted to transport infrastructure and to industrial and commercial uses also increased considerably during the period: 150 and 60%, respectively (Ministerio de Fomento, 2006).

fiscal resources. However, among the many consequences already mentioned the impact on municipal finances is perhaps the most relevant. Although many factors have an influence on the amount, allocation and distribution of local public spending, there is a growing conviction that urban spatial structure is gaining in importance. Low-density expansion increases the costs of providing local public services. Major investments are required to extend the highway network, and water, electricity or sewer lines to a relatively small number of residents (see., e.g., Carruthers, 2002). Likewise, as a result of the greater dispersion of population in the municipality, such districts fail to capitalize on economies of scale and optimise on facility location of several public services, including public education, police protection or public transportation (Carruthers and Ulfarsson, 2006).

Thus, the aim of this paper is to determine empirically the impact of urban sprawl on the costs of providing local public services. Specifically, we estimate a *per capita* local public spending equation both for aggregate spending and for six disaggregated spending categories that intuitively should be more markedly influenced by urban sprawl: *Community Facilities, Basic Infrastructures and Transport, Local Police, Culture and Sports, Housing and Community Development* and *General Administration.* Four variables are introduced in measuring urban sprawl. The main one is a measure of density, defined as the urbanized land per person. This variable is measured at the municipal level, i.e. where the policy decisions concerning the above spending functions are taken. Note that this variable represents an improvement on that adopted in previous empirical analyses. First, the data available for Spain allow us to use the urbanized or developed area instead of the developable land area or even the total land area of the municipality[2] and, second, we are able to employ a more highly disaggregated spatial unit of analysis than that used in previous studies, which had to work with data at the county level (see Ladd 1992, 1994; Carruthers and Ulfarsson, 2002, 2003). Besides, so as to capture the relationship between this variable and the dependent variable more accurately, we use a highly flexible approach that allows our data to determine this functional form. The number of population centres and the number of residential housing units per capita, as well as the percentage of scattered population are additionally included in the model as sprawl measures. Further, we also introduce a number of control variables in the expenditure function so as to take into

[2] Developable land is defined as the total amount of land that is legally recognized as having been developed or which is available for development in each municipality. As such it includes both the built-up and the non built-up areas that are nevertheless available for construction purposes.

account the effect of different potential users, other cost factors and fiscal capacity on expenditure. Having controlled for these effects, we are then in a position to identify the specific impact of urban sprawl on local costs. In other words, we can determine whether among municipalities with the same characteristics the more sprawled ones have to deal with extra costs in providing certain local services.

While much has been written about the causes of urban sprawl, little attention has been paid to its implications, especially to its impact on local budgets. Empirical evidence regarding the fiscal consequences of sprawl is scarce and remains inconclusive (see Ladd, 1992, 1994; Carruthers and Ulfarsson, 2006). Therefore, the present study seeks to extend the empirical literature that examines the costs of urban development of this nature. Further, this is a relatively new study for the Spanish case, since the literature to date has largely focused on the American case and previous analyses conducted in Spain have not examined the effects of sprawl directly. Existing economic studies investigate the determinants of total and current local public spending in Spain (see Solé-Ollé and Bosch, 2005), and include a measure of sprawl as one of its control variables. Solé-Ollé (2001) uses more highly disaggregated measures of spending, but focuses only on the province of Barcelona. Therefore, the present study seeks to provide a more accurate measure of sprawl, as well as undertaking an analysis not only of total and current spending but also of several disaggregated expenditure functions for all of Spain's municipalities. Should our results suggest that urban sprawl is more expensive to maintain than a more compact development, this would then be a starting point for discussing the role that local and regional governments should play in regulating the outcome of this pattern of growth. In this sense, the increasing provision costs of public goods and services, as well as additional consequences related to urban sprawl, have been used by critics of this phenomenon to justify the use of growth control programs and cooperation policies among jurisdictions that promote more compact urban areas (Katz, 2002; Carruthers, 2002; Carruthers and Ulfarsson, 2003).

The article is organized as follows. In the next section we provide a brief overview of previous theoretical studies that have examined the causes and consequences of urban sprawl as well as the existing empirical studies that have analysed the impact of such sprawl on the costs of providing local public services. In the third section we explain the methodology and the data used in carrying out our empirical analysis, and we discuss the main results. Finally, in the last section, we conclude.

## 1.2. Literature review

### *1.2.1. Defining Urban Sprawl*

Despite urban sprawl has become a matter of great concern, a review of the literature points out the lack of a consensus definition of sprawl (Ewing, 1997; McGuire, 2002; Carruthers and Ulfarsson, 2003; Muñiz et al, 2006). Actually, the term of sprawl has been used to describe many different conditions. On the one hand, in several studies urban sprawl is a cause of an externality, such as income and racial segregation of neighbourhoods, traffic congestion and air pollution (Sierra Club, 1998, 2000; Downs, 1999). For instance, Sierra Club (2000) attaches sprawl to an irresponsible and poorly planned development that destroys green space, increases traffic, crowds schools and drives up taxes. On the other hand, sprawl has been also defined as the consequence of particular practices of land use, such as exclusionary zoning, high political fragmentation or lack of centralized planning or control of land uses widespread strip commercial developments (Downs, 1998, 1999; Burchell et al, 1998; Ewing 1997). Also as a consequence, Glaeser and Khan (2003) define sprawl as the inexorable product of car-based living. Finally, sprawl can be associated to different patterns of development. In this sense, Nelson et al (1995) and Pendall (1999) defined urban sprawl as "an unplanned, uncontrolled, and uncoordinated single use development that does not provide for a functional mix of uses and/or is not functionally related to surrounding land uses which variously appears as low-density, ribbon or strip, scattered, leapfrog or isolated development". Brueckner (2000) just define sprawl as an excessive spatial growth of cities, so the problem arises when the growth of cities is larger than the expanding population.

However, as noted in Galster et al (2001), a clearer conceptual and operational definition could be more useful for research purposes on the causes and consequences of urban sprawl. If sprawl is a concept that describes something that occurs within an urban area, it should consist of objective conditions, based on the morphology of landscape, allowing us to measure it empirically and compare the different degrees of sprawl among localities (Muñiz et al, 2006). In this sense, Galster et al (2001) give a more technical definition, considering that sprawl is a pattern of land use that exhibits low values on some of the following dimensions: density, continuity, concentration, clustering, centrality, nuclearity, mixed land uses and proximity.

For our purposes, we will consider a working definition of urban sprawl according to the available data. Thus, urban sprawl is a low-density, spatially expansive and discontinuous urban development pattern.

### *1.2.2. Causes of Urban Sprawl*

The urban economics literature focuses on the Alonso-Muth-Mills monocentric city model to explain the basic determinants of urban sprawl. Specifically, the model explains urban spatial structure as arising from the *trade-off* between commuting costs and land rents. In equilibrium, this *trade-off* requires lower land rents at the urban edge to offset increased commute costs. Then, city size is positively correlated with population and income, and negatively correlated with commuting costs and the price of land at the urban fringe (agricultural rent)[3].

Mieszkowski and Mills (1993) developed the *natural evolution theory*, which asserts that three fundamental forces are responsible for the increasing demand of land in the suburbs and, therefore, for the spatial growth of cities. These forces are population growth, rising real incomes and falling commuting costs (see also Brueckner, 2000, 2001). Cities must expand to accommodate population growth. Rising incomes allow households to satisfy their preferences for more living space as they become richer. Finally, transportation innovations improve travel time considerations and reduce commuting costs, making suburbs a place more attractive to live in. Glaeser and Khan (2003) note that transportation improvements are the main cause of urban sprawl, since they eliminate old transportation scale economies and allow decentralization.

Brueckner (2000) points out that urban development due to these three fundamental forces cannot be faulted as inefficient, unless certain market failures distort

[3] See Mieszkowski and Mills (1993) and Glaeser and Khan (2003) for a further explanation of the model.
Brueckner and Fansler (1989) carried out a cross-sectional analysis using data of 40 American metropolitan areas, and concluded that these key factors explained about the 80% of variation in the spatial extent of urbanized land areas. Metropolitan areas with larger populations, higher incomes, lower transportation costs and lower values of agricultural land occupy greater amounts of land.

their operation. In that situation, the invisible hand fails to allocate resources in a socially desirable manner, so as to maximize aggregate economic welfare. Specifically, three market failures may lead to excessive spatial growth of cities. The first arises from a failure to take into account the social benefits of open space when land is converted to urban use. The second arises from the failure of individuals to internalize the social costs of congestion caused by their commuting[4]. Finally, the third one arises from the failure of new developers to internalize all the public infrastructure costs they generate. Thus, development appears to be artificially cheap, encouraging an urban growth greater than the socially desired.

Additional factors are cited in the literature as driving forces of urban sprawl. For instance, Mieszkowski and Mills (1993) explain urban sprawl in terms of Tiebout sorting. Residents *vote with their feet* and choose their location within an urban area depending not only on their income and transports costs, but also according to their preferences. In this context, fiscal and social problems of central cities (low quality of several public services, crime, congestion and low environmental quality, among others) lead middle-class residents to move to the suburbs, so that they form separate homogeneous communities of individuals of like income, education or race. This way they gain control over the level of public spending, so as to ensure the high-quality provision of public goods that such consumers demand. At the same time, social segregation allows them to avoid subsidizing public consumption of lower income groups. Another fiscal effect arising from the property tax may also contribute to urban sprawl. Brueckner (1999) argues that property tax reduces the intensity of land development, lowering population density and, in turn, causing cities to excessively spread out (see also Brueckner and Kim, 2000 and Song and Zenou, 2005) [5]. Finally, high political fragmentation (Carruthers, 2002, 2003; Carruthers and Ulfarsson, 2002),

[4] When a resident commutes, he generates private costs in terms of time and vehicle operation, but also social costs derived from the extra congestion he imposes on other commuters (Brueckner, 2000).

[5] Land is developed less intensively under property taxation that under a pure land tax, leading to spatial expansion of cities. The property tax is levied on improvements to land, increasing the perceived cost of buildings, so developers reduce tax burden designing projects that use less housing floor per acre of land (Song and Zenou, 2005).
The property tax is also used to finance new infrastructures in the suburbs, allowing new developers to pay the average cost of the new infrastructure, below the marginal cost. In consequence, urban development appears to be artificially cheap, and therefore excessive development occurs (Brueckner, 1999).

certain subsidizing and investment public policies and land use regulations (Glaeser and Khan, 2003; McGuire, 2002) also lead to an excessive spatial expansion of cities.

### *1.2.3. Consequences of Urban Sprawl*

Several benefits have been attributed to urban sprawl in terms of the fulfilment of residents' preferences for larger, single-family detached housing, greater proximity to open spaces, and segregation from some of the problems suffered by the inner city such as pollution, crime and congestion[6]. Nonetheless, these benefits can be offset by a wide variety of social costs[7]. Urban sprawl reduces social interaction and contributes to socioeconomic segregation between the rich of the suburbs and the poor of the inner cities (Downs, 1999; Brueckner, 2000, 2001; Glaeser and Khan, 2003). Then, several poverty problems arise in low-income neighbourhoods, such us increasing crime rates, poor-quality public services and lack of fiscal resources. Increasing commuting due to the more scattered urban areas also increases traffic congestion and, in turn, air pollution (Sierra Club, 1998; Brueckner 2001; Glaeser and Khan, 2003)[8]. Excessive land conversion to urban use diminishes the extent of farmland and forests, which represents a loss of the amenity benefits from open space (Sierra Club, 1998). Besides, if suburbanization goes along with economic activity decentralization, agglomeration economies fall and, in turn, productivity decreases (Glaeser and Khan, 2003)[9]. In addition to these negative consequences, there is one economic impact which is of particular concern: the impact of urban sprawl on the cost-effective provision of local public services. When a city expands, its infrastructure together with certain public

[6] See Gordon and Richardson (1997), Downs (1998), Burchell et al (2002) and Glaeser and Khan (2003) for a further review of the benefits of urban sprawl.

[7] For a further review of the main consequences of urban sprawl, see Mieszkowski and Mills (1993), Brueckner (2000, 2001 and 2001b), Brueckner and Kim (2003), Song and Zenou (2006), Carruthers (2002), Carruthers and Ulfarsson (2002), Glaeser and Khan (2003), McGuire and Sjoquist (2002). Besides, Gordon and Richardson (1997), Downs (1998, 1999), Burchell et al (2002), Glaeser and Khan (2003), Nechyba and Walsh (2004), Brueckner (2000, 2001), Brueckner and Largey (2006), Sierra Club (1998), Khan (2000) and Henderson and Mitra (1996), among others, also offer an explanation of the many factors that might be considered the driving force behind this phenomenon.

[8] Khan (2000) provides evidence that people drive more in more sprawled cities. Moreover, he asserts that environmental consequences of vehicle dependence could be mitigated by using appropriate technologies.

[9] There is a wide literature documenting the importance of agglomeration effects. For instance, Henderson and Mitra (1996) develop a model which emphasizes the fixed infrastructure costs of building new subcenters, and conclude that productivity declines with distance from the city centre.

goods and services need to be increased to maintain a given level of public services for all its residents. Consequently, suburbanization leads to a marked increase in the provision costs of local public services, such as trash collection, police and fire protection, public transport and road cleaning services. In such cases, the lower density of individual consumers undermines economies of scale in the provision of public services, resulting in inefficient cost increases (Elis-Williams, 1987; McGuire and Sjoquist, 2002; Carruthers and Ulfarsson, 2003). Consider for instance two municipalities with the same characteristics (in terms of both size and population) but different densities. In the less dense of the two, there will be a need for more garbage trucks or, alternatively, the trucks available will have to cover longer routes in order to provide the same quality of trash collection to all its residents. Trash collection costs, as well as road cleaning or police protection costs, vary directly with distance. Therefore, the provision of such services is more expensive in less dense municipalities. Spatially expansive development patterns also lead to greater costs because of the larger investments required in extending basic infrastructure (roadways, sewerage, electricity) over greater distances to reach relatively fewer numbers of residents (Carruthers, 2002).

### *1.2.4. Previous empirical studies*

The empirical literature that examines the impact of urban sprawl on the provision costs of local public services and on local budgets in general is relatively scarce and focuses primarily on U.S. cities. This research, moreover, does not always lead to the same conclusions and so we can make no claims as to the presence of a causal relationship between urban sprawl and the provision costs of certain public goods and services. In fact, this relationship remains ambiguous and controversial[10].

[10] Note that part of this ambiguity is due to a lack of a consensus in the accepted definition of sprawl (Ewing, 1997; McGuire and Sjoquist, 2002; Carruthers and Ulfarsson, 2003; Muñiz et al, 2006). Thus, sometimes it is defined as a cause of an externality (Sierra Club, 1998, 2000; Downs, 1999), as the consequence of particular land use practices (Downs, 1998, 1999; Burchell et al, 1998; Ewing 1997; Glaeser and Khan (2003) or it is associated with different patterns of development (Nelson et al, 1999; Pendall, 1999). However, as noted in Galster et al (2001), a clearer conceptual and operational definition would be useful for research purposes. If sprawl is a concept that describes a process that occurs within an urban area, it should include objective conditions based on the morphology of the landscape, which should enable it to be measured empirically (Muñiz et al, 2006).

Several studies have analysed the effect of different development patterns (urban sprawl versus compact development) on the provision costs of public services using cost simulation models (see Burchell and Mukherji, 2003; Speir and Stephenson, 2002). Other studies have adopted an alternative approach based on econometric techniques in order to analyse the relationship between *per capita* local spending and various density measures, while controlling for other public spending determinants (see Carruthers and Ulfarsson, 2003, 2006). All of these studies provide evidence of the positive impact of urban sprawl on the provision costs of certain local public services. However, we also find contradictory findings regarding the impact of urban sprawl on local public finance (Ladd and Yinger, 1989; Ladd 1992, 1994). These authors find that costs rise with high densities, and they attribute this result to social factors, as poverty or crime. But this means that once the researcher has appropriately controlled for these environmental factors, the results should say that sprawl raises costs. This also suggest therefore that both views might be correct, the relationship between sprawl and costs being possibly non-linear. The approach followed will take this into account. Finally, empirical studies conducted in Spain, in common with the studies cited above, do not analyse urban sprawl directly, but rather their main objective is to analyse the determinants of local public spending. However, they do provide some indirect evidence as their demand functions include explanatory variables that proxy urban sprawl (see Solé-Ollé, 2001 and Solé-Ollé and Bosch, 2005).

Given that the empirical evidence available remains poor and, to some extent, controversial, we believe a study of the Spanish case makes an interesting complement to the existing literature. In the section that follows we outline the methodology used in carrying out our study and describe the variables included in the model and the sources used in constructing them.

## 1.3. Empirical analysis

### *1.3.1 The model*

The analysis proposed here requires the estimation of a very similar demand model to that commonly used in the extensive literature on local public spending. This enables us to separate the effects of urban sprawl on local costs from those of other

factors[11]. In such models, the desired level of *per capita* spending is specified as a function of the demand for public services and their provision costs. Therefore, the estimated expenditure function results from combining a cost and a demand model. Below, and in line with the research developed by Borcheding and Deacon (1972), we specify the empirical model used in analysing the determinants of local public spending.

*The cost model.* The starting point is the cost model, where the outcome of local public services ($q$), understood as a measure of the quantity/quality of services enjoyed by the citizen, depends on the level of output or activity performed by the government ($o$), urban sprawl ($d$) and a group of environmental cost factors ($z$):

$$q = \frac{o}{f(d) \cdot h(z)} \tag{1.1}$$

In the case of the production technology of local public services, we assume that the output ($o$) is produced under constant returns to scale, so that the cost function to produce this output, given an input costs index ($w$), and an indicator that captures the level of responsibilities of each municipality ($s$) (see *Dependent variables* in Section 3.2. for an explanation), can be expressed as:

$$C(o, w, s) = o \cdot w \cdot s \tag{1.2}$$

Obtaining $o$ from equation (1.1) and substituting it in (1.2), the output cost function ($C(o,w,s)$) can be transformed in an outcome cost function, $C(q,d,z,w,s)$:

$$C = q \cdot f(d) \cdot h(z) \cdot w \cdot s \tag{1.3}$$

In order to estimate this cost function we need data on the outcome of local public services ($q$). Given that these data are not generally available, an alternative involves combining this cost model with a demand model. In so doing, we are able to obtain an expression without the outcome variable and, as such, it can be easily estimated.

*The demand model.* We start from an outcome demand function of public services, where the residents' desired level of outcome is negatively correlated with their share of the marginal provision cost, and positively correlated with the given resource level and their preferences.

To combine the cost model with the demand model, we use a theoretical model that describes the decision-making process of local governments. Although there is no agreement as to which model is best, the most commonly used in the literature is the

[11] Ladd (1992, 1994), Solé-Ollé (2001) and Solé-Ollé and Bosch (2005), for example, adopt this methodology.

model based on the median voter theorem (Bergstrom and Goodman, 1973). Unfortunately, we are unable to identify the median voter empirically, so we assume that the aim of the local government is to maximize the utility of a representative voter, given by the following expression:

$$\begin{aligned} &\underset{x_r q}{Max}\ U_r(x_r, q, v_r) \\ &s.t. \\ &x_r + t \cdot b_r = y_r; \\ &C = t \cdot B + G; \\ &C = q \cdot f(d) \cdot h(z) \cdot w \cdot s \end{aligned} \tag{1.4}$$

where $U_r$ is the utility function of the representative voter, which depends on the consumption of the private good ($x_r$), the public good outcome ($q$) and their preferences ($v_r$). Three constraints are imposed on this representative voter: first, a budgetary constraint, where $t$ is the tax rate, $b_r$ the voter's tax base and $y_r$ his level of income; second, a local government budgetary constraint, where $B$ is the total tax base of the jurisdiction and $G$ the total amount of transfers received by the local government; and, finally, an outcome cost function (explained above in equation 1.3). The combination of these three constraints yields the following expression:

$$x_r + q \cdot f(d) \cdot h(z) \cdot w \cdot s \cdot \frac{b_r}{b} = y_r + g \cdot \frac{b_r}{b} \tag{1.5}$$

The mean tax base per head is given by $b = B/N$, and transfers received per head by $g = G/N$. So the right-hand side of expression (1.5) measures the overall income of the representative voter. Besides, $b_r/b$ indicates the influence of the tax system on the representative voter's choice (tax share).

The fist order condition obtained by maximizing the utility function, subject to the constraint given in equation (1.5) is:

$$\frac{\partial U_r / \partial q}{\partial U_r / \partial x_r} = f(d) \cdot h(z) \cdot w \cdot s \cdot \frac{b_r}{b} \equiv p_r \tag{1.6}$$

where $p_r$ denotes the tax price, which is defined as the product of the marginal cost of $q$ ($\partial C/\partial q$) and the tax share ($b_r/b$).

In order to adapt this model to an easily estimable framework, we assume that the demand function is log-linear:

$$q = k \cdot (p_r)^{\alpha} \cdot \left( y_r + g \cdot \frac{b_r}{b} \right)^{\beta} \cdot v_r^{\gamma} \tag{1.7}$$

Equation (1.7) indicates that the level of outcome depends on the tax price, on the level of income of the representative voter and on his preferences. Substituting (1.6) in (1.7) and the result in (1.3), we obtain the *per capita* expenditure function:

$$c = k \cdot \left(f(d) \cdot h(z) \cdot w \cdot s\right)^{(\alpha+1)} \left(\frac{b_r}{b}\right)^{\alpha} \cdot (y_r)^{\beta} \left(1 + \frac{g}{y_r} \cdot \frac{b_r}{b}\right)^{\beta} \cdot v_r^{\gamma} \qquad (1.8)$$

Finally, taking logs we obtain the estimable spending equation:

$$\begin{aligned} \ln c = \ln k + (\alpha+1) \cdot \ln(f(d)) + (\alpha+1) \cdot \ln h(z) + (\alpha+1) \cdot \ln w + (\alpha+1) \cdot \ln s \\ + \alpha \cdot \ln(b_r/b) + \beta \cdot \ln y_r + \beta \cdot (g/y_r)(b_r/b) + \gamma \cdot \ln v_r \end{aligned} \qquad (1.9)$$

Therefore, *per capita* local spending depends, on the one hand, on a group of cost factors: urban development patterns, other environmental cost factors (such as population or potential users, among others), input costs and responsibilities. On the other hand, *per capita* local spending is a function of three demand factors: income, tax share and transfers received and preferences.

Note that estimated parameters cannot be interpreted in terms of their direct effect on the costs of providing public services, since the price elasticity of demand (parameter α) is involved in the specification. Cost variables increase service costs and, as a consequence, this reduces the demand for these services. Despite this, and thanks to the log-linear form assumed, it is possible to obtain the direct effect on costs by simply dividing the coefficients of the cost variables by ($\alpha$+1) (Solé-Ollé and Bosch, 2005).

### *1.3.2. Data*

We estimate equation (1.9) by employing a cross-sectional data set of the Spanish municipalities, the structure of which can be described briefly as follows. First, local governments have similar spending responsibilities to those in other countries (i.e. basic infrastructures, social promotion, public safety, community facilities or housing) with the exception of education, which corresponds to regional governments (see the Section on *Dependent Variables* below for a further explanation of the responsibilities structure). Second, there is a high degree of local fragmentation, since 90% of the approximately 8,100 existing municipalities have fewer than 5,000 inhabitants and represent just 5% of the total population. Finally, the services provided at the local level

are financed mainly out of taxes (including the property tax, the local business tax and the local motor vehicle tax) and unconditional grants (roughly one third of current revenues).

Thus, the model given by equation (1.9) is estimated using a cross-sectional sample of 2,500 Spanish municipalities for the year 2003. Data availability has, however, forced us to reduce the size of our data set. Specifically, data regarding several explanatory variables are not available for municipalities with fewer than 1,000 inhabitants. Hence, our data set includes almost all the municipalities with more than 1,000 inhabitants. This we believe to be sufficiently representative given that they account for about 85% of the total population. Additionally, the year of study was not randomly selected but rather determined by the availability of budgetary data disaggregated by functions and sub-functions. Table 1.1 provides the definition, source and descriptive statistics of all the variables included in the analysis.

*Urban sprawl variables.* First, we shall focus on the main variables included in this study, which are those related to urban development patterns. In line with previous studies, we consider urban sprawl to be a low-density growth pattern characterized by the excessive and discontinuous spatial expansion of urban land. However, measuring this phenomenon remains somewhat elusive, with the vast majority of studies employing variants of population density to proxy urban sprawl. But, there is no agreement regarding the right specification for its measurement or its appropriateness as a sprawl measure. First, there is no consensus as to the most suitable variable for capturing density (density of housing units, population or employment), the extent of space over which density should be characterized (total or urbanized area) and the scale at which density should be measured (metropolitan area, municipality or neighbourhood) (see Gordon and Richardson, 1997 and Torrens and Alberti, 2000 for a fuller explanation). Second, as noted in Carruthers and Ulfarsson (2003), density is only part of the picture and, on occasions, it provides a somewhat ambiguous image of the urban form, telling us little about the distribution of residential uses (Galster et al, 2001). Even so, density is the most widely used indicator of sprawl because of its simplicity (Elis-Williams, 1987) and the difficulty of obtaining data for alternative measures (Carruthers and Ulfarsson, 2003).

[Table 1.1 about here]

One of the most common quantifiers is population density itself (Ladd and Yinger, 1989; Ladd, 1992), and this can be combined with alternative measures of sprawl (see Carruthers and Ulfarsson 2002, 2003, 2006; Glaeser and Khan, 2003), so as to provide a more realistic profile of the nature of the urban development. More recently, a number of researchers, aware that existing databases are not suitable for studying the scattered nature of development, have sought to develop more sophisticated methods (see Burchfield et al, 2006). This latest approach is without doubt of great potential, but unfortunately the data available for the Spanish case prevent us from implementing it. Thus, in the present study we employ a density variable, *urbanized land*, in *per capita* terms and measured at the municipal level.

Given that little is known about the exact nature of the relationship between this variable and the costs of providing public services, we adopt a highly flexible approach that allows the data to determine the functional form. Using a *piecewise linear function* (Ladd 1992), the relationship between *per capita* urbanized land and local costs, while controlling for other variables, is estimated as a series of linear connected segments (see Figure 1.1). The estimated coefficients, labelled $\beta_1$ to $\beta_4$ in the corresponding figure, indicate the slope of each segment. With a sufficiently large sample, this technique leads to a close approximation of the true functional form. In order to determine the length of each segment (labelled $d_1$ to $d_3$), various strategies might be used. In the present study we adopt the method employed by Dahlberg et al. (2006). First, we estimate equation (1.9) when including the urban sprawl variable (*urbanized land*). The relationship between *per capita* urbanized land and *per capita* current spending, both variables expressed in logs, is shown in Graph A of Figure 1.2. From the figure it seems that there is a positive and non-linear relationship between both variables in all segments but the first. Next, we estimate equation (1.9) leaving out the urban sprawl variable. If we have correctly controlled for the other explanatory variables, the remaining residual impact should illustrate the effect of the sprawl variable on the local costs. The relationship between the remaining residuals from equation (1.9) and the *per capita* urbanized land is presented in Graph B of Figure 1.2[12]. In general, the graphical analysis suggests a very similar performance. The vast majority of the observations are concentrated in the middle of the diagram, showing a positive relationship between the two variables, while at the extremes of the diagram there are few observations that

[12] We conducted the same analysis for total spending and the four disaggregated spending functions. The graphs obtained show a very similar functional form. For reasons of space, these graphs are not included here.

present any great variability. Thus, two points of inflection can also be identified where the slope of the adjustment line changes (labelled here with the first and third vertical dotted lines). Given the size of the middle segment (which includes the majority of the observations in the sample), we chose to divide it in two (second dotted line). Thus, the *per capita* urbanized land is divided in four segments: less than 75 $m^2$/pop (*urbanized land*_1), between 75 and 160 (*urbanized land*_2*)*, between 160 and 700 $m^2$/pop (*urbanized land*_3*)* and more than 700 $m^2$/pop (*urbanized land*_4)[13].

[Figure 1.1 about here]

[Figure 1.2 about here]

Although density may help to create scale economies for certain public services, it does not, as mentioned above, unilaterally describe the character of urban areas. For example, the spatial extent of the provision area is determinant for many services, since their cost of delivery varies with distance. So, in order to provide a more accurate measurement of the dimension of sprawl, taking into account its spatial dimension, we included additional sprawl variables in the model. Specifically, we added three variables: *residential houses*, *% of scattered population* and number of *population centres*[14], all measured in *per capita* terms. Their inclusion is justified on the following grounds. Suppose that only *urbanized land* is included in the model as a sprawl variable. Obviously, given two municipalities with the same population (both in terms of size and characteristics), the residents in the one with the most *per capita* urbanized land will live in the larger homes. However, little can be said about their spatial distribution, i.e., about the physical form of development. As is shown in Figure 1.3, a municipality with two apartment buildings (municipality A) and a municipality with six single-family houses (municipality B) will both have the same *per capita* urbanized land.

[Figure 1.3 about here]

[13] The first segment includes 9% of the municipalities in the sample, the second 40%, the third 45% and the last 6%.

[14] The National Statistics Institute defines *population centre* as a group of at least ten buildings which form streets, squares and other urban roads. Hence, *scattered population* refers to those people who live in buildings not included within this concept of a population centre.

So, given that *per capita* urbanized land does not capture the full extent of urban sprawl, we included the additional measures of sprawl described above. In this way, the number of *residential houses* identifies whether houses or apartment blocks are the prevalent buildings in the municipality. A predominance of single-family houses, combined with a greater *per capita* urbanized land will be related to a low-density and spatially expansive urban pattern, associated with a higher level of land consumption. Further, the *% of scattered population* and *population centres* will determine the extent to which urban growth is scattered and discontinuous.

*Dependent variables.* As explained above, the Spanish municipal sector is characterized by a high degree of fragmentation, with an extremely large number of municipalities with very small populations, resources and management capacity. Therefore, the responsibilities assumed by local governments are distributed according to the size of their populations, as is established by basic law. Specifically, public provision is compulsory for all municipalities in services such as trash collection, street cleaning services, water supply, sewer system and street lighting, among others. Municipalities with a population greater than 5,000 inhabitants, additionally, have to provide parks, public libraries, and solid waste treatment. Municipalities with a population greater than 20,000 have to provide local police and social services. Finally, municipalities with a population higher than 50,000 inhabitants also have to provide public transport and environmental protection. Further, the law provides that local governments can offer additional services to those cited above, as well as complementing the services provided by other levels of government, in areas such as education, culture, housing, health and environmental protection, in order to satisfy the demands of their residents.

In the present study we focus on those local competences that we consider to be most directly influenced by a low-density and spatially expansive urban development pattern: infrastructures and other facilities (such as sewerage, water supply or street paving and lighting, cultural and sports facilities, public parks), and certain local services (police protection, street cleaning, trash collection). In so doing, we analyse the six expenditure functions of the municipal budget that include these competences (*Basic infrastructure and transportation, Community facilities, Local police, Housing and community development, Culture and sports,* and *General administration*), which

represent about 70% of total local spending[15], as well as total (*Total*) and current local spending (*Current*). In all cases, spending is measured in *per capita* terms. Unfortunately, the expenditure functions we consider do not correspond exactly with those analysed in previous studies, primarily in the U.S. (see Carruthers and Ulfarsson, 2003, 2006). The reason for this is that the structure of the municipal sector in Spain differs from that in the U.S. The two systems do not share the same municipal competences nor do they have the same expenditure composition in terms of the proportion each function represents in terms of total spending. For instance, U.S. empirical studies analyse education, which is perhaps the most important part of U.S. local spending, while in Spain it is not a sole municipal responsibility. Besides, spending on local police is lower in the Spanish case, unlike spending on housing, which is higher.

*Control variables.* Returning to equation (1.9), local public spending depends on both cost and demand factors. The first group of cost factors is related, as outlined above, to the urban development pattern. Additionally, we can identify cost factors other than urban sprawl, such as population, responsibilities, harshness of the environment, spillovers and input costs. In order to account for the effect of these cost factors, we include three groups of control variables in the model (demographic, social and economic cost variables). Finally, four fiscal capacity indicators account for the effect of resources on the demand for local public services[16].

First, we briefly describe the demographic cost variables. Generally, in previous studies population has been introduced as the only demographic cost factor –it being identified with the potential service users. Here, we consider an alternative approach that places resident population in one of several groups, in which they are considered as potential users presenting special needs (Solé-Ollé, 2001). Thus, we include the following variables: total population (*population*), the share of the population below the

[15] The structure of the Spanish municipal budget in 2003 was as follows (percentage of total spending in parentheses): Public Debt (6.6%), General Services (13.2%), Local Police and Public Safety (7.2%), Social Promotion and Protection (10.35%), Economic Regulation (4.7%), Transfers to Public Administration (0.7%), Basic Infrastructures, Transport and Communication (9%) and Production of Social Public Goods (48.15%). This last function includes Health (1.13%), Educational Services (4.1), Housing (17.33%), Community Facilities (12.2%) and Culture (11.61%).

[16] Given that these control variables are not the main objective of this present study, they are discussed here only in brief. See Ladd and Yinger (1989), Ladd (1992) and Solé-Ollé (2001) for a review of arguments that justify their inclusion in the local spending model.

age of five (*% population*<5), between five and nineteen years old (*% population* 5-19) and older than sixty-five (*% population*>65), as well as the shares of the population without studies (*% without studies*) and those that have graduated (*% graduated*). In principle, we would expect the coefficients of these variables to be positive, so that the greater the number of potential users presenting special needs, the greater the local costs should be. Additionally, as previously mentioned, in Spain the level of responsibilities of each municipality varies with population size[17]. Consequently, the more responsibilities the municipality assumes, the higher the local public spending should be[18]. To account for this effect we add three dummies representing the different levels of responsibility (*responsibility*_1*, responsibility*_2*, responsibility*_3)[19]. These variables equal 1 if a municipality has more than 5,000, 20,000 or 50,000 inhabitants, respectively.

Second, we briefly describe the social cost factors. This group of variables controls for the effect of the harshness of the environment on local costs. Specifically the variables included are the share of residents that are immigrants (*% immigrants*), the share of residents that are unemployed (*% unemployed*) and the share of houses built before 1950 (*% old housing*). On the one hand, the first two variables are a measure of disadvantaged residents (Ladd and Yinger, 1989). Given that some services, such as health or social services, are mainly provided to this group of people, a municipality with more disadvantaged residents will spend more than other municipalities in providing the same level of these services. On the other hand, old housing is a measure of the age and, thus, of the quality of the infrastructure. Besides, this variable can provide information about the percentage of residents that live in deteriorated housing. The coefficients of the variables included are expected to affect local public spending positively, according to the results obtained in previous analyses (Solé-Ollé, 2001, Solé-Ollé and Bosch, 2005).

[17] See the previous section on *Dependent Variables* for a more detailed explanation.

[18] However, many local governments tend to provide services even without any established official responsibility, but rather in response to residents' demands. Thus, the relationship between the level of responsibility and local spending might not be as evident as it might at first seem (Solé-Ollé and Bosch, 2005).

[19] These dummies are included in the *Total* and *Current* spending equations. In the four spending functions considered, dummies are not included with the exception of the *Local Police* equation, since this responsibility is compulsory for municipalities with a population higher than 20,000. The services included in the other five functions are either compulsory for all municipalities or non compulsory for any municipality, so dummies are not needed.

