MUNICIPAL OPERATING COSTS-REVENUES IN FUTURE DEVELOPMENTS AS A FUNCTION OF URBAN PLANNING VARIABLES

Francisco Javier Garrido-Jiménez[1]; Francesc Magrinyà[2]; María Consuelo del Moral-Ávila[3]

ABSTRACT

The assessment of a future urban area's economic sustainability is more valuable if it is available in the early stages of the planning process, when the characteristics of the urban pattern are being established. With the aim to integrate economic sustainability in the urban planning decision-making process, this study develops a simple methodology to obtain analytical expressions for municipal operating costs and revenues in a future urban development exclusively in terms of its urban basic variables. Said formulae facilitate not only the assessment of the area's economic balance, but also the analysis at the local or supralocal level of each variable's economic role. Its application in a sample of Spanish cities with populations between 100.000 and 300.000 inhabitants has shown that, for these cities, municipal revenues depend equally on floor area ratio, property values and housing density, while expenditures do so firstly on relative length of road and secondly, on housing density. Economic sustainability from the municipal standpoint is usually achieved when housing density ranges from 40 to 80 dwellings per hectare.

CE Database subject headings: Urban development; Public Services; Planning; Sustainable Development

Author keywords: Linear Efficiency; Density; Economic Sustainability; Services to the Property

[1] Ph. D. Civil Engineering, City of Almeria Planning Board, 73 Federico Garcia Lorca Av. 04004, Almeria, Spain. E-mail: fjaviergarrido@hotmail.com. Telephone: (+34) 950152167. Associate Professor at the Department of Engineering. University of Almeria (UAL). (corresponding author)

[2] Ph. D. Civil Engineering, Professor, Department of Civil and Environmental Engineering. School of Civil Engineering, Technical University of Catalonia-Barcelona Tech (UPC), Campus North, Building B1-101, 1-3 Jordi Girona St. 08034, Barcelona, Spain. E-mail: francesc.magrinya@upc.edu. Telephone: (+34) 934017268.

[3] Ph. D. Architect, Professor, Department of Architectonic Constructions, School of Architecture, University of Granada (UGR), Severo Ochoa Av., 18071, Granada, Spain. Email: cdma@ugr.es. Telephone: (+34) 958240812.

INTRODUCTION

Today, it can be assumed that new urban developments must be sustainable from the environmental, social and economic point of view, thus contributing to the sustainability of the urban area where they are located (Krueger and Buckingham, 2012). To achieve this goal, it is necessary to consider sustainability criteria during the decision-making process of each stage of the development, starting with the design or redesign of new urban areas. From the environmental point of view, this means that some issues should be taken into account, such as the consumption of energy, valuable ecosystems or building materials, the creation of green areas or the limitation of waste production (Naess, 2001). From the social standpoint, these would include the levels of security, inclusivity or equal access to public services (Dempsey et al. 2011); and, from the economic perspective, the capacity of the new area to generate the economic resources that its own metabolism consumes (Ewers and Nijkamp, 1990).

Among all the above-mentioned items, consideration of economic sustainability criteria, -being adequately weighed -, has been very limited in practice. For example, in a country with a large urban dynamic such as Spain, its legal implementation has not occurred until the Land Act of 28th of May of 2007, when it became mandatory for zone planning to include an economic sustainability measure which assesses the operating cost of new public services for the Public Administrators involved. Apart from the existence of a greater public awareness of urban development's social and environmental aspects, the implementation of economic sustainability criteria in the urban planning process clashes with the large number of factors involved and the complexity of some of them. This is a problem especially at the time of drafting the zone plan, when some of the urban variables which most determine the future operating costs and revenues are fixed without the data necessary to make accurate economic forecasts.

For this reason, this study has focused on the economic aspects of urban sustainability, by proposing a methodology for obtaining the expressions of municipal operating costs and revenues in a new development exclusively in terms of its main urban variables. Once these expressions have been elaborated, the urban planner can make economic forecasts during the planning process without resorting to variables other than those regarding urban planning, which allows for an easy comparison between different patterns for the same zone. Thus, the economic role of each variable can be assessed before it is definitely fixed.

The study is structured as follows: the next section analyzes firstly the techniques used to estimate operating cost and revenues for specific urban areas and their limitations, and secondly the studies which have explored the relationship between the main urban planning variables and public services' operating cost. The following section is dedicated to explaining the methodology followed to obtain the municipal operating cost-revenue functions in terms of urban variables from local fees, taxes and public services operating cost, using a sample of eight Spanish cities with populations between 100.000 and 300.000 inhabitants. Finally, based on this sample of cities, the usefulness of these functions is shown not only to compare costs and revenues, but also to analyze the economic role each urban planning variable plays at the local or supralocal level in the economic sustainability of new urban areas.

BACKGROUND

Methodology to estimate the cost/revenue balance in future urban developments

Economic sustainability studies, or simply cost/revenue or fiscal impact analyses, were first used in the United States in the 1930s to analyze developed or future urban areas from an economic point of view. Their main characteristic is that the economic balance assessed is not focused on the investment in construction of infrastructure, but on the future operation of public services once the new area of the city is developed and inhabited. The first study of this type was carried out in 1933 for a neighborhood of 1.500 inhabitants in the city of Indianapolis; said study compared the annual revenues of the municipality for property tax with local costs for health, police and fire protection services. The analysis detected a negative fiscal balance for the municipality of $81,463 (Mace, 1961).

Although these studies may be of a very varied nature, it is necessary at least to estimate, on the one hand, a set of tax concepts (taxes and fees) and on the other hand, the operating cost of public services involved. Additionally, it is essential to define whether only direct economic concepts will be considered, or whether even the indirect or induced ones will also be taken into account (Paulsen, 2009). Depending on the approach of the study, each of the above-mentioned items will have an income or expense nature, since it is possible to estimate the economic balance for an indeterminate number of people, such as the inhabitants of the area analyzed or the whole city (social balance); for all the Public Administrators involved (public balance), or for the Local Finance (municipal balance) (Klug and Hayashi, 2007).

From a methodological point of view, once the subject and object of the study have been defined, it is common to estimate each cost and revenue item, to add them and to compare both concepts. However, this apparent conceptual simplicity clashes with the fact that while tax items usually have a formal nature and they are properly publicized, the assessment of unit operating cost of public services may present difficulties. The latter, consisting of the amount of service units provided (level of service) and their unit cost (Ladd and Yinger, 1989) is not usually available, as Public Administrations do not often have adequate cost accounting for the public services they are responsible for, either for their territory as a whole, or for specifics areas (Castel, 2006). Therefore, it is necessary to estimate each unit operating cost from theoretical or empirical sources (Dajani 1973). The theoretical approach is based on the assessment of its individual elements (material, labor, etc.), while the empirical one, which is more precise, is based on data provided by the private or public managers of urban services or the public budget (Hirsch, 1968; Downing and Gustely, 1977). If the source used is the budget, problems arising from the existence of shared expenses among different services (Bradford et al, 1969; Guengant, 1995) or cyclical costs (Downing and Gustely, 1977) must be taken account of.

The existence of all these difficulties is what has largely restricted the massive use of that kind of assessment. Still, at the same time, it has led many researchers to work on simpler assessment tools. Those simplified methodologies, focusing mainly on the cost side of fiscal impact, were collected by Burchell and Listokin (1978) and they are summarized in Table 1:

AVERAGE COSTING METHODS	
Per Cápita Multiplier	The costs and revenues of the new population are extrapolated from the current *per capita* values
Service Standard	The necessary new staff is assessed and the total cost of each service is calculated from labor per capita cost
Proportional Valuation	For non-residential developments. Costs and revenues are estimated from the ratio between future and current property values
MARGINAL COSTING METHODS	
Comparable city	Comparison between cities whose size is similar to that which will result after new development
Employment anticipation	Revenues and costs are estimated from the new jobs created

Table 1. Simplified methods for costing in new urban developments

Source: Author from Burchell y Listokin (1978)

However, despite their apparent simplicity, the use of less complex methods has significant limitations. For example, for the use of average methods - based on extrapolation of ratios -, new development should cause no jumps on the quantity or characteristics of public services to be provided (Richardson, 1971; Guelton and Navarre, 2010) and its characteristics need to be very similar to the existing city's (Heikkila and Davis, 1997). Meanwhile, marginal methods such as comparable city or employment anticipation are more theoretical than practical (Burchell and Listokin, 1978).

