SPRAWL, BLIGHT AND THE ROLE OF URBAN CONTAINMENT POLICIES. EVIDENCE FROM US CITIES [*]

Miriam Hortas Rico

ABSTRACT. US post-war suburbanization has reshaped the spatial pattern of growth in many metropolitan areas, with population and employment shift toward the suburbs resulting in the urban decay of central cities. This being the case, the adoption of adequate anti-sprawl policies should lead to a reduction in city blight. Availability of detailed blight measures at the city level enables us to undertake a novel empirical analysis to test this hypothesis. The empirical specification presented here identifies the specific impact of more stringent anti-sprawl policies adopted at the metro-level, proxied by the adoption of urban containment policies, on city blight. Results indicate that the adoption of such policies have effectively contributed to the reduction of downtown deterioration.

JEL Codes: R14, R30, R52

Keywords: blight, urban sprawl, urban containment policies.

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1. Introduction

US post-war suburbanization has reshaped the spatial pattern of growth in many metropolitan areas as many factors interact to generate urban sprawl. Population growth combined with individual housing preferences, higher income levels, a reduction in transport costs and an improvement in road networks have ensured that the demand for land at the urban fringes is in a constant state of growth (Mieskowski and Mills, 1993; Brueckner and Fansler, 1983; Brueckner, 2000, 2001; McGrath, 2005; Baum-Snow, 2007; Wassmer, 2008). In parallel with these forces, increasing political fragmentation (Carruthers and Ulfarsson, 2002), aspects of the physical geography (Burchfield et al., 2006), certain subsidy programs, public investment policies and land-use regulations (Glaeser and Kahn, 2004; McGuire and Sjoquist, 2002) have also been instrumental[1].

This rapid suburbanization has created many of the challenges that US cities face today, ranging from traffic congestion, air pollution and a loss of amenity benefits from open space to the weakening of agglomeration economies and economies of scale in the production of local public services. Claims are also made that sprawl induces the movement of large shares of population and employment to suburban communities, thereby contributing to socioeconomic segregation between the suburban rich and the inner city poor[2]. This predominantly "white flight" of the middle- and upper-income classes has given rise to many poverty-related problems in downtown neighborhoods, including increasing crime rates, poor-quality public services, a shortage of fiscal resources and a lack of reinvestment and maintenance in existing building structures, resulting in the deterioration and decay of central cities. These inner-city problems promote 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).

It is not surprising, then, that the problem of central city urban decay has become a matter of concern throughout US metropolitan areas. Interest in blight is not, however, of recent origin. Indeed, early writers on blight and urban renewal stressed the complex relationships between central city and suburban development (see, for instance, Fisher, 1942; Breger, 1967; Davis, 1960; Davis and Whinston, 1961; Bradbury, Downs and Small, 1980) with central city decline being identified as a diseconomy of urbanization. More recently, Brueckner and Helsley (2011) have developed a dynamic urban model to show that sprawl and urban blight can be considered the byproduct of the same underlying economic process, both phenomena being responses to fundamental market failures distorting the socially desired

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

[2] The growing body of literature on the economics of urban sprawl is surveyed in Glaeser and Kahn (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.

allocation of population and urban land within jurisdictions[3]. Unpriced traffic congestion, open-space externalities, and unpriced suburban infrastructure make suburban living cost inefficient, 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 curb sprawl and the decline of central cities by raising reinvestment and reducing 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 the quantity of development and the price 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. They have, however, potentially adverse 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 centers (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 favor of more appropriate anti-sprawl measures. In this context, newly designed urban containment policies (hereinafter, UCPs) 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 revitalization 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 the development of infill sites and the redevelopment of inner core areas. To that end, they can combine mixed-use and high-density zoning, affordable housing strategies and land supply monitoring, with capital investment plans and various redevelopment incentives[6].

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

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 such a 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 tolls, open-space amenity taxes and impact fees. 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).

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 modeling.

6 See Section 3.2. for further details on UCPs.

analyzing 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), and on central city construction activity (Nelson et al., 2004b), i.e. the effect on both housing supply and central city housing prices. There is not, however, any empirical evidence for the success of policy remedies in preventing central city deterioration. Generally speaking, a review of the literature leads to the conclusion that the evidence for the extent of city blight, and for policy-oriented decision-making aimed at addressing the problem of central city urban decline, remains somewhat limited.

Therefore, the present study seeks to add to the existing empirical literature on the relationship between central city and suburban development and the role played by anti-sprawl policies. It represents, as such, the first attempt in the empirical literature to address blight reduction in U.S. central cities. Moreover, the conclusions derived from this analysis should help orient public policy in terms of regional and local land-use decision-making and central city revitalization.

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 can help reduce urban decay. Available micro data from the American Housing Survey on external conditions of buildings and neighborhoods enable us to construct detailed blight measures at the city level for a representative sample of 125 metropolitan areas. We report a novel empirical analysis of the determinants of city blight and of the role of corrective policies in preventing central city deterioration. Our empirical specification includes a number of control variables that take into account the effect of socioeconomic and housing 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, proxied here by the adoption of UCPs, on city blight. In other words, we can determine whether among metropolitan areas with the same characteristics the ones with UCPs in place have experienced significant blight reductions in their central cities. Besides, the possible endogeneity problem of such policies is considered and the baseline model is re-estimated using two-stage least squares.

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 describe the methodology, data sources and variables used in carrying out our empirical analysis. Our 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.