Third, we briefly describe the economic cost factors. To account for input costs, we include a wage variable (*wage*), measured as the ratio between total wages and salaries paid and the number of workers. Given that wage data is not available at the municipal level, we have used provincial information. We expect a positive impact of wages on costs, since the higher the salary in the private sector, the higher the salary should be in the public sector in order to attract workers.

The effect of spillovers on local public spending is measured through two dummies. First, a dummy that is equal to 1 if the municipality is a central city (*central city*), defined as provincial capitals or municipalities with a population higher than 100,000. Second, a dummy that is equal to 1 if the municipality belongs to an urban area (*urban area*), that is, if the municipality is located less than 35 kilometres from a central city. We assume that such municipalities have to bear higher costs derived from the greater mobility generated in these areas. Nevertheless, in these cases spillovers might increase also as the population surrounding these particular municipalities increases (Solé-Ollé and Bosch, 2005; Solé-Ollé, 2006). To account for this effect, these two variables are multiplied by the ratio between the population of the rest of the urban area and the population of the municipality (*central city* × *surrounding population*, and *urban area* × *surrounding population*). Additionally, we include a further two variables that account for those non-residents that can be considered potential users of local public services: the share of second homes in each municipality (*% second homes*) and the number of tourists *per capita* (*tourists*). In line with previous findings, we can expect a positive effect of these variables on *per capita* local spending (Solé-Ollé and Bosch, 2005).

Finally, the last group of control variables includes three variables that account for the effect of resources on the demand for local public services. The first variable is a measure of *per capita* income (*income*), whose coefficient (parameter $\beta$ in equation (1.9)) is the income elasticity of demand. The second variable included is the *tax share*, defined as the tax bill of the representative resident divided by the *per capita* tax revenues of the municipality. Its coefficient refers to the price elasticity (parameter $\alpha$ in equation (1.9))[20]. The tax bill includes two taxes, the property tax and the vehicle tax[21], and is computed as follows. On the one hand, we calculate the sum of the property tax

[20]Both income and tax share refer to the representative resident. Given that we are not able to obtain data regarding the representative voter, we have used the data for the average voter.

[21] Note that the business tax has not been included in the tax bill on the grounds that the average voter is not likely to be a business owner.

per urban unit, which is multiplied by the average number of residential urban units *per capita* of the sample. On the other hand, we obtain the sum of the vehicle tax per vehicle and we multiply it by the average number of vehicles *per capita* in the sample. Then, we add both and divide them by the *per capita* tax revenues of the municipality. A negative coefficient of the income elasticity of demand and a positive coefficient of the price elasticity are expected.

Finally, in order to account for the transfers received by each municipality we include two per capita variables: *Current transfers* and *Capital transfers*. Both variables, according to the specification in equation (1.9), are divided by income and multiplied by the tax share. Transfers received by municipalities from upper tiers of government are expected to influence local spending positively.

### *1.3.3 Results*

The *per capita* local public spending function, specified in equation (1.9), is estimated using the ordinary least squares approach. The results of *per capita* current spending are shown in Table 1.2. We performed four estimations using the same model (equation (1.9)), the only difference being the sprawl variable included each time. Thus, in Column (1) we introduced *urbanized land* per capita. In Column (2) we introduced *urbanized land*, as well as the other three sprawl measures: *residential houses*, *% of scattered population* and the number of *population centres*. In order to disaggregate the total effect of the *per capita* urbanized land in several segments, in Column (3) we included as our sprawl measure the *piecewise linear function* (see section 3.2.a): *urbanized land*_1 (< 75 $m^2$ / pop), *urbanized land*_2 (75 - 160 $m^2$/ pop), u*rbanized land*_3 (160 - 700 $m^2$/ pop), and *urbanized land*_4 (> 700 $m^2$/ pop). Finally, in Column (4), we introduced the variables of Column (3) along with the other three sprawl measures.

[Table 1.2 about here]

The econometric specification implemented enables us to identify the specific impact of sprawl on spending, since we are able to isolate the effects of other municipal characteristics by introducing a set of control variables. In other words, we are now in a position to compare municipalities with the same characteristics in order to see if those

with higher levels of sprawl have to bear higher local service provision costs. Our results indicate that *urbanized land* has a positive and significant impact on local costs - when included in the model by itself (Column 1) and also when interacting with the other three sprawl measures (Column 2) - with a coefficient around 0.06. Given that the variables are expressed in logarithms, the estimated parameters can be interpreted as the price elasticity. Then, a 1% increase in urbanized land increases local public spending by around 0.06%. However, given that the price elasticity is lower than one, the impact of sprawl on costs is greater than the impact on spending. That is, the increase in provision costs is greater than the increase in the level of public services provided. So, once the coefficient has been identified[22], a 1% increase in urbanized land increases local public spending by around 0.11%. From Columns (2) and (4) we can observe that the estimated coefficients of *residential houses* are positive, significant and of a very similar magnitude. So, if we compare two municipalities with the same characteristics and the same *per capita* urbanized land, the one presenting the more scattered distribution of housing will have to bear higher local service provision costs. However, the number of *population centres* has a negative and significant impact on local costs, showing that the higher the number of population centres, the lower public spending will be. The results obtained for this variable can be understood as follows. In a municipality with several population centres (for instance the main population centre and a number of housing developments) the local government will not respond to their demands equally. Quite the opposite, in those population centres mainly comprising second homes, the local authority will provide as few public services as possible, leading to a reduction in public spending. This occurs as second-home owners are usually non residents who are, therefore, unable to use their voting rights to control the mayor's performance in that jurisdiction[23]. Finally, the *% of scattered population* coefficient is positive but not statistically significant.

As can be seen in Column (3), when *urbanized land* is divided in four segments[24] (*piecewise linear function*), all the segments with the exception of the third are statistically significant, albeit that the coefficients present different magnitudes. The

[22] As discussed in section 1.3.1, although the parameters cannot be interpreted as their direct effect on costs, the log-linear specification allows us to identify them simply by dividing by ($\alpha$+1).

[23] Typically politicians seek to maximize the number of votes they obtain by satisfying their residents' preferences. In this context, a politician would have no incentive to respond to the public service demands of non residents.

[24] See Figure 1.4 for a graphical analysis.

coefficients of the first, second and fourth segments are positive and significant, with the slope (and, therefore, the marginal impact on local costs) of the fourth being higher than those of the other two. Thus, we can infer that in a municipality where *urbanized land* ranges between 75 and 160 $m^2$/pop (median urban sprawl), a 1% increase in this variable leads to a 0.17% increase in costs, while this impact increases up to 0.26% when *urbanized land* is higher than 700 $m^2$/pop (high urban sprawl). The estimation results in Column (4) show that when the main urban variable interacts with the other three measures of sprawl, the four coefficients of the piecewise linear function become positive and significant. The greater impact of *per capita* urbanized land on costs occurs in both at the highest and lowest population densities (first and last segment, respectively). That is, this variable has a notable impact on costs in compact municipalities, as well as in those municipalities that have already undergone considerable urban sprawl and which continue to spread out. Finally, the magnitude and sign of the other three sprawl measures are the same as in Column (2).

If we now consider the control variables of the model, we see first of all that the price elasticity, identified as the estimated coefficient of the *tax share*, is around -0.45, and that the income elasticity of demand, identified as the coefficient of per capita *Income*, takes a value of 0.75. The magnitude and sign of both coefficients are in accordance with previously published results in the literature. Second, the estimated coefficient of transfers is positive and significant, and can be interpreted as follows. An additional euro of *current transfers* leads to an increase in spending fifteen times higher than that produced by one euro of income, or twice as much in the case of *capital transfers*, suggesting a strong 'flypaper effect' (se also Solé-Ollé, 2001) Third, as expected, the *responsibilities* coefficients are positive and significant, unlike the *population* coefficient, which is positive but not statistically significant. A higher level of responsibilities associated with a larger population leads to an increase in the provision costs of local public services. The share of population younger than five (*% population < 5*), the share of graduate population (*% graduated*), as well as the share of residents that are immigrants (*% immigrants*) have a positive impact on local spending, as indicated by their positive and significant coefficients. The elderly (*% population >65*) present a negative and significant coefficient in two of the four specifications. Unemployed residents (*% unemployed*) and those without studies (*% without studies*), and the share of old housing (*% old housing*) do not have a statistically significant effect on current spending. The two variables that account for spillover effects, *central city*

and *urban area*, do not have a statistically significant effect, either. According to the coefficients of the *% of* s*econd houses* and the number of *Tourists*, the non-residents considered as potential users have a positive impact on local costs. Finally, *wages*, in line with the theory, lead to greater costs.

Therefore, the sign and the magnitude of estimated coefficients, as well as the explanatory capacity of the model (around 55%), are consistent with the results obtained in previous analyses of the determinants of local public spending in the Spanish case (Solé-Ollé, 2001; Solé-Ollé and Bosch, 2005). These findings allow us to validate the empirical model used here, giving us confidence in the robustness of the results we obtained for the urban sprawl variables.

In Table 1.3 we show the estimation results of the urban sprawl variables for *Total spending* and the six expenditure functions[25]. In general, the results obtained for *Total spending* are analogous to those for *Current spending* (which have been explained above). We should stress, however, that here the *% of scattered population* coefficient is positive and significant. Besides, the estimation results for the control variables are very similar in all cases (that is, for total and current spending, and the five spending functions), with the exception of the *Basic infrastructures and transportation* function.

If we now consider the sprawl variables of the six spending functions, we can see in Columns (1) and (2) that the coefficient of *urbanized land* is positive and significant for all functions apart from *Housing and community development,* where it is not statistically significant. On the basis of these results, we can infer that urban development patterns have a different impact on local costs, depending on the type of public service under consideration. Thus, after identification, a 1% increase in *urbanized land* increases *Basic infrastructure and transportation* costs by 0.28%, *Community facilities* costs by 0.11%, *Local police* costs by 0.10%, *Housing and community development* costs by 0.08%, *Culture and sports* costs by 0.17% and *General administration* costs by 0.12%. This provides evidence of the additional local costs generated by the extension of roads to new housing developments. The same is true of police protection, trash collection and street cleaning services, among others. A greater degree of population dispersion undermines the use of scale economies, leading to increased costs.

[25] Estimation results for the control variables of the model are not included in this paper. However, they can be requested from the authors by email.

Our estimation results for the other three sprawl measures are shown in Columns (2) and (4). The coefficient of *residential housing* is positive and statistically significant only in the case of two expenditure functions: *Housing and community development* and *Local police*. The number of *population centres* has a negative effect in all the expenditure functions apart from *Basic infrastructures and transportation*, where it is positive. This might indicate that the extension of roads and other infrastructure to new housing developments has a positive impact on costs, since they represent a great investment when providing a service to a relatively small number of residents. It is also important to highlight the positive and significant coefficient of the *% of scattered population* in two expenditure functions: *Community facilities* and *Local police*. In other words, municipalities with a more scattered population have to deal with higher costs as regards police protection and local services such as street cleaning, trash collection and water supply.

The piecewise linear coefficients, shown in Columns (2) and (4), are very similar for the various spending functions but differ slightly from those obtained in the total and current spending specifications. Thus, we can infer that the functional form of *urbanized land* has also changed slightly (see Figure 1.4). Specifically, in all the spending functions, apart from *Basic infrastructures and transportation* and *General administration*, the segment that now remains statistically significant is the last one (> 700 $m^2$ / pop). Therefore, the impact of a lower population density on these four spending functions increases in the municipalities presenting the highest levels of urban sprawl in contrast to those with the lowest levels. In such cases, the effect of an additional 1% of *per capita* urbanized land increases costs by between 0.33 and 0.85%. The expenditure function in *Culture and Sports* also presents a positive and significant coefficient in the second segment. The results for *Basic infrastructures and transportation* and *General administration* show that the only segment with a significant coefficient is the third (160 - 700 $m^2$ / pop). Thus, at this level of urban sprawl the increase in costs (0.06%) is mainly due to road construction (0.04%) and administration (0.017%) costs. Besides, these results might indicate that increases in *per capita* current spending in the first segment (per capita urbanized land lower than 75 $m^2$/pop) are due to services other than those included in the functions already analysed.

[Table 1.3 about here]

[Figure 1.4 about here]

Overall we can establish that these six expenditure functions account for about 81% of the total increase in costs due to urban sprawl[26]. In particular, a 1% increase in *urbanized land* raises costs by 0.11%. Twelve per cent of this increase (0.013%) is due to an increase in *Community facilities* costs, 21% to an increase in *Basic infrastructures and transportation* (0.023%), 13% to an increase in *Housing and community development* (0.014%), 6% to an increase in *Local police* (0.007%), 17% to an increase in *Culture and sports* (0.019%) and 12% to an increase in *General administration* (0.014%). In addition, the analysis of the third and last segments of the *piecewise linear function* shows that at this level of urban sprawl approximately all the increase in costs (due to urban sprawl) is attributable to the cost increases in the local services considered in this study.

Finally, we can employ this estimated impact of sprawl on local costs to simulate the situation in Spain over recent years e.g., the period 1995-2005. As shown in section 1.3.1, *per capita* costs depend on the level of outcome, a group of environmental cost factors and urban sprawl (see equation (1.3)). Assuming that both the quality of public services ($q$) and the environmental costs factors ($z$) have remained almost constant over this period, we can compute the increase in local costs that is basically attributable to urban sprawl ($f(d)$) starting from the following expression:

$$\frac{1}{N}\sum_i c_i^t = \bar{q}\cdot\frac{1}{N}\sum_i f(d_i^t)\cdot\bar{z} \tag{1.10}$$

Where $i$ indicates municipality, $t$ year, and $N$ is the number of municipalities. Hence, we can simulate the average increase in costs due to the impact of sprawl between 1995 and 2005 for each spending category ($C_j$) by computing the following ratio:

$$C_j = \frac{\frac{1}{N}\sum_i c_i^{2005}}{\frac{1}{N}\sum_i c_i^{1995}} = \frac{\frac{1}{N}\bar{q}\cdot\sum_i f(d_i^{2005})\cdot\bar{z}}{\frac{1}{N}\bar{q}\cdot\sum_i f(d_i^{1995})\cdot\bar{z}} = \frac{\frac{1}{N}\sum_i urbanized\ land_i^{2005\left(\frac{\hat{\beta}_j}{\hat{\alpha}_j+1}\right)}}{\frac{1}{N}\sum_i urbanized\ land_i^{1995\left(\frac{\hat{\beta}_j}{\hat{\alpha}_j+1}\right)}} \tag{1.11}$$

[26] This percentage has been computed from the coefficients, after identification, in Column (1) of Tables 1.2 and 1.3.

where $\hat{\beta}_j / \hat{\alpha}_j + 1$ is the estimated coefficient of urbanized land once correctly identified (obtained from Tables 1.2 and 1.3), *i* denotes the municipality, *j* denotes the expenditure category and *N* the sample size[27]. Our results indicate that between 1995 and 2005 *per capita* local costs have increased on average by 2.3% due to the impact of urban sprawl. In particular, sprawl has increased community facility costs by 2.3%, infrastructure costs by 7%, housing and local police costs by 2%, administrative costs by 2.7% and culture costs by 3.7%. However, there exists a high degree of dispersion among the sample, given that the increase in costs ranges from 1% up to 80%. More specifically, in 4% of the municipalities analysed the impact on costs is above 10%. The municipalities in which urban sprawl has had the most marked impact on budget levels are mainly those that presented a *per capita* urbanized land below the average level for 1995 and which faced a higher growth rate in terms of the amount of land developed in the period under analysis.

## 1.4.Conclusions

Urban development patterns have undergone notable changes in Spain in recent years with the adoption of the spatially expansive and scattered urban growth model of urban sprawl. One of the main consequences of this phenomenon is widely thought to be the increasing costs of providing local public services.

Given that previous empirical analyses designed to test this hypothesis are scarce –and where they do exist they focus primarily on the U.S. case–, we believe that this study of the situation in Spain can make a significant contribution to the existing literature. Here, we have examined the influence of urban sprawl on total and current spending, as well as on the six measures of spending which we consider likely to be most affected by urban sprawl (*Community facilities, Basic infrastructures and transportation, Housing and community development, Local police, Culture and sports*, and *General administration*). In so doing, we have estimated eight expenditure equations with the data from 2,500 municipalities for the year 2003. Urban development patterns were first measured in terms of *urbanized land*, i.e., a measure of the amount of

[27] Note that for this simulation exercise we have used a much larger sample than before, given that the only variable required, *urbanized land,* is available for 7,300 of the existing 8,100 municipalities.

*per capita* built-up area within each municipality. We should stress that our data were available at the local level, that is at the very level where political decisions concerning the public services analysed here are taken. In order to account for the potentially nonlinear relationship between this variable and local costs, we assumed a *piecewise linear function*. In addition to this measure, three other variables were included in the model in an attempt at providing a more accurate measurement of the scale of urban sprawl: *residential houses*, *% of scattered population, population centres.* Finally, we included a group of control variables so as to distinguish the effects of urban sprawl on local costs from those of other cost and demand factors. In this way, once we had controlled for a set of municipal characteristics, we were then able to determine the specific impact of sprawl on costs. Our estimation results for the control variables proved to be very similar to those obtained in previous analyses, indicating the robustness of our empirical model and, more specifically, of our urban sprawl results.

In general, our estimation results indicate that low-density developments led to greater provision costs in all the spending categories considered, with the exception of *Housing*. By adopting the *piecewise linear function* assumption we were able to disaggregate this total effect, revealing that the impact on total costs accelerated at very low and very high levels of sprawl, i.e., in those locations where *per capita* urbanized land was less than 75 (compact pattern) or greater than 700 $m^2$/pop (urban sprawl pattern). Further, the impact of urban sprawl on the provision costs of the public services considered here was particularly marked at high levels of sprawl (*per capita* urbanized land between 160 and 700, and greater than 700 $m^2$/pop). These results suggest that in municipalities with a spatially expansive urban development pattern, the provision costs of public services increase initially as a result of increasing road construction costs and rising general administration costs, and then, if the urban sprawl advances further, costs continue to rise as a result of higher costs in providing community facilities, housing, local police and culture. In those municipalities with very low levels of urban sprawl (<75 $m^2$ / pop), the increase in local costs was due to public services other than those analysed here. The other three measures of sprawl serve to reinforce our results. The *% of scattered population* coefficient was positive and significant in *Total Spending, Community facilities* and *Local police*, and the *residential houses* coefficient in *Housing and community development* and *Local police*. *Population centres* had a negative impact on costs, except in the case of *Basic infrastructures and transportation*, where it was positive. This negative sign might indicate that local governments tend to pay scant regard to the public service demands

emanating from the housing developments of non residents, given that they are unable to exert any political control over the mayor. Moreover, the simulation carried out for the period 1995-2005 showed the average increase in local costs attributable to urban sprawl to be quite low (around 2.3%) and, therefore, easily met by the local governments. However, in those municipalities where the amount of urbanized land was below the 1995 average but where urban sprawl was considerable during the period, the increase in costs was markedly higher (above 10%).

Thus, in this paper we have provided evidence of the nonlinear impact of urban sprawl on the costs of providing local public services. Further, more spatially expansive urban development patterns undermine the use of scale economies in the provision of certain public services, such as trash collection, street cleaning and public transport. The extension of basic infrastructures over longer distances to reach a relatively small number of residents leads to an inefficient increase in local costs. This increase should not perhaps be seen as a problem since it results from the specific new urban development pattern desired by the residents. In this sense, the fulfilment of their preferences might justify the higher rates of taxation needed to subsidise these increased costs. However, problems arise when new developers fail to internalise the full costs that they generate, leaving the local government to pay for them (i.e., the municipal authorities raise the taxes of all residents in the jurisdiction and ask for higher transfers from the upper tiers of government).

Finally, we should emphasise that this study simply provides evidence of the existence of higher provision costs of several local services due to urban sprawl. Hence, further research into the impact of sprawl on local revenues is needed so as to determine more accurately the net fiscal impact of this phenomenon on municipal budgets.

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## 1.6. Tables and Figures

**Figure 1.1. Piecewise linear function**

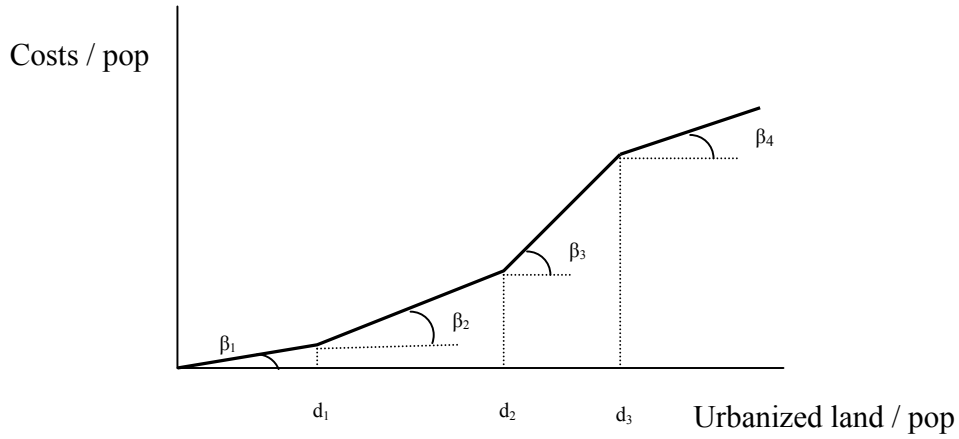



**Figure 1.2. Scatter diagrams**

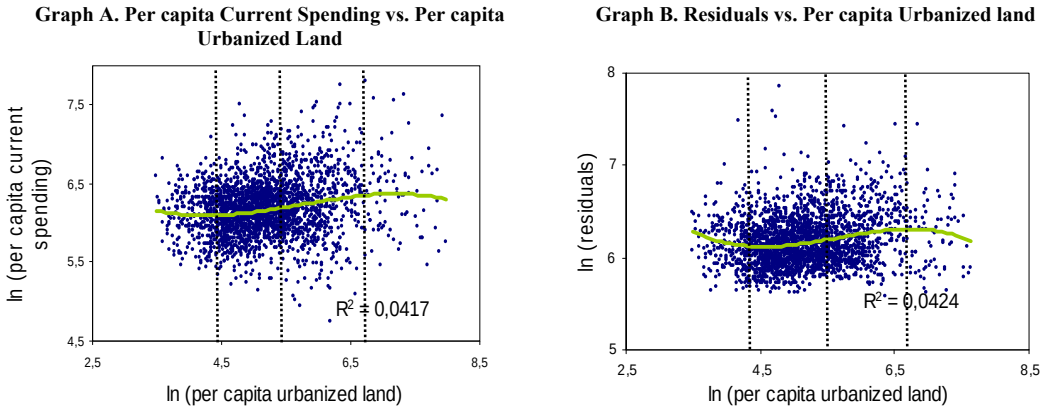
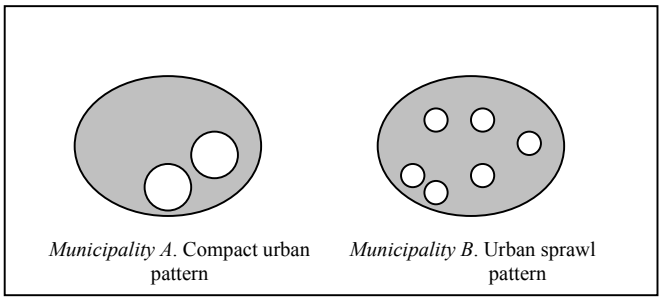


**Figure 1.3. Compact urban pattern vs. Urban sprawl pattern**




Note: the grey area indicates the total land area of the municipality, while the white area denotes urbanized land.

**Figure 1.4. *Piecewise linear function*. Comparison between current spending and six disaggregated measures of public spending**

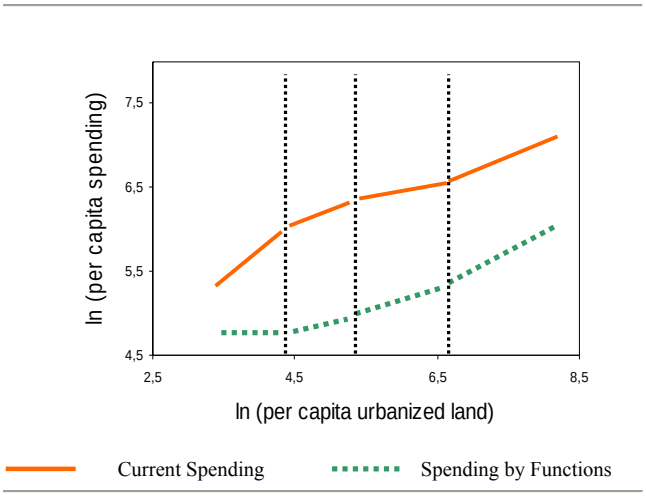


**Table 1.1. Definition of the variables, Descriptive Statistics and Sources**

| *Definition* | *Mean* | *St. Deviation* | *Sources* |
|---|---|---|---|
| *Total spending* | 782.38 | 381.59 | Spanish Ministry of Finance (*Liquidación de Presupuestos de las Entidades Locales*, 2003) |
| *Current spending* | 516.75 | 219.36 | |
| *Local police* | 27.63 | 32.35 | |
| *Basic infrastructures and transportation* | 92.31 | 125.01 | |
| *Community facilities* | 79.97 | 69.16 | |
| *Housing and community development* | 123.6 | 133.76 | |
| *Culture and Sports* | 115.21 | 102.35 | |
| *General administration* | 127.98 | 104.71 | |
| *Current grants* | 223.67 | 99.005 | |
| *Capital grants* | 130.28 | 150.92 | |
| *Urbanized land* | 261.94 | 365.04 | Property Assessment Office (*Catastro Inmobiliario Urbano. Estadísticas básicas por municipios y de parcelas urbanas*, 2003) |
| *Residential houses* | 0.5371 | 0.2417 | |
| *% Scattered population* | 0.0651 | 0.1321 | *Nomenclátor* (National Statistics Institute, 2003) |
| *Population centres* | 0.002 | 0.0037 | |
| *Population* | 14583.3 | 79598.2 | *Census of Population and Housing* (National Statistics Institute, 2001) |
| *% Immigrants* | 0.0592 | 0.0663 | |
| *% Population < 5* | 0.0452 | 0.0138 | |
| *% Population 5-19* | 0.1582 | 0.0311 | |
| *% Population > 65* | 0.2028 | 0.0731 | |
| *% Without studies* | 0.1454 | 0.0929 | |
| *% Graduates* | 0.0694 | 0.0392 | |
| *% Unemployed* | 0.1467 | 0.1016 | |
| *% Old houses* (built before 1950) | 0.2471 | 0.1683 | |
| *% Second houses* | 0.1805 | 0.1549 | |
| *Tourists* (Tourist index / population) | 119.719 | 455.001 | *Anuario Económico "La Caixa"* |
| *Wage* | 25440.18 | 2708.62 | Spanish Regional Accounts and Quarterly Survey of the Labour Market (National Statistics Office, 2003) |
| *Central city* | 0.0231 | 0.2438 | Own elaboration |
| *Urban area* | 101.85 | 289.59 | |
| *Income* | 8887.76 | 1744.43 | |
| *Tax Share* | 0.6666 | 0.2212 | Property Assessment Office, National Statistics Office, Spanish Ministry of Finance, and *Anuario Económico "La Caixa"* |

Notes: Budgetary variables, wages and income measured in euros; urbanized land measured in square metres. Budgetary variables, urbanized land, residential housing, population centres and income in *per capita* terms.

**Table 1.2. Effects of urban sprawl on local current spending in Spain. Cross-section for the year 2003. Sample of 2,500 municipalities (1)**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | (i) *Urban development patterns* | | | |
| *Urbanized land* | 0.0578 (6.12)*** | 0.0625 (6.67)*** | -- | -- |
| *Piecewise linear function:* | | | | |
| *Urbanized land_1* (< 75) | -- | -- | 0.0896 (2.45) ** | 0.1456 (4.00) *** |
| *Urbanized land_2* (75 - 160) | -- | -- | 0.0904 (3.42) *** | 0.0738 (2.85) *** |
| *Urbanized land_3* (160 - 700) | -- | -- | 0.0182 (0.99) | 0.0311 (1.71) * |
| *Urbanized land_4* (>7 00) | -- | -- | 0.1402 (3.37) *** | 0.1281 (3.15) *** |
| *Residential houses* | -- | 0.0878 (3.52)*** | -- | 0.0879 (3.46) *** |
| *% Scattered population* | -- | 0.0032 (1.34) | -- | 0.0027 (1.12) |
| *Population centres* | -- | -0.0554 (-10.62)*** | -- | -0.0551 (-10.51) *** |
| | (ii) *Demographic, social and economic cost factors* | | | |
| *Population* | 0.0187 (1.57) | 0.0014 (0.12) | 0.0186 (1.54) | -0.0002 (-0.02) |
| *Responsibilities_1* (5,000 - 20,000) | 0.0716 (3.78) *** | 0.0685 (3.66) *** | 0.0721 (3.79) *** | 0.0672 (3.59) *** |
| *Responsibilities _2* (20,000 - 50,000) | 0.0829 (2.60) *** | 0.0603 (1.93) ** | 0.0831 (2.61) *** | 0.0583 (1.88) * |
| *Responsibilities _3* (> 50,000) | 0.1071 (2.28) ** | 0.0491 (1.06) | 01112 (2.38) ** | 0.0514 (1.12) |
| *% Population* (< 5) | 0.2125 (6.80) *** | 0.1251 (3.91) *** | 0.2049 (6.55) *** | 0.1187 (3.70) *** |
| *% Population* (5-19) | 0.0900 (1.64) | -0.0035 (-0.06) | 0.0882 (1.58) | -0.0084 (-0.15) |
| *% Population* (> 65) | 0.0158 (0.45) | -0.0686 (-1.90) * | 0.0081 (0.23) | -0.0774 (-2.12) ** |
| *% Without studies* | 0.0062 (0.58) | 0.0036 (0.35) | 0.0034 (0.32) | 0.0015 (0.14) |
| *% Graduates* | 0.0421 (2.62) *** | 0.0308 (2.00) ** | 0.0405 (2.51) ** | 0.0282 (1.82) * |
| *% Unemployed* | 0.0003 (0.02) | -0.0096 (-0.73) | 0.0001 (0.01) | -0.0090 (-0.69) |
| *% Immigrants* | 0.0253 (3.73) *** | 0.0239 (3.69) *** | 0.0242 (3.60) *** | 0.0231 (3.59) *** |
| *% Old houses* | -0.0041 (-0.50) | 0.0077 (0.94) | -0.0040 (-0.48) | 0.0081 (0.97) |
| *% Second houses* | 0.0135 (2.72) *** | 0.012 3 (2.44) ** | 0.0138 (2.75) *** | 0.0125 (2.45) ** |
| *Tourists* | 0.0037 (3.07) *** | 0.0048 (4.02 ) *** | 0.0036 (3.00) *** | 0.0047 (3.92) *** |
| *Wage* | 0.1498 (2.33) ** | 0.1242 (1.93) * | 0.1598 (2.45) ** | 0.1395 (2.16) ** |
| *Central city* | -0.0057 (-0.43) | 0.0020 (0.18) | -0.0041 (-0.29) | 0.0036 (0.29) |
| *Urban area* | 0.00001 (0.48) | 0.00003 (1.26) | 0.00001 (0.64) | 0.00004 (1.37) |
| | (iii) *Fiscal capacity indicators* | | | |
| *Income* | 0.7455 (14.18) *** | 0.6833 (13.34) *** | 0.7516 (14.37) *** | 0.6907 (13.53) *** |
| *Tax share* | -0.4581 (-18.49) *** | -0.4486 (-16.80) *** | -0.4650 (-18.39) *** | -0.4545 (-16.71) *** |
| *Current transfers* | 0.1570 (18.27) *** | 0.1588 (18.31) *** | 0.1578 (18.23) *** | 0.1600 (18.27) *** |
| *Capital transfers* | 0.0238 (4.60) *** | 0.0225 (4.44) *** | 0.0237 (4.60) *** | 0.0224 (4.42) *** |
| $R^2$ | 0.5351 | 0.5616 | 0.5370 | 0.5633 |
| F statistic (zero slopes) | 114.63 *** | 111.17 *** | 101.90 *** | 100.06 *** |

Notes: Ordinary least squares results. t statistics are shown in brackets. * Significantly different from zero at the 90 percent level; ** Significantly different from zero at the 95 percent level; *** Significantly different from zero at the 99 percent level.