Relationship between the cost/revenue balance and urban planning variables

When the operating cost and revenues associated with urban developments started to be assessed, the influence of the urban pattern on the economic balance obtained became clear

(Boston City Planning Board, 1934). This influence is not uniform for all expenses and revenues items or all public services. It is indeed more intense in the so-called services “to property” (Mace, 1961), such as water supply, sewage, street lighting or waste collection (Boadway and Kitchen, 1984), since their size and form depend on the location of the buildings. Additionally, there is another set of personal services, named services “to people", such as sports facilities, libraries, social services, etc. which are more related to the amount of population than to its distribution on the territory (Deber et al., 2006).

The relationship between the urban pattern and the size and morphology of some of the main public services has been analyzed in many studies, which have tried to determine what urban planning variables impact on their operating and maintenance economic balance, why and to what extent. Usually, the approach to this field has been conducted using two different techniques: econometric studies and so-called "engineering" studies (Ladd, 1992). Econometric studies, the vast majority in the last decades, are used for discovering the mathematical relationships between economic variables (cost or revenue), and the variables which determine them, regardless of whether they are of urban, social (Alesina et al., 1999; Carruthers and Ulfarsson, 2008) or political nature (Hagen and Vabo, 2005; Tellier, 2006). Since econometric studies are based on statistical data which are often unavailable below the municipality level, they are usually used to analyze the relationship between variables at the regional (Ladd, 1994) or national level (Bastida et al., 2013), but are not so in terms of concrete urban developments. In contrast, "engineering" studies frequently draw their conclusions from the analysis of a small sample of future or existing urban patterns (Frank, 1989). This characteristic gives them a greater practical value, although more limited from a scientific point of view. The main results obtained from both types of studies about the incidence of urban planning variables on the operating and maintenance costs or revenues of the urban services are as follows:

Land use

The studies suggest that from the public point of view, the higher the income level of inhabitants in residential areas the more fiscally favorable they become, while industrial and commercial would remain virtually neutral (Margolis, 1956; Burchell and Dolphin, 2009). However, these results must be interpreted with caution, since the city is characterized by a mixture of uses and it is very difficult to allocate the operating cost of a public service to each of them. Other studies such as Wong's (1996) and Costa's (2011) showed that the presence of tourism activities increased municipal per capita spending on the provision of basic public services.

Housing density

The role of this variable in the economic balance of urban developments has been widely studied, but many uncertainties in this aspect still remain (Edwards and Xiao, 2009). Apart from the different scope or territorial scale of the studies, there are several reasons that contribute to these uncertainties. For example, Ladd (1992) detected that while econometric studies show an increase in the cost of providing public services when housing density rises, the opposite is observed in "engineering" studies. The difference is that in many econometric studies, housing or population density is measured in average terms on the municipal area, so any rise in population will automatically increase housing or population density; this overlooks the possible impact of growing population dispersion within the municipal limits (Elis-Williams, 1987). Said shortcoming might be detected in lower territorial scale studies or when the municipal developed area is considered (Carruthers and Ulfarsson, 2003; Hortas and Solé-Ollé, 2010). Other sources of uncertainty are the difficulty to isolate the economic role of housing density from other urban or non-urban variables such as building type (Windsor, 1979; Fouchier, 2001), population income level (Kain, 1967; Dekel, 1995; Kotval and Mullin, 2006); or to differentiate economies of density from economies of scale, since high density usually appears in large population settlements (Solé-Ollé and Bosch, 2005; Holcombe and Williams, 2008).

Apart from all the above said, most "engineering" and econometric studies seem to indicate that increasing housing density decreases per capita cost of providing public services. As an example, research carried out by authors such as Wheaton and Schussheim (1955) or Real Estate Research Corporation (RERC) (1974) – which would be included in the “engineering” group - show savings of up to 11% when housing density increases. Whereas Downing and Gustely (1997) showed that the annual operating costs of public services in an area of 1.000 dwellings was three times higher if the density were 1 dw/acre compared to 60 dw/acre. Meanwhile, econometric studies as those carried out by Dekel (1995) have indicated that low density is always in deficit regardless of income level of the inhabitants. Carruthers and Ulfarsson (2003) showed that in low density developments, linear services are more expensive, and it is difficult to obtain economies of scale for others such as school services. In the case of Spanish municipalities, Hortas and Solé-Ollé (2010) and Bastida et al. (2013) drew similar conclusions. Unlike this mainstream theory, some other studies do not show a significant influence of this variable if the effect of the greater range of services in high density areas is eliminated (Guengant, 1995) or call into question the notion that high housing density results in global savings in the provision of public services (Kain, 1967; Peiser, 1989; Gordon and Richardson, 1997; Morlet, 2001; Holcombe and Williams, 2008).

Relative dimensions of public space

In public services which consist of a physical infrastructure, operating cost largely depends on either linear or area size (Stone, 1973; Martin and March, 1975; Carruthers, 2002). For this reason, many studies have found that when the relative length or area of road in an urban development increases, per capita cost also rises for services such as sewage (Speir and Stephenson, 2002), street cleaning (Alvarez et al., 2005) or public lighting (Tähkamo et al., 2012). In this context, it is important to differentiate the role of variables such as the relative road length or area, housing density and lot size, which are sometimes used as equivalents, since the correspondence between the three is only direct on exclusively single-family developments (Urban Land Institute, 1958; Najafi et al, 2007; Mohamed, 2009). For example, when the number of building floors is variable, the very same housing density can lead to very different urban patterns. The importance of differentiating the role that the relative size of public spaces and housing density play in the operating cost of public services appears evident in cities with declining population, where per unit area population decreases while the amount of infrastructure to operate remains fixed (Koziol, 2004; Moss, 2008).

Location of development

The location of a development in its urban context can have different economic effects. Those related to social context would appear most obvious, as this aspect largely determines the characteristics and the range of services to be provided as well as the level of fees and taxes. Other aspects involved are the distance from the new urban development to common infrastructures (Speir and Stephenson, 2002) or the capacity available in the nearest (Wheaton and Schussheim, 1955; Office Fédéral du Developpement Territorial, 2000). When social costs of development are being assessed, this variable strongly influences transport costs arising from the distance between households and work centers (Transport Cooperative Research Program, 2002).

Building type

As noted before, the role of this variable is often confused with housing density since both variables are closely linked in many of common urban developments. However, this variable plays a distinct role and only a few studies have tried to isolate it. They have shown a slight decrease in per capita operating costs for some services when the building type - usually multi-family buildings - allows for grouping mailboxes or water meters to be managed (Stone, 1973; Brück et al., 2000).

METHODOLOGY FOR OBTAINING MUNICIPAL OPERATING COST AND REVENUE

Objectives and description of the methodology

As already noted, the economic sustainability of an urban area, - particularly from the point of view of the Public Administrators providing public services -, is measured by its ability to generate the economic resources that its own operation will require in the long term. The aim of this study is to provide a simplified tool for estimating the municipal operating costs and revenues for the horizon year in a new development when the zone plan is being drafted. For this purpose, a methodology has been developed to obtain the analytical expressions of these costs and revenues exclusively in terms of said development's basic urban variables. Through these equations, it is possible to assess the economic balance of the analyzed area as well as the costs and revenues' sensitivity against the variation of each urban variable before they are definitely fixed. Apart from this, their use with consistent samples allows for the obtainment of results at the supralocal level.

The use of the operating costs and revenues equations is a great advantage over the existing simplified assessment methods, since it does not depend on the similarity between the new urban areas and the pre-existing ones, nor does it require the use of data different from urban planning ones that are available at the moment the plan is being drafted.

This study has referred to municipalities or equivalent local governments (municipal costs) as they are usually responsible for providing the services more closely related to territory (Ermini and Fiorillo, 2008). Yet, the method proposed could also be used when several administrations (public costs) are providing them (Joassart-Marcelli and Musso, 2005).

Nevertheless, it should be noted that were several entities to be involved in providing services “to property”, the optimal urban form might be different for each of them, from the economic sustainability point of view.