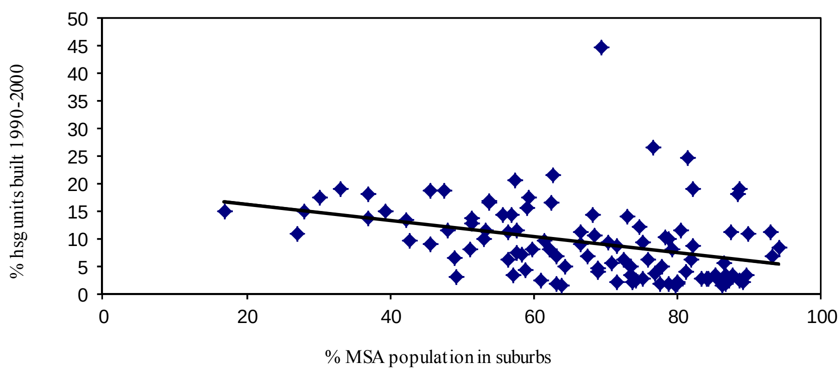
2. Urban blight

2.1. The causes of blight

As noted above, economic progress and major structural changes to transport systems 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, given that suburban expansion responds mainly to the migration of central city residents rather than to the accommodation of new population growth. As Breger (1967) explains, 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 over-utilization of property).

A new approach to the examination of the relationship between city and suburban growth has recently been developed by Brueckner and Helsley (2011). Their claim is that blight is not a consequence of sprawl but rather the result of the inefficient allocation of population driven by the same market failures that generate sprawl. In other words, the market mechanism has not functioned properly in the urban economy, resulting in 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 1 plots the share of Metropolitan Statistical Area (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, ρ= -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 1. Correlation between sprawl and blight



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

This being the case, the adoption of anti-sprawl policies would also serve 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 to move toward the center. The resulting increase in housing prices in the center then acts as an incentive for building reinvestment and maintenance, thereby reducing urban decay (see Brueckner and Helsley, 2011, for a fuller explanation). Besides, Davis and Whinston (1961) use an example based on the Prisoner's

Dilemma to show how the presence of neighboring effects and the property owners' strategic behavior to maximize the returns to their investment can explain persistence in blight. According to the authors, property owners may neglect reinvestment and improvements in existing structures in anticipation of the arrival of more intensive uses which might bring capital gains. In this scenario, rational individual action might allow property to deteriorate and blight to occur, leading to a process of contagious neighborhood decline. Hence, as Brueckner and Helsley (2001) conclude, blight arises from the interaction of these neighborhood externalities and an event that causes an initial decline in building maintenance and reinvestment, identified by the authors as the natural operation of the land market in the presence of sprawl-inducing distortions.

2.2. The blight measure

Breger (1967, p.372) defines 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".

Thus, while urban blight includes both social and economic dimensions, it is primarily a physical phenomenon. It involves the obsolescence, deterioration, the fall into disrepair and decay of buildings in central cities due, among other reasons, to neglect, depopulation, lack of economic support and deficient reinvestment in older central city properties. In this sense, recent papers define it as a spatial concentration of deficient housing maintenance or reinvestment in older central city properties (see Brueckner and Helsley, 2011, p.205; Bento et al., 2011, p.440).

In accordance with these definitions, the blight measures used in this paper are based on the physical characteristics of buildings drawn from the American Housing Survey (AHS), which 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 neighborhood quality, housing costs, equipment and fuels, size of housing units, 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[7].

We draw on available micro data files containing 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

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

corresponding weights to obtain a representative sample of housing units within central cities of 125 selected metropolitan areas[8]. Selected characteristics on external building conditions reflect serious damage to the structure mainly caused by continuous neglect, vandalism, and so forth, and refer to both the building itself and general neighborhood conditions. In particular, selected variables reflecting blight include: housing units with boarded up or broken windows; housing units with holes in the roof or with missing roof materials or surface roof sagging caused by extensive damage to the structure or serious neglect; housing units with outside walls missing the siding or bricks, with outside walls that slope, lean, slant or buckle; and housing units that have been abandoned or vandalized, trash or junk in streets or roads needing repairs, all within half a block. Descriptive statistics of the characteristics considered are presented in Table 1. Note that all variables are expressed as proportions of the total number of housing units.

Table 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.

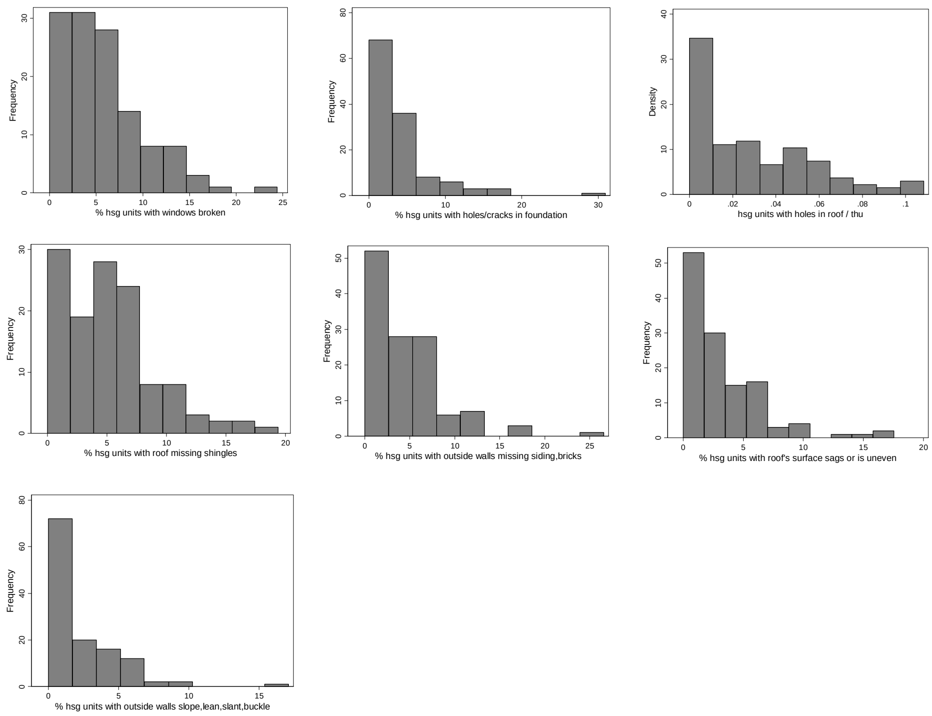
A preliminary analysis of the blight data reveals two main findings. First, the frequency distributions presented in Figure 2 exhibit significant variations in the degree of blight in the central cities of the US. Second, the neighborhood condition variables present more marked indications of blight. For example, more than half the cities considered in the sample reported the need for road repairs and improvements in trash collection in neighboring streets. Moreover, as shown in Table 1, the mean values obtained after clustering cities according to the existence of anti-sprawl policies (i.e. UCPs) show that, as expected, blight levels are lower in cities without those policies in place. That is, a preliminary inspection of 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

[8] 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 (employed instead of the pure weight, as 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 1 of Appendix 1.