**Table 1.3. Effects of urban sprawl on total spending and six expenditure functions in Spain. Cross-section for the year 2003. Sample of 2,500 municipalities. (1)**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | (i) *Total spending* | | | |
| *Urbanized land* | 0.0564 (5.49) *** | 0.0617 (6.00) *** | -- | -- |
| *Piecewise linear function:* | | | | |
| *Urbanized land_1* (< 75) | -- | -- | 0.0815 (1.86) * | 0.1207 (2.66) *** |
| *Urbanized land_2* (75 - 160) | -- | -- | 0.0875 (3.04) *** | 0.0788 (2.76)*** |
| *Urbanized land_3* (160 - 700) | -- | -- | 0.0150 (0.76) | 0.0268 (1.35) |
| *Urbanized land_4* (>7 00) | -- | -- | 0.1495 (3.02) *** | 0.1393 (2.91) *** |
| *Residential houses* | -- | 0.0457 (1.56) | -- | 0.0459 (1.53) |
| *% Scattered population* | -- | 0.0058 (2.19) ** | -- | 0.0054 (2.02) ** |
| *Population centres* | -- | -0.0485 (-8.73) *** | -- | -0.0480 (-8.62) *** |
| | (ii ) *Community facilities* | | | |
| *Urbanized land* | 0.0643 (2.59) *** | 0.0669 (2.67) *** | -- | -- |
| *Piecewise linear function:* | | | | |
| *Urbanized land_1* (< 75) | -- | -- | 0.1182 (1.28) | 0.1030 (0.69) |
| *Urbanized land_2* (75 - 160) | -- | -- | -0.0742 (-0.91) | -0.0597 (-0.73) |
| *Urbanized land_3* (160 - 700) | -- | -- | 0.0537 (1.06) | 0.0581 (1.14) |
| *Urbanized land_4* (>7 00) | -- | -- | 0.2866 (3.17) *** | 0.2696 (3.02) *** |
| *Residential houses* | -- | 0.0533 (0.97) | -- | 0.0531 (0.96) |
| *% Scattered population* | -- | 0.0209 (2.75) *** | -- | 0.0193 (2.52) ** |
| *Population centres* | -- | -0.0372 (-2.23) ** | -- | -0.0353 (-2.11) ** |
| | (iii) *Basic infrastructures and transport* | | | |
| *Urbanized land* | 0.1234 (2.73) *** | 0.1228 (2.67) *** | -- | -- |
| *Piecewise linear function:* | | | | |
| *Urbanized land_1* (< 75) | -- | -- | 0.3472 (1.50) | 0.2549 (1.08) |
| *Urbanized land_2* (75 - 160) | -- | -- | -0.2503 (-1.60) | -0.2187 (-1.40) |
| *Urbanized land_3* (160 - 700) | -- | -- | 0.2337 (2.64) *** | 0.2223 (2.51) ** |
| *Urbanized land_4* (>7 00) | -- | -- | 0.1888 (0.94) | 0.2154 (1.05) |
| *Residential houses* | -- | -0.2094 (-2.73) ** | -- | -0.2118 (-2.75) *** |
| *% Scattered population* | -- | 0.0115 (0.89) | -- | 0.0094 (0.94) |
| *Population centres* | -- | 0.0542 (1.95) ** | -- | 0.0532 (1.92) * |
| | (iv) *Housing and community development* | | | |
| *Urbanized land* | 0.0339 (1.24) | 0.0388 (1.41) | -- | -- |
| *Piecewise linear function:* | | | | |
| *Urbanized land_1* (< 75) | -- | -- | -0.1201 (-0.76) | -0.0562 (-0.35) |
| *Urbanized land_2* (75 - 160) | -- | -- | 0.1058 (1.11) | 0.0925 (0.97) |
| *Urbanized land_3* (160 - 700) | -- | -- | -0.0816 (-1.45) | -0.0690 (-1.22) |
| *Urbanized land_4* (>7 00) | -- | -- | 0.4103 (4.61) *** | 0.3880 (4.36) *** |
| *Residential houses* | -- | 0.1618 (2.44) ** | -- | 0.1616 (2.40) ** |
| *% Scattered population* | -- | 0.0053 (0.63) | -- | 0.0053 (0.62) |
| *Population centres* | -- | -0.0694 (-3.99) *** | -- | -0.0651 (-3.73) *** |

**Table 1.3. (continued)**

| Variables | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | | (v) *Local police* | | |
| *Urbanized land* | 0 .0841 (2.28) ** | 0.0913 (2.47) ** | -- | -- |
| *Piecewise linear function:* | | | | |
| *Urbanized land*_1 (< 75) | -- | -- | 0.0548 (0.36) | 0.1367 (0.83) |
| *Urbanized land*_2 (75 - 160) | -- | -- | 0.0317 (0.27) | 0.0483 (0.42) |
| *Urbanized land*_3 (160 - 700) | -- | -- | 0.0432 (0.53) | 0.0512 (0.64) |
| *Urbanized land*_4 (>7 00) | -- | -- | 0.3591 (2.21) ** | 0.3079 (1.93) * |
| *Residential houses* | -- | 0.3582 (3.10) *** | -- | 0.3568 (3.07) *** |
| *% Scattered population* | -- | 0.0291 (2.66) *** | -- | 0.0282 (2.55) ** |
| *Population centres* | -- | -0.1428 (-6.06) *** | -- | -0.1414 (-5.95) *** |
| | | (vi) *General administration* | | |
| *Urbanized land* | 0.0629 (3.43) *** | 0.0724 (3.92) *** | -- | -- |
| *Piecewise linear function:* | | | | |
| *Urbanized land*_1 (< 75) | -- | -- | 0.0392 (0.35) | 0.1149 (1.02) |
| *Urbanized land*_2 (75 - 160) | -- | -- | 0.0537 (0.82) | 0.0390 (0.60) |
| *Urbanized land*_3 (160 - 700) | -- | -- | 0.0725 (2.09) ** | 0.0912 (2.61) *** |
| *Urbanized land*_4 (>7 00) | -- | -- | 0.0501 (0.70) | 0.0395 (0.55) |
| *Residential houses* | -- | 0.0012 (0.03) | -- | -0.0015 (-0.04) |
| *% Scattered population* | -- | 0.0001 (0.02) | -- | 0.0016 (0.03) |
| *Population centres* | -- | -0.0596 (-5.02) *** | -- | -0.0603 (-5.02) *** |
| | | (vii) *Culture and sports* | | |
| *Urbanized land* | 0 .0671 (3.18) *** | 0.0793 (3.72) *** | -- | -- |
| *Piecewise linear function:* | | | | |
| *Urbanized land*_1 (< 75) | -- | -- | -0.0142 (-0.14) | 0.0932 (0.84) |
| *Urbanized land*_2 (75 - 160) | -- | -- | 0.2991 (4.32) *** | 0.2798 (4.03) *** |
| *Urbanized land*_3 (160 - 700) | -- | -- | -0.0496 (-1.19) | -0.0264 (-0.62) |
| *Urbanized land*_4 (>7 00) | -- | -- | 0.1879 (2.28) ** | 0.1712 (2.11) ** |
| *Residential houses* | -- | 0.0499 (0.73) | -- | 0.0521 (0.75) |
| *% Scattered population* | -- | -0.0015 (-0.23) | -- | -0.0007 (-0.12) |
| *Population centres* | -- | -0.0807 (-6.04) *** | -- | -0.0794 (-5.93) *** |

Notes: Ordinary least squares results. t statistics are shown in brackets. * Significantly different from zero at the 90 percent level; ** Significantly different from zero at the 95 percent level; *** Significantly different from zero at the 99 percent level.

# CHAPTER II.

# URBAN SPRAWL AND LOCAL PUBLIC FINANCE: A DYNAMIC PANEL DATA ANALYSIS

## 2.1. Introduction

Since the mid-90s Europe has undergone intense urbanization. Its cities have sprawled, resulting in a pattern of discontinuous, low-density outward expansion, known as urban sprawl. This new urban development model, exclusive to U.S. cities since the beginning of the 20th century, has now become part of the European landscape. Besides, as available data show, the situation acquires particular importance in the southern regions of the continent, with Spain being no exception.

According to data from the Spanish Ministry of Housing, some 600,000 dwellings per year were initiated between 1996 and 2005, a figure that almost doubled annual domestic demand for new homes[1]. Moreover, most of this building activity took the form of scattered, spatially-expansive urban growth. Consequently, between 1987 and 2005 the proportion of artificial land rose by 54.86%, reflecting primarily the expansion in land for new infrastructure and developments located at the urban fringe[2]. Yet, marked differences are evident in the spatial distribution of this growth across the country, with it being particularly intense in Mediterranean coastal areas (i.e., in the tourist zones of Catalonia, Valencia, Murcia, Andalusia and the Balearic Islands that had not been developed in the 80s, which grew, on average, by 50% during this period) and within the urban area of Madrid, where dispersed residential land grew, on average, by 25%[3]. Figure 2.1 illustrates Spanish major urban and tourist areas while Figure 2.2 show scattered urban growth experienced in those areas over the period 1994-2006.

[Figure 2.1 about here]

[ Figure 2.2 about here]

[1]Between 1996 and 2006 dwellings for about 16 million people were initiated in Spain (considering 2.84 residents per household), while the population grew by only 5.5 million people (Spanish Ministry of Housing and National Statistics Institute).

[2]Data provided by the *Corine Land Cover Project* (1990, 2000 and 2006), Spanish Ministry of Public Works.

[3] The increase in the proportion of developed land along the Mediterranean coast is basically the result of an increase in demand for second homes, while within the urban area of Madrid it reflects an increase in the mobility of the city's residents, attracted by lower housing prices, and with a preference for single detached homes and for the higher environmental quality of life available in areas surrounding the main city.

Several benefits have been attributed to urban sprawl in terms of the fulfilment of residents' preferences for larger, single-family detached housing, greater proximity to open spaces, and segregation from some of the problems suffered by the inner city such as pollution, crime and congestion. Nonetheless, these benefits can be offset by a wide variety of social costs, including traffic congestion, air pollution and social segregation.

Consequently, the intensity and the impact of recent, rapid land-use change mean urban sprawl has become a contentious and widely-debated topic among academics, urban planners and the general public[4]. Specifically, one of the main costs of this phenomenon has been identified as the impact of sprawl on local public finance. This spatially expansive and low-density growth increases the provision costs of local public services, given that sprawl tends to undermine scale economies and increase costs inefficiently (Carruthers, 2002; Carruthers and Ulfarsson, 2003, 2008). Spatially expansive development patterns are also associated with higher costs because of the considerable levels of investment required to extend basic infrastructure over greater distances so as to reach relatively smaller numbers of residents (Carruthers, 2002). Yet, this new urban development pattern also seems to be a source of potential funds for local governments, in terms of increased grants from upper tiers of governments and revenues associated with building activity (*development revenues* hereinafter), including planning permissions, construction taxes, taxes on land value improvements, revenues from the sales of public land and asset revenues.

In the light of the above, it might be concluded that as land-use changes occur, the balance of municipal revenues and expenditures changes as well. Given this relationship, local authorities need to be aware of the long-term financial implications of their land-use decisions and the need to re-examine the role played by state and regional governments in regulating the outcome of this growth pattern. However, the empirical treatment of this relationship has typically focused on purely cross-sectional or static panel data analysis. The dynamic links between local budgets and urban sprawl have not been previously addressed in the literature. Yet, it is by explicitly analisyng the time dimension that could allow for a direct statement on what may happen over time if cities

[4] See, for instance, EEA (2006), European Parliament (2009), Greenpeace España (2009). This relevance has also been recognized in press, i.e. the articles "La costa es ya un cementerio de hormigón" (El País 27/07/2009) and "El satélite que divisó el ladrillo" (El País 13/04/05).

continue to spread out. Thus, the purpose of this study is to shift the focus more explicitely to the time-series dimension of the panel data. We seek to provide evidence regarding the time profile of the fiscal adjustment to a sprawl shock and, therefore, to determine the net fiscal impact of this growth pattern on local public finance. The availability of disaggregated budget data at the local level for 4,000 Spanish municipalities for the period 1994-2005 allows a dynamic analysis to be undertaken, based on the estimation of a panel vector autoregressive model (PVAR). Note that the model specification chosen is suited to the purpose of this paper for several reasons. First, it does not require a priori theory regarding the relationship between the variables in the model. Second, it allows all variables to be endogenous whitin a system of equations, in which the short-run dynamic relationships can subsequently be identified. Therefore, the model enables us to determine the impact of sprawl on the different budget components simultaneously. Third, as opposed to the unique and stable long run equilibrium assumed by a static analyis, the use of PVAR envolves a dynamic analysis that takes into account possible changing equilibria as cities growth.

Thus, we first explore how sprawl interacts with local budgets by breaking the non-financial deficit down into several components: current spending, tax revenues, current transfers, capital spending, capital transfers and development revenues. Unobserved individual effects and a set of time dummies are included in all the regressions. The estimation procedure relies on the application of Generalised Method of Moments (GMM) techniques in order to ensure consistent and efficient estimates. Having been correctly specified, the model allows the Generalised Impulse Response Functions (GIRFs) to be computed, so as to determine the way in which municipal budgets adjust to an urban sprawl shock and the role that is played by upper tiers of government in this process. Overall, with these findings we seek to contribute to the existing empirical literature on the consequences of sprawl, as well as orienting public policy in terms of its local land-use decision-making.

The rest of this article is organized as follows. In the next section we provide a brief overview of the definition, causes and consequences of sprawl as well as the empirical literature analysing the fiscal impact and the dynamics of municipal finances. In the third section we briefly describe the Spanish municipal sector. The fourth section describes the data used in carrying out the empirical analysis. The fifth section outlines

the analytical framework while the main results are discussed in the sixth section. Finally, the last section concludes.

## 2.2. Literature review

### *2.2.1. What is sprawl?*

A review of the literature points out the lack of a consensus definition of sprawl (Ewing, 1997; McGuire and Sjoquist, 2002; Carruthers and Ulfarsson, 2003; Muñiz et al, 2006). Sometimes it is defined as a cause of an externality (Sierra Club, 1998, 2000; Downs, 1999), the consequence of particular practices of land use (Downs, 1998, 1999; Burchell et al, 1998; Ewing 1997; Glaeser and Khan (2003) or it can be associated to different patterns of development (Nelson et al, 1999; Pendall, 1999). However, as noted in Galster et al (2001), a clearer conceptual and operational definition could be more useful for research purposes. If sprawl is a concept that describes something that occurs within an urban area, it should consist of objective conditions, based on the morphology of landscape, allowing us to measure it empirically (Muñiz et al, 2006). Therefore, here we consider that urban sprawl is a low-density growth pattern characterized by excessive and discontinuous spatial expansion of urban land[5].

### *2.2.2. Causes and consequences of sprawl*

Initially population growth was considered the main cause of this spatially expansive and low density growth, as cities needed to expand to accommodate new residents. However, over the last 20 years only moderate increases in population have been accompanied by a sizeable expansion of urban areas[6], suggesting that factors other than population growth are more likely to be driving the process today. Individual housing preferences combined with higher income levels, the reduction in transport costs and the improvement in road networks ensure that the demand for land at the urban fringe is in a constant state of growth (Mieskowski and Mills, 1993; Brueckner and Fansler, 1983; McGrath, 2005). Moreover, high levels of political fragmentation

[5] The measurement of this concept will be discussed later on, in the *Data Section*.
[6] As data from the European Environmental Agency (EEA, 2006) show, during this period population has grown by only 6 percent while built-up areas increased by 20 percent.

(Carruthers, 2002; Carruthers and Ulfarsson, 2002) and competition between municipalities have also been instrumental (EEA, 2006)[7].

In Spain, however, various additional factors may be considered determinants of this change in land use: first, an economic growth model based on sectors with intense land-consumption demands, including construction, transport and tourism; second, the increasing foreign and domestic demand for second homes, motivated by rising income levels together with favourable mortgages and low interest rates[8], and encouraged by increasing speculation in the housing market (representing nearly one third of total housing demand); third, the considerable investment in public transport and infrastructure undertaken by public authorities over the last two decades; and, fourth, poorly defined land-use regulations together with the absence of control and intergovernmental coordination on matters relating to urban planning, which has given local authorities plenty of room to manoeuvre in their urban growth decision-making. Indeed, a number of studies recognise that the absence of region-wide cooperation and weak centralised urban planning policies result in excessive city growth (see, e.g., Carruthers and Ulfarsson, 2002). Finally, certain public subsidy and investment policies, in particular those whose design implies the allocation of resources according to the infrastructure deficit generated by population growth, seem to have fostered sprawl[9].

Urban sprawl can have several desirable outcomes ranging from the fulfilment of residents' preferences for larger, single-family detached housing and greater proximity to open spaces, to segregation from some of the problems that blight the inner city, such as pollution, crime and congestion. Despite its attractions, sprawl has been blamed for the social costs it incurs for an urban area, including traffic congestion, air pollution, social segregation, loss of farmland and a reduction in open-space amenities, among

[7] Brueckner (2000, 2001), Brueckner and Kim (2003), Burchfield et al (2006), Burchell et al (1998, 2002), Glaeser and Khan (2004), Nechyba and Walsh (2004) and Wassmer (2008), among others, also offer an explanation of the many factors that might be considered the driving force behind this phenomenon.

[8] Between 1990 and 2000 the number of second homes increased by 40%, as a percentage of total homes (Housing and Population Census, National Institute of Statistics).

[9] In Spain, land-use regulatory responsibilities are shared by different levels of government. The central government establishes the land-use regulation benchmark (as regards the protection of areas designated "non-developable"), while local governments are responsible for passing municipal land-use plans. In practice, local authorities enjoy considerable freedom in determining a municipality's urban planning. During the 90s, increasing the land supply was deemed to be the remedy for excessively high housing prices, and so successive land-use reforms focused on facilitating the conversion of land from rural to urban uses (Fernández, 2008; Bilbao *et al.*, 2006).

others[10]. Specifically, one of the main costs of this phenomenon has been identified as the impact of sprawl on local public finance. This spatially expansive and low-density growth increases the provision costs of local public services, including refuse collection, police and fire protection, public transport and road cleaning services, given that sprawl tends to undermine scale economies and increase costs inefficiently (Carruthers, 2002; Carruthers and Ulfarsson, 2003, 2008). Spatially expansive development patterns are also associated with higher costs because of the considerable levels of investment required to extend basic infrastructure (roads, sewerage, electricity) over greater distances so as to reach relatively smaller numbers of residents (Carruthers, 2002). Yet, this new urban development pattern also seems to be a source of potential funds for Spain's local governments, in terms of revenues associated with building activity and increased grants from upper tiers of governments. Moreover, in the case of Spain, urban developers are under the obligation to hand over a portion of newly developed land to the municipality (Aguinaga, 2002; Fernández, 2008, Maldonado and Suárez-Pandiello, 2008). According to the data available, *development revenues* (i.e., planning permits, construction taxes, taxes on land value improvements, public land sales and asset revenues) grew considerably over the period 1994-2005, increasing their weight within total non-financial revenues by 10%[11]. As a result, these revenues have displaced the property tax and become the main and most attractive source of finance for local governments[12]. Additionally, the limited capacity of local management to obtain and handle resources means many municipalities face financial difficulties as they strive to satisfy their residents' demands. This being the case, sprawl can be a good funding instrument for municipal authorities[13].

[10] See Brueckner (2000, 2001), Downs (1999), Ewing (1997) Glaeser and Khan (2004) and Sierra Club (1998) for a review of the consequences of sprawl.

[11] Note that neither the tax on land value improvements nor the construction tax is likely to be justified from an economic point of view. However, as explained in Slack (2006) and Bird and Slack (1991), local governments levy development charges to cover the growth-related costs associated with new development. These charges provide the municipality with revenues to finance the infrastructure needs arising from this growth. Therefore, the existence of such charges is justified on the ground that growth should pay for itself rather than being a burden for existing taxpayers. See also Brueckner (2001) for further details on the internalisation of the full costs generated by new developers.

[12] See Pou (2007) and the article "Las grandes ciudades españolas apoyan sus ingresos en el negocio urbanístico" (Expansión 22/05/2007).

[13] In fact, a preliminary analysis of the data showed that localities facing higher financial burden and lower net savings in the early 90s fuelled urban expansion more intensely than did those without such financial problems.

*2.2.3. Fiscal impacts of sprawl: the static approach*

A review of the literature indicates that the research question raised here has not been previously addressed. The most similar studies are perhaps those that undertake fiscal impact analyses - a method that estimates the likely cost-revenue impact of a particular land-use development pattern based upon recent experiences in a given location. This tool was standardized by Burchell and Listokin (1978) and has subsequently been widely adopted by local policy-makers in making their land-use decisions[14]. Drawing on these methods, analysts determine the net difference between the public expenditures that is likely to be incurred when providing roads and other services to a new urban development and the corresponding revenues. They also examine the fiscal impact of alternative development scenarios (e.g., testing different densities or spatial patterns).

However, only a handful of studies have used cost functions derived from cross-section regression analyses to determine the impact of either population growth (Ladd, 1992, 1994) or alternative residential developments (Carruthers, 2002; Carruthers and Ulfarsson, 2003, 2008; Heikkila and Craig, 1991; Kelsey, 1996; Bunnell, 1998;) on the fiscal position of local governments. For the Spanish case, only Hortas-Rico and Solé-Ollé (2010) have analyzed the impact of this urban development pattern on the provision costs of certain local public services. They provide evidence of the positive and non-linear impact of low-density development patterns on the provision costs of various local public services. In particular, their results suggest that in municipalities with a spatially expansive urban development pattern, the provision costs of public services increase initially as a result of rising road construction costs and general administration costs, and then, as the urban sprawl advances, costs continue to rise as a result of increasing expenditure in the provision of community facilities, housing, local police and culture.

*2.2.4. Fiscal impacts of sprawl: the dynamic approach*

As noted above, however, an impact on local revenues can also be expected, and as such the net fiscal impact on local budgets remains undetermined. The analysis of the

[14] See Kotchen and Schulte (2009) for further details.

impact of sprawl on local budgets could be undertaken using a dynamic panel data approach, since the effect on expenditures and revenues might present a different time profile. The typical way to proceed involves examining the intertemporal linkages between the variables of interest. This implies analysing vector autoregressive models in a panel data framework, combining the tools that are typically adopted in a time series context with the techniques applied to panel data models. Note that the model specification chosen is suited to the purpose of this paper for several reasons. First, it does not require a priori theory regarding the relationship between the variables in the model. Second, it allows all variables to be endogenous whitin a system of equations, in which the short-run dynamic relationships can subsequently be identified. Therefore, the model enables us to determine the impact of sprawl on the different budget components simultaneously. Third, as opposed to the unique and stable long run equilibrium assumed by a static analyis, the use of PVAR envolves a dynamic analysis that enables us to disentangle the short and the long run effect on municipal budgets as cities growth.

This model specification has, however, several limitations. On the one hand, the model identifies the impact of sprawl on public spending and revenues rather than the direct effect on costs and tax bases. On the other hand, data requirements for such long time periods considerably reduces the availability of control variables that, once included in the model, could account of other determinants of the local policy decision-making.

Awared of the trade-off between the static and the dynamic approach, the present study seeks to complement the empirical evidence previously found in static analysis.

A few empirical studies have been undertaken with a sole focus on the intertemporal linkages of a local budget. The first to address this issue was Holtz-Eakin *et al.* (1988), in which the authors described an instrumental variables technique to estimate and test panel vector autoregression models with unobserved heterogeneity. Subsequently, several authors have implemented this technique in analysing local government behaviour. Holtz-Eakin *et al.* (1989), Dahlberg and Johansson (1998, 2000), Moisio and Kangasharju (1997) and Moisio (2000), using US, Swedish and Finnish municipal data, respectively, provide evidence of significant intertemporal linkages over a short-time period between budget variables. In the case of Spain, Solé-Ollé and Sorribas (2009), in line with a few other papers (Buettner and Wildasin, 2006; Buettner, 2007), examine whether local government budgets undergo any adjustments following a

budget shock, focusing on the role played by intergovernmental grants in this process. The paper, therefore, adopts the same theoretical framework, but addresses a quite distinct question regarding the dynamic relationship between local budgets and urban sprawl. Moreover, here we work with richer data, in terms of both the number of locations included in the sample and the level of disaggregation of the budget data.

### 2.3. The Spanish Municipal Sector: an overview.

Spain is a decentralized country composed of three different levels of government: the central government, 17 regional governments named Autonomous Communities and about 8,000 local governments. The latter are characterized by their high degree of fragmentation (about 60% of existing municipalities have fewer than 1,000 inhabitants and represent just 5% of the total population), which implies a structure of many independent units of government with very small populations, and limited public resources and management capacity. Table 2.1 summarizes the composition and evolution of local budgets in Spain during the period considered in the present study.

*The expenditure side***.** In Spain, as in the U.S. and many other countries, municipalities are responsible for delivering a huge range of public services traditionally assigned to local governments. Thses services include refuse collection, street cleaning, water supply, sewer system and street lighting, local police and public transport, among others. Note, however, that their list of responsibilities does not extend to include services that consume large amounts of resources, such as education, health or social services.

*The revenue side.* Similarly to the U.S., the local provision of these public services is financed primarily from local taxes (which include the property tax, local business tax and local motor vehicle tax) and the non ear-marked grants that local governments receive from upper levels of government. In fact, direct taxes, user charges and current transfers account for more than 60 percent of total municipal revenues (see Table 2.1).
Yet, the limited management capacity of local government to obtain and handle resources means that many municipalities face financial difficulties when trying to meet their expenditure needs. On the one hand, Spanish local governments are able to modify the tax rates of all the taxes assigned to them, albeit subject to compulsory minimum tax

rates and ceilings set by the central authority. However, the main local taxes (property tax, business tax and motor vehicle tax) have fairly inelastic tax bases and are considered inequitable and, as such, are somewhat unpopular, impeding municipalities from making any short-term adjustments. On the other hand, local debt is limited since 2001 by compliance to the Budget Stability Law. Thus, a number of local governments maintain the investment levels required.

[Table 2.1 about here]

to satisfy their residents' demands by relying either on immediate financing derived from urban expansion or on transfers from upper tiers of government[15]. However, it would appear that the decision to depend on building activity as a source of finance is not a consequence of the failure of other fiscal sources to generate revenues but a local political option. In other words, municipal authorities have not reached their tax autonomy ceiling as determined by other taxes but rather they have opted to increase their dependence on immediately significant and less unpopular revenues linked to the real estate cycle.

As can also be seen in Table 2.1, a great proportion of Spain's local taxes and user charges are related to the building activity (e.g. taxes on land value improvements, construction taxes, and planning permits). In fact, these local taxes along with asset revenues and public land sales might be considered as being the most closely linked to the real estate cycle (and as such they are highly volatile), regardless of the current revenues status of most of them. Note that all these *development renevues* have increased considerably over the past fifteen years, almost doubling their share within local non-financial revenues (from a 14% in 1994 to a 24% in 2006). The same can be said of intergovernmental capital grants, the role of which has also been enhanced as a source of municipal revenues over the period considered[16].

[15] Note that grant financing has several associated perils, in terms of moral hazard problems (so that local governments, aware that intergovernmental grants insure against budget shocks, tend to implement overly risky policies), incentives to soften budget constraints (providing in their turn incentives to run up excessive local deficits which authorities assume will be covered by future grants), the diffusion of accountability or the stimulation of rent-seeking and clientelism (see Devarajan *et al*., 2009, and Persson and Tabellini, 1997, for more comprehensive explanations).

[16] In Spain, nearly all current transfers originating from central government are non-earmarked (primarily the Revenues Sharing Grant), while most current transfers from the ACs are ear-marked (transfers for which each municipality must apply in order to access funding). Besides,

So, in short, Spain has a similar structure of federalism to the one existing in the U.S. that has derived in a system of numerous, diverse and economically important local governments that enjoy a relatively high degree of local fiscal autonomy[17]. Both countries have similar responsibilities and tax possibilities although Spain's local governments can rely to a great extent on transfers to fund investment.

## 2.4. Data

### *2.4.1. The sample*

The empirical application of this study relies on a wide dataset of Spanish municipalities covering the period 1994-2006[18]. The first year (1994) was not selected randomly, but rather determined by data constraints, given that the data required to construct the urban sprawl variable was not available prior to this year. Nonetheless, the period of study is particularly relevant to the aim of this paper, since in the mid-90s the Spanish housing market started to recover, leading to a period of urban expansion -particularly intense between 2002 and 2006- that has driven the Spanish economy until recent years. Considering a period of growth is particularly relevant for the present study as differences in urban expansion both across locations and over time are needed to identify its impact on local budgets. Years included in the sample consider both moderate (1994-2001) and intense (2002-2006) growth with intensity varying considerably across locations, so that different the impact on budgets of municipalities with very different degrees of sprawl can be analysed. Note that the period 2007-2009 was excluded from the sample since the economic crises completely stopped the building activity and, therefore, no impact of urban expansion could be identified in those years.

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capital transfers are ear-marked grants that mainly finance capital expenditure projects proposed by local governments. Since no general funds are provided in Spain to pay for facilities and infrastructures, the ACs have set up Local Works Programs. Their goal is to co-operate in the provision of facilities and services that are of municipal competence. The municipality needs to present a project in response to a regular invitation and, if accepted, the grantor covers a proportion of the project's costs. The allocation of these funds is highly discretional on the part of the grantor, and they usually serve to compensate communities in financial trouble, especially the small ones, whose expertise and technical capability is sometimes limited.

[17] See, for instance Buettner and Wildasin (2006).

[18] Note that, since the panel has only 12 years of data, conclusions cannot be drawn regarding long-run budget dynamics but it is possible to analyse the short-term effects of sprawl shocks.

Finally, note that the analysis of the relationship between urban sprawl and budget variables must be conducted at the local level. This is because policy decisions concerning urban planning are taken principally by municipal governments, while sprawl affects the revenues and expenditures that fall primarily under the control of local authorities. Moreover, as Holtz-Eakin *et al.* (1989) and Dahlberg and Johansson (1998) point out, the availability of budget data at the local level represents an improvement with respect to earlier studies where national data had to be used and avoids our having to deal with stabilisation and aggregation problems. In the first instance, cyclical adjustments had to be made to take into account the stabilization activity in which the central government was involved, while in the second, the analysis of local government behaviour via national data obviously added an aggregation problem to the estimation.

Next we briefly describe the variables included in the model. Note that the model specification implemented here requires data to be available for a considerably long time period. This being the case, data on public budgets and the sprawl measure turn out to be the only data sources available for the period considered. It compromises both the definition of sprawl (as it is explained later on) and the inclusion of additional control variables, such as resident income, that take account of other determinants of the local policy decision-making[19]. Even so, we seek to provide evidence on the adjustment process of local budgets to a sprawl shock and, therefore, the current specification is still suited for the purpose of the paper. Descriptive statistics and definitions are provided in Table 2.2.

[Table 2.2 about here]

### *2.4.2. Urban Sprawl variable*

Urban sprawl can be defined as a low-density growth pattern characterized by the excessive and discontinuous spatial expansion of urban land. However, obtaining a reliable measure of urban sprawl is complicated by both the lack of consensus as to its definition and obvious data constraints.

[19] Nonetheless, additional results for a subsample of municipalities (determined by data constraints) considering political variables and income are presented in the *Robustness Check* section.

On the one hand, there is no agreement regarding the right specification for its measurement or its appropriateness as a sprawl measure. First, there is no consensus as to the most suitable variable for capturing density (density of housing units, population or employment), the extent of space over which density should be characterized (total or urbanized area) and the scale at which density should be measured (metropolitan area, municipality or neighbourhood) (see Gordon and Richardson, 1997 and Torrens and Alberti, 2000 for a fuller explanation). Second, as noted in Carruthers and Ulfarsson (2003), density is only part of the picture and, on occasions, it provides a somewhat ambiguous image of the urban form, telling us little about the distribution of residential uses (Galster et al, 2001). Even so, population density is the most common quantifier of sprawl (Ladd and Yinger, 1989; Ladd, 1992), because of its simplicity (Elis-Williams, 1987) and the difficulty of obtaining data for alternative measures (Carruthers and Ulfarsson, 2003). Yet, this single measure, while easy to compute, might not be sufficiently informative to describe the full spatial dimension of urban sprawl. For this reason, some researchers have sought to introduce additional measures so as to characterize more fully this particular pattern of urban development (see, for instance, Carruthers and Ulfarsson, 2003, 2008; Burchfield et al, 2006).

On the other hand, availability of data is a key constraint when estimating PVAR models. In fact, per capita built-up area remains the only data source currently available for comparing land use patterns across the country as a whole. Unfortunately, alternative data sources are neither available for the whole period considered (percentage of scattered population) nor exhibiting enough temporal variation required in a dynamic panel data framework (e.g. number of population centres per municipality).

Nonetheless, as available data shows, most of the urban development experienced in Spain during the period considered took the form of scattered growth while the area undergoing compact development scarcely increased[20]. This being the case, the sprawl measure used in the present study becomes an appropriate proxy of urban sprawl.

Thus, as noted above, urban sprawl is considered here as a growth pattern that is characterized by the excessive spatial expansion of urban land. Indeed, sprawl reflects the over-consumption of land per person rather than simple urban expansion or population growth and, hence, it is proxied here using a density variable (defined as

[20] As noted in the introduction, data provided by the aerial photographs of the *Corine Land Cover* project (new dwellings constructed at the urban fringe or, in other words, low density residential land) reflects the same growth pattern of Spanish cities as the administrative data used in the present study (built-up area).

*sprawl*$_{it}$) that represents per capita built-up area. This variable is measured at the municipal level, i.e. where the policy decisions concerning the above spending functions are taken, and it represents an improvement on that adopted in previous empirical analyses. First, the data available for Spain allow us to use the urbanized or developed area instead of the developable land area or even the total land area of the municipality[21] and, second, we are able to employ a more highly disaggregated spatial unit of analysis than that used in previous studies, which had to work with data at the county level (see Ladd 1992, 1994; Carruthers and Ulfarsson, 2002, 2003)[22]. Note that a consideration of administrative boundaries as the definition of consumed land area is not particularly useful as the municipal limits may include a large amount of vacant land or even non-developable land. The only way to obtain a meaningful measure of density requires using the built-up area devoted to urban activities. Note also that, as explained in Carruthers and Ulfarsson (2008), total municipal land area is held constant, so the percentage of local land area that is developed measures the spatial extent of development or, in other words, the horizontal dimension of sprawl.

### *2.4.3. Budget variables*

Spanish local budgets are classified in terms of revenues and expenditures sections (see Table 2.1). In line with previous studies, the budget variables used here have been constructed similarly in accordance with the nature of revenues and expenditures, using the data provided by the Spanish Ministry of Economy and Finance. Hence, *Current Expenditures (CE*$_{it}$*)* are defined as the sum of expenditures on public wages, the purchase of goods and services, debt service and current transfers, and *Capital Expenditures (KE*$_{it}$*)* as the sum of real investments and capital transfers. On the revenues side, we first consider *Current Transfers (CT*$_{it}$*)* and *Capital Transfers (KT*$_{it}$*)*. As to revenues coming from taxes, recent availability of more disaggregated data enables us to identify and separate those revenues linked to the real estate market to those revenues coming from taxes levied on other items. Then, we define *Development Revenues (DR*$_{it}$*)* as the sum of revenues from the sales of public land, asset revenues and all taxes

[21] According to the Spanish Property Assessment Office developable land is defined as the total amount of land that is legally recognized as having been developed or which is available for development in each municipality. As such it includes both the built-up and the non built-up areas that are nevertheless available for construction purposes.

[22] As it is shown in *Section 2.6.3*, alternative measures of sprawl are robust to the main results obtained using an inverse of population density.

associated with building (planning permissions, construction taxes and taxes on land value improvements)[23] and *Tax Revenues ($TR_{it}$)* which include all other direct and indirect taxes as well as user charges. All budget variables have been deflated using the regional Consumer Price Index and are expressed in per capita terms[24].

The use of more accurately defined budget variables is essential here, since the standard aggregation of budget data implemented in studies elsewhere might well result in misleading interpretations of our results, especially on the revenues side. To date, current and capital revenues, which respectively include own revenues and current transfers, and public land sales and capital transfers, have been considered. Thus, a positive impact of urban sprawl on current revenues can be interpreted as follows: this spatially expansive urban development pattern increases the ability of municipal authorities to generate revenues, but at the same time it requires higher levels of government to cover their additional costs by increasing transfers to municipalities. Similarly, higher levels of capital revenues in cities with greater urban sprawl can be explained as the additional revenues generated by urban expansion, as well as being the result of higher capital transfers from upper tiers of government to growing municipalities. Therefore, these definitions needed be modified to enhance their precision.

## 2.5. Analytical Framework

### *2.5.1. A panel Vector Autoregressive Model*

As stated above, the aim of this paper is to investigate the dynamic effect on local public finance following a change in urban growth patterns. A vector autoregressive methodology is suited to this purpose given the absence of an a priori theory regarding the relationship between the variables in the model[25]. The methodology is based on a framework that allows all variables to be considered as endogenous within a system of

[23] Note that this variable includes revenues that might be considered as being more closely linked to the real estate cycle (and as such they are highly volatile), regardless of the current revenues status of some of them.

[24] Both the Consumer Price Index and population data have been obtained from the Spanish National Statistics Institute. The latter corresponds to the Population Census undertaken at the beginning of each year.

[25] As noted in Greene (2006), VARs are not just the reduced form of a structural model, since researchers report that simple, small-scale VARs without a possibly flawed theoretical foundation have proved as good as, or better than, large-scale structural equation systems.

equations, in which the short-run dynamic relationships can subsequently be identified (Lutkephol, 2005)[26].