With the aim to show not only the methodology for obtaining the formulae but also their complementary utilities, a sample of cities has been used to carry out the study rather than only one. Spanish cities have been chosen, since they provide all the services “to property” (water supply, sewage, waste collection, transportation and disposal, street lighting and roads and parks maintenance); for this reason, their economic impact on each new urban area is expected to be notably influenced by the urban form. All of them have a population between 100.000 and 300.000 inhabitants, since in cities below or above this range it is more likely to find revenue or expenditure singularities (Solé-Ollé and Bosch, 2005). As indicated, in order to obtain not only individual results for each city, but also broader results for this range of cities, there has been an attempt to cover all the Spanish geography and its per capita income level (La Caixa, 2005). There are 56 cities in this range of population (2010) in Spain; thus, the sample size is large enough.

According to the proposed methodology, it is necessary to follow three steps in order to obtain the analytical expressions for municipal costs and revenues. Firstly, depending on the Public Administration analyzed, the economic flows involved should be identified, as well as the urban variables that influence them. Secondly, public costs and revenues are assessed for a set of prototype developments whose planning variables are known. Finally, the analytic expressions are obtained through a multivariate analysis where the independent variables are the economic ones and the regressors correspond to the urban variables.

Economic flows involved

The methodology has been conceived from the perspective of the Public Administrations and only direct tax exchanges between these entities and the future inhabitants of the area will be considered, since this is the most common expression of economic relationships between the two parts. The annualized cost of building infrastructure with its interests has not been included as the investment is usually paid by private companies. However, it would not be a problem to consider it, were this not the case. Instead, annual depreciation cost of the infrastructure has been considered, as its renewal at the end of its useful life is usually assigned to the entity which operates it, regardless of who paid for it at the beginning. This method is exclusively based on the intrinsic characteristics of residential developments and does not consider jumps in the quantity or quality of the services provided for the whole city. Social cost cannot be assessed, since this would require taking into account the distribution of households and work centers in the urban context which implies more complex estimations (Klug and Hayashi, 2007). For these reasons, this methodology could be categorized as a fiscal impact method.

Considering the above, the first step is to determine the items of revenues and expenses considered, as well as the urban planning variables closely linked to each one. They are shown in Table 2. Individuating services "to people" and "to property" has been both useful and descriptive, given their different relationship with the urban planning variables:

ITEM	COST/REVENUE FUNCTION	URBAN DETERMINANT	REFERENCE
REVENUES (€/ha/yr)			
Services "to people" revenues	$Serv.Peop.Inc./Inh./yr\ x\ inh/dw\ x\ D$	$D\ (dw/ha)$	Mace (1961)
Services "to property" revenues			
Property tax	$V\ x\ Tax\ x\ 10000\ x\ E$	$E(m2/m2)$/V(€/m2)	Solé-Ollé (2006)
Vehicle tax	$Tax.\ x\ veh.no/dw\ x\ D$	$D\ (dw/ha)$	Solé-Ollé (2006)
Wat.Supply/Sew./Treat.	$Fee/m3\ x\ wat.con/inh\ x\ inh/dw\ x\ D$	$D\ (dw/ha)$	Vallés & Zárate (2012)
Refuse coll./Disp/Treat.	$Fee\ /\ dw\ x\ D$	$D\ (dw/ha)$	Puig-Ventosa (2008)
Garage fee	$Fee\ x\ garaje\ no.$	$garage\ no. = f(D)$	*
EXPENSES (€/Ha/yr)			
Services "to people" expenses	$Ser.Peop..Exp/Inh./yr\ x\ inh/dw\ x\ D$	$D\ (dw/ha)$	Mace (1961)
Services "to property" expenses			
Water supply	$m3\ cost\ x\ wat.con/inh\ x\ inh/dw\ x\ D$	$D\ (dw/ha)$	AEAS (2011)
Water pipe. mainten.	$maint.unit\ cost\ x\ pipe\ lenght$	$pipe\ lenght = f(L)$	AEAS (2011)
Sewage pipe. mainten.	$maint.unit\ cost\ x\ pipe\ lenght$	$pipe\ lenght = g(L)$	AEAS (2011)
Sewage treatment	$m3\ cost\ x\ wat.con/inh\ x\ inh/dw\ x\ D$	$D\ (dw/ha)$	AEAS (2011)
Refuse collection	$ref.coll.unit\ cost/dw\ x\ D$	$D\ (dw/ha)$	Dijkgraaf & Gradus (2003)

Refuse disp/treat.	$m3\ cost\ x\ ref.prod./inh.x\ inh./dw\ x\ D$	$D\ (\ dw/ha)$	Callan & Thomas (2001)
Street cleaning	$Clean.unit.cost/m\ x\ L$	$L\ (\ lenght.road/ha)$	Álvarez et al. (2004)
Public lighting	$luminary\ unit\ cost\ x\ luminary\ no.$	$luminary\ no. = h(L)$	San Martín (1985)
Parks/Gardens maint.	$maint.unit.cost\ x\ Parks\ area$	$parks\ area = k(D)$	**
Pavements maint.	$m2\ repair.unit\ cost\ x\ \%\ repair\ x\ S$	$S\ (\ road\ area/ha)$	***

Urban Planning Variables: (D) Housing Density (dw/ha); (E) Floor Area Ratio (m2/m2); (V) Building Value (€/m2 lot or floor area); (L) Relative Length of road (m/ha); (S) Relative road area (% road area / developed area)

* It is assumed that there is a garage for each single-family house or twenty multi-family houses

** Spanish planning regulations establish the parks and gardens area in proportion to housing density

*** It is assumed that 0.5% of public roads of new development will be annually repaired

Table 2. Revenues and expenses items considered and urban planning variables linked to them

Source: Author

Table 2 shows that urban planning variables with influence on per unit area revenues of services “to property” would be: housing density (D), the floor area ratio (E) and the value of lot or future buildings (V). The latter could be considered as a *proxy* for the location of the analyzed area within its urban context. On the expenditure side, the urban planning variables involved would be: housing density (D), the relative dimensions of public space, expressed as the relative length of road per unit developed area (L) or the percentage of road area on the developed area (S). Since the nature of services “to people” is strictly related to population size, the revenues and expenditures per unit area associated with that type of services depend exclusively on housing density (D). In addition to the urban variables indicated, Table 2 shows that revenue and expenditure items depend on the tax burden, on the per unit operating cost of a service or on a per-household ratio.

The necessary data according to Table 2 were obtained from different sources. Data on local taxes and the size of households were obtained from the Spanish Ministry of Finance and Public Administration, while per capita revenues and expenses in services “to people" were obtained from the municipal budget. Although, as indicated, it is possible to use different sources for estimating the unit cost of public services, the most accurate method was finally opted for, by obtaining the necessary data through interviews with the municipal person in charge of each service. It should be noted that the operating cost of the services has not been homogenized to any standard, because this study aims to determine if the level of service provided by the municipality could be afforded with the existing tax burden under certain urban conditions. Data for each municipality relating to the year 2011 are shown in Table 3:

	AG	GR	AL	SA	MA	LO	LL	SS
REVENUES								
Services "to people" revenues								
Peop.Reven.(€/inhab/yr)	581	855	541	632	721	546	575	1134
Services "to property" revenues								
Property tax (%)	1,100	0,650	0,539	0,700	0,3300	0,5300	0,6900	0,1832
Vehicle tax (€/veh/yr)	63,05	64,24	62,41	62,99	68,16	57,81	64,75	81,56
Wat.Supply/Sew./Treat. fee(€/dw/yr)	425,76	523,08	389,64	135,24	253,20	105,12	125,52	160,08
Refuse collect/disp/treat. fee (€/dw/yr)	89,21	89,52	62,50	119,42	105,41	45,88	57,30	116,34
Garage fee (€/gar./yr)	64,14	202,50	110,95	105,66	18,99	115,23	119,70	65,17
EXPENSES								
Services "to people" expenses								
Peop.Expen.(€/inh./yr)	731	912	566	725	789	622	812	1166
Services "to property" expenseses								
Drinking water cost (€/m3)	0,40	0,26	0,43	0,37	0,25	0,23	0,41	0,31
Water pipe. mainten.unit cost (€/m)	1,99	2,62	2,16	1,83	1,53	6,02	1,68	4,38
Sewage pipe. mainten. unit cost(€/m)	3,71	1,62	3,75	2,42	5,38	6,02	3,15	9,50
Sewage treat. unit cost (€/m3)	0,17	0,19	0,13	0,16	No mun.	0,47	0,19	0,22
Refuse collection unit. cost (€/dw/yr)	88,77	84,88	58,40	43,80	37,12	40,15	51,10	62,04
Refuse treat. unit cost (€/inh/yr)	39,41	34,49	18,25	13,50	22,26	11,82	8,03	57,65
Street cleaning unit. cost (€/m)	34,45	47,05	18,98	8,39	6,62	14,96	18,61	24,40
Street lighting energy/maint. cost (€/lum)	132,80	86,53	85,89	106,95	84,70	78,78	75,55	97,48
Parks/Gardens maint. Unit cost (€/m2)	15,12	4,01	3,23	3,17	2,26	2,40	3,38	11,05
Pavem. maint. (€/m2)	21,19	21,19	21,19	21,19	21,19	21,19	21,19	21,19
RATIOS								
Vehicles/dw	1,52	1,44	1,41	1,17	1,10	1,08	1,14	1,10
Inhab./dw	3,16	2,92	3,06	2,75	2,79	2,72	2,75	2,69
Water Cons./inh./day (l)	218	250	215	202	167	133	196	134
Cities: Algeciras (AG); Granada (GR); Almeria (AL); Salamanca (SA); Mataro (MA); Logroño (LO); Lleida (LL); San Sebastian (SS)								