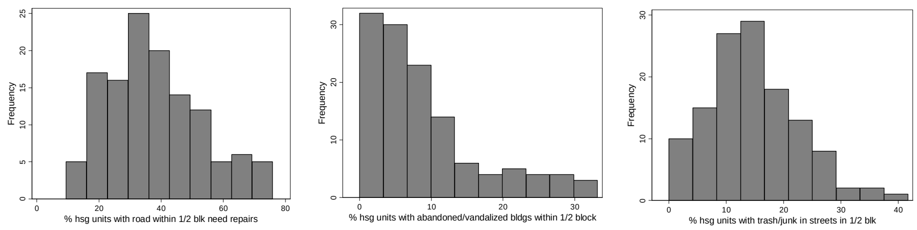
blight is necessary to understand the observed differences. For this purpose, more robust conclusions from the econometric analysis are presented below.

Figure 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.

2.3. Principal Component 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)[9]. The most common method for reducing dimensionality is the principal component analysis (PCA) 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.

9 Further details on conducting the principal component analysis are presented in Appendix 2.

Central city blight measures can be grouped into two different categories on the basis of their nature. We define a first group of external building conditions with reference to windows, roof and walls, and a second group of neighborhood conditions. PCA is then applied to each group of blight measures. The results allow us to identify one component in each group of variables that cover 47 and 65%, respectively, of the variance of the original data set (see Table 2)[10].These two components are included in the regression analysis as dependent variables. As a result, two different equations are estimated, one for each component.

Table 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	47.30	47.3	3.3108	47.30	47.30
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	6.70	88.33			
Component 6		0.4599	6.57	94.90			
Component 7		0.3572	5.10	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 shows the weights applied to each individual blight measure to obtain the retained component which is, as discussed above, a linear combination of the initial blight variables (Column 1). The results show the contribution of each blight measure to the component. For the first set of blight measures, all the variables are equally represented in the new blight index, as each variable explains between 10 and 17% of this newly created index. In the second set of blight measures, the three initial variables account for 35, 28 and 37% of the new blight index, respectively. The correlations between each initial blight measure and the retained component are presented in the last column of Table 3. As can be seen, the initial blight measures of neighborhood conditions are highly correlated to the new blight index (a coefficient around 0.8), whereas the correlation is somewhat weaker between external building conditions and their new summary indicator (a coefficient between 0.58 and 0.75).

[10] According to the Kaiser-Guttmann rule, only factors with an eigenvalue greater than one are retained.

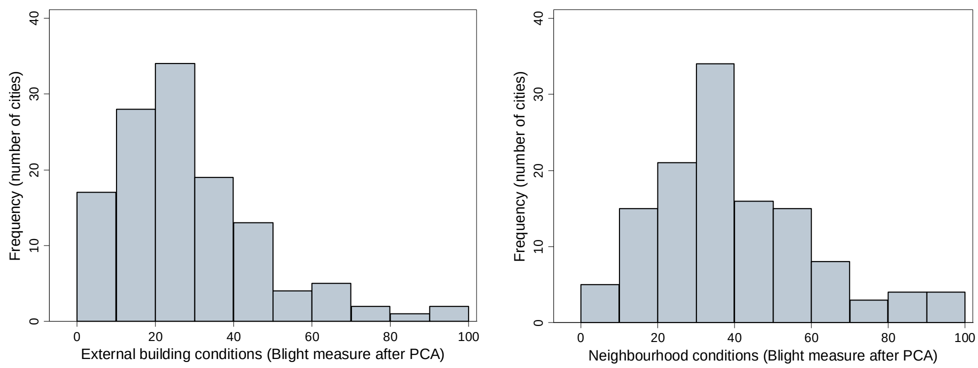
Table 3. Weights, contributions and correlations between the blight measures and the components retained.

	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.

Figure 3 presents the frequency distributions obtained for the two indexes of blight obtained after PCA[11]. The results suggest that the new blight indexes exhibit a similar pattern of variation to those presented in Figure 2 for single blight measures.

Figure 3. Frequency distributions of new blight measures



Source: own elaboration after PCA.

3. Empirical framework

3.1. The sample

The empirical study is based on a sample of 105 selected MSAs and their corresponding central cities[12]. The MSA was chosen as the unit of analysis for several reasons. As explained in Woo and

[11] The geographical distribution of the two blight indexes across central cities in MSAs included in the sample is presented in Maps 2 and 3 of Appendix 1.

Guldmann (2011), Consolidated Metropolitan Statistical Areas (CMSAs) have to be discarded because they often extend across more than one state and they are, therefore, too large to capture the influence of a single 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 each MSA.

The sample size was not randomly chosen but rather determined by the availability of data. As discussed, 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 to reduce city blight was available for just 105 of these. As shown in Table 4, a 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, the MSAs included in the sample account for about 80 percent of the total MSA population. Thus, we believe that the sample data are reasonably representative of all MSAs in the U.S.

Table 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.

3.2. Empirical specification

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

$$\text{Blight}_{ji,2000} = \alpha_j \ \text{UCP}_{k,1970-2000} + \beta_j \ \text{X}_{i1990} + \phi_j \text{Blight}_{ji,1990} + \varepsilon_{ij} \quad (1)$$

[12] The U.S. Office of Management and Budget defines an 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.