Thus, the model for testing this hypothesis is very similar to that adopted in Holtz-Eakin *et al*. (1989) and in Dahlberg and Johansson (1998, 2000) for analyzing the intertemporal linkages between local budget variables. According to these papers and assuming endogenous urban sprawl, the reduced form of a panel vector autoregressive model can be expressed, using matrix notation, as follows:

$$X_{it} = \alpha_{0t}^{X} + \sum_{j=1}^{p} \phi_j^{X} X_{i,t-j} + f_i^{X} + u_{it}^{X} \tag{2.1}$$

where $X_{it}$ = ($CD_{it}$, $KD_{it}$, $sprawl_{it}$)' is the vector of jointly determined dependent variables, in which $sprawl_{it}$ denotes the urban sprawl measure and $CD_{it}$ and $KD_{it}$ are current and capital non-financial deficit respectively. The subscripts $i$ denote cross-sectional units (municipalities), $i$ = 1, …,N, subscripts $t$ time periods, $t$ = (p+1), …,T, and $p$ the lag length. $\alpha_{0t}$ is the time dummy, included in the model to account for common shocks that affect all municipalities in the same way[27], $\phi_j$ is the $m$ x $m$ coefficient matrix, where $m$ is the number of endogenous variables, $f_i$ is the unobserved heterogeneity or individual effect that controls for municipal specific characteristics and $u_{it}$ is the idiosyncratic error, assumed to be white noise and independent across individuals[28].

[26] Note that a cross-sectional analysis only captures the contemporaneous impact of the variables, while working with panel data allows the researcher to investigate the dynamics of the process, as it considers both inter-individual differences and intra-individual dynamics. Moreover, dynamic panel data models, in which lagged values of the dependent variables are included as regressors, also take into account the short-run reactions of the variables included in the model.

[27] The inclusion of year-fixed effects in the specification should control for all common innovations in municipalities and, hence, estimation results should only capture how idiosyncratic shocks on sprawl affect the budget variables of the system. This could be a problem if the sprawl shocks were common to all municipalities. However, we do believe this is not the case, since a preliminary analysis of the data shows that the sprawl impact differs according to localities.

[28] In the reduced form all right-hand side variables are predetermined at time $t$. As there are no time $t$ endogenous variables included as regressors, any variable has a direct contemporaneous effect on the other variables of the system. However, since the vector of innovations may be contemporaneously correlated, a shock to an equation affects all other endogenous variables in time t, as is shown when computing the Generalised Impulse Response Functions.

In order to disentangle the adjustments made by the various budget components to an urban sprawl shock, we present an extended specification of the model given by expression (1), by disaggregating each component of the non-financial deficit.
Let the non-financial deficit ($NFD_{it}$) be defined by the following expression:

$$NFD_{it} = CD_{it} - KD_{it} = (CE_{it} - TX_{it} - CT_{it}) - (KE_{it} - KT_{it} - DR_{it}) \quad (2.2)$$

where $CE_{it}$ denotes current expenditures, $TX_{it}$ tax revenues, $CT_{it}$ current transfers, $KE_{it}$ capital expenditures, $KT_{it}$ capital transfers and $DR_{it}$ development revenues[29].
According to (2.2), the model given by (2.1) can be reconsidered so that the vector of jointly determined dependent variables can be specified as $X_{it}$=($CE_{it}$, $TX_{it}$, $CT_{it}$, $KE_{it}$, $KT_{it}$, $DR_{it}$, $sprawl_{it}$)'.

Therefore, the model disaggregates the non-financial deficit into six different components ($CE_{it}$, $TX_{it}$ , $CT_{it}$, $KE_{it}$, $KT_{it}$ and $DR_{it}$). The breaking down of the two non-financial deficit components allows us to investigate in detail how both the current and capital deficits adjust to an urban sprawl shock. In other words, we are able to see whether an increase (decrease) in the current deficit resulting from a sprawl shock is attributable to an increase (decrease) in current spending or a decrease (increase) in tax revenues or current transfers. Likewise, an increase (decrease) in the capital deficit might respond to an increase (decrease) in capital spending or alternatively to a decrease (increase) in capital transfers or the revenues associated with building. Besides, this breaking down of local budgets allows us to clearly identify the costs and benefits of urban sprawl (in terms of the impact on expenditures and revenues, respectively).

### *2.5.2. Generalized Impulse Response Functions*

Estimated coefficients from the reduced form of the model above can be used to implement dynamic simulations by means of the generalised impulse response functions (GIRFs hereinafter), as described in Pesaran and Shin (1997). GIRFs measure the adjustment pattern of each endogenous variable in a dynamic system in reaction to a shock, which is either to itself or to any other endogenous variable. An initial advantage

[29] The composition of each of these variables is explained in the *Data Section*. See the previous section for further details on the *Development Revenues* variable. Also note that all variables are expressed in per capita terms.

of these impulse response functions is that they take into account the historical observed distribution of the residuals, i.e. they do not analyse the effect of a shock on a variable assuming that the other variables remain constant, but rather consider the correlation between the endogenous variables of the system. Moreover, they overcome the main shortcoming of traditional 'orthogonalized' impulse response functions (Hamilton, 1994), as they are invariant to the ordering of the endogenous variables in the vector autoregressive model[30].

## 2.6. Estimation results

In this section we present the estimation results for the specification given by expression (2.1), based on system-GMM techniques (Arellano and Bover, 1995; Blundell and Bond, 1998)[31]. Also note that the model is estimated equation by equation. As Baltagi (1995) stated, even though the innovations may be contemporaneously correlated, this procedure is asymptotically efficient and joint estimation does not improve efficiency since the set of regressors is the same in each equation.

### *2.6.1. Model specification*

Before estimating the model, it is important to verify its proper specification in terms of optimal lag length. To do so, and adopting a general-to-specific approach, we selected a sufficient lag length to ensure there was no serial correlation in the error terms of the first-differenced equations[32]. In line with previous studies (see Holtz-Eakin *et al*., 1989, Dahlberg and Johansson, 1998, 2000) we initiated the analysis with a three-year dynamic process and then tested for a possible reduction in the number of lags in all the equations simultaneously.

[30] The derivation of the GIRFs is presented in the Appendix 2.1.
[31] See Appendix 2.2 for further details.
[32] The tests for serial correlation are provided by the m1 and m2 statistics developed by Arellano and Bond (1991), which are asymptotically distributed as N(0,1). The residuals in levels must be uncorrelated, which implies that those in the first-differenced equation can exhibit serial correlation of order one but not of order two. In other words, an AR(1) process is expected in the first-differenced residuals since $\Delta u_{it}=u_{it}-u_{i,t-1}$ and $\Delta u_{i,t-1}=u_{i,t-1}-u_{i,t-2}$ share a common term, $u_{i,t-1}$. By contrast, an AR(2) process indicates autocorrelation in the first-differenced residuals, since $u_{i,t-1}$ from $\Delta u_{it}=u_{it}-u_{i,t-1}$ and $u_{i,t-2}$ from $\Delta u_{i,t-2}=u_{i,t-2}-u_{i,t-3}$ are related. In practice, m1 is expected to be significant but not m2.

As the results in Table 2.3 show, we found first-, though not second-, order correlation in the residuals from the first-differenced equations, indicating that there is no serial correlation in the residuals in levels[33].

[Table 2.3 about here]

Once the model has been correctly specified, the next step involves testing the possibility of shortening the lag length, by excluding one lag at a time from all regressors. As noted in Dahlberg and Johansson (2000), this can be achieved by initiating a sequential procedure by means of the difference-Hansen statistic (see also Arellano and Bond, 1991). This statistic is computed as the difference between the values of the Hansen test in both the restricted and the unrestricted models[34]. Results are presented in Table 2.4. The p-value of the difference-Hansen statistic indicates that the model can be shortened to two lags but not any further[35]. Hence, the equations for the model considered here require a specification with only two lags in order to capture the whole dynamics of the process.

[Table 2.4 about here]

*2.6.2. Response of budget variables to a sprawl shock*

Note that the reduced form depicted in equation (1.1) is a pure forecast model, as it is a reflection of the true but unknown structural model. This implies refraining from the analysis of individual coefficients after system-GMM estimation since neither their sign nor their magnitude has any causal interpretation in a vector autoregressive context

[33] We expect an AR(1) process in the first-differenced residuals since $\Delta u_{it}=u_{it}-u_{i,t-1}$ and $\Delta u_{i,t-1}=u_{i,t-1}-u_{i,t-2}$ share a common term, $u_{i,t-1}$.

[34] The Hansen test is an overidentifying restrictions test provided after system-GMM estimation. Under the null of valid instruments, the test is asymptotically $\chi^2$-distributed with k-n degrees of freedom, where k is the number of instruments and n is the number of estimated parameters (see Arellano and Bond, 1991; Arellano, 2003). Thus, the difference-Hansen statistic is asymptotically $\chi^2$-distributed with $m_R$-$m_U$ degrees of freedom, where $m_R$ and $m_U$ are the degrees of freedom of the restricted and the unrestricted model, respectively. Note that the restricted model is the one with the longer lag length, since using more instruments is equivalent to imposing more assumptions (in terms of moment conditions) while in the unrestricted model only a subset of instruments is used.

[35] The Sprawl equation could be reduced to one lag, but this would imply serial correlation. For this reason we do not reduce the model specification to one lag.

(i.e. the lagged effects of a particular variable tell us nothing about their contemporaneous correlation)[36].

However, the estimation of a vector autoregressive model does provide us with certain insights into local government behaviour and the dynamic adjustment pattern of all municipal budget components to a shock in the sprawl equation by means of the computed GIRFs[37]. These are summarized in terms of the average effect as well as the adjustment one, four and six years after the sprawl shock. All the responses are at present values[38] as shown in Table 2.5. Note that each row describes the impact of one standard error shock on the sprawl equation for each local budget component (in 2005 € per capita). Several interesting findings emerge from the analysis of these results.

If we first consider the average effects presented in the first column, we can see that urban sprawl generates both a current and a capital surplus. More specifically, one standard deviation of sprawl (which represents 141 per capita square metres and about a 60% increase in Spanish average sprawl levels[39]) generates a current surplus and a capital surplus of 5.26 and 8.02 € per capita, respectively. Second, sprawl leads to a considerable increase in current expenditures. In fact, when a municipality undergoes urban sprawl, local politicians extend public goods and services to the new developments located at the urban fringe, leading to an increase in local current expenditure. However, this increase in current expenditures is offset to a slightly greater extent by increases in current revenues (other than those associated with building), which in this instance are mainly operating transfers. Specifically, one standard deviation shock to sprawl leads to an increase in current expenditures of 5.89 €, an increase in tax revenues of 5.22 € and an increase in current transfers of 5.25 €, all in per

[36] The estimation was performed using one step system-GMM estimation, given that the two-step estimated standard error tends to be downward biased and, hence, unreliable (see Arellano and Bond, 1991; Bond, 2002; Roodman, 2008). Note also that a correction to the standard errors was applied. The set of equations included in the model passed both the autocorrelation tests and the test for the validity of instruments. Estimation results are shown in the Appendix 2.3.

[37] According to the empirical literature, the estimation of a micro panel vector autoregressive model of this type requires computing the GIRFs for a short reaction period (7 years in our case). For a robustness check, longer time horizons were applied yielding similar results. Nonetheless, any coefficient was significant after the 7th year. The bootstrapped standard errors of the GIRFs were computed by conducting 500 replications with replacement. Then, the 5th and 95th percentiles of this distribution were used as confidence intervals for the impulse responses.

[38] The discount tax rate was fixed at 3%.

[39] The mean and standard deviation of all variables are shown in Table 2.2.

capita terms. In other words, a 60% increase in sprawl increases current expenditures, tax revenues and current grants, on average, by 1.32%, 2.15% and 2.94%, respectively.

[Table 2.5 about here]

Third, the impact of sprawl on capital spending was particularly high, with a 60% increase in sprawl resulting in a 6.7% increase in capital expenditures. This result suggests that the sprawled growth of cities requires heavy investment in infrastructure to maintain a given level of provision of public goods and services for all residents in a jurisdiction. Note that these findings are in line with those obtained in Hortas-Rico and Solé-Ollé (2010) who provide evidence of the additional costs generated by the spatially expansive growth of Spanish municipalities. More specifically, their findings suggest that, among all the public services analysed, the greatest costs are those incurred from extending roads and basic infrastructure to new housing developments[40].

Yet, capital grants from upper tiers of government and development revenues increase in order to meet the new demands for infrastructure (by 15.68 and 10.44 € per capita, respectively, which represent about a 10% increase in average values for both budget components) resulting in a capital surplus of 8.02 € per capita. Thus, these results show that development revenues play an important role in covering the extra capital expenditures generated by new infrastructure needs. In other words, this urban development pattern increases the ability of municipal authorities to generate revenues (through construction taxes, planning permits and taxes on land value improvements, among others). However, these revenues, which can be immediately generated, do not cover all additional facilities and infrastructure needs so that eventually grant financing is also required for the adjustment.

Overall, it can be concluded that benefits appear to exceed costs, encouraging municipalities to plan and zone for low density without necessarily considering the full fiscal, social and environmental consequences of such policies. The development

[40] A 1% increase in sprawl raises *Basic Infrastructures and Transportation* costs by 0.28%, *Community facilities* costs by 0.11%, *Local police* costs by 0.10%, *Housing and community development* costs by 0.08%, *Culture and sports* costs by 0.17% and *General administration* costs by 0.12%. A simulation exercise conducted by the authors showed that the average increase in sprawl during the period analyzed was about 40%, which resulted in a 2% increase approximately in Spain's local current costs and a 7% increase in the country's infrastructure costs. When considering the smaller sample of 1,033 municipalities used in the present paper, rather than the complete set of 7,300 local governments, this impact stood at 1.6% and 4.7%, respectively.

revenues, in addition to both current and capital grants from upper tiers of government, play an important role in the adjustment process initiated by municipalities to urban sprawl shocks. Thus, local governments undergoing urban expansion rely heavily on grant financing and immediately relevant revenues from building activity to cover the sizeable investments required by new housing developments located at the urban fringe.

As previously noted, the dynamic approach adopted in the present paper allows us to provide evidence not only regarding the aforementioned net fiscal impact of this growth pattern on local public finance but also the time profile of this fiscal adjustment. In particular, the model specification chosen enables us to disentangle the short and the long run effect of sprawl on municipal budgets. Then, our second set of results -Columns (2) to (4)- show the response of the budgets components one, four and six years after the sprawl shock. The main finding that arises from these results is the temporary impact of sprawl on the capital component of the budgets (since GIRF coefficients are not statistically significant after the $4^{th}$ year). Quite the opposite, a sprawl shock exhibits a more permanent impact on the current component of the budgets.

### 2.7. Robustness Checks

In this section we present two sets of additional estimations. The first one examines alternative measures of urban sprawl while the second one accounts for other municipal determinants of the local policy decision-making.

In the present paper sprawl has been proxied by an inverse of population density, i.e. per capita built-up area. As explained in Section 2.4.3., in our view, this measure is the most appropriate. However, one could argue that it does not capture the full dimension of sprawl and, therefore, alternative ways to quantify this urban growth should be considered. Accordingly, our first robustness check uses an alternative measure of sprawl. In particular, we look at the per capita number of residential housing units provided by the Spanish Property Assessment Office. The fiscal adjustment pattern experienced by local governments is very similar to the one obtained when sprawl is defined as per capita built-up area.

The analysis up to this point has assumed that all Spanish municipalities follow a common fiscal adjustment process in response to an urban sprawl shock. However, cities will behave differently in line with specific municipal characteristics, including population size, the initial level of sprawl, income levels or political factors[41]. Thus, the typically weaker financial situation described for smaller municipalities might encourage them to rely more heavily on sprawl as a funding tool, while it is probable that municipalities which experienced major land-use changes at the beginning of the 90s will continue to sprawl more readily than their more compact counterparts. Similarly, sprawl is more likely to occur in richer localities, since it responds to improvements in income levels along with an individual preference for single-family detached housing, greater proximity to open space and segregation from some of the problems suffered by the inner city such as pollution or crime.

Hence, we decided to perform further estimations on subsamples of the municipalities.

First, we estimated the model separately for large and small cities. In order to ensure a reasonable number in each group, the sample was split into two population categories, below and above 5,000 inhabitants, containing 329 and 704 observations, respectively[42]. The results are provided in Table 2.6. In the case of the impact of a sprawl shock on the current deficit and its components, the results were largely similar to those presented above. By contrast, the impact of sprawl on the capital deficit components was considerably higher in small cities. In fact, the investment needs of small municipalities resulting from urban expansion more than double those encountered in big cities. Moreover, small cities are much more reliant on development revenues and transfers from higher tiers of government to finance the investment needs generated by sprawl.

[Table 2.6 about here]

Second, we estimated the model for two groups of municipalities based on their initial level of sprawl. We determined a cut-off point around the average level of sprawl in the sample, while ensuring (as above) a reasonable number of observations in both new sub-samples. Thus, we ended up with 569 and 464 municipalities with initial sprawl levels

[41] The variables were chosen so that no correlation existed between them.

[42] Note that this division is in keeping with the allocation of responsibilities to the municipalities provided for under Spanish law. Thus, in small cities only the provision of basic services is compulsory, while in the larger ones a number of other responsibilities are included. See *Section 2.3* for further details.

below and above 200 square metres per capita of built-up area, respectively. The adjustment recorded in local budgets was quantitatively higher (although in most instances not statistically significant) in those cities where urban sprawl was evident from the beginning of the period. More specifically, in cities that had already undergone urban sprawl and which continued to expand during the 90s, the impact on urban revenues doubled that recorded in their more compact counterparts.

Third, further estimations were carried out taking into account the income level of municipalities[43]. The adjustment pattern of local governments to a sprawl shock was similar to the one obtained for the entire sample. Nonetheless, the impact of sprawl on both the current deficit and the capital deficit components was quantitatibly higher in richer cities.

Fourth, an additional set of estimations was performed according to local political factors. Availability of data on electoral contests held in 1995, 1999 and 2003 allos us to distinguish the municipalities with right-wing councils over the sample period considered from those with left-wing councils. Thus, the sample was split into two groups of municipalities[44]. From the results we can infer that political information on the time to departure of the decision makers is important when determining the fiscal adjustment of local budgets. In fact, these results show that right-wing municipalities experienced a quantitatibly higher fiscal adjustment process. Besides, the results confirm the partisan dimension of transfers from higher levels of government, since the increase on both current and capital transfers in right-wing municipalities more than doubled those received by their left-wing counterparts[45].

[43] One could think of the income level of each locality as a control variable of the model. Scarce availability of income data at the local level prevented us from introducing this measure as an exogenous variable, since it could compromise the identification of estimated parameters of the model. In fact, the inclusion of the income level would reduce both the cross-sectional and the time dimensions of the sample to 500 observations and 6 years, respectively, while increasing the number of estimated parameters up to 15 in each of the seven equations of the system. Alternatively, the estimation of the original model was performed for two subsamples of municipalities, according to their income level in 1996 (the first year where income data was available).

[44] Once again, it was not possible to introduce this dummy variable as a control variable of the model. Given that the econometric procedure implies taking first differences of the model, any variable without time variation is automatically dropped from the analysis.

[45] Recall that during the period under analysis Spain had the right-wing party in the central government. These results are in line with those obtained in Solé-Ollé and Sorribas (2007), which show that municipalities aligned with an upper layer of government receive more grants than those that are unaligned.

Generally speaking, however, the results aforementioned confirmed the findings for the entire sample presented in the previous section.

## 2.8. Conclusions

This study has sought to provide insights into the relationship between urban sprawl and municipal budgets by analysing how local government budgets adjust to a change in the urban development pattern. Thus, the study has drawn on a broad panel dataset from Spanish municipalities for the period 1994-2005 to estimate a panel vector autoregressive model. The modelling approach adopted here has enabled us to investigate how each individual budget component (namely current expenditures, tax revenues, operating grants, capital expenditures, capital transfers and development revenues) adjusts to an urban sprawl shock by means of Generalised Impulse Response Functions.

The GIRF results show, on the one hand, that the sprawl of cities produces both a current and a capital surplus leading to a short-run overall surplus for local governments. On the other hand, the methodology adopted in the present study enables us to determine the time profile of this local fiscal adjustment. The main finding that arises from these results is the temporary impact of sprawl on the capital component of the budgets (since GIRF coefficients are not statistically significant after the $4^{th}$ year). Quite the opposite, a sprawl shock exhibits a more permanent impact on the current component of the budgets.

The results record an increase in current expenditures, suggesting that local politicians will provide additional public goods and services for new housing developments. Moreover, urban sprawl is associated with large investment requirements as roads and basic infrastructures are extended for the new residents located at the urban fringe. Most of the adjustments to a sprawl shock are borne by upper tiers of government via grant financing (principally capital transfers) together with the not insignificant role played by the revenues associated with the real estate cycle itself (tax on land use improvements, building permits, construction taxes, public land sales, etc.). On the whole, these findings indicate that benefits of sprawl appear to exceed its costs.

However, the over-reliance of municipalities on grants to make adjustments to their budgets highlights a potential moral-hazard problem. Additional infrastructure requirements associated by spatially expansive growth are funded in the main by upper tiers of government, encouraging municipalities to promote urban expansion without necessarily considering the full fiscal consequences of such policies. Here, this problem could be due to the design of Spain's grant system, since some capital transfers are dependent on the municipalities' infrastructure deficit, which in turn is usually induced by urban growth. Note that these results are in line with US based findings which indicate that federal regulatory and funding policies have shaped American land use and helped to skew local development toward urban sprawl rather than focus it on the revitalization of cities and sustainable growth in the surrounding regions. Then, existing empirical evidence suggest that urban sprawl is a national problem, fueled in part by federal policies when combined with other factors, such as market forces and local zoning.

Therefore, it seems that Spain's local governments, as their counterparts in the U.S., face fiscal viability problems and use "external" funds (meaning grants from upper tiers of government) to balance their budgets and this apparent softening of budget constraints could distort local policy decisions. As noted in Buettner and Wildasin (2006), this effect is particularly relevant for larger cities in the U.S. Besides, there are inefficiencies attributed to grant financing of new urban developments at the urban fringe. In fact, the problem arises when new developers fail to internalise the full costs that they generate, leaving the local government to pay for them (i.e. municipal authorities raise the taxes of all residents in the jurisdiction and ask for higher transfers from the upper tiers of government). As a result, sprawl does not pay for itself but rather becomes a burden on all existing taxpayers (Slack, 2002).

Overall, results presented here suggest that local authorities need to be aware of the long-term financial implications of their land-use decisions and the need to re-examine the role played by state and regional governments in promoting this growth pattern. In particular, a policy reform regarding the restructuring of grants received as well as finding appropriate local funding tools that make new developers internalise the full costs they generate would help containing urban sprawl and promoting smarter and more compact urban growth patterns.

Finally, note that the Spain's structure of federalism is similar to the one existing in the U.S., with similar responsibilities and tax possibilities, although exhibiting a great reliance on transfers to fund investment.Then, the present analysis on the impact of local funding tools on land-use decision-making is in line with other previous studies that explore the relationship between the structure of local public finance and urban growth patterns (e.g. Slack, 2002). Most of them focus on the role played by certain local taxes (mainly the property tax and the land tax) in containing urban sprawl in the U.S. (see, for instance, Brueckner and Kim, 2003; Song and Zenou, 2006; and Banzhaf and Lavery, 2010), while others do care about the perverse incentives of revenues generated by urban growth as a source of finance (EEA, 2006). Therefore, the present paper seeks to enlarge existing empirical literature on the link between the different sources of local revenues and the growth pattern of cities while using a dynamic approach that exploits the time dimension of that relationship. Obviously, the methodology presented here has several limitations, mainly in terms of lack of a theoretical framework and the availability of additional variables that account for other determinants of local land-use decision-making, that should be addressed in future research.

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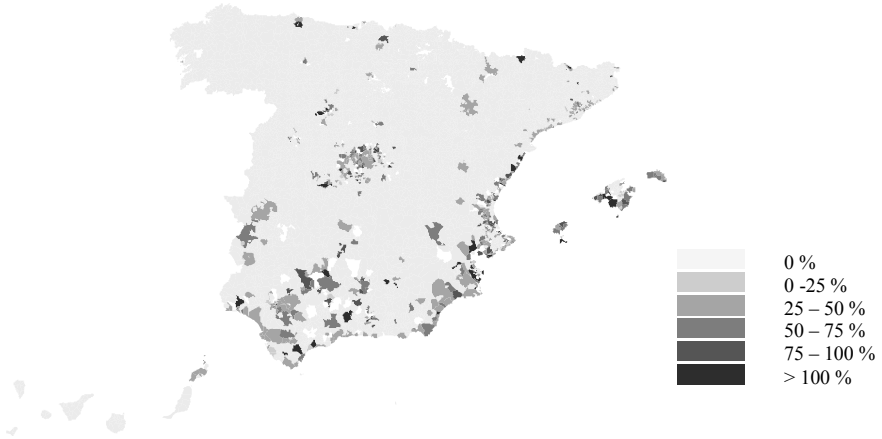
## 2.10. Tables and Figures

**Map 1. Major urban and tourist areas in Spain**


Notes: (i) Urban areas include all municipalities surrounding a main city (population greater than 100,000 inhabitants and provincial capitals) within a distance of 30km; (ii) Touristic areas include all municipalities sorrounding a main tourist city within a distance of 15 km.
Source: own elaboration according to data provided by Spanish Institute of Statistics and the Economic Yearbook of La Caixa.

**Map 2. Low density residential areas as a proportion of all residential areas built, period 1990-2006.**




Source: own elaboration according to data provided by the *Corine Land Cover* project.

**Table 2.1. Municipal budgets in Spain, 1994-2006 (%)**

| | 1994 | 2006 |
|---|---|---|
| **(a) Local Expenditures** | | |
| **Non-financial Expenditures** | 87.01% | 94.82% |
| *Current Expenditure:* | | |
| I. Wages and salaries | 30.41% | 29.93% |
| II. Purchases of goods and services | 24.36% | 30.14% |
| III. Debt service | 6.92% | 1.51% |
| IV. Current grants | 6.07% | 7.47% |
| *Capital Expenditure:* | | |
| VI. Real investment | *17.17%* | 23.03% |
| VII. Capital grants | 2.07% | 2.73% |
| **Financial expenditures** (financial assets and liabilities) | 12.99% | 5.18% |
| **(b) Local Revenues** | | |
| **Non-financial revenues** | 83.87% | 92.37% |
| *Current Revenue:* | | |
| I. Direct taxes | 27.20% | 26.69% |
| Property taxes | 13.96% | 15.23% |
| Motor vehicle taxes | 4.46% | 4.61% |
| Tax on land value improvements | 1.84% | 3.05% |
| Business taxes | 6.60% | 3.01% |
| II. Indirect taxes | 2.58% | 5.53% |
| Construction taxes | 2.55% | 4.65% |
| III. User charges (includes planning permissions) | 16.19% | 17.56% |
| IV. Current transfers | 27.69% | 26.50% |
| V. Asset revenues | 2.06% | 2.36% |
| *Capital Revenue:* | | |
| VI. Real investment sales (includes public land sales) | 2.12% | 6.42% |
| VII. Capital transfers | 6.02% | 7.31% |
| **Financial revenues** (financial assets and liabilities) | 16.13% | 7.63% |
| Development revenues | 14.2% | 23.5% |

Note: Economic classification of Spanish municipal budgets by sections.
Source: Spanish Ministry of Economy.

**Table 2.2 Descriptive statistics of the variables**

| *Variable* | *Mean* | *Std. Dev.* | *Definition* |
|---|---|---|---|
| ***Sprawl$_{it}$*** | 224.115 | 140.738 | Built-up area per capita |
| *Current Expenditures$_{it}$* | 444.948 | 209.478 | Wages$_{it}$ + Purchases of goods and services $_{it}$+ Debt service$_{it}$ + Current grants$_{it}$ |
| *Tax Revenues$_{it}$* | 243.219 | 163.394 | Direct Taxes$_{it}$ + Indirect Taxes$_{it}$ + User Charges$_{it}$ - Development Revenues$_{it}$ |
| *Current Transfers$_{it}$* | 201.797 | 104.572 | Current Trasnfers$_{it}$ |
| ***Current Deficit$_{it}$*** | -0.109 | 110.878 | Current expenditures$_{it}$ – Tax revenues$_{it}$ – Current Transfers$_{it}$ |
| *Capital Eexpenditures$_{it}$* | 269.862 | 334.336 | Real Investment$_{it}$ + Capital Grants$_{it}$ |
| *Capital Transfers$_{it}$* | 164.293 | 292.395 | Capital Transfers$_{it}$ |
| *Development Revenues$_{it}$* | 113.842 | 155.692 | Taxes on land value improvements$_{it}$ + Construction taxes$_{it}$ + Planning permits$_{it}$ + Asset revenues$_{it}$ + Public land sales$_{it}$ |
| ***Capital Deficit$_{it}$*** | -8.259 | 168.503 | Capital Expenditure$_{it}$ – Capital Transfers$_{it}$ – Development Revenues$_{it}$ |
| ***Non Financial Deficit$_{it}$*** | -8.369 | 154.365 | Current Deficit$_{it}$ – Capital Deficit$_{it}$ |

Notes: (i) The definition of the fiscal variables is based on the economic classification of the Spanish budget by sections (see Table 1). (ii) All budget variables are deflated using the regional Consumer Price Index, expressed in € 2005 and scaled in terms of population size. (iii) Sprawl variable is measured in per capita square metres.
Sources: Spanish Ministry of Economy and Finance, Spanish National Statistics Institute and Spanish Property Assessment Office.

**Table 2.3. Autocorrelation Tests for the initial model specification. p=3, N=1,120, T=12**

| | m1 | m2 |
|---|---|---|
| Sprawl$_{it}$ | -2.88 [0.004] | 0.31 [0.755] |
| Current Expenditures$_{it}$ | -1.58 [0.115] | 0.19 [0.852] |
| Tax Revenues$_{it}$ | -0.93 [0.354] | -1.69 [0.091] |
| Current Transfers$_{it}$ | -1.39 [0.163] | -0.57 [0.570] |
| Capital Expenditures$_{it}$ | -3.68 [0.000] | 1.63 [0.103] |
| Capital Transfers$_{it}$ | -4.82 [0.000] | -0.35 [0.729] |
| Development Revenues$_{it}$ | -1.23 [0.219] | -1.66 [0.100] |

Note: Results obtained after one-step system-GMM estimation using asymptotic values. P-values in parentheses. m1 and m2 are the Arellano-Bond tests for AR(1) and AR(2) processes in the first-differenced residuals, respectively.

**Table 2.4. Reduction of lag length: p=3, N=1,120, T=12**

| Equation | Lag reduction | Difference-Hansen statistic |
|---|---|---|
| $Sprawl_{it}$ | 3 → 2 | 2.98 [0.3947] |
| | 2 → 1 | 2.17 [0.5378] |
| Current $Expenditures_{it}$ | 3 → 2 | 3.76 [0.5844] |
| | 2 → 1 | 15.35 [0.0177] |
| Tax $Revenues_{it}$ | 3 → 2 | 12.96 [0.075] |
| | 2 → 1 | 20.08 [0.0012] |
| Current $Transfers_{it}$ | 3 → 2 | 1.22 [0.7482] |
| | 2 → 1 | 8.77 [0.0325] |
| Capital $Expenditures_{it}$ | 3 → 2 | 1.96 [0.1615] |
| | 2 → 1 | 24.3 [0.0020] |
| Capital $Transfers_{it}$ | 3 → 2 | 9.93 [0.6221] |
| | 2 → 1 | 19.03 [0.0399] |
| Development $Revenues_{it}$ | 3 → 2 | 10.75 [0.1499] |
| | 2 → 1 | 30.76 [0.0001] |

Note: p-values in parentheses.

**Table 2.5. Dynamic adjustment of local budgets to a sprawl shock**

| | **Average effect** | 1 year after shock | 4 years after shock | 6 years after shock |
|---|---|---|---|---|
| **(1) Benefits of sprawl** | | | | |
| Tax revenues | 5.22 [0.57]*** | 4.28 [0.79]*** | 5.53 [1.40]*** | 5.28 [1.78]*** |
| Development revenues | 10.44 [1.47]*** | 8.94 [2.98]*** | 10.83 [3.43]*** | 10.89 [4.41]** |
| Current transfers | 5.25 [1.01]*** | 6.97 [1.89]*** | 5.92 [2.57]** | 5.14 [3.00]* |
| Capital transfers | 11.17 [3.97]*** | 14.58 [5.13]*** | 16.06 [6.96]** | 15.82 [12.52] |
| **(2) Costs of sprawl** | | | | |
| Current expenditures | 5.89 [0.79]*** | 6.24 [1.46]*** | 5.95 [1.98]*** | 5.54 [2.38]** |
| Capital expenditures | 10.31 [6.41]*** | 17.33 [5.52]*** | 18,42 [8.18]** | 18,13 [19.62] |
| **Net fiscal impact=(1)-(2)** | 15,88 | 11,20 | 13,97 | 15,77 |
| **Current Deficit** | -4.58 | -5.01 | -5.50 | -4.88 |
| **Capital Deficit** | -11.30 | -6.19 | -8.47 | -10.89 |

Notes: (i) The last three columns refer to the GIRF coefficient 1, 4 and 6 years after the sprawl shock, respectively; (ii) All the coefficients are expressed in present values (discount rate set at 3%); (iii) Any GIRF coefficient was significant after the $7^{th}$ year; (iv) Bootstrapped standard errors shown in brackets: 1,000 replications with replacement; (v) ***, ** and * denote statistically significant coefficients at the 99%, 95% and 90% levels, respectively; (vi) Net fiscal impact is defined as benefits minus costs of a sprawl shock to municipal budgets; (v) As stated in expression (2), current deficit is defined as current expenditures minus tax revenues and current transfers, while capital deficit is defined as capital expenditures minus capital transfers and development revenues.

**Table 2.6. Present value of GIRFs**

**(i) Subsamples according to city size**

| | *Municipalities with population <5,000 inhabitants* | *Municipalities with population >5,000 inhabitants* |
|---|---|---|
| *Response of* | *Innovation to sprawl* | |
| $CD^+$ | -5.51 [1.40]*** | -5.07 [1.22]*** |
| *CE* | 7.09 [0.89]*** | 5.30 [0.70]*** |
| *TX* | 4.92 [0.34]*** | 4.79 [0.59]*** |
| *CT* | 7.67 [1.02]*** | 5.59 [0.81]*** |
| *KD* | -8.60 [10.32] | -5.28 [1.58]*** |
| *KE* | 17.87 [9.18]* | 6.69 [0.90]*** |
| *KT* | 14.03 [3.81]*** | 6.28 [0.77]*** |
| *UR* | 12.45 [1.68]*** | 5.68 [1.02]*** |
| $NFD^+$ | -14.11 [10.41] | -10.35 [1.98]*** |

**(ii) Subsamples according to initial level of sprawl**

| | *Municipalities with initial sprawl <200 pc squared meters* | *Municipalities with initial sprawl >200 pc squared meters* |
|---|---|---|
| *Response of* | *Innovation to sprawl* | |
| $CD^+$ | -3.40 [2.09]* | -6.81 [6.89] |
| *CE* | 5.28 [1.25]*** | 8.55 [3.64]* |
| *TX* | 2.92 [0.54]*** | 6.31 [0.86]** |
| *CT* | 5.76 [1.52]*** | 9.05 [5.56] |
| *KD* | -9.65 [7.37] | -11.02 [128.85] |
| *KE* | 14.41 [3.80]*** | 23.99 [22.61] |
| *KT* | 16.40 [6.01]*** | 19.78 [132.72] |
| *UR* | 7.65 [1.75]*** | 15.23 [7.28]* |
| $NFD^+$ | -13.05 [7.68]* | -17.82 [128.92] |

Notes: (i) Bootsrap standard errors shown in brackets: 1000 replications with replacement; (ii) ***, ** and * denote statistically significant coefficients at the 99, 95 and 91% levels; (iii) CD, KD and NFD have been computed manually according to expression (2).