Table 3. Tax burden, ratios and operation and maintenance unit cost of public services in the municipalities analyzed

Source: Author

As can be observed in Table 3, both the level of fiscal pressure and the operating cost of public services are quite heterogeneous in the municipalities considered, despite constituting a relatively homogeneous sample. All the services "to property" are provided by municipalities, with the exception of Mataro, where sewage treatment is at a higher territorial level.

Construction of the income and expenses formulae

Table 2 shows that the relationship between each operating costs and revenues item and urban variables is always linear. This means that the relationship at a global level will also be so. Since all urban variables are expressed as per unit area ratios, total incomes and expenses will be expressed as per hectare and year ratios. Therefore, the relationship between economic and urban variables could be expressed analytically as follows:

$$Incomes\ (€/ha/yr) = \alpha x E + \beta x V + \gamma x D + \delta \qquad (1)$$

$$Expenses\ (€/ha/yr) = \phi x D + \varphi x L + \psi x S + \omega \qquad (2)$$

Where the coefficients of proportionality α, β, γ, φ, φ and ψ would be the sum of the individual coefficients of proportion α_i, β_i, γ_i, $\emptyset_i$, φ_i and ψ_i existing between each cost and revenue item and the urban variables that determine it:

$$Incomes\ (€/ha/yr) = \sum_{i=1}^{k}(\alpha_1 + \cdots \alpha_k) * E + \sum_{i=1}^{m}(\beta_1 + \cdots \beta_m) * V + \sum_{i=1}^{n}(\gamma_1 + \cdots + \gamma_n) * D + \delta \qquad (3)$$

$$Expenses\ (€/ha/yr) = \sum_{i=1}^{p}(\emptyset_1 + \cdots \emptyset_p) * D + \sum_{i=1}^{q}(\varphi_1 + \cdots \varphi_q) * L + \sum_{i=1}^{r}(\psi_1 + \cdots + \psi_r) * S + \omega \qquad (4)$$

Most individual coefficients are known as they are the tax and fee rates, per household ratios or operating cost of public services shown in Table 3. However, in other cases the relationship between each item of income and expense and the urban variables that determine them is an unknown function (Table 2). To solve this problem and to obtain the global coefficients for the expressions of municipal incomes (1) and expenses (2), it is deemed most appropriate to conduct a multivariate analysis based on the assessment of the total operating incomes and expenses for the horizon year in a set of prototype urban developments, with known infrastructure and urban variables, and then perform a linear regression between urban (regressors) and economic (dependent) variables. This methodology combines the advantages of both the engineering and econometric studies as it can be used to assess specific developments and it is based on analytical equations.

However, in order to obtain consistent equations it is necessary for the number of prototypes (iterations) to be large enough, thus covering the full range of logical values for each variable and all possible combinations between them. Given the particularities of each building type (commercial uses, collective garages, etc.), this example independently analyzes the isolate and semi-detached single-family and multi-family building types. Combining the values for each urban variable shown in Table 4, a total of 36 scenarios for incomes and 64 for expenses were obtained, which is significantly higher than those used in "engineering" studies such as Wheaton and Schussheim's (1955), RERC (1974), Downing and Gustely's (1977) or Speir and Stephenson's (2002):

		Isolate single-family				Semi-detached single family				Multi-Family			
E	**(m2/m2)**	0,20 0,25 0,35				0,35 0,40 0,50				0,35 0,50 1,00			
V	**€/m2 lot/floor**	180 270 360				1250 1875 2500				1250 1875 2500			
D	**dw/ha**	5	10	15	20	15	20	30	40	20	40	60	80
L	**m/ha**	175	200	225	250	175	200	225	250	100	125	150	175
S	**%road/dev.area**	20	25	30	35	20	25	30	35	25	30	35	40

Table 4. Reference values for each variable used in the developed of prototypes

Source: Author

As regards the characteristics of the prototypes, the recommendations of Caminos and Goethert (1978) were followed, thus using square developments of 400 m. by 400 m. with grid pattern not to introduce a bias between variables. An example of the prototypes with their urban pattern and associated infrastructures is shown in Figure 1:

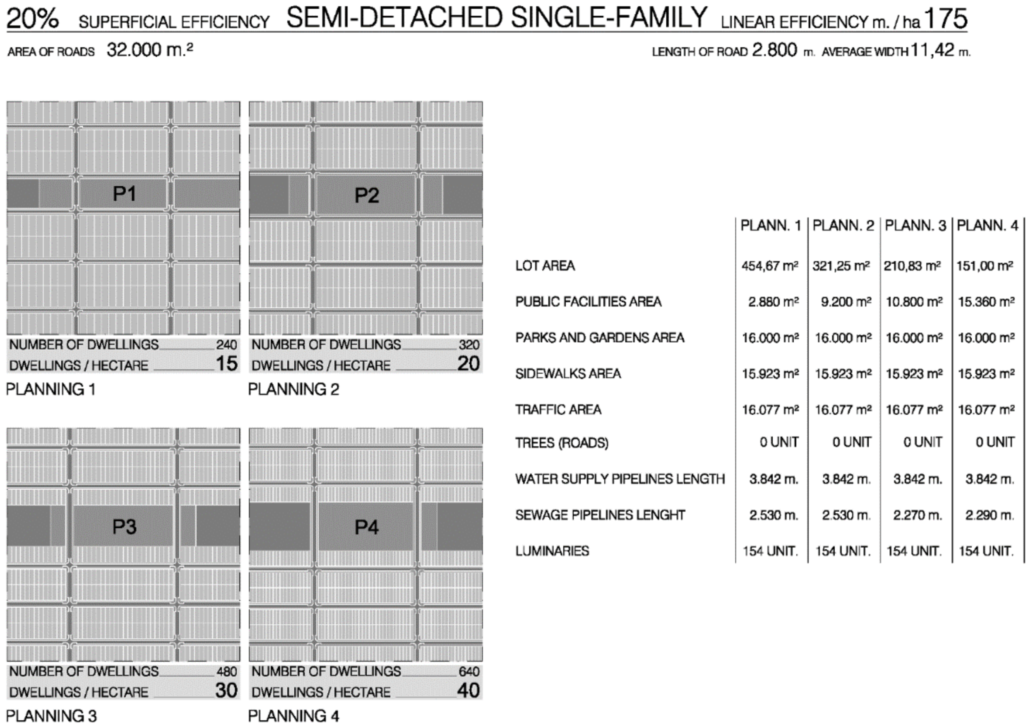


Fig. 1. Example of prototypes and their main urban planning variables and infrastructures

Source: Author

Once revenues and expenses for each prototype and municipality for the horizon year (all the dwellings inhabited) have been estimated and the multivariate analysis performed, the coefficients obtained for linear regressions for each municipality for equations (1) and (2) are shown in Table 5:

	Coefficients of revenue expressions							
	AG	**GR**	**AL**	**SA**	**MA**	**LO**	**LL**	**SS**
Isolated S-F								
α	50061,06	29575,00	24535,14	31850,00	15015,00	24115,00	31327,07	8335,60
β	33,09	19,54	15,99	21,05	9,92	15,93	20,74	5,50
γ	2488,80	3401,33	2303,26	2161,65	2468,96	1807,10	1947,24	3490,15
δ	571,36	341,84	360,71	368,14	173,55	278,73	374,65	96,34
R^2	0,996	0,999	0,999	0,998	1,000	0,998	0,998	1,000
Sem-Det. S-F								
α	103125,00	60937,50	50531,25	65625,00	30937,50	49687,50	64262,34	15566,42
β	25,08	14,82	12,29	15,96	7,52	12,08	15,73	4,17
γ	3520,77	3520,08	3520,08	2289,54	2529,25	1903,42	2074,40	3520,77
δ	-47029,29	-27790,03	-23044,35	-29927,73	-14108,78	-22569,57	-29378,19	-7162,27
R^2	0,996	0,999	0,998	0,998	1,000	0,998	0,997	1,000
Multi-Family								
α	102991,45	60858,58	50465,81	65540,01	30897,43	49623,15	64404,52	16442,95
β	38,68	22,85	18,95	24,61	11,60	18,63	24,26	6,44
γ	2657,65	3348,04	2367,70	2140,46	2511,21	1838,53	1981,65	3477,89
δ	-69986,08	-40124,09	-33854,42	-44853,09	-19962,25	-33732,76	-44214,96	-10167,32
R^2	0,996	0,999	0,998	0,998	1,000	0,998	0,997	1,000

Coefficients of cost expressions								
	AG	**GR**	**AL**	**SA**	**MA**	**LO**	**LL**	**SS**
Isolated S-F								
ϕ	2671,69	2975,98	1986,98	2187,22	2348,15	1865,02	2429,97	3430,60
φ	79,77	104,41	46,34	27,20	19,96	37,90	45,85	54,60
ψ	176,38	151,75	160,60	162,05	167,10	168,22	157,99	191,40
ω	16546,59	5429,25	5051,75	4476,89	4347,20	5449,11	4984,72	14406,69
R^2	0,999	1,000	0,999	0,999	0,999	0,999	1,000	0,999
Sem-Det. S-F								
ϕ	2672,07	2974,86	1987,95	2188,06	2350,34	1864,45	2430,84	3433,28
φ	80,50	105,46	48,10	28,34	22,08	40,79	47,37	57,88
ψ	177,87	156,61	207,27	232,47	208,76	203,53	198,25	245,05
ω	16433,72	5191,13	3978,16	3200,24	3254,39	4275,94	4072,11	12834,43
R^2	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Multi-Family								
ϕ	2839,77	3013,24	2015,93	2216,98	2366,86	1878,00	2460,94	3546,70
φ	89,69	111,22	55,95	34,28	32,13	52,07	53,95	73,27
ψ	152,61	136,66	173,77	183,58	180,49	173,09	166,65	208,41
ω	10962,89	3487,17	3112,31	3062,82	2299,50	3023,22	3182,31	8281,11
R^2	0,999	1,000	1,000	1,000	1,000	1,000	1,000	1,000

Cities: Algeciras (AG); Granada (GR); Almeria (AL); Salamanca (SA); Mataro (MA); Logroño (LO); Lleida (LL); San Sebastian (SS)

Table 5. Coefficients obtained for municipal operating cost and revenue expressions

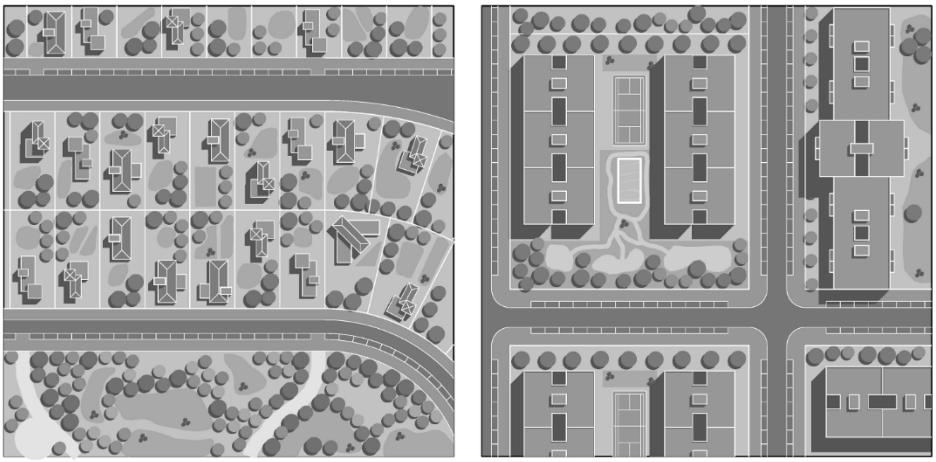
Source: Author

The coefficients obtained for each municipality are very different from each other due to the significant differences existing in taxes, fees and operating cost of services (Table 3). Instead, correlation coefficients are very high in all cases due to the direct proportionality between the urban and economic variables, even in those cases where the relationship was unknown (Table 2). The expressions obtained are applicable to the tax burden and operating cost of services at a particular time, but its updating only requires the application of the values modified to the prototype developments used. Thus, the public entity providing public services may have a current equation on hand for making economic prognosis with very little effort.

APPLICATION OF THE REVENUES AND EXPENSES EQUATIONS IN MEDIUM-SIZED SPANISH CITIES

Urban patterns for economically sustainable developments in Spanish medium-sized cities

As indicated, Public Administrators providing all or part of the services "to property" can obtain with this method the equations to estimate their own operating costs and revenues in a future development in terms of its basic urban variables. An example of incomes and expenses assessment for two alternative patterns in the same zone exclusively in terms of their determinant urban variables (Table 2) in the Spanish municipalities selected is shown in Figure 2:



FUTURE DEVELOPMENT-1

E1 = 0,22 m²/m²
V1 = 250 €/m² (lot)
D1 = 12 dw/ha
L1 = 210 m/ha
S1 = 28%

FUTURE DEVELOPMENT-2

E2 = 0,80 m²/m²
V2 = 1.500 €/m² (floor)
D2 = 60 dw/ha
L2 = 150 m/ha
S2 = 40%

	€/ha/yr				€/ha/yr			
	INC1*	EXP1	INC1-EXP1	%INC1/EXP1	INC2*	EXP2	INC2-EXP2	%INC2/EXP2
AG	42264	70297	-28033	0,60	195403	200907	-5504	0,97
GR	44667	67316	-22649	0,66	207162	206431	731	1,00
AL	31786	43124	-11338	0,74	150454	139411	11043	1,08
SA	32791	40973	-8152	0,80	146983	148567	-1584	0,99
MA	30247	41395	-11149	0,73	146904	156350	-9446	0,94
LO	26564	40499	-13935	0,66	122589	130437	-7848	0,94
LL	30446	48197	-17751	0,63	138208	165597	-27389	0,83
SS	38409	72399	-33990	0,53	188122	230275	-42153	0,82

* Incomes reduced by 15% because municipality rate of collection on fees and taxes (Spanish Ministry of Finance and Public Administration, 2012)

Fig. 2. Example of operating expenses and revenues prognosis

Source: Author

As indicated, in addition to showing the usefulness of the method to obtain results at the local level, by selecting a consistent sample of Spanish cities with a population between 100.000 and 300.000 people, it has been possible to obtain representative results of economic sustainability in new developments for this range of cities according to their representative urban variables (Table 2):

<u>Isolated single-family developments</u>

Employing housing density as a common variable between revenues and expenses (Table 2), Figure 3 shows that maximum per unit area annual revenues (floor area ratio (E) and the property values (V) at their maximum levels) are not able to equal the minimum expenses (with the relative road length (L) and area (S) at their minimum levels). Thus, it is possible to conclude that in this range of population, it is not possible to reach economic sustainability for future urban developments in Spanish cities based exclusively on isolated single-family dwellings. The exception obtained in the city of Salamanca is based on an unusual combination of high house size (more than 500 m2) and high property value (more than 2.000 €/m2 or $2.640/m2).