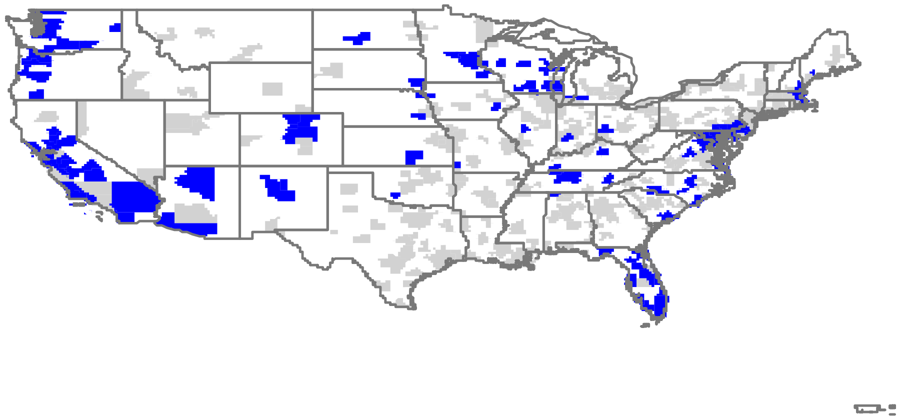
Where $Blight_{ji,2000}$ is the value of the blight measure *j* in city *i* in 2000, *j*=1,2, $Blight_{ji,1990}$ is the initial level of blight, UCP_{jt} is the urban containment policy in place prior to the period of analysis in metro area *k*, $\mathrm{X}_{i,1990}$ is a vector of city and metro characteristics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

Therefore, we analyze the correlation between the adoption of urban containment programs between 1960 and 2000 and city blight levels 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 obtain an overview of the correlation between growth containment and city blight in the 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 the UCP does not have a significantly different impact on blight reduction in statistical terms.

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 allocate efficiently new development as well as to balance the forces of decentralization and to promote the revitalization 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 the suburban population to move toward the center. The preservation of open space, cost-efficient construction and the use of urban structure are among their intended goals also.

Thus, the measure used in this analysis is a categorical variable that takes on a value of one if an UCP was in place prior to 2001 in each of the MSAs considered. The data, provided by Nelson et al. (2004), are drawn from a nationwide survey of metropolitan planning organizations in order 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 focuses on the adoption of urban growth boundaries, service extension limits and greenbelts. This data comprises a representative sample of the whole population. Thus, the set includes observations for 331 MSAs in 50 different states, 102 of which adopted a UCP between 1960 and 2000. As shown in Figure 4, MSAs with a UCP in place are located mainly along the east and west coasts of the country, with just a few located in the interior. The data also report the year of adoption of the UCP: twenty-two out of the 102 MSAs adopted a UCP before 1980, 38 did so during the 80s, 35 during the 90s and only one in the year 2000. In addition, a distinction can be drawn 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: forty-nine out of 102 MSAs formally adopted region-wide UCPs, while 53 adopted containment programs within a subset of the region's counties. When merging this sample with our blight data we obtain a sample of 107 MSAs, 36 of which have formally adopted a UCP. Note that contained areas were equally distributed according to the decade of adoption. Moreover, in half of the cases all counties were contained (see Table 5)[13].

Figure 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)

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 are not available for the year 1990, we proxy them with the proportion of new housing units built between 1980 and 1990[14].

Table 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.

Next, a set of controls are added to the econometric specification to check for the robustness of the correlation between blight and the adoption of a UCP. This set of variables includes a variety of

13 Detailed UCP maps according to the year of adoption and the type of containment program in place are presented in Appendix 1.

14 The correlation coefficient between the blight level in 2000 and the proportion of housing units built between 1990 and 2000 has a value of around 0.4. Thus, the proportion of housing units built between 1980 and 1990 is expected to be a good proxy of the city blight level in 1990.

observable city and metropolitan area characteristics drawn from the U.S. Bureau of Census (Decennial Census, the three-year estimates of the American Community Survey, the City and County Data Book and the Bureau of Justice Statistics) and seek to account for the other main factors affecting the level of central city blight. Descriptive statistics are presented in Table 6.

Table 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

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

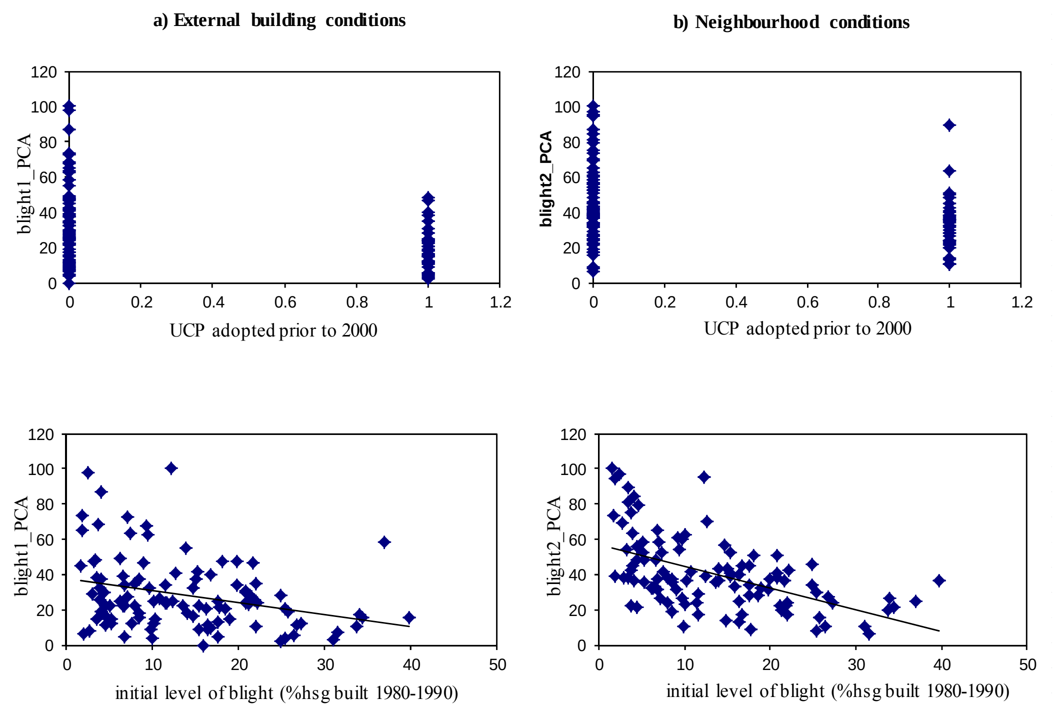
Second, we add a set of variables that account for the quality of life in central cities. This group of variables includes the city crime rate, measured as the weighted average of the number of violent crimes per 1,000 of population, and the proportion of the central city population that is Black and Hispanic in 1990. These variables could help explain 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 expect a positive correlation between this set of quality of life variables and the level of central city blight. The expectation, as such, is that the greater the occurrence of what residents are likely to view as negative factors in a central city, the greater the *flight from blight* we can expect to see: thus, the higher the crime rate, and the higher the proportion of Black and Hispanic residents, the greater the level of blight.