## Appendix 2.1. Generalised Impulse Response Functions

As described in Pesaran and Shin (1997) GIRFs measure the adjustment pattern of each endogenous variable in a dynamic system in reaction to a shock, which is either to itself or to any other endogenous variable.

Hence, denoting the known history of the economy up to time t-1 by $\Omega_{t-1}$ and letting $\delta_j$ be the shock on the *j*th equation, the GIRF of $X_t$ at horizon $n$ is defined by

$$GIRF_x\left(n,\delta_j,\Omega_{t-1}\right)=E\left(x_{t+n}\mid u_{jt}=\delta_j,\Omega_{t-1}\right)-E\left(x_{t+n}\mid\Omega_{t-1}\right) \quad \text{(A2.1)}$$

Note that this expression establishes that the GIRF for the endogenous variables vector $x_t$, $n$ periods ahead, is the difference in the expected value of $x_{t+n}$ when taking $\delta_j$ shock into account. As shown in Pesaran and Shin (1997), under the assumption of normally distributed errors, the scaled GIRF of the effect of one standard error shock to the *jth* equation at time $t$ on $x_{t+n}$ is given by

$$\psi_j^g\left(n\right)=\sigma_{jj}^{-1/2}A_n\Sigma e_j \quad n=0,\ 1,\ 2,... \quad \text{(A2.2)}$$

where $A_n$ denotes the MA coefficient matrix at $t+n$, $e_k$ is $m$ x *1* the selection vector with unity as its *k*th element and zero elsewhere.

## Appendix 2.2. Econometric procedure and model specification

Omitting $f_i$ from the above regressions results in inconsistent estimates, since it correlates with the right-hand side variables. In this context, a common way to proceed is to get rid of the fixed effect by taking the first differences in the above model. Since $u_{it}$ is white noise, this transformation introduces a first-order moving average process in the new residual term that creates an endogeneity problem in the equation. Thus, an instrumental variable approach has to be applied so as to ensure consistent estimates[1].

[1] In micro panel data models, i.e. large N and short T, where lagged dependent variables are included as regressors, the within groups estimator gives inconsistent estimates (Nickell, 1981). Besides, applying pooled OLS, which omits the unobserved heterogeneity, would be inconsistent as well.

The orthogonality conditions satisfied by $u_{it}$ can be used to identify the parameters of the model, given that $\Delta u_{it}$ is uncorrelated with $X_{i,t-1}$ for s ≥ 2. Hence, the values of lagged variables can be used to define the matrix of possible instruments for the equations in first differences, say $Z_{it}$, so that $E[Z_{it}\Delta u_{it}] = 0$ and $E[X_{it}\Delta u_{it}] \neq 0$.

Provided that this is an overidentified case, efficiency requires that we use all available instruments by means of the Generalised Method of Moments (GMM) rather than a simple Instrumental Variables (IV) or Two Stage Least Squares (2SLS) approach[2]. In the case of fixed-effect dynamic panel data with a large cross-section observed over a short time period, Holtz-Eakin *et al.* (1988) and Arellano and Bond (1991) developed an estimator that uses all available lagged values of the variables in levels at each time period as instruments in the first-differenced equation. But, as noted in Arellano and Bover (1995) and Blundell and Bond (1998), the lagged values of the dependent variable may be weak instruments for the first differences when the series is particularly persistent, i.e. when the variables are close to a random walk. In this case, it is better to implement the system-GMM estimator in order to avoid possible biases. This estimator combines the moment conditions for the equations in first differences with additional moment conditions for the equations in levels. In particular, under the additional assumption that past changes of the instrumented variables are orthogonal to the current error term in levels, it is possible to use instruments in levels for the first-differenced equations and first-differenced instruments for the equations in levels (Arellano, 2003; Roodman, 2007, 2008).

[2] The IV estimator, proposed by Anderson and Hsiao (1982), uses values of the variables in levels or in differences lagged two periods as instruments. This procedure leads to consistent but inefficient estimates, since not all moment conditions are used and the serial correlation structure in the residuals is not taken into account.

## Appendix 2.3.

**Table A1. Detailed estimation results, p=2, n=1,033, T=12**

| | $CE_{it}$ | $TX_{it}$ | $CT_{it}$ | $KE_{it}$ | $KT_{it}$ | $UR_{it}$ | $SPRAWL_{it}$ |
|---|---|---|---|---|---|---|---|
| $CE_{it-1}$ | 0.894** | 0.095** | -0.005 | 0.076 | -0.061 | 0.209* | -0.004 |
| | [0.356] | [0.045] | [0.072] | [0.176] | [0.105] | [0.124] | [0.003] |
| $CE_{it-2}$ | 0.051* | 0.053*** | 0.032 | -0.095 | -0.088 | 0.087** | 0.003 |
| | [0.215] | [0.012] | [0.029] | [0.122] | [0.070] | [0.043] | [0.003] |
| $TX_{it-1}$ | -0.014 | 0.344 | -0.012 | 0.149 | 0.161 | -0.061 | -0.013** |
| | [0.123] | [0.217] | [0.038] | [0.192] | [0.108] | [0.057] | [0.005] |
| $TX_{it-2}$ | 0.047 | 0.463** | -0.014 | -0.138 | -0.056 | -0.092 | 0.003 |
| | [0.039] | [0.161] | [0.014] | [0.129] | [0.082] | [0.080] | [0.006] |
| $CT_{it-1}$ | 0.041 | -0.074** | 0.675** | -0.123 | 0.113 | -0.179** | -0.003 |
| | [0.164] | [0.027] | [0.225] | [0.247] | [0.100] | [0.084] | [0.003] |
| $CT_{it-2}$ | -0.019 | -0.047** | 0.223 | 0.285*** | 0.211** | -0.106** | 0.001 |
| | [0.020] | [0.017] | [0.151] | [0.108] | [0.074] | [0.044] | [0.003] |
| $KE_{it-1}$ | -0.009 | 0.029* | -0.013 | 0.678 | -0.353* | 0.113 | 0.001 |
| | [0.034] | [0.012] | [0.023] | [0.479] | [0.200] | [0.082] | [0.002] |
| $KE_{it-2}$ | 0.019 | 0.026** | 0.004 | 0.121** | 0.078* | 0.019 | 0.001 |
| | [0.020] | [0.010] | [0.009] | [0.051] | [0.042] | [0.019] | [0.001] |
| $KT_{it-1}$ | -0.0004 | -0.030 | 0.024 | -0.185 | 0.862*** | -0.074 | -0.001 |
| | [0.025] | [0.013] | [0.022] | [0.453] | [0.263] | [0.074] | [0.002] |
| $KT_{it-2}$ | -0.012 | -0.031 | 0.004 | 0.209*** | 0.252*** | -0.023 | -0.001 |
| | [0.019] | [0.010] | [0.011] | [0.052] | [0.050] | [0.021] | [0.002] |
| $UR_{it-1}$ | -0.004 | -0.021*** | 0.003 | -0.039 | 0.186* | 0.164 | -0.001 |
| | [0.061] | [0.008] | [0.023] | [0.242] | [0.110] | [0.242] | [0.002] |
| $UR_{it-2}$ | 0.008 | -0.013 | -0.015 | 0.151* | 0.082 | 0.347*** | -0.001 |
| | [0.026] | [0.010] | [0.015] | [0.086] | [0.061] | [0.096] | [0.002] |
| $Sprawl_{it-1}$ | 0.053 | 0.141* | -0.055 | 0.473 | 0.553 | 0.103 | 1.457*** |
| | [0.143] | [0.078] | [0.052] | [0.374] | [0.345] | [0.163] | [0.179] |
| $Sprawl_{it-2}$ | -0.060 | -0.126* | 0.038 | -0.371 | -0.479 | -0.038 | -0.450** |
| | [0.151] | [0.075] | [0.054] | [0.378] | [0.354] | [0.162] | [0.182] |
| m1 | -2.23** | -2.07** | -2.67*** | -3.95*** | -5.82*** | -1.95* | -4.58*** |
| m2 | 0.30 | -1.38 | 0.10 | 0.49 | -0.16 | -1.41 | 1.65 |
| Hansen test | 17.14 | 14.25* | 16.38 | 32.38 | 50.63* | 28.65 | 14.61 |

Notes: (i) Estimation results after system-gmm estimation, including individual and time effects in all equations. (ii) Heteroskedasticity standard errors in brackets. (iii) ***, ** and * denote statistically significant coefficients at the 99, 95 and 91% levels. (iv) m1 and m2 are the Arellano's AR(1) and AR(2) tests for autocorrelation while the Hansen test checks for the validity of the instruments used in the estimation procedure (see *Section 5.1.* for further details). (v) All equations pass both the autocorrelation tests and the test for overidentifying restrictions with the exception of the TX and KT equations, where the null of valid instruments is rejected at 10%. However, these results should be interpreted with caution since, as noted in Dahlberg and Johansson (2000), estimation techniques that are generally adopted tend to reject too often a true null of validity of instruments (type I error).

# CHAPTER III

# SPRAWL, BLIGHT AND THE ROLE OF URBAN CONTAINMENT PROGRAMS

## 3.1. Introduction.

US post-war suburbanization has reshaped the spatial pattern of growth in many metropolitan areas. Urban sprawl emerged as a result of the interaction among different driving forces. Population growth combined with individual housing preferences, higher income levels, the reduction in transport costs and the improvement in road networks ensure that the demand for land at the urban fringe is in a constant state of growth (Mieskowski and Mills, 1993; Brueckner and Fansler, 1983; McGrath, 2005; Brueckner, 2000, 2001; McGrath, 2005; Baum-Snow, 2007; Wassmer, 2008). High political fragmentation (Carruthers and Ulfarsson, 2002), physical geography (Burchfield et al, 2005), certain subsidizing and investment public policies and land-use regulations (Glaeser and Khan, 2003; McGuire and Sjoquist, 2002) have also been instrumental[1].

This rapid suburbanisation has created, however, many of the challenges we face today, ranging from traffic congestion, air pollution and loss of the amenity benefits from open space to the undermining of agglomeration economies and economies of scale in the production of local public services. The claim is also made that sprawl induces the movement of large shares of population and employment to suburban communities contributing to socioeconomic segregation between the rich of the suburbs and the poor of the inner cities[2]. This primarily "white and middle- and upper-income-class flight" makes several poverty-related problems arise in downtown neighbourhoods, such as increasing crime rates, poor-quality public services, lack of fiscal resources and lack of reinvestment and maintenance in exiting building structures, leading to the deterioration and decay of central cities. These inner-city problems induce even further population shift toward the suburbs, reinforcing the process of suburban

[1]According to data provided by the U.S. Census, between 1990 and 2000 the metropolitan population outside central cities grew 22.96 percent; whereas the population of central cities grew only by 8.84 percent. Besides, during the period considered around 40 percent of central cities experienced declines in population. As a result, in 2000, 40.4 percent of the metropolitan population lived outside of the central city, an increase from 37.5 percent in 1990.

[2] There is a growing body of literature on the economics of urban sprawl surveyed in Glaeser and Khan (2004) and Nechyba and Walsh (2004). See also Ewing (1997), Burchell (1998), Sierra Club (1998), Cullen and Levitt (1999), Downs (1999), Carruthers and Ulfarsson (2003, 2008) and Brueckner and Largey (2008) for a review of the consequences of sprawl.

growth and urban decay (Bradford and Kelejian, 1973; Mills and Price, 1984; Mieskowski and Mills, 1993).

It is not surprising, then, that the problem of central city urban decay has become a matter for concern throughout US metropolitan areas. Public interest in blight is not, however, of recent origin. Indeed, early writers on blight and urban renewal pointed out the complex relationships between central-city and suburban development (see, for instance, Fisher, 1942; Breger, 1967; Davis, 1960; Davis and Whinston, 1961; Bradbury et al, 1980). The decline of central cities was clearly seen as a diseconomy of urbanization. More recently, Brueckner and Helsley (2011) developed a dynamic urban model to show that sprawl and urban blight can be considered the byproduct of the same underlying economic process, both being responses to fundamental market failures distorting the socially desired allocation of population and urban land within jurisdictions[3]. Unpriced traffic congestion, open-space externalities, or unpriced suburban infrastructure make the cost of suburban living to be inefficiently low, drawing residents away from the central-city and resulting in excessive suburban population. This population shift in turn depresses housing prices in the centre, undermining incentives to maintain or reinvest in existing downtown structures.

In this context, the adoption of corrective growth management policies may help preventing sprawl and the decline of central cities as they raise reinvestment and reduce urban blight[4].

Traditionally, land-use regulations (such as zoning ordinances or minimum lot sizes) have been the tool most frequently used to limit the excessive growth of cities. Adoption of land-use regulations is justified on the basis of both quantity and price control of development (Helsley and Strange, 1995). That is, such policies aim to limit negative externalities of urban growth, prevent sprawl and guarantee a fair distribution of the tax burden generated by urban growth. There are, however, potentially adverse

[3] According to the authors, urban development due to traditional fundamental forces (population growth, rising real incomes and falling commuting costs) cannot be faulted as inefficient, unless certain market failures distort their operation. In that situation, the invisible hand fails to allocate resources in a socially desirable manner, so as to maximize aggregate economic welfare, leading to excessive spatial growth of cities (see also Brueckner 2000, 2001).

[4] Brueckner and Helsley (2011) refer to price-based policies to correct sprawl-inducing market failures, i.e. congestion toll, open-space amenity tax and impact fee. Nonetheless, the authors show that the introduction of quantity-based policies, such as urban growth boundaries, could also lead to an efficient overall equilibrium (including the level of reinvestment in central-city buildings).

social and economic effects. Land-use regulations have a considerable impact on land and housing prices, as they tend to increase housing prices while lowering the value of vacant land (Brueckner, 2000). Besides, land-use regulations are blamed for exacerbating the problem of affordable housing while enhancing the exclusionary problem of ethnic and racial minorities and the deterioration of city centres (Fisher, 1942; Downs, 1999; Pendall, 2000; Quigley et al, 2004; Chakraborty et al, 2010)[5]. Overall, these undesired outcomes have reduced the popularity of these policies in favour of more appropriate anti-sprawl measures. In this context, newly designed urban containment policies have emerged in response to the perverse consequences of restrictive land-use controls. These policies combine regulations and incentives to guide and efficiently allocate new development as well as to balance the forces of decentralization and promote the revitalisation of communities. As explained in Nelson et al (2004), they are explicitly designed to limit the development of land outside a defined urban area, while encouraging development of infill sites and redevelopment of inner core areas. To that aim, they can combine mixed-use and high-density zoning, affordable housing strategies and land supply monitoring, with capital investment plans and various redevelopment incentives.

While there has been extensive discussion of city and suburban growth, little attention has been paid to growing concerns about the blight in U.S. cities and the effectiveness of corrective anti-sprawl policies on preventing the deterioration of downtown structures.

In fact, there are only a few studies analysing the impact of different urban containment programs on the size (Wassmer, 2006) and the spatial structure of metropolitan areas (Woo and Guldmann, 2011), on residential segregation (Nelson et al, 2004), or on the central-city construction activity (Nelson et al, 2004b), i.e. the effect on both housing supply and prices in central city. There is not, however, empirical evidence on the success of policy remedies in preventing central city deterioration. Generally speaking, a review of the literature points out that evidence on the extent of blight and the policy-

[5] See also Quigley and Rosenthal (2005), Glaeser et al (2006), Malpezzi (1996), Shen (1996), Levine (1999), Ihlanfeldt (2004), Thorson (1997), Mayer and Somerville (2000) or Glaeser and Ward (2009) for empirical evidence on the consequences of land-use regulations in the U.S. Cooley and LaCivita (1982), Engle et al (1992), Sakashita (1995), Brueckner (2000), Brueckner and Lai (1996), Helsley and Strange (1995), Bento et al (2006) and Schone et al (2011), among others, are examples of theoretical research regarding growth control modelling.

oriented decision-making aimed at addressing the problem of central-city urban decline is somewhat limited.

Therefore, the present study seeks to enlarge existing empirical literature on the relationship between central-city and suburban development and the role played by anti-sprawl policies. It is, therefore, a first attempt in the empirical literature to address blight reduction in U.S. central cities. Besides, conclusions derived from this analysis could help orienting public policy in terms of its regional and local land-use decision-making and central city revitalisation.

Our initial aim is to develop an accurate measure of urban blight so that we might empirically test whether the adoption of anti-sprawl policies could help reducing urban decay. Available micro data from the American Housing Survey on external conditions of buildings and neighborhoods enables us to construct detailed blight measures at the city level for a representative sample of 125 metropolitan areas. We, therefore, undergone a novel empirical analysis on the determinants of city blight and the role of corrective policies in preventing central city deterioration. Our empirical specification includes a number of control variables so as to take into account the effect of socioeconomic and housing characteristics both at the city and metro level. Having controlled for these effects, we are then in a position to identify the specific impact of more stringent anti-sprawl policies adopted at the metro-level, proxied here by the adoption of urban containment policies, on city blight. In other words, we can determine whether among metropolitan areas with the same characteristics the ones with urban containment programs in place face significant blight reductions in their central cities.

The article is organized as follows. In the next section we provide an overview of the concept and measurement of urban blight. In the third section we explain the methodology, data sources and variables used in carrying out our empirical analysis. Main results and their implications are discussed in the fourth section and several robustness checks are presented in the fifth section. Finally, in the last section, we conclude.

## 3.2. Urban blight

### *3.2.1. The causes of blight*

As noted above, the economic progress and major structural changes in transportation and government policy, among others, have fostered urban sprawl, setting up the economic and social conditions for urban decay of central cities. Fisher (1942) notes that the accelerating population shift toward the suburbs has accentuated the problem of the central city areas, as suburban expansion responds mainly to migration of central-city residents rather than to the accommodation of new population growth. As explained in Breger (1967), urban blight is a diseconomy of urbanization as it arises from the causal forces that commonly relate to economic progress and urban growth (i.e. changing land use and technological change, rising social standards and the progressive overutilization of property).

A new approach to the relationship between city and suburban growth has been recently developed by Brueckner and Helsley (2011). The claim is that blight is not a consequence of sprawl but the result of inefficient allocation of population driven by the same market failures that generate sprawl. That is, the market mechanism has not functioned properly in urban economy, leading to an inefficient allocation of population between the inner city and the suburbs. Several sprawl-inducing distortions to the urban economy (unpriced traffic congestion, failure to account for the amenity value of open space, and average- rather than marginal- cost pricing of infrastructure) have resulted in excessive suburban population, with an inefficient loss of residents in the central zone. This population shift in turn depresses housing prices in the centre, undermining incentives to maintain or reinvest in existing downtown structures. This hypothesis is clearly supported by the U.S. data. Figure 3.1 plots the share of MSA population living in the suburbs in 2000 against the percentage of housing units built in the central cities during the period 1990-2000: the correlation, $\rho = -0.36$, is statistically different from zero. This result suggests that, as expected, the large population movements towards suburban locations are positively correlated to the decay of construction activity in central places.

[Figure 3.1 about here]

This being the case, the adoption of anti-sprawl policies would serve as well as a tool for blight reduction. The corrective mechanism works as follows. A corrective policy reduces sprawl, as it curbs downtown population shift toward the suburbs while encouraging suburban population move toward the centre. Then, the housing price increases in the centre become an incentive for building reinvestment and maintenance, reducing urban decay (see Brueckner and Helsley, 2011 for further explanation). Besides, Davis and Whinston (1961) use an example based on the Prisoner's Dilemma to show how the presence of neighbouring effects and the property owners' strategic behaviour to maximize the returns to investment can explain persistence in blight. According to the authors, property owners can neglect reinvestment and improvements in existing structures in anticipation of the arrival of more intensive uses which might bring capital gains. Then, rational individual action might allow property to deteriorate and blight to occur, leading to a process of contagious neighbourhood decline. Hence, as summarized in Brueckner and Helsley (2001), blight arises from the interaction of these neighbourhood externalities and an event causing an initial decline in building maintenance and reinvestment, identified from the authors as the natural operation of the land market in the presence of sprawl-inducing distortions.

### *3.2.2. The blight measure*

Breger (1967, pp.372) defined the concept of urban blight as follows:

> "Urban blight designates a critical stage in the… depreciation of real property beyond which its existing condition or use is unacceptable to the community… This process appears to involve either functional depreciation (loss of productivity) or social depreciation (loss of prestige) or both".

Hence, urban blight encompasses both social and economic dimensions, although it is primarily a physical concept. It refers to the obsolescence, deterioration, disrepair and decay of buildings in central cities due to neglect, depopulation, lack of economic support and deficient reinvestment in older central city properties, among others. In this sense, recent papers on urban blight have defined it as a spatial concentration of

deficient housing maintenance or reinvestment in older central-city properties (see Brueckner and Helsley, 2011, pp. 205; Bento et al, 2011, pp.440).

According to these definitions, blight measures used in this paper are based on the physical characteristics of buildings drawn from the American Housing Survey (AHS). This is the largest, regular national housing sample survey in the United States. The survey collects data on the Nation's housing, including apartments, single-family homes, mobile homes, vacant housing units, household characteristics, income, housing and neighbourhood quality, housing costs, equipment and fuels, size of housing unit, and recent movers. National data are collected every other year, from a fixed sample of about 50,000 homes which has been scientifically selected to represent a cross section of all housing in the nation, updated each year to include new construction[6].

We use available micro data files containing the individual household responses to the survey questions to construct 11 different blight measures at the central city level. The survey identifies which units are located within the central city of each MSA (as defined by the Office of Management and Budget). Hence, all central city units are selected from the raw data and reweighed using the corresponding weights to obtain a representative sample of housing units within central cities of 125 selected metropolitan areas[7]. Selected characteristics on external building conditions reflect a serious damage to the structure mainly caused by continuous neglect, vandalism, and so forth. They do refer to both own buildings and neighbourhood conditions of structures. In particular, selected variables reflecting blight include: housing units with windows boarded up or broken; housing units with holes in roof or with roof missing materials or surface sags caused by extensive damage to the structure or serious neglect; housing units with outside walls missing siding or bricks, with outside walls slope, lean, slant or buckle; and housing units with abandoned or vandalized buildings, trash or junk in streets or roads needing repairs within half a block. Descriptive statistics of the characteristics

[6] http://www.census.gov/housing/ahs/

[7] The American Housing Survey public use file identifies housing units as being in central cities of metropolitan areas via the METRO3 variable. In order to obtain totals by MSA, we weighted our tabulations using WGT90GEO (wgt90geo is used instead of the pure weight, since the distribution of housing units across MSAs is of particular importance in our study). The geographical distribution of MSAs included in the blight sample is presented in Map 3.1 of Appendix 3.1.

considered are presented in Table 3.1. Note that all variables are expressed as proportions of total housing units.

A preliminary analysis of the blight data points out two main facts. First, the frequency distributions presented in Figure 3.2 exhibit a significant pattern of variation in the degree of blight occurring in different central cities. Second, greater indicators of blight are found among the neighbourhood conditions variables. More than half of the cities considered in the sample reported that road repairs and improvements in trash collection were needed in the neighbouring streets. Besides, as it is shown in Table 3.1, mean values observed after clustering cities according to the existence of UCP show that, as expected, blight levels are lower in cities with UCP in place. That is, a first look at the data seems to support the hypothesis of the effectiveness of stringent anti-sprawl policies in preventing central city deterioration. Nonetheless, a regression-based analysis of the causes of urban blight is necessary to understand the observed differences. To that aim, more robust conclusions from the econometric analysis are presented below.

[Table 3.1 about here]

[Figure 3.2 about here]

### *3.2.3. Principal Components Analysis*

Given that the number of variables that proxy central-city blight is high, we use a multivariate statistical technique to summarize all the available information in a smaller number of variables with minimum loss of information (Hair et al, 2010)[8]. To that aim, the principal components analysis (PCA) is the common approach to reduce dimensionality as it creates uncorrelated components or factors, where each component is a linear weighted combination of the initial variables so that the first few components contain most of the variations in the original dataset.

According to their nature, central city blight measures can be grouped into two different categories. We define a first group of external building conditions regarding windows, roof and walls, and a second group of neighborhood conditions. Then, PCA is applied to each group of blight measures. Results allow us to identify one component in each

[8] Further explanation on Principal Components Analysis is presented in Appendix 3.2.

group of variables which cover 47% and 65%, respectively, of the variance of the original data set (see Table 3.2)[9]. The two components obtained will be included in the regression analysis as dependent variables. As a result, two different equations will be estimated, one for each component.

Table 3.3 show the weights applied to each individual blight measure in order to obtain the component retained which is, as aforementioned, a linear combination of the initial blight variables (Column 1).

[Table 3.2 about here]

[Table 3.3 about here]

The results show, on the one hand, the contribution of each blight measure to the component. For the first set of blight measures, all variables are equally represented in the new blight index created, as each variable explains between 10 and 17% of the new blight index created. In the second group of blight measures, neighbourhood conditions, each initial variable explains between 35, 28 and 37% of the new blight index, respectively. On the other hand, correlations between each initial blight measure and the component retained are presented in the last column of Table 3.3. As it can be seen, initial blight measures related to neighbourhood conditions are highly correlated to the new blight index (coefficient around 0.8), whereas the correlation is slightly weaker between external building conditions and their new summary indicator (coefficient between 0.58 and 0.75).

Figure 3.3 present the frequency distributions obtained for the two indexes of blight obtained after PCA[10]. The results suggest that the new blight indexes exhibit a similar pattern of variation than those presented in Figure 3.2 for single blight measures.

[Figure 3.3 about here]

[9] According to the Kaiser and Guttman rule, only factors with an eigenvalue greater than one are retained.

[10] The geographical distribution of the two blight indexes across central cities in MSAs included in the sample is presented in Maps 3.2 and 3.3 of Appendix 3.1.

## 3.3. Empirical framework

### *3.3.1. The sample*

The empirical work is based on a sample of 105 selected Metropolitan Statistical Areas (MSAs) and their corresponding central cities[11]. The MSA was chosen as the unit of analysis for several reasons. As it is explained in Woo and Guldmann (2011), Consolidated Metropolitan Statistical Areas (CMSAs) need to be discarded because they often extend across more than one state and they are, therefore, too large to capture the influence of a unique central city. On the other hand, MSAs are metropolitan areas (MAs) surrounded by non-metropolitan areas. Since MSAs do not closely interact with other MAs, the impacts of UCPs can be measured effectively within MSAs.

The sample size was not randomly chosen but determined but the availability of data. As aforementioned, blight measures were only available for a representative sample of 125 central cities, and urban containment data used to test whether more stringent anti-sprawl policies help reducing city blight existed for only 105 of them. As it is shown in Table 3.4, comparison of this sample with the universe of U.S. MSAs in 2000 indicates that large MSAs are over-represented in the sample. The mean population of the sample was 1,707,982 in 2000, while the mean population of all MSAs was 719,222. However, the sample does not differ significantly from other MSAs in terms of median household income, unemployment rate, population growth or income growth between 1990 and 2000. Besides, MSAs included in the sample account for about 80 percent of total MSA population. Thus, we believe that the sample data are reasonably representative of all MSAs in the U.S.

[Table 3.4 about here]

[11] The U.S. Office of Management and Budget defines a MSA as a geographic entity containing a core urban area population of 50,000 or more. Each MSA consists of one or more counties and includes the counties containing the core urban area, as well as any adjacent counties that have a high degree of social and economic integration (as measured by commuting to work) with the urban core. The central city is defined as the principal city with the largest population within the MSA. Thus, the remaining principal cities of the MSA, if any, are considered suburbs.

*3.3.2. Empirical specification*

In this section, we describe the empirical strategy adopted for assessing the influence of UCP on city blight reduction. To that aim, the relationships between the variables of interest is assumed to be as follows:

$$\text{Blight}_{ji,2000} = \alpha_j \ \text{UCP}_{k,1970-2000} + \beta_j \ \text{X}_{i1990} + \phi_j \text{Blight}_{ji,1990} + \varepsilon_{ij} \qquad (3.1)$$

Where $Blight_{ji,2000}$ is the value of the blight measure $j$ in city $i$ in 2000, $j$=1,2, $Blight_{ji,1990}$ is the initial level of blight, $\text{UCP}_{jt}$ is the urban containment policy in place prior to the period of analysis in metro area $k$, $\text{X}_{i,1990}$ is a vector of city and metro characteristics in 1990, $\beta_j, \phi_j$ are the coefficient vectors and $\varepsilon_{ij}$ is the error term.

Therefore, we analyze the correlation between the adoption of urban containment programs between 1960 and 2000 and the blight level of cities in 2000, and whether this correlation is robust to the inclusion of the initial blight level in 1990 and a set of control variables. Thus, the main purpose of our empirical analysis is to explore the long-run impacts that result from the implementation of UCPs so as to get a picture of the correlation between growth containment and city blight in a context of a monocentric city model. In fact, alternative model specifications presented in the *Additional Results* section reinforce this idea, as the year of adoption of UCPs has not a significantly different impact on blight reduction from a statistical point of view.

*3.3.3. Urban containment policies*

In order to test whether the reduction of blight in central cities is correlated to the presence of more stringent anti-sprawl policies, we first introduce the urban containment policy variable. These policies combine regulations and incentives to guide and efficiently allocate new development as well as to balance the forces of decentralization and promote the revitalisation of communities. They are explicitly designed to contain urban development within a planned urban area, while encouraging redevelopment of inner core areas that might otherwise be neglected. In other words, such corrective policies are intended to curb downtown population shift toward the suburbs while encouraging suburban population move toward the centre. Preservation

of open space, cost-efficient construction and use of urban structure are also among their intended goals.

Hence, the measure used in this analysis is a categorical variable that takes on a value of one if an urban containment policy was in place at the beginning of the period under investigation (2001) in each of the MSAs considered. The data, provided by Nelson et al (2004), draws from a nation-wide survey of metropolitan planning organisations to identify the existence of a formally adopted containment policy in each MSA. Although UCPs can include a wide variety of tools to shape metropolitan growth, this survey is focused on the adoption of urban growth boundaries, service extension limits and greenbelts.

Nelson et al (2004) data is a representative sample of the whole population that consists of observations for 331 MSAs of 50 different states, 102 of them adopted UCP between 1960 and 2000. As it is shown in Figure 3.4, MSAs with UCP in place are mainly located along the east and the west coast of the country, whereas only a few of them are located inland. Available data also reports, on the one hand, the year of adoption of the UCP. 22 out of 102 MSAs adopted the UCP before 1980, 38 did it during the 80s, 35 during the 90s and only one in the year 2000. On the other hand, a distinction can be established between areas with region-wide containment programs (i.e., all counties contained) and areas with containment programs in place within a subset of the region's jurisdictions. 49 out of 102 MSAs formally adopted region-wide UCP while 53 adopted containment programs within a subset of the region's counties. When merging this sample with our blight data we end up with a sample of 107 MSAs, 36 of them with formally adopted UCP. Note that contained areas were equally distributed according to the decade of adoption. Besides, in half of the cases all counties were contained (see Table 3.5)[12].

[Figure 3.4 about here]

[Table 3.5 about here]

Besides, a lagged measure of blight is included in the equation to account for the initial level of central city deterioration. Given that data on central city blight is not

[12] Detailed maps on UCP according to the year of adoption and the type of containment program in place are presented in Appendix 3.1.

available for the year 1990, we proxy it with the proportion of new housing units built between 1980 and 1990[13].

Next, a set of controls are added to the econometric specification so as to check for the robustness of the correlation between blight and the adoption of UCP. This set of variables includes a variety of observable city and metropolitan area characteristics drawn from the U.S. Bureau of Census (Decennial Census, the 3-year estimates of the American Community Survey, the City and County Data Book and the Bureau of Justice Statistics) and intend to account for the main other factors affecting the level of blight in central cities. Descriptive statistics are presented in Table 3.6.

First, we control for several socioeconomic characteristics that influence the demand for housing in the city centre. We include the population living in central city and their median household income in 1990. The former indicates the strength of central city and thereby its attractiveness as a place of residence and its ability to influence development patterns, while the later indicates residents' demand and tastes and it accounts, therefore, for the effect of the resources on the demand for housing quality.

Second, we add a set of variables that account for the quality of life in central cities. This group of variables includes the city crime rate, measured as the weighted average violent crimes per 1,000 of the population, and the proportion of the central city population that is black and hispanic in 1990. These variables could help explaining population shift towards the suburbs as residents *vote with their feet* and choose their location within an urban area depending not only on their income and transports costs, but also according to their preferences. In this context, inner city problems lead middle-class residents to move to the suburbs, so that they form separate homogeneous communities of individuals of like income, education or race. Hence, we do expect a positive correlation between this set of quality of life variables and the level of blight in central cities.

[Table 3.6 about here]

[13] The blight level in 2000 is correlated to the proportion of housing units built between 1990 and 2000, with a coefficient around 0.4. Then, the proportion of housing units built between 1980 and 1990 is expected to be a good proxy of the city blight level in 1990.

The expectation is that the greater the occurrences in a MSA central place that residents are likely to view as negatives, the greater the flight from blight that is expected to occur. Thus the greater the percentage of the central place crime rate, the greater the proportion of black and hispanic people, the greater should be the level of blight.
Additionally, per capita federal expenditures are also added to the model specification so as to examine whether federal spending in central cities contributes to the vitality of the cities and, hence, to blight reduction (Woo and Guldmann, 2011).

### *3.3.4. Partial correlations*

In Figure 3.5 we look at the raw correlation between our two indexes of central city blight in 2000 and the adoption of UCP. As it can be seen, MSAs with UCP in place prior to 2000 exhibit lower level of central city blight than those uncontained. This result holds for both indexes of blight, *external building conditions* and *neighbourhood conditions*. In both cases, the correlation with the UCP variable is statistically different from zero at the 99 percent level, with coefficients around -0.33 and -0.27, respectively.
Moreover, the level of central city blight is also correlated to the initial level of blight (measured here as the percentage of new housing units built during the 80s). The lower the initial level of central city blight, the lower the level of blight in 2000.

[Figure 3.5 about here]

So far, we have provided evidence on the negative correlation existing between UCP and the central city blight. Nonetheless, as explained at the beginning of the paper, blight is also correlated to sprawl as they are driven by the same process, both being responses to fundamental market failures distorting the socially desired allocation of population and urban land within jurisdictions (Brueckner and Helsley, 2011). According to this, the adoption of UCP should also be related to lower levels of sprawl in the MSAs considered. As it is shown in Figure 3.6, there is a clear correlation between the central city blight (measured as our index of blight after PCA) and the sprawl of the suburbs, proxied here as the population density (inhabitants / urbanized land). Those MSA with higher population densities (i.e. the less sprawled ones) face

lower levels of central city blight. Hence, the higher the level of central city deterioration, the higher the level of sprawl in that MSA.

[Figure 3.6 about here]

### 3.4. Main results and policy implications

The regression-based results of the empirical model are provided in Table 3.7. The analysis tests whether the adoption of UCPs leads to lower blight levels in central cities, ceteris paribus. According to the PCA applied to the set of blight measures (see *Section 3.2*), two separate regression analysis are presented. The two panels labelled *External building conditions* and *Neighbourhood building conditions* represent the two indexes obtained after PCA. For the sake of clarity, a linear transformation has been applied to each index so as to take values on the interval (0,100).
Note that the econometric specification implemented enables us to identify the specific correlation between UCP and blight, since we are able to isolate the effects of other city level characteristics by introducing the set of control variables explained above. In other words, we are now in a position to compare cities with the same characteristics in order to see if those contained experienced a reduction in blight.