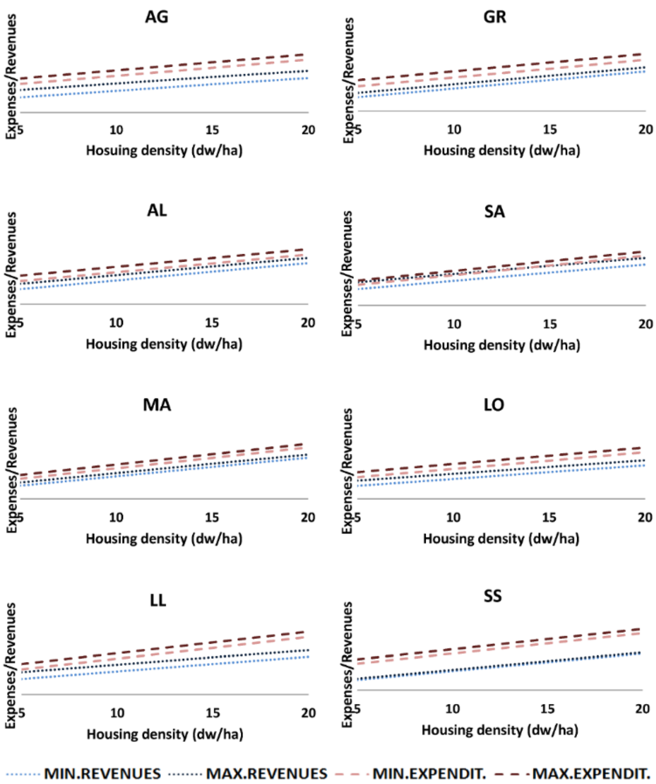


Fig. 3. Per unit area annual incomes and expenses envelopes. Isolate single-family dwellings

Source: Author

Semi-detached single-family developments

If the same comparison is carried out for semi-detached single-family building type, it is observed that, except in the city of San Sebastian, the spending envelope is contained within the revenue envelope (Figure 4):

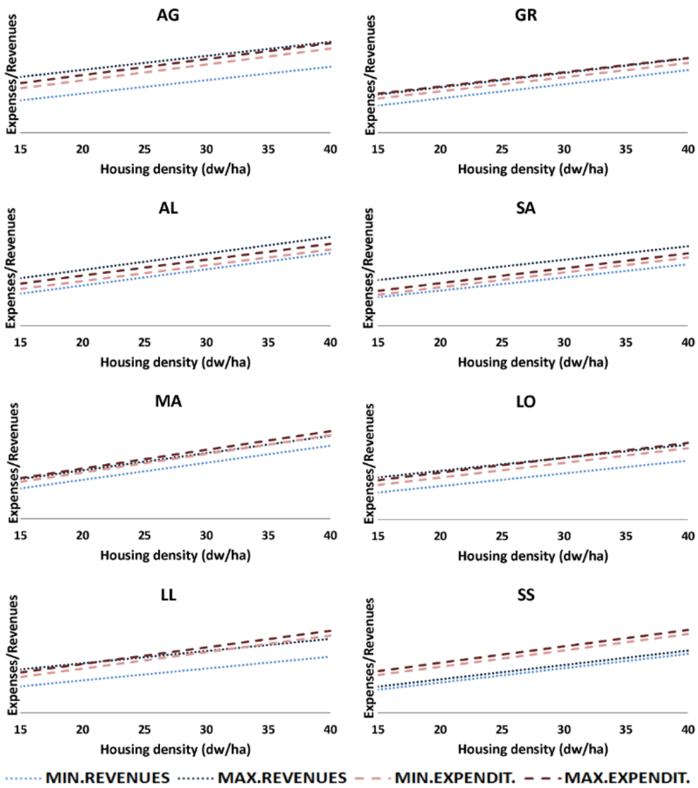


Fig. 4. Per unit area annual incomes and expenses envelopes. Semi-detached single-family dwellings

Source: Author

Combinations where the municipal incomes are able to equal the minimum expenses (the relative road length (L) and area (S) at their minimum levels) in each city are listed in Table 6, when combinations containing unusual dwelling size for this building type in Spain (over 300 m2) are removed, - that is, those with floor area ratio (E) of 0,50 m2/m2 and housing density of 15 dw/ha-:

Housing Density (D) (dw/ha)	Floor Area Ratio (E) and Property Value (V) combinations								
	E1-V1	E1-V2	E1-V3	E2-V1	E2-V2	E2-V3	E3-V1	E3-V2	E3-V3
15		SA	AG,AL,SA, LO		AL,SA	AG,GR,AL, SA,MA,LO, LL			
20		SA	AG,AL,SA		AL,SA	AG,GR,AL, SA,LO,LL	SA	AG,AL,SA, LO	AG,GR,AL, SA,MA,LO,

									LL
30		AL	AL,SA		AL,SA	AG,GR,AL, SA,LO		AL,SA	AG,GR,AL, SA,MA,LO, LL
40		AL	AL,SA		AL,SA	GR,AL,SA		AL,SA	AG,GR,AL, SA,LO

AG: ALGECIRAS GR: GRANADA AL: ALMERIA SA: SALAMANCA MA: MATARÓ LO: LOGROÑO LL: LLEIDA SS: S.SEBASTIÁN

PROPERTY VALUE (V): V1: 1.250 €/m^2 V2: 1.875 €/m^2 V3: 2.500 €/m^2

FLOOR AREA RATIO (E): E1: 0,35 m^2/m^2 E2: 0,40 m^2/m^2 E3: 0,50 m^2/m^2

Table 6. Economically sustainable combinations of Housing Density (D), Floor Area Ratio (E) and Property Values (V). Semi-detached single-family dwellings

Source: Author

The above results might suggest that in this building type, with the relative length and area of roads at their minimum values, economic sustainability is achieved when housing density is above 15 dw/ha and the property values over 1.875 €/m2 ($2.490/m2) in Almeria and Salamanca and over 2.500 €/m2 ($3.320/m2) in the rest of cities. However, since the average value for this building type in Spain is around 1.193 €/m2 ($1.584/m2) (Bank of Spain, 2014), it can be concluded that this building type would not be economically sustainable for this size of cities except in areas with very high income levels.

Multi-Family developments

As in the previous case, the envelope of expenditure for this building-type is within that of revenue, with the exception of San Sebastian. For this reason it is theoretically possible to find economically sustainable urban patterns in multi-family developments. This is reflected in Figure 5:

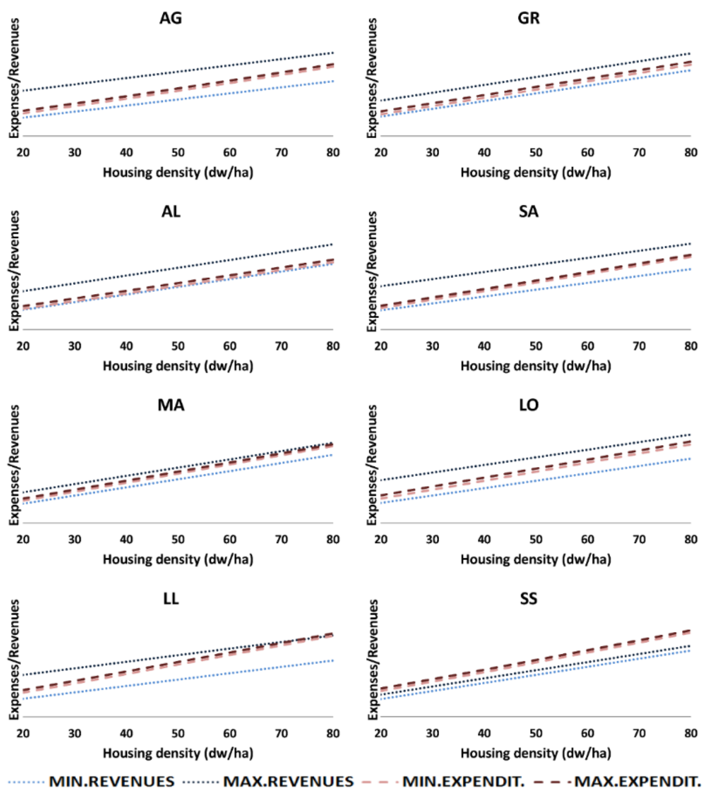


Fig. 5. Per unit area annual incomes and expenses envelopes. Multi-family dwellings

Source: Author

Once dwellings which are unusual size (over 160 m2) are eliminated - housing density (D) of 20 dw/ha with floor area ratio (E) values of 0,50-1,00 m2/m2 and housing density of 40 dw/ha with floor area ratio of 1,00 m2/m2-, the combinations of urban variables where it is possible to reach economic sustainability are as shown in Table 7:

Housing Density (D) (dw/ha)	Floor Area Ratio (E) and Property Value (V) combinations								
	E1-V1	E1-V2	E1-V3	E2-V1	E2-V2	E2-V3	E3-V1	E3-V2	E3-V3
20		AL,SA	AG,GR,AL, SA,LO						
40		AL	GR,AL,SA	AL	AG,GR, AL,SA	AG,GR, AL,SA, MA,LO			
60		AL	AL	AL	AL	AG,GR, AL,SA	GR,AL, SA	AG,GR, AL,SA,MA, LO	AG,GR, AL, SA,MA, LO,LL
80		AL	AL		AL	GR,AL	GR,AL	AG,GR, AL,SA,LO	AG,GR, AL, SA,MA, LO,LL

AG: ALGECIRAS GR: GRANADA AL: ALMERIA SA: SALAMANCA MA: MATARÓ LO: LOGROÑO LL: LLEIDA SS: S.SEBASTIÁN
PROPERTY VALUE (V): V1: 1.250 €/m^2 V2: 1.875 €/m^2 V3: 2.500 €/m^2
FLOOR AREA RATIO (E): E1: 0,35 m^2/m^2 E2: 0,50 m^2/m^2 E3: 1,00 m^2/m^2

Table 7. Economically sustainable combinations of Housing Density (D), Floor Area Ratio (E) and Property Values (V). Multi-family dwellings

Source: Author

For this building type, when the value of the properties is the lowest (1.250 €/m2 or $1.660/m2), equilibrium between revenues and expenses is possible in Almeria with a housing density above 40 dw/ha, and in Granada and Salamanca above 60 dw/ha. If the property value rises to 1.875 €/m2 ($2.490/m2), equilibrium is possible for all the other cities about 60 dw/ha with exception of Lleida, where property value needs to rise to 2.500 €/m2 ($3.320/m2); and San Sebastian, where it cannot be achieved. The average property value for this building type in Spain in the year 2013 was 1.401 €/m2 ($1.860/m2) (Bank of Spain, 2014) and thus, it follows that under certain conditions, it is possible to find economically sustainable urban patterns in future developments based on multi-family buildings from a municipal standpoint. For this sample, the values of housing density necessary to reach economic sustainability are similar or slightly higher than the average for a city as a whole, as they range from 34 dw/ha (Algeciras) to 61 dw/ha (Granada and Mataro). Since cities are ordered in Figures 3,4 and 5 in terms of per capita income - Algeciras being the lowest and San Sebastian the highest -, the result might show that the higher the income level of the citizens, the more difficult it is to find economic sustainability in new urban developments. Although further study would be necessary, it is possible to state that this results from a wider level of service in wealthier cities.

Another interesting result that might be obtained from Figure 5, which is that when housing density increases, operating expenses per unit area rise 19% faster than revenues on average. For this reason, by using the expressions of expenses and revenues for each city (Table 5), it is obtained that the equilibrium is lost in the range of 80 dw/ha in Salamanca to 120 dw/ha in Granada.

The role of urban variables on the municipal cost/revenue balance in Spanish medium-sized cities

The analytical expressions of municipal revenues and expenditures in terms of urban variables allows for the isolation of the economic role each of them plays, which solves a common shortcoming in this type of studies. Apart from services "to people", whose incomes and revenues depend exclusively on housing density, for public services more closely related to the territory (services “to property”), each urban variable’s influence is as follows (Table 2):

<u>Floor area ratio (E)</u>

This variable determines 36% of revenues on average, with a maximum of 60% when the other variables reach their minimum values, and 16% when these values decrease to their lowest. When its influence is minimal, each floor area 0.1 m2/m2 increment makes revenues rise by 2%. Still, when its participation is the highest, that increase is between 6-10%.

<u>Property value (V)</u>

This variable’s average level of contribution to municipal incomes in services “to property” is 33%, ranging from 14% to 59%. When its contribution is minimal, in developments based on isolated single-family buildings, each increase in lot prices of 50 €/m2 ($66/m2) makes municipal revenues rise about 1%; whereas when its contribution is the highest (multi-family building type), each increase of 250 €/m2 ($332/m2) in floor values makes incomes rise 7%.

<u>Housing density (D)</u>

Its average contribution in the income side is 31%, with a maximum value of 56% and a minimum of 12%. When its influence is greater, each increase of 5 dw/ha determines a 27-59% increase in municipal revenues in services “to the property”, depending on the building type; however, when its contribution is the lowest, revenues grow between 6-11%. For expenditures, the average contribution is 36%, with a minimum of 9% and a maximum of

75%. In this case, a 5 dw/ha increase rises municipal per unit area expenditures between 7-20% minimum and 20-32% maximum.

Relative length of road (L)

This variable determines 48% of the municipal costs in services “to the property” on average, with 17% minimum values for multi-family developments and 79% maximum for isolated single-family dwellings. When this urban variable contributes the most, each 25 m/ha increment makes expenditure rise by 4%, whereas whenever this contribution is minimal, the same increase in this variable makes expenditure grow only by 1%.

Relative road area (S)

The average contribution of this variable to municipal expenses in services “to property” is 16%, with a peak of 28% in semi-detached single-family dwellings and a minimum of 7% in multi-family buildings. The sensitivity of municipal expenses when this variable changes its value is very low, ranging from a maximum value of 2% to a minimum of 0.4% for each 5% relative road area increment on the total developed area.

RESULTS

Apart from the methodology to obtain the analytical expressions for municipal operating costs and revenues in a future urban development exclusively in terms of its urban basic variables, the study has shown that municipal revenues in the services closely related to the territory - water supply, sewage, sanitation, refuse collection, transportation and disposal, public lighting and parks and roads maintenance - are influenced by variables such as floor area ratio, the value of the properties (proxy for the location of the development in the urban context) and housing density. For the sample of cities analyzed, the contribution of each variable is 36%, 33% and 31% respectively. For municipal spending in those services, also named services “to the property", the influence would be 36% for the housing density, 48% for the relative length of road and 16% for the relative road area on the total developed area.

DISCUSSION OF RESULTS

With regard to the characteristics an urban development should have to be economically sustainable - where an economically sustainable development is defined as that whose municipal revenues are sufficient to cover required spending for the provision of public services in the long-term -, the study might show that in the case of medium-sized Spanish cities, the developments based exclusively on single-family dwellings (neither isolated nor semi-detached) are not sustainable from the economic point of view. For multi-family dwellings, results are heavily influenced by the strong contribution of the property tax on municipal revenues and therefore, by property values; thus, this study shows that with property values at around 1.250 €/m2 ($1.660/m2) and housing density at around 60 dw/ha (with minimal road development), it is possible to find economically sustainable urban patterns in this building type, whereas if property value rises to 1.750 €/m2 ($2.320/m2), housing density should drop to 40-60 dw/ha depending on the city. Finally, if the value of the properties rises to 2.500 €/m2 ($3.320/m2), housing density may drop to 20 dw/ha. Quite an interesting result is that very high housing density morphologies, above 80-120 dw/ha, are not economically sustainable, since when this variable increases, per unit area cost does so 19% faster than revenues on average.

CONCLUSIONS

This study has mainly contributed to showing how it is possible to obtain the analytical expression for municipal operating costs and revenues in a new urban development as a function of its main urban variables, based on the tax burden, household ratios and the unit operating cost of public services. Since the results obtained are expressed as per unit area ratios, formulae use is independent from the size of the development and more appropriate than per capita estimations; after all and in the long term, the municipality manages physical infrastructures regardless of the degree of occupation of the dwellings. These formulae allow planners and local authorities not only to assess costs and revenues, but also to analyze the economic role each urban planning variable plays in the economic sustainability of that urban area in the early stages of planning drafting, when the main characteristics of the future urban morphology are being fixed. Of course, this does not mean that planning must be formulated exclusively in economic terms, but it is desirable that economic sustainability criteria should be taken into account throughout the decision-making process.

BIBLIOGRAPHY

Alesina, A., Baqir, R. and Easterly, W. (1999). "Public goods and ethnic divisions." *Quarterly Journal Economic,* 114(4), 1243-1284.

Álvarez, X.C., Caride, M.J. and González, X.M. (2005). "Evaluación económica del servicio de recogida de basuras en los municipios gallegos [Economic evaluation of the refuse collection service in Galician municipalities]." *Revista de Estudios Regionales,* 72, 85-112.