Additionally, per capita federal expenditure is 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. Partial correlations

Figure 5 shows the raw correlation between our two indexes of central city blight in 2000 and the adoption of UCPs. As can be seen, MSAs with UCPs in place prior to 2000 exhibit lower levels of central city blight than those that were uncontained. This result holds for both indexes of blight, *external building conditions* and *neighborhood 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.

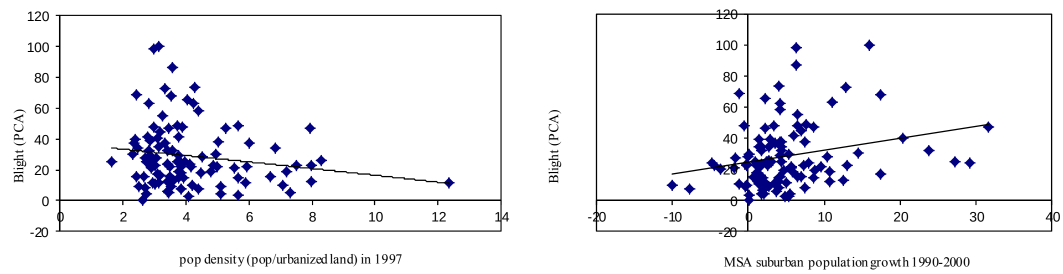
Figure 5. The correlates of central city blight.



Source: own elaboration after PCA.

Up to this juncture, we have provided evidence for a negative correlation between UCPs and central city blight. However, as explained at the beginning of this discussion, blight can also be correlated with 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). Accordingly, the adoption of UCPs should also correlate with lower levels of sprawl in the MSAs under consideration. As shown in Figure 6, there is a clear correlation between central city blight (measured as our index of blight after introduction of the PCA) and suburban sprawl, proxied here as population density (inhabitants/urbanized land). Those MSAs with higher population densities (i.e. the ones with least sprawl) face lower levels of central city blight. Hence, the higher the level of central city deterioration, the higher is the level of sprawl in that MSA.

Figure 6. Correlation between sprawl and urban blight



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

4. Main results and policy implications

The regression-based results of the empirical model are provided in Table 7. The analysis tests whether the adoption of UCPs leads to lower blight levels in central cities, *ceteris paribus*. Following the PCA applied to the set of blight measures (see *Section 2*), two separate regression analyses are presented. The two panels, labeled *External building conditions* and *Neighborhood building conditions*, represent the two indexes obtained after the 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 discussed above. In other words, we are now in a position to compare cities with the same characteristics in order to see if those that underwent containment experienced a reduction in blight.

Columns (1) to (4) report the estimated coefficients from different model specifications according to expression (1). In Column (1) only the UCP variable is included; 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); and, finally, in column (4) we add regional dummies for large regions (Northeast, South, West and Midwest – the latter being 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 derived from economic theory (see Brueckner and Helsley, 2011), the regression findings show that the adoption of more stringent anti-sprawl policies help to reduce the deterioration in central city structures. U.S. central cities within contained metropolitan areas, measured here by their adoption of UCPs, have lower blight levels than those within metropolitan areas without UCPs 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*). In this case, cities with a UCP in place have seen average declines in their blight index of approximately six points. As shown in panel *b*, no significant effects were found in the *neighborhood 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 to reduce the current level of blight. In other words, 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. Specifically, a one standard deviation increase in the proportion of new housing built in the 80s yields a four-point decrease in the first blight index considered. The impact on the second blight index (*neighborhood conditions*) ranges from three to seven 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 the estimated coefficients present the expected sign; however, some are found not to be statistically significant. First, richer central cities experience less blight than their poorer counterparts. A one standard deviation increase in the median household income of central cities results in an approximately four to five point decrease in the blight indexes. Second, Table 7 also shows the negative impact of central city population on blight. However, the magnitude of the estimated coefficients is quite small and it does not have a statistically significant impact on city blight.

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* by around three points, while a one standard deviation increase in the percent of black population living in central places increases the blight index of *neighborhood building conditions* by between six and eight points. Higher central city crime rates have an unmistakable positive impact on blight in all the specifications considered. As shown in Table 6, a one standard deviation increase in this variable yields an increase in the blight index that ranges from three to five points.

The amount of per capita federal aid received has a significant impact on the level of central city blight. Specifically, a one standard deviation increase in this variable reduces the blight index of *external building conditions* by three points. Thus, the results indicate that federal spending in central cities contributes to their vitality 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), except the impact of UCPs on the neighborhood conditions index, which becomes clearly insignificant.

Table 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.

All in all, these results are useful for obtaining a general overview of the influence of a certain type of corrective anti-sprawl policy on a desired target variable, namely the 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 elsewhere in the literature.