Columns (1) to (4) report the estimated coefficients from different model specifications according to expression (1). Then, in Column (1) only the UCP variable is included. Next, in Column (2) we add the initial level of central city blight. In Column (3) a set of control variables is also added to the model, as given by expression (1). Finally, in column (4) we additionally include regional dummies for big regions (Northeast, South, West and Midwest – the latter was the omitted category-) to capture all other region-specific unobservable characteristics. To aid comparison across variables, we report standardized coefficients that measure the absolute change in the blight index for a one standard deviation change in each explanatory variable.

Consistent with a priori expectations of economic theory (see Brueckner and Helsley, 2011), the regression findings show that the adoption of more stringent anti-sprawl policies help reducing the deterioration in central city structures. U.S. central

cities within contained metropolitan areas, measured here by the adoption of urban containment programs, have lower blight levels than in those within metropolitan areas without urban containment policies in place. It is also interesting to note that this result holds for the two indexes of blight. Unless estimated coefficients are always negative, as expected, they are only statistically significant for the index of *external building conditions* (panel *a*). Then, cities with UCP in place have seen average declines in their blight index of approximately 6 points. As it is shown in panel *b*, no significant effects were found on the *neighbourhood building conditions* index. Besides, the estimated results show that the initial level of blight, proxied here as the percent of new housing units built between 1980 and 1990, helps reducing the current level of blight. That is, the higher the proportion of new housing units built in the past and, hence, the lower the level of initial blight, the lower the level of central city blight in 2000. In particular, one standard deviation increase in the proportion of new housing built in the 80s yields to a 4 points decrease in the first blight index considered. The impact on the second blight index (neighbourhood conditions) ranges from 3 to 7 points, depending on whether regional dummies are included or not.

We now turn to the interpretation of the results obtained for the set of control variables included in the baseline model given by expression (1) and presented in Columns (3) and (4). In general, all estimated coefficients have the expected sign regardless the lack of statistical significance of some of them. First, richer central cities experience less blight than the poorer ones. A one standard deviation increase in the median household income of central cities results in an approximately 4 or 5 points decrease in the blight indexes. Second, Table 3.7 also shows a negative impact of central city population on blight. Nonetheless, the magnitude of the estimated coefficients is quite small and it does not have a statistically significant impact on city blight.

[Table 3.7 about here]

The results obtained for the variables accounting for the *flight from blight* are in accordance with the theory as they exhibit a clearly positive influence on the level of central city blight. A one standard deviation increase in the percent of central city population that is hispanic increases the blight index of *external building conditions* in around 3 points, while one standard deviation increase in the percent of black

population living in central places increases the blight index of *neighborhood building conditions* between 6 and 8 points. A higher level of central city crime has a clear positive impact on blight in all specifications considered. As it is shown in Table 3.7, one standard deviation increase in this variable yields to an increase in the blight index that ranges from 3 to 5 points.

With regard to the amount of per capita federal aid received has a significant impact on the level of central city blight. In particular, one standard deviation increase in this variable reduces the blight index of *external building conditions* by 3 points. Thus, results indicate that federal spending in central cities contributes to the vitality of the cities and, hence, to blight reduction.

Finally, note that when regional dummies are added to the econometric specification (Column (4)) the results hold for all variables considered (in terms of magnitude and significance) but the impact of UCP on the neighbourhood conditions index, which becomes clearly insignificant.

Overall, these results are useful to get a feeling for the influence of a certain type of corrective anti-sprawl policy on a desired target variable, namely prevention of central city deterioration. Besides, the explanatory capacity of the model is considerably high (between 0.35 and 0.50) and consistent with results obtained in previous related literature.

### 3.5. Additional results

We explore the sensitivity of our results in a number of different ways. First, data provided by Nelson et al (2004) allows us to differentiate between two types of UCP according to their scope. In particular, a distinction can be established between areas with region-wide containment programs and areas with containment programs in place within a subset of the region's jurisdictions (see Table 3.5 in Section 3.3). According to

the results presented in Columns (1) and (2) of Table 3.8, no consistent effects were found[14].

Second, urban containment was measured by the existence of a formally adopted containment policy (growth boundary, service extension limits or greenbelt) prior to the start of the study period in 2001. In addition, the availability of the year in which containment programs were established is used to test the proposition that effects would be more pronounced the longer the programs were in existence. To that aim, we perform additional estimations including three categorical variables that take value 1 whether the UCP was adopted in the 70s, 80s and 90s, respectively. As it is shown in Columns (3) and (4) of Table 3.8 regression results indicate that the year of adoption of UCPs has not a statistically significant different impact on blight reduction. This finding is in line with Nelson et al (2004) results. They analyze whether UCPs have an impact on the level of central-city construction activity and provide evidence of no consistent effects of length of program.

[Table 3.8 about here]

The estimated coefficients of the set of control variables are very close to those presented in the previous section (see Table 3.7) and, therefore, no further comments are presented here.

## 3.6. Robustness checks

### *3.6.1. An alternative measure of blight: an average of the initial blight variables*

As explained in Section 3.2, the dataset used in the present paper consists of a variety of central city blight measures, regarding different aspects of building conditions. The statistical technique applied to the data is clearly the most suitable one, as it summarizes all the available information in a smaller number of variables with minimum loss of information. In doing so, the index obtained accounts for the co-variation shared by all the original variables and, therefore, this may be a better estimate than simple or weighted averages of the initial blight measures. Nonetheless, in this

[14] A *t test* on the linear combination of the estimated coefficients of these variables was performed. The null hypothesis was not rejected, indicating that the difference between the two coefficients is not statistically different from zero.

section we define an alternative measure of blight as the average of all variables considered. The results are presented in Table 3.9.

[Table 3.9 about here]

The results are in line with the ones presented in Table 3.7 albeit the lower magnitude of all the coefficients. The impact of the UCP ranges from 1 to 3 points decrease in the average level of central city blight, while this effect disappears once the regional dummies are included in the model. With regard to the set of controls, all have the expected sign but a magnitude around the unity in almost all cases. These results could reflect the lower capacity of the average measure of blight as a variable to summarize adequately the information contained in the initial blight measures.

*3.6.2. An alternative measure of anti-sprawl policies: the Wharton Residential Land Use Regulation Index.*

As stated in the introduction, UCP are newly designed urban containment policies have emerged in response to the perverse consequences of traditional restrictive land-use controls. These policies combine regulations and incentives to guide and efficiently allocate new development as well as to balance the forces of decentralization and promote the revitalisation of communities. To that aim, they can combine mixed-use and high-density zoning, affordable housing strategies and land supply monitoring, with capital investment plans and various redevelopment incentives. Therefore, they turn out to be the most suitable growth control policies to address the problem of central city blight.

Nonetheless, there exists in the recent empirical literature of growth controls an alternative measure of anti-sprawl policy, the Wharton Residential Land Use Regulation Index (WRLURI hereinafter) developed in Gyourko, Saiz and Summers (2008). The authors use a nationwide municipal survey of land use regulation, the 2005 Wharton Regulation Survey, to produce a number of indexes that summarize information on the different aspects of the regulatory environment and capture the intensity of local growth control policies in a number of dimensions[15]. These indexes are then compiled in a

[15] This dimensions include: the degree of involvement by various local actors in the development process; state-level legislative and executive branch activity pertaining to land use

single aggregate measure by means of factor analysis, the WRLURI. Saiz (2010) processes the original municipal-based data to create average regulation indexes by metropolitan area using the probability sample weights developed by Gyourko, Saiz, and Summers (2008). Lower values in the Wharton Regulation Index indicate a less restrictive or more laissez-faire approach toward real estate development. Metropolitan areas with high values of the index conversely have zoning regulations or project approval practices that constrain new residential real estate development.

This measure is not entirely appropriate for the present study for two main reasons. First, as it captures the overall regulatory environment, it encompasses many regulations that are not directly related to the control of sprawl. Second, the regulations considered in the index are mainly related to traditional land-use regulations (such as zoning ordinances or minimum lot sizes) but they do not explicitly address high-density zoning, affordable housing strategies, land supply monitoring, capital investment plans or any other redevelopment incentive to promote downtown revitalisation. These shortfalls prevented us from using the index as the main growth control policy in the paper. Nonetheless, the significant correlation of the WRLURI with the UCP variable (around 0.5) let us consider it as a plausible alternative measure of growth control management for the following reason. Measures considered in the WRLURI are not explicitly designed to prevent urban decay and promote central city revitalisation but it is also true that blight reduction could emerge as an indirect byproduct of those policies. Thus, and being aware of its limitations, we use the WRLURI to perform further estimations of the baseline model for a robustness check. The results are presented in Table 3.10.

[Table 3.10 about here]

regulation; state court involvement and the degree of deference to municipal control (based on the tendency of appellate courts to uphold or restrain four types of municipal land-use regulations: impact fees and exactions, fair share development requirements, building moratoria, and spot or exclusionary zoning.); local zoning approval; local project approval; local assembly (measures direct democracy and captures whether there is a community meeting or assembly before which any zoning or rezoning request must be presented and voted up or down); supply restrictions (reflects the extent to which there are explicit constraints on supplying new units to the market); density restrictions in the form of minimum lot size requirements; and exactions required to developers to pay their allocable share of costs of any infrastructure improvement associated with new development. See Gyourko et al (2008) for further details.

As expected, the impact of the WRLURI on central city blight reduction is lower than the one obtained with UCP. As noted above, the difference in these results could be explained on the ground of each policy design. The UCP are explicitly designed to control blight and promote central city revitalisation while the regulations considered in the WRLURI focus on sprawl control and, indirectly, their implementation could have a positive but not intended effect of central city blight reduction.

*3.6.3. Addressing the possible endogeneity problem of growth control programs.*

In this section we account for the fact that the relationship between UCP and blight might be bidirectional. That is, since central cities with higher levels of urban decay in previous years are more likely to adopt policies to contain urban blight, containment programs may affect and be affected by the level of central city blight. Although we control for this fact to some degree by restricting the definition of the presence of UCP to those MSAs that adopted policies prior to the study period (year 2000), any correlation between lagged city blight and current blight levels would reintroduce the problem. In order to address this potential endogeneity problem, we estimate our baseline model by means of two-stage least squares (TSLS).

Thus, we need to find a group of variables correlated to UCP but not related to the level of central city blight. In this regard, a revision of the literature points out that the locations with more desirable amenities are more regulated (see, for instance, Hilbert and Robert-Nicoud, 2010; Saiz, 2010). Given that people prefer to live in nice places, places endowed with desirable amenities are developed earlier and it is likely that land-use regulations are required to limit excessive urban growth and to preserve those locations. Saiz (2010) also asserts that growth managements programs correlate with the fraction of unavailable land within each MSA, which is calculated combining the area corresponding to steep slopes, oceans, wetlands, lakes and other water features. Intuitively, this variable is correlated with UCP because MSAs with a greater proportion of unavailable land are more likely to be interested in adopting containment programs to limit urban expansion. Likewise, this variable should not be correlated with the current level of city blight because it has been exogenously determined.

Besides, political ideology is also assumed to play an important role in determining the strength of preferences for environmental preservation (Kahn, 2011) and, hence, to

promote stronger growth management programs (Nelson et al, 2004; Hilber and Robert-Nicoud, 2010).

The degree of fragmentation in the planning system of a region could lead to possible development competitions in fringe areas, promoting low density suburbanisation (Carruthers and Ulfarsson, 2002; Carruthers, 2003; Wassmer, 2008). As noted in Carruthers (2002), the political fragmentation of regions is also responsible for fostering sprawl and blight because, by dividing authority among many small local governments, it undermines the overall ability of land-use planning to shape the outcome of metropolitan growth. That is to say, a higher number of local government units within the MSA leads to a weaker coordination of land-use policies, facilitating suburban development while contributing to downtown deterioration. Thus, efforts aimed at promoting jurisdictional cooperation and regulatory consistency across metropolitan areas are central for efficacy of growth management programs.

Thus, the set of variables chosen as instruments for the UCP are the following. First, local amenities are proxied by the average heating and cooling-degree days, a coastal dummy and the percentage of undevelopable land provided in Saiz (2010). Second, the influence of political ideology is proxied here by the state share of votes that went for the Democratic candidate in the 1976 presidential election. Third, political fragmentation is measured as the per capita number of counties within each MSA. Finally, the homeownership rate in 1990 is also included as an instrument; to account for the fact that homeowners favour regulations to raise their property values and, therefore, locations with a large share of homeowners should be more regulated (Fischel, 2001).

We run a first-stage regression where the possible endogenous variable, UCP, is regressed on the set of instruments explained above plus the other control variables of the model (given by expression (3.1)). Then, the predicted variable is included in a second-stage regression as independent variable in the original regression equation. The regression results of equation (3.1) with UCP being treated as endogenous variable are provided in Table 3.11. Column (1) reports the first-stage estimated coefficients of our instruments. The results show that the share of democratic vote, the mean heating degree days and the percentage of undevelopable land are particularly helpful in our quest to identify the effects of UCP on blight. On the one hand, liberal voters are

probably more interested in conservation issues and, thus, more likely to be interested in adopting UCP to curb urban sprawl. On the other hand, local amenities play an important role in explaining the regulatory environment. First, the higher the percentage of undevelopable land the higher the level of regulation required to limit urban expansion. Second, the mean heating degree days capture the city's extremely hot climate. This is a characteristic that makes open space less attractive and, in turn, less correlated to sprawl and the need for stronger growth management programs, as shown by the negative sign of its estimated coefficient. Finally, the level of fragmentation, the homeownership rate, the mean cooling degree days and the coastal dummy have the expected sign although they are not significant. Nevertheless, the set of instruments is jointly significant[16].

[Table 3.11 about here]

Column (2) reports the TSLS regression results for the *external building conditions* index. The TSLS coefficient for the UCP variable is negative and significant. The coefficient is larger than the OLS one (see Table 3.7), confirming the presence of a downward bias. According to this result, contained cities exhibit an index of central city blight 17 points lower than those uncontained. As to our set of controls, all coefficients have the expected sign and a very similar magnitude to those obtained for our OLS specifications (see Table 3.7), albeit only the income and federal aid variables remain significant. The results for the *neighbourhood conditions* index are provided in Column (3). Once again, the impact of the UCP is negative, as expected, but not significant.

## 3.7. Conclusions

US post-war suburbanization has reshaped the spatial pattern of growth in many metropolitan areas. Both population and employment shift toward the suburbs has resulted in urban decay of central cities. There is a body of research focused on policy remedies aimed at curbing sprawl and fostering more compact urban developments. One of its main theoretical conclusions is that city blight turns out to be a beneficial byproduct of anti-sprawl programs, as they not only limit urban growth but provide

[16] The Sargan test of overidentifying restrictions was performed after the first-stage estimation and the null hypothesis of valid instruments was not rejected (see Table 3.11).

incentives to redirect population growth and investment away from the suburbs toward neglected inner core areas (Brueckner and Helsley, 2011).

Unless the phenomenon of blight has a more than 50-year history, the discussion on its causes and possible policy remedies is rather a phenomenon from recent years. In fact, empirical evidence on city blight and the effectiveness of anti-sprawl policies on preventing the deterioration of downtown structures is somewhat limited. Several studies have recently analyzed the impact of growth management programs on sprawl (Wassmer, 2006; Woo and Guldmann, 2011) and central city revitalization (Dawkins and Nelson, 2003; Nelson et al, 2004b). Nonetheless, these studies focus on population, employment and construction activity to proxy central city status rather than a measure of blight per se. Unlike existing research, the present study is a first attempt to analyze the impact of anti-sprawl policies, proxied by the adoption of metro-level urban containment programs, on city blight, defined here as the physical deterioration of downtown structures. Micro data drawn from the American Housing Survey allows us to construct 12 specific blight measures based on external physical characteristics of buildings and neighbourhoods for 125 U.S. central cities. For the sake of simplicity, this information on city blight is summarized in a smaller number of variables with the minimum loss of information by means of Principal Components Analysis. Thus, we end up with two new blight indexes that will be included in the regression analysis as dependent variables. Our empirical specification enables us to determine the specific impact of UCP on the blight level of central cities, as all other metropolitan and city characteristics affecting urban blight are taken into account by the inclusion of a set of control variables. Results indicate that the adoption of UCP translates into significant blight reductions in those contained cities. Thus, we offer empirical evidence that urban containment programs are achieving one of their intended goals of reducing central city deterioration. In this regard, it is also worthwhile to note the non-negligible role played by upper tiers of government, as per capita federal aid also contributes to blight reduction and central city revitalization.

Finally, one must highlight the importance of the central city to the regional economy. Blight reduction can produce positive externalities that enhance the growth and economic progress beyond the city's boundaries. Several studies have empirically addressed this research question. As noted in Voith (1998), suburbs also benefit from investment and revitalization of downtown, as they find that city income growth

enhances suburban growth (Voith, 1998). Another example is provided in Muro and Puentes (2004), where the authors provide evidence on the relationship between reduced city poverty rates and metropolitan income growth.

Therefore, evidence suggests that central cities and their suburban areas remain closely interconnected[17]. This being the case, central city revitalisation and metropolitan area development may be seen as complements rather than substitutes. Both cities and suburbs could improve their welfare through cooperative containment programs aimed at curbing sprawl and fostering more compact urban developments while preventing urban decline in city core areas.

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[17] See Ihlanfeldt (1995) for a review of the arguments and empirical evidence of sources of interdependence that link the economies of central cities and their suburbs.

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## 3.9. Tables and Figures

**Table 3.1. Blight measures from the American Housing Survey, n=125 U.S. cities.**

| | All cities | | | Cities with UCP in place | | | Cities without UCP | | |
|---|---|---|---|---|---|---|---|---|---|
| **Blight measure** | **Mean** | **Min.** | **Max.** | **Mean** | **Min.** | **Max.** | **Mean** | **Min.** | **Max.** |
| **External building conditions (windows, roof & walls):** | | | | | | | | | |
| Percent housing units with windows broken | 5.71 | 0 | 24.43 | 3.93 | 0 | 13.57 | 6.55 | 0 | 24.42 |
| Percent housing units with holes/cracks in foundation | 3.75 | 0 | 30.93 | 2.71 | 0 | 7.95 | 4.37 | 0 | 30.94 |
| Percent housing units with holes in roof | 2.87 | 0 | 10.84 | 1.88 | 0 | 5.53 | 3.28 | 0 | 10.84 |
| Percent housing units with roof missing shingles | 5.08 | 0 | 19.39 | 3.84 | 0 | 10.41 | 5.63 | 0 | 19.39 |
| Percent housing units with outside walls missing siding or bricks | 4.45 | 0 | 26.55 | 2.39 | 0 | 8.2 | 5.29 | 0 | 26.55 |
| Percent housing units with roof's surface sags or is uneven | 3.07 | 0 | 17.57 | 2.11 | 0 | 8.22 | 3.57 | 0 | 17.57 |
| Percent housing units with outside walls slope, lean, slant, buckle. | 2.11 | 0 | 17.09 | 1.24 | 0 | 6.13 | 2.52 | 0 | 17.09 |
| **Neighbourhood conditions:** | | | | | | | | | |
| Percent housing units with abandoned/vandalized buildings within 1/2 block | 8.92 | 0 | 33.18 | 6.34 | 0 | 33.18 | 10.32 | 0 | 31.51 |
| Percent housing units with trash or junk in streets in 1/2 block | 14.61 | 0 | 41.68 | 13.84 | 9.42 | 33.42 | 15.6 | 0 | 41.68 |
| Percent housing units with road within 1/2 block need repairs | 38.26 | 9.42 | 75.96 | 32.38 | 9.42 | 44.37 | 41.99 | 13.46 | 75.96 |

Source: own elaboration based on the American Housing Survey micro data files.

**Table 3.2. Principal Components Analysis for blight measures**

| | kmo measure (1) | Initial eigenvalues | | | Extraction sums of squared loadings | | |
|---|---|---|---|---|---|---|---|
| | | **Total** | **% of variance** | **Cumulative %** | **Total** | **% of variance** | **Cumulative %** |
| **External building conditions:** | 0.8137 | | | | | | |
| Component 1 | | 3.3108 | 47.3 | 47.3 | 3.3108 | 47.3 | 47.3 |
| Component 2 | | 0.9602 | 13.72 | 61.02 | | | |
| Component 3 | | 0.7952 | 11.36 | 72.38 | | | |
| Component 4 | | 0.6475 | 9.25 | 81.63 | | | |
| Component 5 | | 0.4689 | 6.7 | 88.33 | | | |
| Component 6 | | 0.4599 | 6.57 | 94.9 | | | |
| Component 7 | | 0.3572 | 5.1 | 100 | | | |
| **Neighbourhood building conditions:** | 0.6547 | | | | | | |
| Component 1 | | 1.9387 | 64.62 | 64.62 | 1.9387 | 64.62 | 64.62 |
| Component 2 | | 0.6433 | 21.44 | 86.07 | | | |
| Component 3 | | 0.4179 | 13.93 | 100 | | | |

Notes: (1) The Kaiser-Meyer-Olkin measure was performed so as to test whether the partial correlations among variables are small. It provides an index -between 0 and 1- of the proportion of variance among the variables that might be common variance. A value of the index in the .90s is 'marvellous', in the .80s 'meritorious', in the .70s 'middling', in the .60s 'mediocre', in the .50s 'miserable' and below .5 'unacceptable'(Kaiser, 1974). Our analysis gives values of 0.81 and 0.65, respectively, indicating that the sampling adequacy was greater than 0.5 and therefore satisfactory.
The Bartlett's test of sphericity was conducted and the null hypothesis of uncorrelated variables (i.e., the correlation matrix is the identity matrix) was rejected, indicating that the blight sample is adequate for PCA.

**Table 3. Weights, contributions and correlations between the blight measures and the components retained.**

| | Weights (eigenvectors) | Contribution of each variable to the component | Correlation between each variable and the component |
|---|---|---|---|
| **External building conditions (windows, roof & walls):** | | | |
| Percent housing units with windows broken | 0.3233 | 0.1045 | 0.5883 |
| Percent housing units with holes/cracks in foundation | 0.3569 | 0.1274 | 0.6494 |
| Percent housing units with holes in roof | 0.3995 | 0.1596 | 0.7269 |
| Percent housing units with roof missing shingles | 0.3880 | 0.1505 | 0.7060 |
| Percent housing units with outside walls missing siding or bricks | 0.4121 | 0.1698 | 0.7498 |
| Percent housing units with roof's surface sags or is uneven | 0.4126 | 0.1702 | 0.7508 |
| Percent housing units with outside walls slope, lean, slant, buckle. | 0.3434 | 0.1179 | 0.6248 |
| **Neighbourhood conditions:** | | | |
| Percent housing units with abandoned/vandalized buildings within 1/2 block | 0.5961 | 0.3553 | 0.8299 |
| Percent housing units with trash or junk in streets in 1/2 block | 0.5256 | 0.2763 | 0.7318 |
| Percent housing units with road within 1/2 block need repairs | 0.6069 | 0.3683 | 0.8450 |

Source: own elaboration after PCA.

**Table 3.4. Comparisons of the sample MSAs with the MSA population**

| *Selected characteristics* | *Sample MSAs* | *MSA population* |
|---|---|---|
| Total population 1990 | 153,940,911 | 192,727,000 |
| Total population 2000 | 181,046,096 | 225,982,000 |
| Average population 1990 | 1,452,272 | 818,546 |
| Average population 2000 | 1,707,982 | 719,222 |
| Population growth 1990-2000 | 18.83% | 14% |
| Median household income 1990 | 31,076 | 32,086 |
| Median household income 2000 | 44,482 | 41,789 |
| Median household income growth 1990-2000 | 43.13% | 30.24% |
| Unemployment rate 2000 | 4.06% | 4.1% |

Source: U.S. Census Bureau, 1990 and 2000 Census of Population and Housing.

**Table 3.5. Urban Containment Policies**

| | Original sample (n=331) | Our sample (n=107) |
|---|---|---|
| MSAs without UCP: | 229 | 71 |
| MSAs with UCP: | 102 | 36 |
| According to the year of adoption: | | |
| *Adopted in the 60s-70s* | 28 | 12 |
| *Adopted in the 80s* | 38 | 11 |
| *Adopted in the 90s* | 35 | 13 |
| *Adopted in 2000* | 1 | |
| According to the type of UCP: | | |
| *Metro UCP* | 49 | 17 |
| *Submetro UCP* | 53 | 19 |

Source: Own elaboration.

**Table 3.6. Descriptive Statistics**

| Name | Mean (SD) | Min | Max |
|---|---|---|---|
| Urban Containment Programm in place prior to 2000 | 0.3277 (0.4713) | 0 | 1 |
| Initial level of blight (% housing units built 1980-1990) | 13.4739 (9.0111) | 1.5996 | 39.7966 |
| Central city population, 1990 | 451,243 (826,818) | 49,178 | 7,322,564 |
| Central city median household income, 1990 | 26,026.92 (4,823.5) | 16,925 | 46,206 |
| Percent central city population hispanic, 1990 | 10.6281 (15.3505) | 0 | 76.8522 |
| Percent central city population black, 1990 | 22.0704 (17.6074) | 0.8462 | 75.6746 |
| Crime rate: weighted average crimes per 1,000 of the population in central cities, 1990 | 0.05609 (0.0491) | 0.0013 | 0.2453 |
| Federal aid (in 1,000 $) per 100 of the population in central cities, 1990 | 4.6056 (5.6183) | 0.0001 | 26.2941 |

Source: own elaboration

**Table 3.7. Estimation results of urban containment effect on central city blight.**

| *Dependent variable:* | External building conditions | | | | Neighbourhood building conditions | | | |
|---|---|---|---|---|---|---|---|---|
| *Explanatory variables:* | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| Urban Containment Policy | -13.98*** | -12.84*** | -6.974** | -5.808* | -11.47*** | -7.586** | -0.667 | 1.589 |
| | (3.018) | (3.085) | (3.228) | (3.362) | (3.450) | (3.257) | (3.320) | (3.365) |
| Initial level of blight | | -4.833*** | -4.660** | -4.178** | | -10.30*** | -7.452*** | -3.182* |
| | | (1.833) | (2.039) | (2.019) | | (1.732) | (1.734) | (1.786) |
| Central city population, 1990 | | | -1.486 | -1.333 | | | 0.297 | -0.891 |
| | | | (1.190) | (1.253) | | | (1.064) | (1.081) |
| central city median household income, 1990 | | | -5.219** | -4.901** | | | -3.887** | -4.836*** |
| | | | (2.205) | (2.261) | | | (1.751) | (1.814) |
| Percent central city population hispanic | | | 2.475 | 3.212* | | | 0.589 | 1.157 |
| | | | (1.831) | (1.901) | | | (1.543) | (1.403) |
| Percent central city population black | | | 0.608 | 0.511 | | | 5.861*** | 8.364*** |
| | | | (2.753) | (2.925) | | | (2.146) | (2.211) |
| Percent central city crime rate | | | 3.905* | 3.866* | | | 3.268* | 4.992** |
| | | | (2.064) | (2.161) | | | (1.844) | (1.914) |
| Per capita federal aid, central city | | | -3.201** | -2.721* | | | -0.0727 | -0.641 |
| | | | (1.352) | (1.490) | | | (1.359) | (1.344) |
| Regional dummies | No | No | No | Yes | No | No | No | Yes |
| Constant | 33.03*** | 39.96*** | 62.37*** | 63.99*** | 44.50*** | 58.28*** | 60.92*** | 57.59*** |
| | (2.411) | (3.942) | (12.50) | (11.97) | (2.428) | (3.716) | (10.67) | (10.58) |
| R-squared | 0.110 | 0.177 | 0.315 | 0.338 | 0.070 | 0.311 | 0.505 | 0.557 |

Notes: (i) * Significantly different from zero at the 90 percent level, ** Significantly different from zero at the 95 percent level, *** Significantly different from zero at the 99 percent level; (ii) Robust standard errors in parentheses.

**Table 3.8. Estimation results of urban containment effect on central city blight (UCP by type and year of adoption), n=105**

| *Dependent variable:* | a. External building conditions | | | | c. Neighbourhood building conditions | | | |
|---|---|---|---|---|---|---|---|---|
| *Explanatory variables:* | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| Urban Containment Policy: | | | | | | | | |
| metro UCP | -12.77*** | -5.572* | | | -10.09*** | 0.0538 | | |
| | (3.465) | (3.140) | | | (3.262) | (3.717) | | |
| submetro UCP | -12.89*** | -5.990 | | | -5.325 | 2.774 | | |
| | (3.661) | (4.632) | | | (4.459) | (4.367) | | |
| UCP_70s | | | -13.49*** | -7.177 | | | -10.86** | 0.719 |
| | | | (4.159) | (4.927) | | | (4.362) | (4.630) |
| UCP_80s | | | -12.68*** | -1.498 | | | -5.420 | 4.599 |
| | | | (4.215) | (4.856) | | | (4.274) | (4.524) |
| UCP_90s | | | -12.35*** | -7.106* | | | -6.219 | 0.616 |
| | | | (3.777) | (3.883) | | | (4.965) | (4.041) |
| Initial level of blight | -4.832** | -4.175** | -4.848** | -4.461** | -10.32*** | -3.202* | -10.44*** | -3.373* |
| | (1.842) | (2.032) | (1.881) | (2.120) | (1.725) | (1.800) | (1.766) | (1.867) |
| Central city population, 1990 | | -1.342 | | -1.191 | | -0.831 | | -0.790 |
| | | (1.267) | | (1.277) | | (1.105) | | (1.102) |
| central city median household income, 1990 | | -4.855** | | -5.176** | | -5.134** | | -5.036*** |
| | | (2.345) | | (2.600) | | (2.014) | | (1.886) |
| Percent central city population hispanic | | 3.212* | | 3.119 | | 1.159 | | 1.087 |
| | | (1.913) | | (1.984) | | (1.376) | | (1.395) |
| Percent central city population black | | 0.533 | | 0.117 | | 8.220*** | | 8.087*** |
| | | (2.968) | | (3.031) | | (2.250) | | (2.263) |
| Percent central city crime rate | | 3.869* | | 4.029* | | 4.972*** | | 5.111*** |
| | | (2.175) | | (2.195) | | (1.879) | | (1.879) |
| Per capita federal aid, central city | | -2.749* | | -3.025* | | -0.456 | | -0.857 |
| | | (1.589) | | (1.628) | | (1.381) | | (1.367) |
| | | -8.640 | | -8.523 | | 9.128 | | 9.634 |
| Regional dummies | No | Yes | No | Yes | No | Yes | No | Yes |
| Constant | 39.95*** | 63.75*** | 39.98*** | 66.23*** | 58.32*** | 59.15*** | 58.48*** | 59.19*** |
| | (3.962) | (12.39) | (4.015) | (13.67) | (3.720) | (11.62) | (3.771) | (11.11) |
| Observations | | | | | | | | |
| R-squared | 0.177 | 0.338 | 0.177 | 0.343 | 0.315 | 0.558 | 0.315 | 0.560 |

Notes: (i) * Significantly different from zero at the 90 percent level, ** Significantly different from zero at the 95 percent level, *** Significantly different from zero at the 99 percent level; (ii) Robust standard errors in parentheses.

**Table 3.9. Estimation results of urban containment effect on average central city blight, n=105.**

| *Explanatory variables:* | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Urban Containment Policy | -2.714*** | -2.196*** | -0.905* | -0.540 |
| | (0.549) | (0.523) | (0.525) | (0.579) |
| Initial level of blight | | -1.556*** | -1.250*** | -0.769** |
| | | (0.293) | (0.319) | (0.319) |
| Central city population, 1990 | | | -0.0873 | -0.189 |
| | | | (0.190) | (0.202) |
| central city median household income, 1990 | | | -0.873*** | -0.928*** |
| | | | (0.318) | (0.342) |
| Percent central city population hispanic | | | 0.164 | 0.307 |
| | | | (0.243) | (0.244) |
| Percent central city population black | | | 0.554 | 0.789* |
| | | | (0.429) | (0.457) |
| Percent central city crime rate | | | 0.846** | 1.015*** |
| | | | (0.338) | (0.368) |
| Per capita federal aid, central city | | | -0.370* | -0.371* |
| | | | (0.202) | (0.223) |
| Regional dummies | No | No | No | Yes |
| Constant | 9.273*** | 11.40*** | 13.76*** | 13.60*** |
| | (0.422) | (0.665) | (1.908) | (1.912) |
| R-squared | 0.129 | 0.308 | 0.483 | 0.504 |

Notes: (i) * Significantly different from zero at the 90 percent level, ** Significantly different from zero at the 95 percent level, *** Significantly different from zero at the 99 percent level; (ii) Robust standard errors in parentheses.

**Table 10. Estimation results of the Wharton Residential Land Use Regulation Index on central city blight, n=102.**

| *Dependent variable:* | External building conditions | | | | Neighbourhood building conditions | | | |
|---|---|---|---|---|---|---|---|---|
| *Explanatory variables:* | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| WRLURI | -7.752*** | -7.273*** | -5.357*** | -4.244* | -1.780 | -0.870 | 2.234 | 1.008 |
| | (2.080) | (2.015) | (2.034) | (2.547) | (2.359) | (2.063) | (1.781) | (2.020) |
| Initial level of blight | | -5.783*** | -5.007** | -3.477* | | -10.99*** | -7.166*** | -3.000 |
| | | (1.876) | (2.080) | (2.091) | | (1.782) | (1.801) | (1.914) |
| Central city population, 1990 | | | -0.868 | -1.035 | | | 0.348 | -0.747 |
| | | | (1.200) | (1.276) | | | (1.058) | (1.122) |
| Central city median household income, 1990 | | | -5.730** | -5.816** | | | -4.496** | -4.878** |
| | | | (2.210) | (2.286) | | | (1.770) | (1.868) |
| Percent central city population hispanic | | | 3.494* | 4.005** | | | 0.173 | 1.083 |
| | | | (1.806) | (1.854) | | | (1.604) | (1.352) |
| Percent central city population black | | | 0.918 | 1.491 | | | 5.934*** | 8.518*** |
| | | | (2.826) | (3.067) | | | (2.203) | (2.366) |
| Percent central city crime rate | | | 3.667 | 3.930* | | | 3.079 | 4.432** |
| | | | (2.307) | (2.363) | | | (2.091) | (2.034) |
| Per capita federal aid, central city | | | -3.200** | -3.017* | | | -0.170 | -0.715 |
| | | | (1.501) | (1.610) | | | (1.463) | (1.494) |
| Regional dummies | No | No | No | Yes | No | No | No | Yes |
| Constant | 28.72*** | 37.40*** | 62.26*** | 63.97*** | 40.19*** | 56.70*** | 63.90*** | 58.65*** |
| | (1.995) | (3.842) | (12.92) | (12.24) | (2.082) | (3.747) | (10.90) | (11.00) |
| R-squared | 0.083 | 0.164 | 0.322 | 0.337 | 0.004 | 0.292 | 0.498 | 0.547 |

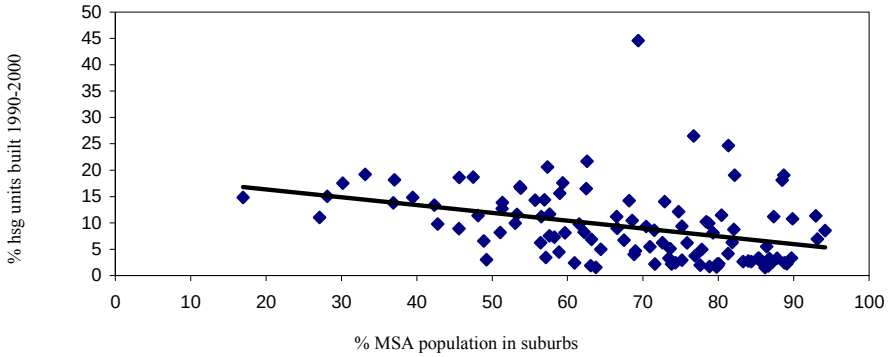
Notes: (i) * Significantly different from zero at the 90 percent level, ** Significantly different from zero at the 95 percent level, *** Significantly different from zero at the 99 percent level; (ii) Robust standard errors in parentheses.