5. Additional results

We explore the sensitivity of our results in a number of different ways. First, the data provided by Nelson et al. (2004) allow us to differentiate between two types of UCP on the basis of their scope. Specifically, a distinction can be established between areas with region-wide containment programs and those with containment programs in place within a subset of the region's jurisdictions (see Table 5 in Section 3). Based on the results presented in Columns (1) and (2) of Table 8, no consistent effects were found[15]. Second, urban containment was measured on the basis of the existence of a formally adopted containment policy (growth boundary, service extension limits or greenbelt) prior to the start of the study

[15] 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.

period in 2001. In addition, the availability of the year in which the UCPs were introduced can be used to test the proposition that their effects would be more pronounced the longer the programs had been in operation. To this end, we perform additional estimations including three categorical variables that take a value of 1 whether the UCP was adopted in the 70s, 80s and 90s, respectively. As shown in Columns (3) and (4) of Table 8, the regression results indicate that the year of adoption of the UCP does not have a statistically significant different impact on blight reduction. This finding is in line with Nelson et al. (2004), who analyzed whether UCPs have an impact on the level of central city construction activity and provided evidence of no consistent effects of program length. The estimated coefficients of this set of control variables are very similar to those presented in the previous section (see Table 7) and, therefore, no further comments are presented here.

Table 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.

6. Robustness checks

6.1. An alternative measure of blight: an average of the initial blight variables

As explained in Section 2, the dataset used in the present paper consists of a variety of central city blight measures capturing different aspects of central city building conditions. The statistical technique applied to the data is clearly the most suitable, as it is able to summarize all the information available into a smaller number of variables with the minimum loss of information. By so doing, the index thus obtained accounts for the co-variation shared by the original variables and, as such, this should be a better estimate than simple or weighted averages of the initial blight measures. Nonetheless, in this section we define an alternative measure of blight as the average of all the variables considered. The results are presented in Table 9. The results are in line with those presented in Table 7, albeit they present the lowest magnitudes of all the coefficients. The impact of the UCP ranges from a one to three point decrease in the average level of central city blight, although this effect disappears once the regional dummies are included in the model. As for the set of controls, all present the expected sign but record a magnitude of around one in almost all cases. These results may well reflect the lower capacity of the average measure of blight as a variable for summarizing adequately the information contained in the initial blight measures.

Table 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.

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

As discussed in the introduction, UCPs are newly designed policies that have emerged in response to the perverse consequences of traditional restrictive land-use controls. The policies combine regulations and incentives to guide and efficiently allocate new development as well as to balance the forces of decentralization and promote the revitalization of communities. To achieve this, they might combine mixed-use and high-density zoning, affordable housing strategies and land supply monitoring, with capital investment plans and various redevelopment incentives. As such, they appear to be the most suitable growth control policies for addressing the problems of central city blight.

However, the recent empirical literature of growth controls includes an alternative measure of anti-sprawl policy, the Wharton Residential Land Use Regulation Index (hereinafter, WRLURI) 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 different aspects of the regulatory environment and capture the intensity of local growth control policies in a number of dimensions[16]. These indexes are then compiled in a single aggregate measure (the WRLURI) by means of factor analysis. 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 index values conversely tend to implement zoning regulations or operate 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 those of traditional land-use regulation (zoning ordinances and 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 revitalization. These shortfalls prevented us from using the index as the main growth control policy in this paper. Nonetheless, the significant correlation of the WRLURI with the UCP variable (around 0.5) means it can be considered 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 revitalization, but it is also true that blight reduction could emerge as an indirect byproduct of those policies. Thus, and while 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 10.

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[16] These 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 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.

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.

As expected, the impact of the WRLURI on central city blight reduction is lower than that obtained with the UCP. As noted above, the difference in these results is attributable to their respective policy designs. The UCPs are explicitly designed to control blight and promote central city revitalization while the regulations that form part of the WRLURI are concerned with controlling sprawl, yet indirectly their implementation could have a positive, if unintentional, effect on central city blight reduction.

6.3. Addressing the possible endogeneity problem of growth control programs

In this section we account for the fact that the relationship between UCPs 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 initial level of central city blight. Although we control for this possibility to some degree by restricting the definition of the presence of UCPs 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 UCPs but which are not related to the level of central city blight. In this regard, a review of the literature suggests that locations with the most desirable amenities tend to be the locations that are most closely regulated (see, for instance, Hilber and Robert-Nicoud, 2010; Saiz, 2010). Given that people prefer to live in nice places, locations endowed with desirable amenities are developed earlier and it is quite likely that land-use regulations have to be instrumented to limit excessive urban growth and preserve those locations. Saiz (2010) also reports that growth management programs correlate with the fraction of unavailable land within each MSA, calculated by combining the area corresponding to steep slopes, oceans, wetlands, lakes and other water features. Intuitively, this variable is correlated with UCPs since 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 is unlikely to be correlated with the current level of city blight because it has been exogenously determined.

In addition, political ideology is also assumed to play an important role in determining the strength of preferences for environmental preservation (Kahn, 2011) and, hence, for promoting stronger growth management programs (Nelson et al., 2004; Hilber and Robert-Nicoud, 2010). The degree of fragmentation in a region's planning system could potentially result in development competition in fringe areas, promoting low density suburbanization (Carruthers and Ulfarsson, 2002; Carruthers, 2003; Wassmer, 2008). As Carruthers (2002) notes, the political fragmentation of regions is also responsible for fostering sprawl and blight because, by dividing authority among many small local governments, the overall ability of land-use planning to shape the outcome of metropolitan growth is undermined. In other words, a high number of local government units within the MSA tends to weaken 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 to the efficacy of growth management programs.

Consequently, the set of variables selected 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 land unavailable for development provided by Saiz (2010). Second, the influence of political ideology is proxied here by the state share of votes cast in favor of the Democratic candidate in the 1976 presidential election. Third, political fragmentation is measured as the 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 favor regulations to raise their property values and, therefore, locations with a large share of homeowners can be expected to 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 in the model (given by expression (1)). The predicted variable is then included in a second-stage regression as an independent variable in the original regression equation. The regression results of equation (1) with the UCP being treated as the endogenous variable are provided in Table 11. Column (1) reports the first-stage estimated coefficients of our instruments. The results show that the democratic vote share, the mean heating degree days and the percentage of land unavailable for development are particularly useful in our attempts to identify the effects of the 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 UCPs to curb urban sprawl. On the other, local amenities play an important role in explaining the regulatory environment. First, the higher the percentage of land unavailable for development, the higher is the level of regulation required to limit urban expansion. Second, the mean heating degree days capture a city's extremely hot climate. This is a characteristic that makes open space less attractive and, in turn, less closely correlated with sprawl and the need for stronger growth management programs, as shown by the negative sign of its estimated coefficient.

Table 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.

Finally, the level of fragmentation, the homeownership rate, the mean cooling degree days and the coastal dummy present the expected sign, although they are not significant. However, when considered together, the set of instruments is jointly significant[17].Column (2) reports the TSLS results for the *external building conditions* index. The TSLS coefficient for the UCP variable is negative and significant. The coefficient

[17] 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).

is higher than that provided by OLS (see Table 7), confirming the presence of a downward bias. Based on this result, contained cities exhibit an index of central city blight that is 17 points lower than the index presented by their uncontained counterparts. As for our set of controls, all the coefficients present the expected sign and a very similar magnitude to those obtained for our OLS specifications (see Table 7), albeit only the income and federal aid variables remain significant. The results for the *neighborhood conditions* index are presented in Column (3). Once again, the impact of the UCP is negative, as expected, but not significant.

7. Conclusions

US post-war suburbanization has reshaped the spatial pattern of growth in many metropolitan areas, in a process that has seen population and employment shifting toward the suburbs and the urban decay of central cities. A body of research has been built up concerned with policy remedies aimed at curbing such sprawl and fostering more compact urban developments. One of its main theoretical conclusions is that city blight is in fact a byproduct of anti-sprawl programs, as they not only limit urban growth but provide incentives to redirect population growth and investment away from the suburbs toward neglected inner core areas (Brueckner and Helsley, 2011).

The fact that city blight is only a recent phenomenon means the current discussion on its causes and potential remedies remains largely undeveloped. In fact, empirical evidence on city blight and the effectiveness of anti-sprawl policies on preventing the deterioration of downtown structures remains limited. Several studies have 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., 2004). 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 represents the first attempt to analyze the impact of anti-sprawl policies, proxied by adopting 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 allow us to construct 12 specific blight measures based on the external physical characteristics of buildings and neighborhoods for 125 U.S. central cities. For the sake of simplicity, these details of city blight are summarized in a smaller number of variables with the minimum loss of information by means of principal component analysis. Thus, we end up with three different variables that are included as dependent variables in the regression analysis. Our empirical specification enables us to determine the specific impact of UCPs on the level of blight in central cities, with all other metropolitan and city characteristics affecting urban blight being taken into account by the inclusion of a set of control variables. Our results indicate that the adoption of UCPs has a significant impact in terms of the reduction of blight in these contained cities. As such, we are able to report empirical evidence of urban containment programs achieving one of their intended goals, that of the reduction of central city deterioration. In this regard, it is worthwhile noting also 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, the importance of a central city to the regional economy should not be underestimated. In this regard, blight reduction can generate positive externalities that enhance growth and economic progress beyond a city's boundaries. Several studies have empirically addressed this research question. As noted in Voith (1998), suburbs also benefit from investment and the subsequent revitalization of downtowns, as city income growth in turn enhances suburban growth. A further example is provided by Muro and Puentes (2004), who report evidence of the relationship between lower city poverty rates and metropolitan income growth.

Therefore, the evidence seems to suggest that central cities and their suburban areas remain closely interconnected[18]. This being the case, central city revitalization and metropolitan area development should perhaps be seen as complements rather than substitutes. This would mean that cities and suburbs alike 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.

8. References

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[18] See Ihlanfeldt (1995) for a review of the empirical evidence pointing to the sources of interdependence linking the economies of central cities and their suburbs.

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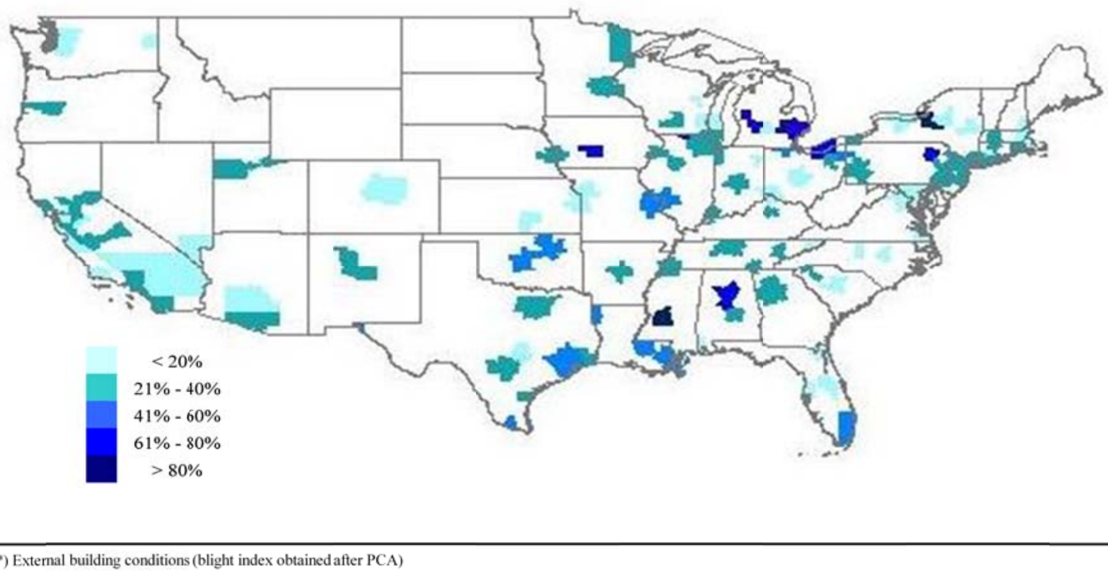
Appendix 1. Blight and urban containment program maps.