**Table 3.11. Instrumental Variables approach**

| | **First-stage** | **Second-stage** | |
|---|---|---|---|
| *Dependent variable:* | | External building conditions | Neighbourhood building conditions |
| *Explanatory variables:* | | | |
| Urban Containment Policy *(instrumented)* | | -17.76** | -3.871 |
| | | (9.158) | (7.594) |
| Initial level of blight | 0.0508 | -3.311 | -7.022*** |
| | (0.0932) | (2.103) | (1.718) |
| Central city population, 1990 | -0.0360 | -0.901 | 0.943 |
| | (0.0396) | (1.437) | (1.305) |
| Central city median household income, 1990 | 0.0903 | -5.633* | -4.449 |
| | (0.101) | (3.396) | (2.892) |
| Percent central city population hispanic | -0.116 | 1.855 | 0.543 |
| | (0.0824) | (1.864) | (1.408) |
| Percent central city population black | -0.0455 | -0.041 | 5.346** |
| | (0.0736) | (2.827) | (2.153) |
| Percent central city crime rate | -0.0469 | 3.292 | 2.870* |
| | (0.0617) | (2.061) | (1.749) |
| Per capita federal aid, central city | 0.0179 | -3.095** | 0.167 |
| | (0.0483) | (1.614) | (1.492) |
| *Instruments:* | | | |
| Share democratic vote, 1972 | 0.0134*** | | |
| | (0.00418) | | |
| Fragmentation | -0.0481 | | |
| | (0.0628) | | |
| Homeownership rate, 1990 | 0.00770 | | |
| | (0.0515) | | |
| Mean heating degree days | -0.153** | | |
| | (0.0763) | | |
| Mean cooling degree days | -0.0407 | | |
| | (0.124) | | |
| Coastal dummy | 0.172 | | |
| | (0.167) | | |
| Percent unavailable land | 0.10021* | | |
| | (0.0528) | | |
| Constant | -0.229 | 66.67*** | 63.73*** |
| | (0.717) | (16.34) | (14.88) |
| R-squared | 0.313 | 0.232 | 0.470 |
| *Sargan test* | | 3.2048 | 10.0972 |
| *F-Statistic* | 7.43 | | |

Notes: (i) * Significantly different from zero at the 90 percent level, ** Significantly different from zero at the 95 percent level, *** Significantly different from zero at the 99 percent level; (ii) Robust standard errors in parentheses.

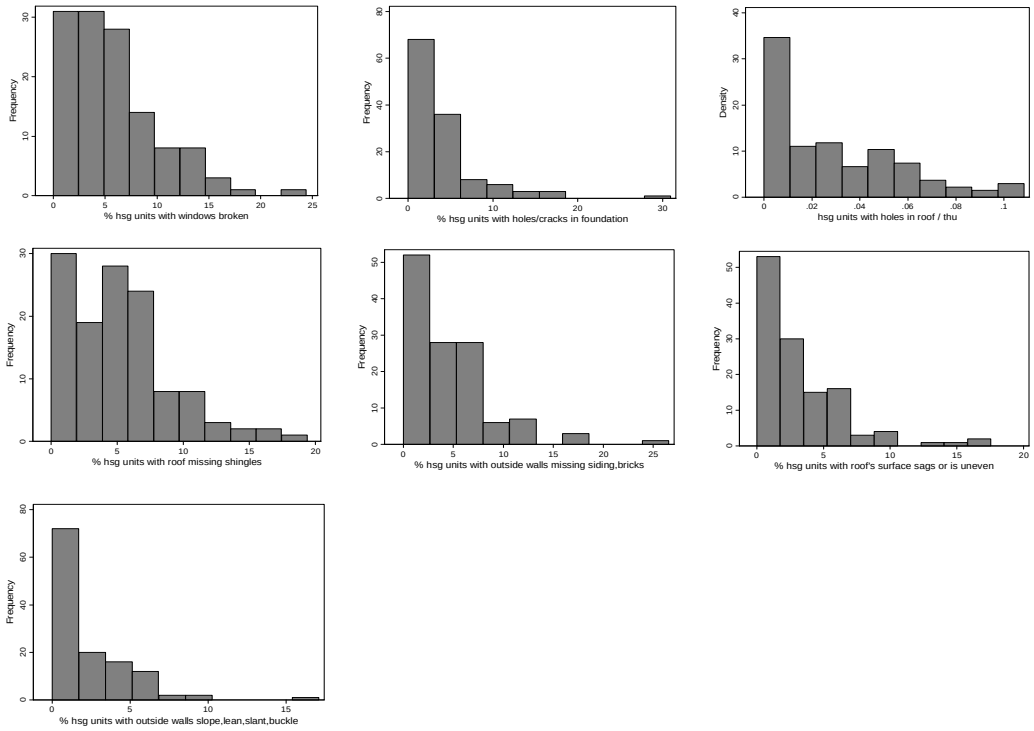
**Figure 3.1. Correlation between sprawl and blight**



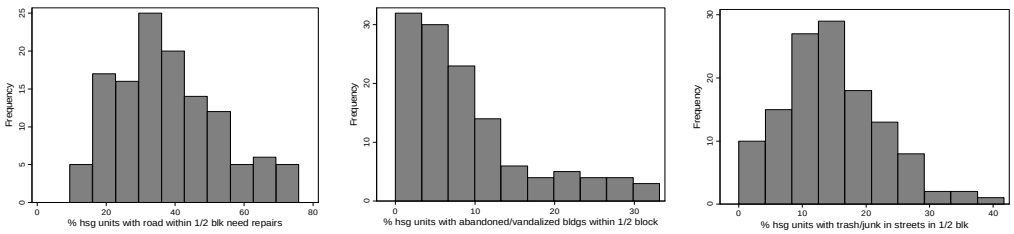

Own elaboration using data of U.S. Bureau of Census.

**Figure 3.2. Frequency distributions of selected blight measures.**

*External building conditions (windows, roof and walls):*

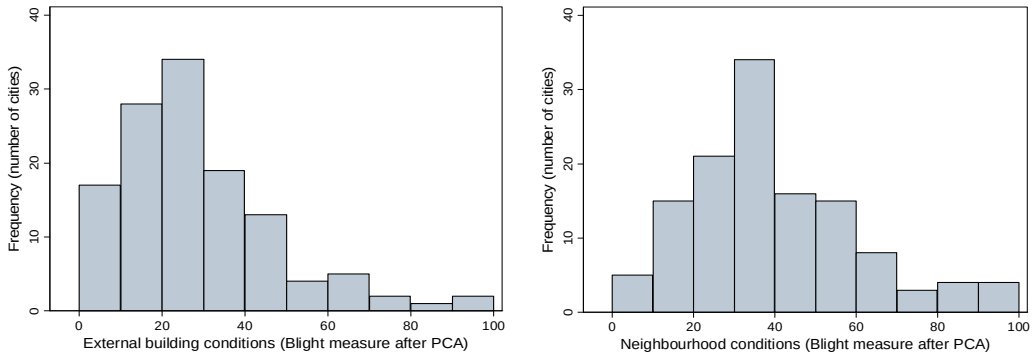



*Neighbourhood building conditions:*



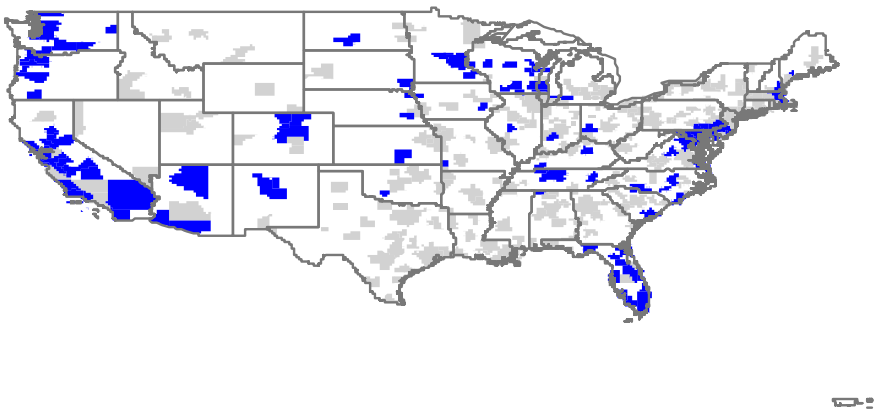

Own elaboration using data of the American Housing Survey.

**Figure 3.3. Frequency distributions of new blight measures**




Source: own elaboration after PCA.

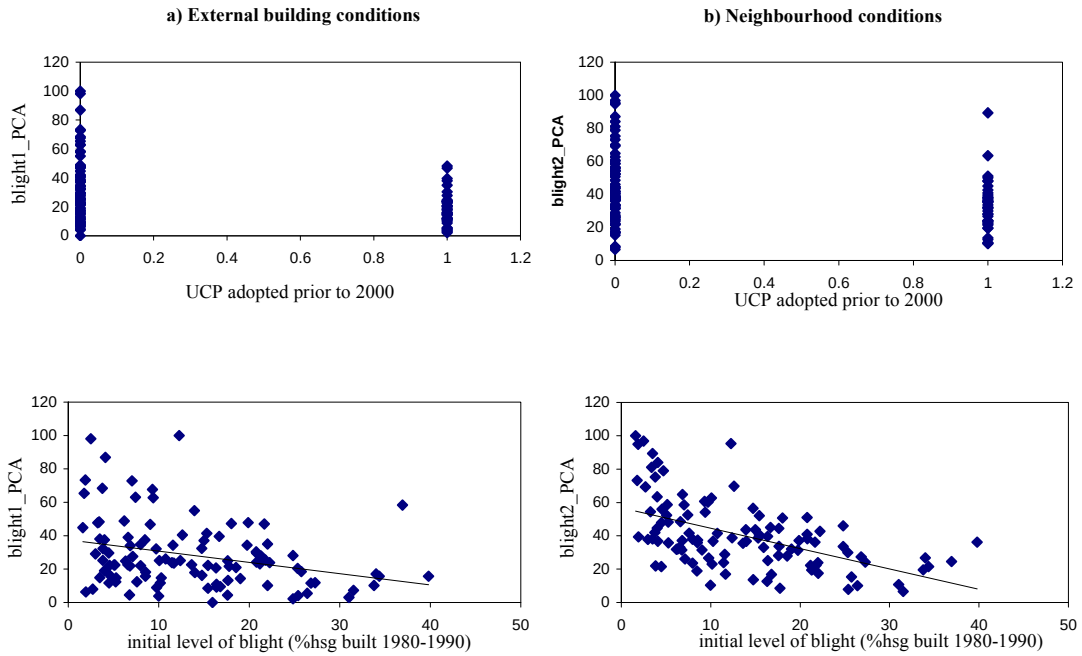
**Figure 3.4. Metrolopiltan Statistical Areas included in the UCP sample**



Notes: in blue MSAs that adopted UCP prior to 2000; in grey those MSA without UCP in place.

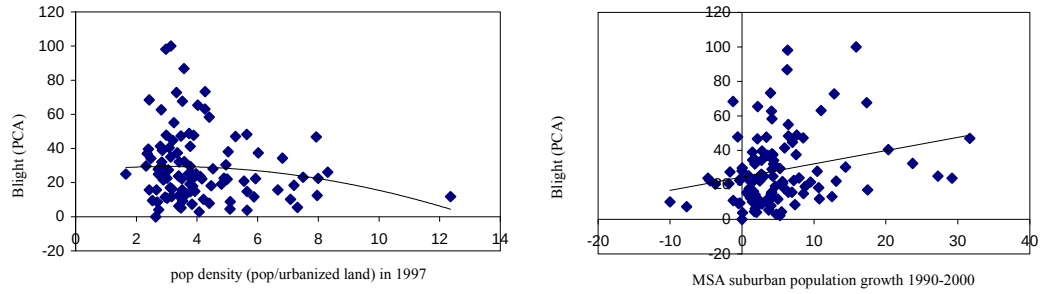
Source: own elaboration using TIGER/Line Shapefile, U.S., Metropolitan Division National., provided by the U.S. Department of Commerce, U.S. Census Bureau, Geography Division. Data provided by Nelson et al (2004)

**Figure 3.5. The correlates of central city blight.**




Source: own elaboration after PCA.

**Figure 3.6. Correlation between sprawl and urban blight**




Own elaboration. Blight (PCA) is the blight index obtained after PCA (external building conditions)

## Appendix 3.1. Maps on blight and urban containment programs.

**Figure A3.1. Metrolopiltan Statistical Areas included in the blight sample, n=125.**

Source: own elaboration using the American Housing Survey data files and the *TIGER/Line Shapefile, U.S., Metropolitan Division National.,* provided by the U.S. Department of Commerce, U.S. Census Bureau, Geography Division.

**Figure A3.2. The degree of central city blight, 2000*, n=125.**


(*) External building conditions (blight index obtained after PCA)

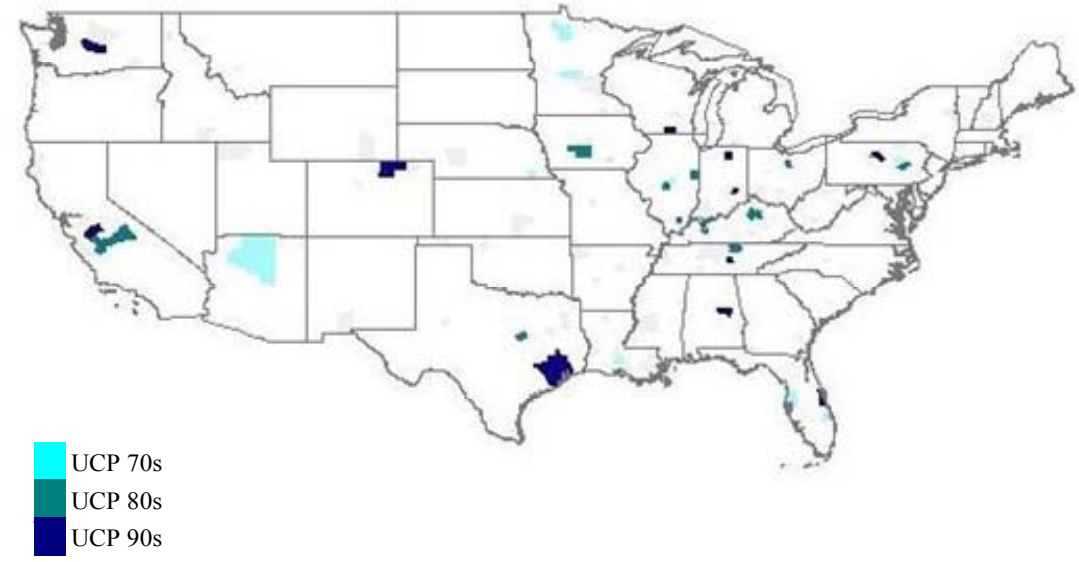
Source: own elaboration using TIGER/Line Shapefile, U.S., Metropolitan Division National., provided by the U.S. Department of Commerce, U.S. Census Bureau, Geography Division.

**Figure A3.3. The degree of central city blight, 2000*, n=125.**


(*) Neighbourhood conditions (blight index obtained after PCA)

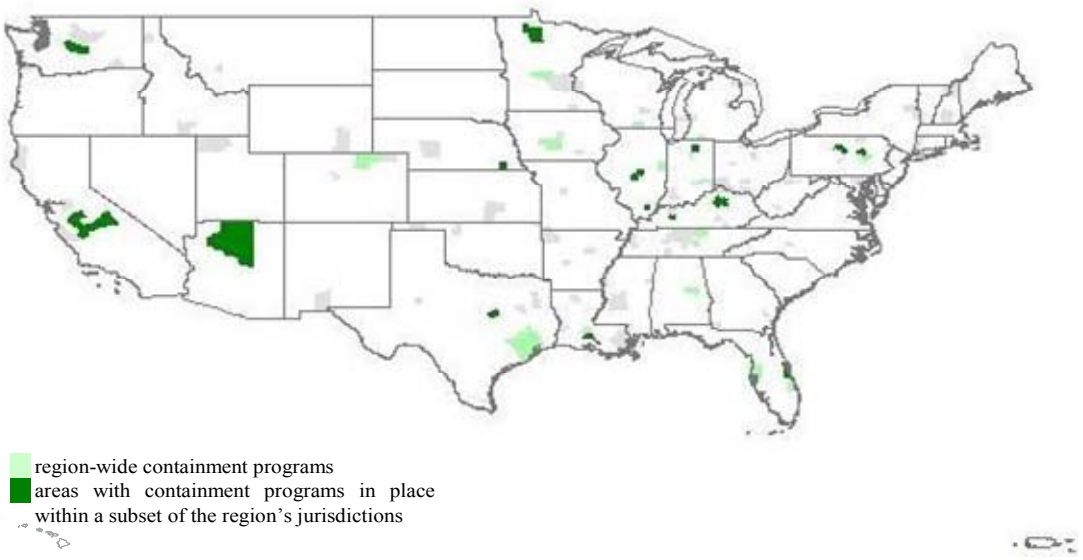
Source: own elaboration using TIGER/Line Shapefile, U.S., Metropolitan Division National., provided by the U.S. Department of Commerce, U.S. Census Bureau, Geography Division.

**Figure A3.4. Metrolopiltan Statistical Areas in the sample according to the year of adoption of the UCP, n=107.**




Source: own elaboration using *TIGER/Line Shapefile, U.S., Metropolitan Division National.,* provided by the U.S. Department of Commerce, U.S. Census Bureau, Geography Division. Data provided by Nelson et al (2004)

**Figure A3.5. Metrolopiltan Statistical Areas in the sample according to the type of UCP adopted, n=107.**




Source: own elaboration using *TIGER/Line Shapefile, U.S., Metropolitan Division National.,* provided by the U.S. Department of Commerce, U.S. Census Bureau, Geography Division. Data provided by Nelson et al (2004)

## Appendix 3.2. Principal Components Analysis

Principal Components Analysis (PCA hereinafter) is a multivariate statistical technique used to reduce the number of variables in a data set into a smaller number of 'dimensions'. PCA is applied whenever a set of correlated and quantitative variables are available with the aim of obtaining a reduced number of variables, uncorrelated among them and defined as linear combinations of the original ones, so-called principal components (PC hereinafter) or factors, that summarize the original set of variables with the minimum loss of information (Hair et al, 2010).

In mathematical terms, from an initial set of $p$ correlated variables, PCA creates uncorrelated components or factors, where each component is a linear weighted combination of the standardized initial variables. For example, from a set of variables $X_1$ through to $X_p$,

$$\begin{aligned} C_1 &= u_{11}x_1 + u_{12}x_2 + \cdots + u_{1p}x_p) \\ &\vdots \\ C_p &= u_{n1}x_1 + u_{n2}x_2 + \cdots + u_{pp}x_p) \end{aligned}$$

where $u_{pp}$ represents the weight for the $p$th principal component and the $p$th variable.

Initially, we have as many components as original variables ($p$). Nonetheless, only the subset of $m$ components that explains the largest possible amount of variation in the original data is kept. Therefore, uncorrelated PC's are extracted by linear weighted transformations of the initial variables so that the first few PC's contain most of the variations in the original dataset.

The amount of information included in each component is summarized in its variance. That is, the higher the variance the higher the amount of information incorporated in that component. The weights for each principal component are given by the eigenvectors of the correlation matrix, or if the original data were standardized, the co-variance matrix. The variance ($\lambda$) for each principal component is given by the eigenvalue of the corresponding eigenvector. These PCs are extracted in decreasing order of importance so that the first PC accounts for as much of the variation as possible and each successive component accounts for a little less, subject to the constraint that

the sum of the squared weights is equal to one, that is to say the vector of weights is normalized[1].

Hence, the first component $C_1$ is obtained by maximizing its variance

$$V(C_1) = \frac{\sum_{i=1}^{n} C_{1i}^2}{n} = \frac{1}{n} C_1' C_1 = \frac{1}{n} u_1' X' X u_1 = u_1' \left[ \frac{1}{n} X' X \right] u_1 = u_1' V u_1$$

Subject to the constraint

$$\sum_{j=1}^{p} u_{1i}^2 = u_1' u_1 = 1$$

$V(C_1)$ is maximized with the highest eigenvalue $\lambda$ of matrix $V$. Letting $\lambda_1$ be the highest eigenvalue of V and considering $u_1$ as its associated normalized eigenvector ($u_1$'$u_1$=1), we have defined the vector of weights to be applied to the initial variables in order to obtain the first principal component, which can be defined as:

$$C_1 = u_1 X = u_{11} X_1 + u_{12} X_2 + \cdots + u_{1p} X_p$$

The second component ($C_2$) is orthogonal to (i.e. uncorrelated with) the first component, and explains additional but less variation than the first component, subject to the same constraint.

Subsequent components are uncorrelated with previous components; therefore, each component captures an additional dimension in the data, while explaining smaller proportions of the variation of the original variables. Thus, PCA can be useful when there is a severe high-degree of correlation present in the initial variables. Besides, the higher the degree of correlation among the original variables in the data, the fewer components required to capture common information. Note that, whenever the variables in the original dataset are uncorrelated, PCA can be discarded as the PCs obtained are equal to the original variables.

[1] Because the first principal component accounts for the co-variation shared by all attributes, this may be a better estimate than simple or weighted averages of the original variables.

As the sum of the eigenvalues equals the number of variables in the initial data set, the proportion of the total variation in the original data set accounted by each principal component is given by

$$\frac{\lambda_h}{\sum_{h=1}^{p}\lambda_h} = \frac{\lambda_h}{trace(V)}$$

When the variables are normalized, *trace(V) = p*, so that the proportion of the *h*th component on total variation is será $\lambda_h/p$.

Once all coefficients $u_{hj}$ are computed, the values of the PCs for each individual observation in the sample of size *n* can be obtained as follows,

$$Z_{hi} = u_{h1}X_{1i} + u_{h2}X_{2i} + \cdots + u_{hp}X_{pi} \quad h = 1,..., p \quad i = 1,..., n$$

*How many components should be retained?* The number of PCs to be retained can be determined by means of the arithmetic mean criterion. According to this criterion, only components with characteristic root (i.e., the variance of the component) above the average of all characteristic roots should be retained.
Analytically, this criterion implies retaining all components that satisfy the following expression:

$$\lambda_h > \overline{\lambda} = \frac{\sum_{j=1}^{p}\lambda_h}{p}$$

When standardized variables are used, $\sum_{j=1}^{p}\lambda_h = p$, so that only components such that $\lambda_h$ >1 are retained. Thus, an eigenvalue greater than 1 indicates that PCs account for more variance than accounted by one of the original variables in standardized data. This is commonly used as a cut-off point for which PCs are retained.

*Correlations between initial variables and the components.* A clear and meaningful interpretation of the different components obtained after PCA is crucial to derive conclusions. In this regard, it is important to determine the weight of each original variable on the new component as well as the correlations between the variables and the

components. As stated before, a component is a linear combination of a set of variables, but it could be better correlated to some of them tan to others. The correlation coefficient between a component and one of the original variables is computed by multiplying the variable weight (eigenvector) by the square root of its eigenvalue:

$$r_{jh} = u_{hj}\sqrt{\lambda_h}$$

# CONCLUDING REMARKS AND FUTURE RESEARCH

This thesis consists in three essays related to urban sprawl and local public finance. Chapters I and II study the extent to which sprawl affects the balance of local budgets while Chapter III focuses on the connection between sprawl and central city deterioration and the role of urban containment programs as a public policy remedy. In this conclusion I summarize the main findings, derive the policy conclusions that emerge from them and suggest further directions for future research.

While much has been written about the causes of urban sprawl, little attention has been paid to its implications, especially to its impact on local budgets. Empirical evidence regarding the fiscal consequences of sprawl is scarce and remains inconclusive. The studies presented in Chapters I and II adopt different methodologies to extend the empirical literature that examines the costs of urban sprawl as well as the adjustment process of municipal budgets to an urban sprawl shock and the role played by upper tiers of government in this process.

Results presented in *Chapter I*, based on a representative sample of Spanish municipalities for the year 2003, indicate that low-density developments led to greater provision costs in almost all the spending categories considered. Besides, there is evidence of a nonlinear impact of urban sprawl on the costs of providing local public services. By adopting the piecewise linear function assumption we were able to disaggregate the total effect, revealing that the impact on total costs accelerated at very low (compact pattern) and very high levels of sprawl. Further, the impact of urban sprawl on the provision costs of the public services considered here was particularly intense at high levels of sprawl. These results suggest that in municipalities with a spatially expansive urban development pattern, the provision costs of public services increase initially as a result of increasing road construction costs and rising general administration costs, and then, if the urban sprawl advances further, costs continue to rise as a result of higher costs in providing community facilities, housing, local police and culture. In those municipalities with very low levels of urban sprawl the increase in local costs was due to public services other than those analysed here. This inefficient increase in local costs should not be seen as a problem since it might result from the

specific new urban development pattern desired by the residents. In this sense, the fulfilment of their preferences might justify the higher rates of taxation needed to subsidise these increased costs. Moreover, the simulation carried out for the period 1995-2005 showed the average increase in local costs attributable to urban sprawl to be quite low and, therefore, easily met by the local governments. However, in those municipalities where the amount of urbanized land was below the 1995 average but where urban sprawl was considerable during the period, the increase in costs was markedly higher.

Chapter I leaves some open questions. An impact on local revenues can also be expected, and as such the net fiscal impact on local budgets remains undetermined. The study presented in *Chapter II* relies on a broad and novel panel dataset from Spanish municipalities for the period 1994-2005 to shed some light into the link between the different sources of local revenues and expenditures and the growth pattern of cities.

The main findings can be summarized as follows. On the one hand, the sprawl of cities produces both a current and a capital surplus leading to a short-run overall surplus for local governments. On the other hand, the methodology adopted here enables us to determine the time profile of this local fiscal adjustment, suggesting a temporary impact of sprawl on the capital component of the budgets. Quite the opposite, a sprawl shock exhibits a more permanent impact on the current component of the budgets.

The results determine an increase in current expenditures, suggesting that local politicians will provide additional public goods and services for new housing developments. Moreover, urban sprawl is associated with large investment requirements as roads and basic infrastructures are extended for the new residents located at the urban fringe. Most of the adjustments to a sprawl shock are borne by upper tiers of government via grant financing (principally capital transfers) together with the not insignificant role played by the revenues associated with the real estate cycle itself (tax on land use improvements, building permits, construction taxes, public land sales, etc.).

On the whole, these findings indicate that benefits of sprawl appear to exceed its costs, encouraging municipalities to plan and zone for low density without necessarily considering the full fiscal, social and environmental consequences of such policies.

However, the over-reliance of municipalities on grants to make adjustments to their budgets highlights a potential moral-hazard problem. Additional infrastructure requirements associated by spatially expansive growth are funded in the main by upper

tiers of government, encouraging municipalities to promote urban expansion without necessarily considering the full fiscal consequences of such policies. Here, this problem could be due to the design of Spain's grant system, since some capital transfers are dependent on the municipalities' infrastructure deficit, which in turn is usually induced by urban growth.

Therefore, it seems that Spain's local governments face fiscal viability problems and use "external" funds (meaning grants from upper tiers of government) to balance their budgets and this apparent softening of budget constraints could distort local policy decisions. Besides, there are inefficiencies attributed to grant financing of new urban developments at the urban fringe. In fact, the problem arises when new developers fail to internalise the full costs that they generate, leaving the local government to pay for them (i.e. municipal authorities raise the taxes of all residents in the jurisdiction and ask for higher transfers from the upper tiers of government). As a result, sprawl does not pay for itself but rather becomes a burden on all existing taxpayers.

Overall, these results suggest that local authorities need to be aware of the long-term financial implications of their land-use decisions and the need to re-examine the role played by state and regional governments in promoting this growth pattern. In particular, a policy reform regarding the restructuring of grants received as well as finding appropriate local funding tools that make new developers internalise the full costs they generate would help containing urban sprawl and promoting smarter and more compact urban growth patterns.

*Chapter III* shifts the focus of the analysis to another potential problem related to urban sprawl, the physical deterioration of central city structures (so-called urban blight) and the role of public policies. While there has been extensive discussion of city and suburban growth, little attention has been paid to growing concerns about the blight in U.S. cities and the effectiveness of corrective public policies on preventing the deterioration of downtown structures. In fact, a review of the literature emphasizes that evidence on the extent of blight and the policy-oriented decision-making aimed at addressing the problem of central-city urban decline is limited.

The empirical work presented in this Chapter is based on a representative sample of selected Metropolitan Statistical Areas and their corresponding central cities. Micro data drawn from the American Housing Survey allows us to construct 12 novel and specific blight measures based on external physical characteristics of buildings and

neighbourhoods for U.S. central cities. For the sake of simplicity, this information on city blight is summarized in a smaller number of variables with the minimum loss of information by means of Principal Components Analysis.

The results indicate that the adoption of urban containment policies translates into significant blight reductions in those contained cities. Thus, we offer empirical evidence that urban containment programs are achieving one of their intended goals of reducing central city deterioration. In this regard, it is also worthwhile to note the non-negligible role played by upper tiers of government, as per capita federal aid also contributes to blight reduction and central city revitalization. Empirical evidence on the effectiveness of public policies could help orientating policy decision-making in other countries undergoing intense processes of urban sprawl. Early implementation of adequate corrective public policies to prevent central city deterioration and depopulation reduces future pressures on local budgets, in terms of migration of taxable bases and lack of fiscal resources, urban renewal investments and policies aimed at solving poverty-related problems arising from urban blight.

Finally, it is important to highlight the importance of the central city to the regional economy as blight reduction can produce positive externalities that enhance the growth and economic progress beyond the city's boundaries. This being the case, central city revitalisation and metropolitan area development may be seen as complements rather than substitutes. Overall, both cities and suburbs could improve their welfare through cooperative containment programs aimed at curbing sprawl and fostering more compact urban developments while preventing urban decline in city core areas.

Finally, the main findings of this PhD Dissertation could be extended in a number of different ways. First, and in line with previous studies, in this PhD Dissertation urban sprawl has been considered to be a low-density growth pattern characterized by the excessive and discontinuous spatial expansion of urban land. However, measuring this phenomenon remains somewhat elusive since there is no agreement regarding the right specification for its measurement or its appropriateness as a sprawl measure. Even so, variants of population density are the most widely used indicator of sprawl because of its simplicity and the difficulty of obtaining data for alternative measures. Nonetheless, a more accurate measure of sprawl could be developed, aimed at capturing the whole spatial dimension of this urban growth pattern. In this regard, the recent availability of satellite photographs and the use of Geographical Information Systems enable us to

construct such alternative measures of sprawl based on the geographical distribution of suburban developments within Spanish municipalities.

Second, the analysis presented in Chapter II could be improved so as to overcome the main limitations of the methodology used. A vector autoregressive methodology is suited to the purpose of this Chapter, aimed at investigating the dynamic effect on local public finance following a change in urban growth patterns and given the absence of an a priori theory regarding the relationship between the variables in the model. Nonetheless, a theoretical framework could be developed and additional variables accounting for other determinants of local land-use decision-making could be included.

Third, further empirical analysis on the social and environmental consequences of urban sprawl could complement the evidence presented in this thesis. Despite the voluntary nature of this process, as it responds to the fulfilment of residents' preferences, urban sprawl has generated several concerns about the welfare of communities. One such concern is a rising disparity between neighbourhoods. Residents migrating to the suburbs should also be those with higher levels of income. Thus, as urban areas spread out, they become increasingly segregated by income. This income segregation has, in turn, important consequences for local budgets and the provision of public goods. Given the intense and rapid process of urban sprawl recorded in Spain in recent years, the analysis of income inequality and polarization emerge as an interesting topic for future research. Recent availability of a representative sample obtained from population administrative census of income tax returns and the use of appropriate reweighting techniques has allowed us to derive local income distributions and a set of inequality measures at the municipal level that could be used to perform further analysis on the impact of urban sprawl on income segregation and polarization within Spanish municipalities.

Fourth, evidence provided here suggests the use of urban sprawl as short-run strategic tool for local governments. In this regard, further research on modelling the strategic behaviour of local governments could be of interest.

Finally, in this PhD Dissertation we have focused on the consequences of urban sprawl. Nonetheless, empirical evidence on the driving forces of urban sprawl also remains scarce. The role played by geographic determinants, politics, socioeconomic characteristics, road networks, certain subsidizing and investment public policies, land use regulations and local amenities of municipalities, among others, are meant to be the main responsible for the spreading out of cities. Therefore, an analysis on the causes of

sprawl could contribute to a better understanding of this phenomenon as well as to enlarge the limited empirical evidence on this topic.

RESUMEN DE LA TESIS DOCTORAL:

# ESSAYS ON URBAN SPRAWL AND LOCAL PUBLIC FINANCE

(Ensayos sobre la expansión urbana y finanzas públicas locales)

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## 1. Introducción

Esta Tesis está dividida en tres ensayos íntimamente relacionados, cada uno con su propia estructura y metodología. Los tres ensayos son esencialmente empíricos y analizan algunos aspectos relevantes sobre la dispersión urbana y las finanzas públicas locales. Los dos primeros capítulos de la Tesis analizan el impacto de este modelo de crecimiento urbano sobre los presupuestos municipales, tanto por el lado del gasto como del ingreso y teniendo en cuenta tanto un enfoque estático como dinámico. El tercer capítulo contribuye a la comprensión de un fenómeno íntimamente relacionado con la dispersión urbana, el abandono y deterioro físico de las ciudades, así como el papel que las políticas de contención urbana tienen como remedio de política pública. En general, los tres capítulos pretenden orientar en comportamiento de los gobiernos subcentrales y sus políticas públicas en lo que a diseño urbano se refiere.

Durante los últimos años se ha producido en Europa un importante cambio en el patrón de uso del suelo. Se ha pasado de un tipo de crecimiento urbanístico vertical y compacto, a otro de tipo horizontal, caracterizado por ser espacialmente expansivo y de baja densidad, conocido con el nombre de dispersión urbana o suburbanización. Este nuevo modelo urbanístico se ha producido de forma prácticamente exclusiva en las ciudades norteamericanas desde principios del siglo XX, y no ha sido hasta los últimos años cuando se ha expandido por gran parte del continente europeo. En un informe reciente de la Agencia Europea de Medio Ambiente (EEA, 2006) se señala que el suelo consumido por persona en Europa se ha más que duplicado en los últimos 20 años. Concretamente, la superficie construida ha aumentado, durante este período, un 20%, mientras que la población sólo lo ha hecho en un 6%. Como demuestran los datos, además, la situación adquiere especial relevancia en las regiones del sur del continente, entre las cuales destaca el caso español. En España, el 34% del litoral mediterráneo está totalmente edificado en su primer kilómetro desde la costa, y la superficie artificial ha crecido un 30% desde 1987.

Según datos del Ministerio de la Vivienda, se iniciaron en España entorno a 600.000 viviendas por año entre 1996 y 2005, cifra que casi doblaba la demanda doméstica anual de nuevas viviendas. Además, gran parte de esta construcción adoptó la forma de crecimiento urbano espacialmente disperso. En consecuencia, datos proporcionados por la imágenes de satélite del Proyecto Corine Land Cover (Ministerio de Fomento, 2006) muestran como entre 1987 y 2005 la proporción de superficie artificial se incrementó en

un 54,86%, reflejando principalmente el mayor consumo de suelo para dar cabida a nuevas infraestructuras y urbanizaciones situadas en la periferia de los municipios.
En esta misma línea, los datos de la Dirección General del Catastro apuntan que la tasa de variación de la superficie construida durante el período 1994-2005 fue del 40%. Ello se ha producido principalmente como consecuencia del proceso de urbanización, siendo el ritmo medio anual de crecimiento del suelo construido del 1.9%, valor que se sitúa por encima de la media europea. Además, una cuarta parte de esta construcción ha adoptado la forma de crecimiento urbano de baja densidad, mientras que la superficie destinada a crecimiento urbano compacto aumentó en un escaso 4%. Asimismo, los datos muestran importantes diferencias en la distribución espacial de este crecimiento en España, siendo particularmente intenso a lo largo de la costa mediterránea (esto es, zonas turísticas de Cataluña, Valencia, Murcia, Andalucía y las Islas Baleares con escaso desarrollo urbanístico durante la década de los ochenta) y en el área urbana de Madrid.

En el marco de la literatura de economía urbana, se parte del modelo de ciudad monocéntrica Alonso-Muth-Mills para determinar cuáles son los factores causantes de la expansión de las ciudades. Este modelo establece que la estructura urbana es el resultado del *trade-off* entre los costes de desplazamiento y el precio del suelo (Miezkowski y Mills, 1993; Glaeser y Khan, 2004). En equilibrio, este *trade-off* requiere precios del suelo menores en el límite urbano para compensar el incremento en los costes de desplazamiento. Por tanto, el tamaño de las ciudades está relacionado positivamente con la población y la renta, y negativamente con los costes de desplazamiento y el precio de suelo agrícola o suburbano.
Mieszkowski y Mills (1993) desarrollan la teoría de la evolución natural basándose en este modelo, según la cual son tres las fuerzas fundamentales que incrementan la demanda de suelo en los suburbios: el crecimiento de la población, el incremento de la renta y la reducción de los costes de transporte (véase también Brueckner, 2000, 2001). Una ciudad debe expandirse para dar cabida al crecimiento de la población. Mejoras en los niveles de renta permiten a los hogares satisfacer sus preferencias por un mayor consumo de suelo. Las innovaciones en los sistemas de transporte mejoran los tiempos de desplazamiento y reducen sus costes, haciendo de los suburbios un lugar atractivo donde vivir. Glaeser y Khan (2004) señalan que este último factor es la principal causa de la dispersión urbana, en tanto que elimina las economías de escala de las tecnologías de transporte antiguas, permitiendo así la descentralización.

Por otro lado, según Brueckner (2000), el crecimiento urbano que ocurre como respuesta a estas tres fuerzas fundamentales no puede considerarse ineficiente. La crítica a la expansión urbana sólo puede justificarse si el funcionamiento de dichas fuerzas se ve distorsionado por la existencia de fallos de mercado. En tal situación, el mercado por sí mismo no es capaz de distribuir los recursos de una forma socialmente deseable y, por tanto, no se maximiza el bienestar social. Estos fallos de mercado son básicamente tres. En primer lugar, el no considerar el valor social intrínseco del medio ambiente cuando suelo rústico se convierte en urbanizable. En segundo lugar, los individuos no internalizan los costes sociales de congestión que generan con sus desplazamientos por carretera. Finalmente, los costes de las infraestructuras públicas necesarias para las nuevas construcciones no son considerados por quienes construyen. De este modo, al no considerar este tipo de costes, la dispersión urbana resulta aparentemente menos costosa, generando una expansión mayor de lo que sería socialmente deseable.

En la literatura también se citan otros factores como causantes adicionales de la dispersión urbana. Mieszkowski y Mills (1993) ofrecen una teoría basada en el concepto de votar con los pies de Tiebout. Las decisiones de localización de los residentes dentro de un área urbana no dependen tan sólo de la renta y los costes de trasporte, sino que éstos escogen su jurisdicción en función de sus preferencias por las características del entorno, de los potenciales vecinos y los impuestos locales. De este modo, los problemas sociales y fiscales de las ciudades (redistribución de impuestos, baja calidad de determinados servicios públicos, elevada criminalidad, contaminación, y congestión, entre otros) hacen que las clases medias-altas decidan trasladarse a los suburbios, donde creen sus propias comunidades formadas por individuos con similares características de renta, nivel educativo, o raza. Así consiguen el control sobre el nivel de gasto público, asegurándose la provisión de servicios públicos de calidad y evitando financiar el consumo público de individuos con rentas inferiores.

Finalmente, la elevada fragmentación política (Carruthers, 2002; Carruthers y Ulfarsson, 2002), determinadas políticas públicas de subsidios e inversión, controles sobre el uso del suelo (Glaeser y Khan, 2004) y el impuesto sobre la propiedad (Brueckner y Kim, 2003; Song y Zenou, 2005) también fomentan un crecimiento espacial de las ciudades excesivo.

Son diversos los beneficios que pueden atribuirse a la dispersión urbana, en términos de satisfacción de preferencias individuales por viviendas unifamiliares, mayor

proximidad a zonas verdes, y aislamiento de algunos de los problemas sufridos en los núcleos urbanos de las ciudades, como por ejemplo la contaminación, el crimen o la congestión. No obstante, estos beneficios pueden verse contrarestados por un buen número de costes. En las nuevas zonas de baja densidad de población se reducen las interacciones sociales y se pierde el sentimiento de comunidad, al mismo tiempo que se fomenta la segregación entre los ricos de los suburbios y los pobres de los núcleos urbanos (Downs, 1999; Brueckner, 2000, 2001; Glaeser y Khan, 2003). El incremento en el número de desplazamientos, derivado de un tejido urbano más disperso, incrementa los niveles de contaminación y la congestión en carreteras (Sierra Club, 1998; Brueckner 2001; Glaeser y Khan, 2003). Las zonas forestales, los espacios naturales y, consecuentemente, la biodiversidad local también resultan mermadas (Sierra Club, 1998). Si la suburbanización va acompañada de deslocalización de parte de la actividad económica, la reducción en las economías de aglomeración urbanas puede generar reducciones en la productividad (Glaeser y Khan, 2003).

En consecuencia, se ha generado una especial preocupación entorno a la dispersión urbana, no sólo por la rapidez con la que se está produciendo sino también por su notable impacto a nivel social, medioambiental y, sobre todo, económico. En este último grupo de consecuencias destaca el impacto sobre las finanzas municipales. Pese a que son muchos los factores pueden influenciar la cuantía y distribución del gasto público local, existe una creciente convicción que apunta al patrón urbanístico como uno de ellos. Cuando se produce un crecimiento espacialmente expansivo y de baja densidad, como el que caracteriza el fenómeno de la dispersión urbana,, tanto las infraestructuras como determinados bienes y servicios públicos deben incrementarse con el objetivo de mantener constante el nivel de servicios públicos de todos los residentes de la jurisdicción. Es por ello que la suburbanización provoca un importante incremento en los costes de provisión de determinados servicios públicos, tales como la recogida de basuras, la limpieza viaria, policía, bomberos o transporte público. Se requieren grandes inversiones para extender la red de carreteras e infraestructuras de canalización de agua, electricidad o alcantarillado hasta un número relativamente reducido de residentes (Carruthers, 2002). Del mismo modo, como consecuencia de la mayor dispersión de la población en el territorio, no se aprovechan las economías de escala en la provisión de determinados servicios, tales como educación pública, seguridad ciudadana o transporte público, con el consiguiente incremento ineficiente de los costes (Carruthers y Ulfarsson, 2006). Por otra parte, generalmente quienes

construyen en los suburbios no internalizan todos los costes generados, de manera que es el gobierno local quien debe hacerse cargo de ellos. Así pues, resulta que el nuevo crecimiento suburbano es financiado por todos los residentes del municipio mediante el pago de impuestos (Sierra Club, 1998).

Los tres ensayos que componen esta Tesis abordan esta creciente preocupación por el fenómeno de la dispersión urbana y su conexión con las finanzas públicas locales.

El Capítulo I de esta Tesis se centra en el análisis del impacto de proceso de rápida expansión urbana de baja densidad de población en el coste de provisión de los servicios públicos locales. Concretamente, se estimará una función de gasto público local en términos per capita (Borcheding and Deacon, 1972), tanto a nivel agregado como para las categorías de gasto que se supone se pueden ver más afectadas por el proceso de suburbanización: *bienestar comunitario, infraestructuras básicas y transportes, protección civil y seguridad ciudadana, y vivienda y urbanismo*. En el estudio se introducen un conjunto de variables de dispersión urbana que pretenden captar de la mejor forma posible la dimensión espacial de este modelo de crecimiento urbano. Una primera medida de densidad, comúnmente utilizada en los estudios previos, es la superficie construida por habitante. Por tal de captar con la mayor precisión posible la relación entre esta variable y la variable dependiente, se utiliza una aproximación muy flexible que permite que sean los propios datos los que establezcan la forma funcional. Mediante la función lineal por tramos (Ladd, 1992) la relación entre estas dos variables se estima como una serie de segmentos lineales conectados. El número de núcleos de población y de viviendas residenciales por habitante, junto con el porcentaje de población diseminada se introducen adicionalmente como medidas de dispersión. En la función de gasto también se introducen un conjunto de variables de control, que permiten tener en cuenta el efecto que sobre el gasto pueden tener distintos grupos de usuarios, factores de coste externo y la capacidad fiscal de los municipios. Una vez se ha controlado por estos efectos, se puede identificar el impacto específico de la dispersión urbana sobre los cotes locales. En otras palabras, se puede determinar si entre municipios con iguales características los más dispersos soportan mayores costes de provisión de los servicios públicos locales que los que presentan un modelo de crecimiento más compacto. Del análisis econométrico, realizado con datos de 2500 municipios españoles para el año 2003, se espera obtener evidencia del impacto de las variables de dispersión urbana sobre los costes de provisión de los servicios públicos

locales. Si los resultados indican que un modelo de crecimiento urbano disperso es más costoso de mantener que un modelo compacto, será un punto de partida para discutir el papel que gobiernos locales y regionales juegan en la regulación de los efectos derivados de este modelo de crecimiento urbano. En este sentido, mayores costes de provisión asociados a la provisión de determinados servicios públicos, así como otras consecuencias de la dispersión urbana, han sido utilizados como argumentos por parte de los detractores de este fenómeno para justificar el uso de políticas de control de crecimiento urbano y de la cooperación entre los distintos niveles de gobierno para promover patrones de crecimiento urbano más compactos (Katz, 2002; Carruthers, 2002; Carruthers y Ulfarsson, 2003).

Asimismo, este nuevo patrón de crecimiento urbano también resulta ser una importante fuente de recursos potenciales para los gobiernos locales, asociados a mayores transferencias recibidas de niveles de gobierno superiores e ingresos asociados a la actividad inmobiliaria (Aguinaga, 2002; Fernández, 2008, Maldonado and Suárez-Pandiello, 2008). Este hecho permite concluir que cambios en el patrón de crecimiento urbano van asociados también a cambios en el equilibrio entre ingresos y gastos municipales.

El Capítulo II tiene en cuenta estos resultados y expande el análisis con el objetivo de obtener una fotografía del impacto fiscal neto de la dispersión urbana sobre las finanzas públicas locales, considerando simultáneamente la vertiente del gasto y del ingreso. Dada la clara relación existente entre gastos e ingresos municipales con la dispersión urbana, las autoridades locales deberían considerar las implicaciones financieras de largo plazo de sus decisiones sobre política urbanística, así como reexaminar el papel que gobiernos locales y regionales juegan en la regulación de los efectos derivados de este modelo de crecimiento urbano. No obstante, el tratamiento empírico de las relaciones entre finanzas locales y crecimiento urbano se ha centrado siempre en el análisis de sección cruzada (Carruthers, 2002; Carruthers and Ulfarsson, 2003, 2008; Heikkila and Craig, 1991; Kelsey, 1996; Bunnell, 1998;) o de panel dinámico estático, de manera que las relaciones dinámicas entre los presupuestos municipales y el modelo de crecimiento urbano no han sido analizadas en la literatura hasta el momento. De hecho, es el análisis de la dimensión temporal el que permitiría derivar conclusiones robustas sobre lo que ocurre a lo largo del tiempo si las ciudades continúan expandiéndose. A la luz de lo anterior, este segundo capítulo se centra en la dimensión

temporal de los datos de panel para el análisis para aportar evidencia empírica sobre el patrón de ajuste temporal de los presupuestos municipales a *shocks* de dispersión urbana, y así poder determinar el impacto fiscal neto de este modelo de crecimiento sobre las finanzas locales. La metodología estándar para el análisis de estas cuestiones se basa en el análisis de las relaciones intertemporales entre las variables de interés. La disponibilidad de datos presupuestarios desagregados a nivel local para una muestra representativa de municipios españoles para el período comprendido entre 1994 y 2005 permite llevar a acabo un novedoso análisis dinámico, basado en la estimación de un modelo de vector autoregresivo con datos de panel (PVAR). Tal y como señala Lutkephol (2005), en este tipo de modelos se establece un sistema de ecuaciones en el que todas las variables incluidas se consideran endógeneas y dónde las relaciones dinámicas de corto plazo pueden identificarse.

En primer lugar, analizamos cómo la dispersión urbana interacciona con los presupuestos locales desagregando el déficit no financiero en cuatro componentes: gasto corriente, ingresos tributarios, transferencias corrientes, gasto de capital, transferencias de capital e ingresos urbanísticos. La descomposición de los presupuestos municipales en estas variables nos permite identificar con claridad los costes y beneficios asociados a la dispersión urbana (en términos del impacto sobre los gasto e ingresos, respectivamente). Efectos individuales inobservables y efectos temporales se incluyen en el análisis. El proceso de estimación se basa en la aplicación de técnicas de Método Generalizado de Momentos (*system-GMM)* por tal de asegurar estimaciones consistentes y eficientes (Arellano y Bover, 1995; Blundell y Bond, 1998). Una vez el modelo se ha especificado correctamente, se pueden calcular las Funciones de Respuesta al Impulso Generalizadas (Pesaran y Shin, 1997), las cuales permitirán determinar el patrón de ajuste de los presupuestos municipales ante un *shock* de dispersión urbana. Se espera que los resultados obtenidos contribuyan a la literatura empírica existente sobre las consecuencias de la dispersión urbana, así como a la orientación de políticas públicas en lo que a regulación urbanística y ordenación del territorio se refiere.

Hasta el momento los dos primeros capítulos de esta tesis han analizado el impacto de la dispersión urbana sobre las finanzas públicas locales, tanto por el lado del gasto como del ingreso, en su dimensión estática y dinámica. No obstante, la dispersión urbana también es responsable de muchos de los desafíos a los que nos enfrentamos hoy

en día con implicaciones evidentes en términos de política pública. Este patrón de crecimiento urbano disperso induce movimientos de población y empleo hacía los suburbios o periferia de los municipios, contribuyendo así a una segregación entre los ricos de la periferia y los pobres de los núcleos urbanos de la ciudad. La emigración de un buen número de residentes, principalmente de la clase media y alta, hacia la periferia propicia la aparición de diversos problemas relacionados con la pobreza en los núcleos de población de las ciudades, tales como mayores índices de criminalidad, menor calidad en la prestación de servicios públicos, pérdida de recursos tributarios y pérdida de inversión y mantenimiento de las estructuras urbanas existentes, provocando el deterioro de las ciudades. Estos problemas asociados a las ciudades inducen a su vez movimientos adicionales de población hacia los suburbios, reforzando así el proceso de crecimiento suburbano y deterioro de las ciudades (Bradford y Kelejian, 1973; Mills y Price, 1984; Mieskowski y Mills, 1993).

Basándose en estos argumentos, el Capítulo III de la Tesis se cetra en el análisis de la relación entre dispersión urbana y deterioro de las ciudades, centrándose en el papel que las políticas públicas de control de crecimiento podrían tener para mitigar los efectos adversos de este proceso. El ámbito espacial de estudio es Estados Unidos, y su elección se justifica por los siguientes motivos. En primer lugar, es este país la dispersión urbana es un fenómeno arraigado desde hace bastantes décadas. En segundo lugar, el problema del deterioro de las ciudades ha adquirido especial relevancia en sus áreas metropolitanas, suscitando un creciente interés por parte de académicos, políticos y el público en general.

Los primeros investigadores preocupados por el deterioro de las ciudades ya apuntaban las complejas relaciones que existen entre el crecimiento de las ciudades y de los suburbios, esto es, entre el núcleo principal de población de un área urbana y los municipios de la periferia (Fisher, 1942; Breger, 1967; Davis, 1960; Davis y Whinston, 1961; Bradbury or Downs y Small, 1980). El deterioro de las ciudades se veía claramente como una deseconomía de la urbanización. Recientemente, Brueckner y Helsley (2011) han desarrollado un modelo urbano dinámico para mostrar que tanto la dispersión urbana como el deterioro urbano puede considerarse el resultado de un mismo proceso económico, siendo ambos la respuesta a fallos de mercado que distorsionan la distribución de población y superficie urbana socialmente deseable entre jurisdicciones. Las externalidades sobre el medio ambiente o la no incorporación en los

precios de las nuevas infraestructuras asociadas al crecimiento suburbano resultan en un coste de la suburbaniza ción ineficientemente bajo que acaba generando un volum en excesivo de población viviendo en la periferia de las áreas urbanas. Este movimiento de población, a su vez, presi ona a la baja los precios de la vivienda en l as ciudades, disminuyendo así los incentivos para mantenimiento y reinversión en las infraestructuras ya existentes en las ciudades.

En este contexto, la adopción de políticas de cont rol de crecimiento urbano po dría ayudar a prevenir la dispersión urbana y el deterioro de las ciudades. Tradicionalmente, las regulaciones sobre le uso del suelo (zonificación, criterios e dificación) han sido utilizadas como instrumento para limitar el crecimiento excesivo de l as ciudades. No obstante, algunos efectos no deseables de estas políticas (incremento de los precios de la vivienda, problemas de exclusión) han reducido su popularidad, dando paso a otro tipo de políticas más adecuadas (Fisher, 1942; Downs, 1999; Pend all, 2000; Quigley et a l, 2004; Chakraborty et al, 2010). En este contexto, las políticas de contención urbana han surgido como respuesta a las consecuencias perversas de los restrictivos controles sobre los usos del suelo (Nelson et al, 2004). Estas políticas combinan regulación e incentivos para guiar y asignar eficientemente los nue vos desarrollos urbanos, al tiempo que intentar compensar las fuerzas de la descentralización y promover la re vitalización de los núcleos urbanos de las ciudades.

Así pues, el análisis presentado en el Capítulo III de la Tesis pretende contribuir a la literatura empírica existente sobre la rel ación existente entre crecimiento urbano y suburbano y el pape l que juegan las políticas públicas de contención urbana en este proceso. Este trabaj o es, por tanto, u na primera aproximación en l a literatura empírica para abordar el problema del deterioro físico de las ciudades en las áreas metropolitanas de Estados Unidos. Además, las conclusiones que se deriven de los resultados obtenidos ayudarán a orientar políticas públicas relacionadas con la regulación de los usos del suelo y la ordenación del territorio a ni vel local y regional así com o los esfuerzos orientados a devolver y mantener el atractivo urbano de las ciudades. El impacto fiscal sobre los presupuestos locales también podría beneficiarse de la evidencia empírica sobre la efectividad de di chas políticas públicas de contención urbana. Una pronta implementación de és tas podría ayudar a p revenir gastos regionales y locales adicionales orientados a solucionar los prob lemas generados en los núcleos urbanos de las ciudades que experimentan deterioro físico y abandono.

El primer objetivo del estudio consiste en elaborar una medida del deterioro físico de los edificios en las ciudades. La disponibilidad de los datos de la encuesta sobre vivienda en Estados Unidos, *American Housing Survey*, nos ha permitido construir una serie de nuevas variables sobre condiciones externas de los edificios y sobre las condiciones del vecindario para una muestra representativa de áreas metropolitanas. Estas variables se han resumido en dos índices sintéticos con la mínima pérdida de información mediante la aplicación del Análisis de Componentes Principales (Hair et al, 2010). Así pues, estos datos permitirán llevar a cabo un análisis novedoso sobre la relación entre la adopción de políticas de contención urbana y la reducción del deterioro físico de los edificios en las ciudades de Estados Unidos. La especificación empírica incluye una serie de variables de control para tener en cuenta el efecto de determinadas características sociales y económicas de las ciudades. Una vez se ha controlado por estos efectos, se puede identificar el impacto de políticas de control de crecimiento adoptadas a nivel de área metropolitana, e identificadas a través de políticas de contención urbana, sobre el deterioro físico de las ciudades. En otras palabras, se puede determinar si entre áreas metropolitanas con las mismas características, aquellas que han adoptado políticas de contención urbana experimentan niveles inferiores de deterioro físico de sus edificios en sus ciudades principales.

**2. Principales resultados e implicaciones de política económica**

Si bien existe abundante literatura entorno a las causas de la dispersión urbana, ha sido poca la atención prestada a las implicaciones que ésta pueda tener, especialmente en términos de las finanzas públicas. Además de la escasa evidencia empírica existente, los diferentes estudios realizados alcanzan resultados en cierta medida contradictorios (véase Ladd, 1992, 1994; Carruthers y Ulfarsson, 2006). Por tanto, los análisis presentados en los Capítulos I y II de la Tesis, mediante la adopción de distintas metodologías, pretenden contribuir a ampliar la evidencia empírica existente entorno a los costes derivados de este modelo de crecimiento así como al proceso de ajuste fiscal de los presupuestos municipales ante el cambio en la estructura urbana experimentado en España desde los años noventa.

En general, los resultados de las estimaciones presentados en el Capítulo I, basados en una muestra representativa de municipios españoles para el año 2003, ponen

de manifiesto que bajas densidades de población comportan mayores costes de provisión de los servicios locales en casi todas las categorías de gasto consideradas. La utilización de la función lineal por tramos permite desagregar este efecto total por tramos de densidades. Los resultados ponen de manifiesto el impacto no lineal de la dispersión urbana sobre los costes de provisión de determinados servicios públicos locales, concentrándose éste en los municipios con una dispersión o bien muy baja (modelo de crecimiento urbano compacto) o bien muy alta. Además, el impacto de la dispersión urbana sobre los costes de provisión de los servicios analizados es particularmente mayor en municipios con mayores niveles de dispersión urbana. Estos resultados sugieren que en municipios con un patrón de crecimiento urbano espacialmente expansivo, el incremento en los costes de provisión de los servicios públicos se debe, en primera instancia, al incremento de los costes derivados de la construcción de carreteras y al incremento de los costes en servicios relacionados con la administración general y luego, si el municipio continua expandiéndose de este modo, los costes siguen aumentando como consecuencia de mayores costes para la provisión de servicios relacionados con el bienestar comunitario, vivienda, policía local y cultura. En los municipios más compactos (es decir, con menor dispersión urbana), el incremento en los costes se deriva de bienes o servicios públicos distintos a los analizados en este estudio. Este incremento ineficiente en el coste de provisión de los servicios públicos podría no considerarse como un problema, en tanto que se deriva de un nuevo patrón de crecimiento urbano deseado por los residentes. En este sentido, la satisfacción de preferencias de los residentes debería justificar el incremento en los tipos impositivos de los distintos impuestos necesario para cubrir el incremento de costes. Además, la simulación llevada a cabo para el periodo 1995-2005 muestra que el incremento medio en los costes de provisión de los servicios públicos locales debido a la dispersión urbana es relativamente reducido y, por tanto, fácil de internalizar por parte de las autoridades locales. No obstante, en los municipios con niveles de dispersión urbana por debajo de la media nacional en 1995 y que experimentaron un importante proceso de suburbanización a lo largo del periodo considerado, el incremento en los costes fue considerablemente superior.

El Capítulo I deja algunas cuestiones abiertas. También cabría esperar un impacto de la dispersión urbana sobre los ingresos de los gobiernos locales, de manera que el impacto fiscal neto de este modelo de crecimiento urbano sigue indeterminado. El estudio planteado en el Capítulo III se basa en una amplia y novedosa base de datos de

panel para los municipios españoles comprendida entre los años 1994 y 2005, con el objetivo de aportar evidencia sobre la relación entre los distintos componentes de los presupuestos municipales y el patrón de crecimiento de las ciudades. Los principales resultados que se desprenden del análisis se resumen a continuación. Por un lado, la dispersión urbana genera un superávit corriente y de capital que se traduce en un superávit a corto plazo para los gobiernos locales. Por otro lado, la metodología adoptada en el estudio permite determinar patrón temporal de este ajuste fiscal, sugiriendo un impacto temporal de la dispersión urbana sobre el componente de capital de los presupuestos locales, mientras que el impacto es permanente cuando se trata del componente corriente de los mismos.

Los resultados ponen de manifiesto un incremento en el gasto corriente, sugiriendo que los políticos locales aceptarán proveer los bienes y servicios públicos adicionales requeridos por las nuevas urbanizaciones construidas en la periferia de los municipios. Además, la dispersión urbana se asocia a necesidades adicionales de inversión en infraestructuras para extender la red de carreteras e infraestructuras básicas que de cobertura a esas nuevas urbanizaciones periféricas. La mayor parte del ajuste ante un *shock* de dispersión urbana se realiza por parte de los niveles superiores de gobierno con la financiación vía transferencias (principalmente de capital), así como a través de los recursos generados con los tributos asociados a la actividad inmobiliaria. En resumen, los resultados permiten concluir que los beneficios de la dispersión urbana más que compensan los costes que generan.

No obstante, la excesiva dependencia de los gobiernos locales en las transferencias recibidas como mecanismo de ajuste en sus presupuestos plantea un problema de azar moral. Las necesidades de inversión adicionales en infraestructuras para dar cobertura a las nuevas urbanizaciones se financian principalmente con transferencias recibidas de niveles de gobierno superiores, animando a los gobiernos locales a promover la dispersión urbana sin tener en cuenta las consecuencias fiscales de sus decisiones políticas. Este problema podría atribuirse al diseño del sistema de transferencias en España, dado que algunas transferencias de capital están condicionadas al déficit en infraestructuras de los municipios, hecho que a su vez es inducido por la dispersión urbana. Por lo tanto, parece ser que los gobiernos locales en España recurren a las transferencias para equilibrar sus presupuestos, y esta aparente relajación de su restricción presupuestaria puede distorsionar las decisiones de política pública. Además, existen ineficiencias asociadas a la financiación de la dispersión urbana vía

transferencias. De hecho, el problema surge cuando los constructores no internalizan la totalidad de los costes que generan, dejando que sea el gobierno local el que se haga cargo en última instancia (es decir, las autoridades municipales suben los impuestos a todos sus residentes en la jurisdicción y solicitan mayores transferencias a los niveles superiores de gobierno). Como resultado, la dispersión urbana no se autofinancia sino que genera una carga impositiva sobre todos los contribuyentes (Snack, 2002).

En resumen, estos resultados sugieren que las autoridades locales deberían ser conscientes de las implicaciones de largo plazo de sus decisiones en el ámbito de la política urbanística. Asimismo, se debería revisar el papel que juegan los gobiernos central y regional en todo este proceso. En concreto, sería necesaria una reformulación de los mecanismos de transferencias que reciben los gobiernos locales así como también la definición de instrumentos de financiación local apropiados con el objetivo de conseguir que los responsables o beneficiarios de las nuevas construcciones internalizasen completamente los costes generados. De este modo, se conseguiría controlar la expansión urbana y promover formas más eficientes y compactas de crecimiento urbano.

El Capítulo III de la Tesis centra el análisis en otro potencial problema relacionado con la dispersión urbana: el deterioro de los cascos originales de las ciudades y el papel de las políticas públicas. Si bien existe una extensa literatura acerca de las relaciones entre el crecimiento urbano y suburbano es escasa la atención dedicada al análisis del deterioro físico de las ciudades y el papel corrector de las políticas de contención urbana. De hecho, una revisión exhaustiva de la literatura pone de manifiesto que son escasos los trabajos centrados en el análisis de estas cuestiones.
El trabajo empírico presentado en este capítulo se basa en una muestra representativa de áreas metropolitanas de EEUU y sus correspondientes ciudades principales. Los microdatos de la encuesta sobre vivienda, *American Housing Survey*, nos han permitido construir doce nuevas y específicas medidas de deterioro urbano, basadas en las características físicas de los edificios y sus vecindarios en las principales ciudades de EEUU. Para una mejor comprensión, toda esta información se ha resumido en un número reducido de variables con la mínima pérdida de información mediante la aplicación del Análisis de Componentes Principales (Hair et al, 2010).

Los resultados indican que las ciudades principales de aquellas áreas metropolitanas que han adoptado políticas de contención urbana presentan un nivel de deterioro físico de las infraestructuras significativamente menor que en aquellas donde no se han adoptado este tipo de políticas. Así pues, el estudio ofrece evidencia empírica sobre la efectividad de este tipo de políticas al conseguir uno de sus objetivos prioritarios, la contención del deterioro físico de las ciudades. En este sentido, es importante destacar la nada despreciable aportación de niveles superiores de gobierno, ya que las ayudas federales que reciben las ciudades también ejercen un impacto positivo y significativo sobre la reducción del deterioro de las mismas. La evidencia empírica sobre la efectividad de estas políticas podrá ayudar a orientar las decisiones de política pública sobre urbanismo en otros países que también experimentan elevados niveles de dispersión urbana. La implementación temprana de políticas correctivas adecuadas para prevenir el deterioro y abandono de las ciudades genera ganancias de bienestar y reduce futuras presiones sobre los presupuestos municipales, en términos de migración de bases imponibles, pérdidas de recursos impositivos e inversiones en rehabilitación de edificios, así como políticas orientadas a solucionar los problemas que surgen en las ciudades como consecuencia de la pérdida de población y el deterioro urbano, entre los que destacan los problemas de segregación, pobreza o inseguridad ciudadana.

Finalmente, cabe destacar la importancia que las grandes ciudades tienen en la economía regional, dado que la contención del deterioro urbano en estas ciudades genera externalidades positivas que promueven el crecimiento y el progreso económico más allá de sus propios límites administrativos. De ser así, la revitalización de las ciudades y el crecimiento de las áreas urbanas deberían considerarse complementos y no sustitutos (Voith, 1998; Muro y Puentes, 2004). Ciudades y suburbios pueden mejorar conjuntamente su bienestar mediante la cooperación, adoptando programas de contención urbana orientados a prevenir una mayor dispersión urbana al tiempo que ofrecen incentivos para fomentar formas de crecimiento más compactas que ayuden a contrarrestar el deterioro de las ciudades.

### 3. Futuras líneas de investigación

Los principales hallazgos presentados en esta Tesis podrían ampliarse de distintas formas. En primer lugar, y acorde a la literatura previa, en esta tesis la dispersión urbana se ha considerado una pauta de urbanización caracterizada por un crecimiento espacial

excesivo y discontinuo, acompañada de baja densidad de población y de un elevado consumo de suelo. No obstante, la medición de este fenómeno es controvertida, dada la falta de consenso en torno a su definición así como a su correcta especificación. Pese a ello, variantes de la densidad de población han sido, hasta el momento, las variables comúnmente utilizadas como indicador de dispersión urbana, dada su simplicidad y la dificultad para la obtención de medidas alternativas. En este contexto, la definición de una medida más adecuada de dispersión urbana, orientada a capturar toda la dimensión espacial de este modelo de crecimiento urbano, surge como alternativa a tener en cuenta en investigaciones futuras. La reciente disponibilidad de las fotografías de satélite proporcionadas por el proyecto europeo *Corine Land Cover* y el uso de técnicas de Sistemas de Información Geográfica nos permiten construir dichas medidas de dispersión urbana alternativas, basadas en la distribución geográfica de las urbanizaciones en el territorio español.

En segundo lugar, el análisis presentado en el Capitulo II podría mejorarse para tener en cuenta las principales limitaciones de la metodología utilizada. El uso de un modelo vector autoregresivo con datos de panel es adecuado para abordar el principal objetivo del capitulo, centrado en el análisis del impacto dinámico de la dispersión urbana sobre los presupuestos municipales, dada la inexistencia de un marco teórico previo que justifique las relaciones entre las variables consideradas en el modelo. No obstante, podría considerarse el desarrollo de un marco teórico así como la inclusión de variables adicionales que tuviesen en cuenta otros factores determinantes de las decisiones de política urbanística de los ayuntamientos.

En tercer lugar, la realización de otros estudios empíricos para el análisis de las consecuencias sociales y medioambientales de la dispersión urbana podría complementar la evidencia empírica proporcionada en esta Tesis. Pese al carácter voluntario de este fenómeno, ya que responde principalmente a la satisfacción de preferencias de los residentes, la dispersión urbana ha generado diversas preocupaciones acerca del bienestar de las comunidades. Una de estas preocupaciones es la creciente disparidad entre comunidades. Los residentes que emigran a los suburbios son aquellos con mayores niveles de renta. Esta segregación por niveles de renta tiene, a su vez, importantes consecuencias para os presupuestos municipales y la provisión de bienes y servicios públicos. Dado el rápido e intenso proceso de suburbanización experimentado en España en los últimos años, el análisis de la desigualdad de la renta y las cuestiones

relativas a la po larización sugieren una interesante línea de investigación futura. La reciente disponibilidad de una muestra representativa de micro datos fiscales, obtenidas de las declaraciones de renta de IRPF, y el uso de técnicas adecuadas de reponderación nos han permitido derivar distribuciones de renta locales que podrán ut ilizarse para llevar a cabo un análisis sobre el impacto de la dispersión urbana en la desigualdad de la renta y la polarización en España.

En cuarto lugar, la evidencia p roporcionada en esta Tesis sugiere que la dispersión urbana puede haber sido utilizada por parte de los gobiernos locales como una variable estratégica de cor to plazo para fi nanciarse aumentando sus bases impositivas, pero sin tener en cuent a los efectos a largo pl azo. En este sentido, la modelización de este comportamiento estratégico por parte de los gobiernos locales sería un interesante tema de desarrollo futuro.

Finalmente, esta Tesis se ha centrado en el análisis de las consecuencias de la dispersión urbana. No obstante, tambi én existe escasa evidencia empírica sobre las causas de dicho fenómeno. Variables geográficas, políticas, caracterísi cas socioeconómicas, la dotación de carreteras, ciertas políticas públicas de inversión y la regulación sobre los usos del suelo, entre otros, se consideran factores determinantes del excesivo crecimiento horizontal de las ciudades. Por lo t anto, un análisis de las cau sas de este nuevo patrón de creci miento contribuiría a una mejor comprensión del fenómeno así como a incrementar la evidencia empírica existente entorno a este tema.

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