Map 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.

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



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

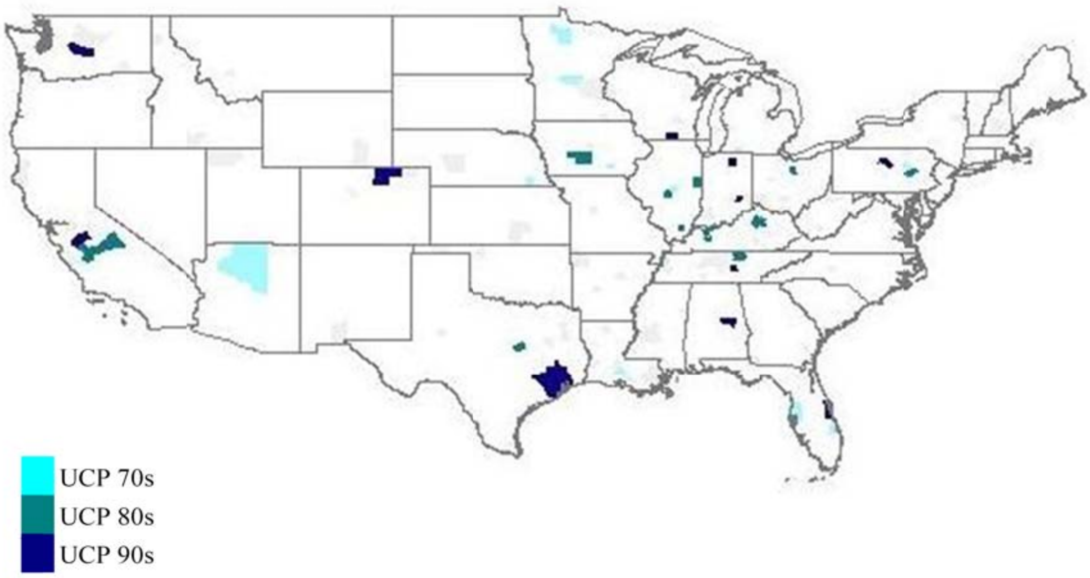
Source: own elaboration using TIGER/Line Shapefile, U.S., Metropolitan Division National., provided by the U.S. Department of Commerce, U.S. Census Bureau, Geography Division.

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

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

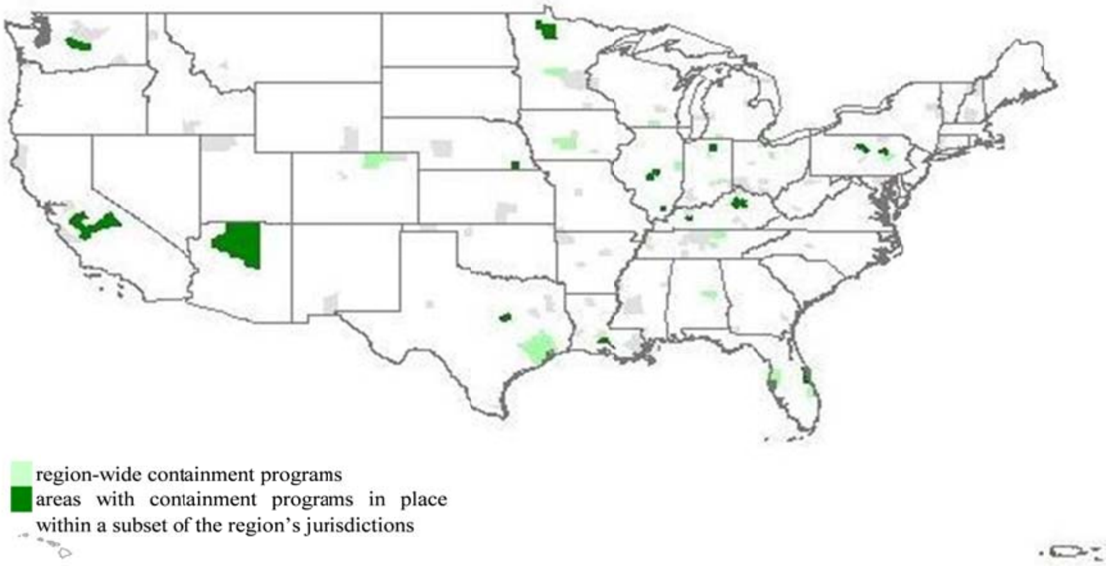
Source: own elaboration using TIGER/Line Shapefile, U.S., Metropolitan Division National., provided by the U.S. Department of Commerce, U.S. Census Bureau, Geography Division.

Map 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)

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



region-wide containment programs
areas with containment programs in place within a subset of the region's jurisdictions

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 2. Principal Component Analysis

Principal component analysis (hereinafter, PCA) is a multivariate statistical technique used to reduce the number of variables in a data set into a smaller number of 'dimensions'. PCA can be applied with a set of correlated and quantitative variables in order to obtain a smaller number of uncorrelated variables, defined as linear combinations of the originals. The resulting principal components (hereinafter, PCs) or factors 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,

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

where u_{pp} represents the weight for the pth principal component and the pth 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 PCs are extracted by linear weighted transformations of the initial variables so that the first few PCs 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 PC are given by the eigenvectors of the correlation matrix, or if the original data were standardized, the co-variance matrix. The variance (λ) for each PC 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[19].

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

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

19 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.

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 λ of matrix V. Letting λ_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:

$$C_1 = u_1X = u_{11}X_1 + u_{12}X_2 + \cdots + u_{1p}X_p$$

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 the number of components that are 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.

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 for 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 hth component on total variation is λ_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,

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

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:

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

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 are accounted for by one of the original variables in the standardized data. This is commonly used as a cutoff point for retaining PCs.

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 in the new component as well as the correlations between the variables and the components. As stated above, a component is a linear combination of a set of variables, but it could be better correlated to some of them than it is 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:

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