Guía de tarifas de los servicios de abastecimiento y saneamiento de agua. (2011). Asociación Española de Abastecimientos de Agua y Saneamientos (AEAS), Madrid, Spain.

Las sociedades de tasación. Actividad y resultados en 2013. (2014). Bank of Spain, Madrid, Spain.

Bastida, F., Guillamón, M.D and Benito, B. (2013). "Municipal spending in Spain: Spatial approach." *Journal of Urban Planning and Development,* 10.1061/(ASCE)UP.1943-5444.0000138.

Boadway, R.W. and Kitchen, H.M. (1984). *Canadian tax policy*, Canadian Tax Foundation, Toronto, Canada.

Report on the income and cost of six districts in the city of Boston. (1934). Boston City Planning Board, Boston, USA.

Bradford, D.F, Malt, R.A and Oates, W.E (1969). "The rising cost of local public services: some evidences and reflections." *National Tax Journal* (pre-1986), 22 (2), 185-202.

Brück, L., Halleux, J.M. and Lambotte, J.M. (2000). *Les surcoûts des services publics collectifs liés à la périurbanisation: les réseaux d´infrastructures et les services de desserte*, SEGEFA, Liege, Belgium.

Burchell R.W. and Dolphin W.R. (2009). *The costs and benefits of alternative growth patterns. The impact assessment of the New Jersey State Plan*, Edward J. Bloustein School of Planning and Public Policy, New Brunswick, USA.

Burchell, R and Listokin, D. (1978). *The fiscal impact handbook*, The Center for Urban Policy Research, New Brunswick, USA.

Callan, S.J and Thomas, J.M. (2001). "Economies of scale and scope: a cost analysis of municipal solid waste services." *Land Economics*, 77(3), 548-560.

Caminos, H. and Goethert, R. (1978). *Urbanization primer*, MIT Press, Cambridge, USA.

Carruthers, J.I. (2002). "The impacts of state growth management programmes: A comparative analysis." *Urban Studies*, 39(11), 1959-1982.

Carruthers, J.I. and Ulfarsson, G.F. (2003). "Urban sprawl and the cost of public services." *Environment and Planning B: Planning and Design*, 30(4), 503-522.

Carruthers, J.I. and Ulfarsson, G.F. (2008). "Does smart growth matter to public finance?." *Urban Studies*, 45(9), 1791-1820.

Castel, J.C. (2006). "Les coûts de la ville dense ou étalée." *Etudes Foncières*, 119, 18-21.

Costa, A. (2011). *Necesidades de gasto de los municipios turísticos.* Universidad de las Islas Baleares, Palma de Mallorca, Spain.

Dajani, J. S. (1973). "Cost studies of urban public services." *Land Economics*, 49, 479-483.

Deber, R., Millan, K., Shapiro, H. and McDougall, C. (2006). "A cautionary tale of downloading public health in Ontario: What does it say about the need for national standards for more than doctors and hospitals?." *Healthcare Policy*, 2(2), 60-75.

Dekel, G. (1995). "Housing density: A neglected dimension of fiscal impact analysis." *Urban Studies,* 32(6), 935-951.

Dempsey, N., Bramley, G., Power, S. and Brown, C. (2011). "The social dimension of sustainable development: Defining urban social sustainability." *Sustainable Development,* 19(5), 289-300.

Dijkgraaf, E. and Gradus, R. (2003). "Cost savings of contracting out refuse collection." *Empirica.* 30(2), 149-161.

Downing, P.B. and Gustely, R.D. (1977). "The public service costs of alternative development patterns: a review of the evidence." In: P.B Downing (Ed), *Local service pricing policies and their effect on urban spatial structure,* University of British Columbia Press, Vancouver, Canada.

Edwards, M. and Xiao, Y. (2009). "Annexation, local government spending and the complicating role of density." *Urban Affairs Review,* 45, 147-165.

Elis-Williams, D.G. (1987). "The effect of spatial population distribution on the cost of delivering local services." *Journal of the Royal Statistical Society- Series A*, 150(2), 152-166.

Ermini, B. and Fiorillo F. (2008). *Local government reform across developed countries: A guideline for comparison,* Working Paper, University of New England, Armidale, Australia.

Ewers, H. and Nijkamp, P. (1990). "Urban sustainability." In: P.Nijkamp (Ed), *Urban sustainability,* Gower Publishing Company, Aldershot, UK.

Fouchier, V. (2001). “Les coûts des densités, problèmes de méthode.” *Etudes Foncières*, 92, 26-28.

Frank, J.E. (1989). *The costs of alternative development patterns. A review of the literature*. Urban Land Institute, Washington DC, USA.

Gordon, P. and Richardson, H.W. (1997). “Are compact cities a desirable planning goal?.” *Journal of the American Planning Association,* 63(1), 95-106.

Guengant, A, Josselin, J.M. and Rocaboy, Y. (1995). “Densités et finances locales. Difficulties de la modélisation.” *Annales de la Recherche Urbaine*, 67, 65-71.

Guelton, S. and Navarre, F. (2010). “Les coûts de l´etalement urbain: urbanisation et comptes publics locaux.” *Flux*, 79/80, 34-53.

Hagen, T.P. and Vabo, S.I. (2005). “Political characteristics, institutional procedures and fiscal performance: Panel data analyses of Norwegian local governments, 1991-1998.” *European Journal of Political Research,* 44(1), 43-64.

Heikkila, E. and Davis, W. (1997). “Rethinking fiscal impacts.” *Journal of Planning Education and Research,* 16(3), 201-211.

Hirsch, W. (1968). “The supply of urban public services.” In: S.Perloff and L.Wingo (Eds.), *Issues in urban economics*, The Johns Hopkins University Press, Baltimore, USA.

Holcombe, R.G. and Williams, D. (2008). “The impact of population density on municipal government expenditures.” *Public Finance Review,* 36(3), 359-372.

Hortas-Rico, M. and Solé-Ollé, A. (2010). “Does urban sprawl increase the costs of providing local public services? Evidence from Spanish municipalities.” *Urban Studies,* 47(7), 1513-1540.

Isard, W. and Coughlin, R. (1957). *Municipal costs and revenues resulting from community growth*, Chandler-Davis, Wellesley, USA.

Joassart-Marcelli, P. and Musso, J. (2005). “Municipal service provision choices within a metropolitan area.” *Urban Affairs Review,* 40(4), 492-519.

Kain, J.F. (1967). *Urban form and the costs of urban services*, MIT-Harvard Joint Center for Urban Studies, Cambridge, USA.

Klug, S. and Hayashi, Y. (2007). "Social and public costs of residential urban sprawl." *Proc., 7th International Conference of the Eastern Asia Society for Transportation Studies*, 58-73.

Kotval, Z. and Mullin, J. (2006). *Fiscal impact analysis: Methods, cases and intellectual debate*, Working Paper, Lincoln Institute of Land Policy, Cambridge, USA.

Koziol, M. (2004). “The consequences of demographic change for municipal infrastructure.” *German Journal of Urban Studies,* 44(1), 1-13.

Krueger, R. and Buckingham, S. (2012). “Towards a ‘consensual’ urban politics? Creative planning, urban sustainability and regional development.” *International Journal of Urban and Regional Research*, 36, 486–503.

Anuario económico de España. (2005). La Caixa, Barcelona, Spain.

Ladd, H.F. and Yinger, J. (1989). *America's ailing cities: fiscal health and the design of urban policy,* The Johns Hopkins University Press, Baltimore, USA.

Ladd, H.F. (1992). “Population growth, density and the costs of providing public services.” *Urban Studies,* 29(2), 273-295.

Ladd, H.F. (1994). “Fiscal impacts of local population growth: a conceptual and empirical analysis.” *Regional Science and Urban Economics,* 24(6), 661-686.

Mace, R. (1961). *Municipal cost revenue research in the United States*, University of North Carolina, Chapel Hill, USA.

Mace, R. and Wickler, W. (1968). *Do single-family homes pay their way?,* Urban Land Institute, Washington DC, USA.

Margolis, J. (1956). “On municipal land policy for fiscal gains.” *National Tax Journal*, 9, 247-257.

Martin, L and March, L. (1975). *Urban space and structures*, Cambridge University Press, Cambridge, UK.

Mohamed, R. (2009). “Why do residential developers prefer large exurban lots? Infrastructure costs and exurban development.” *Environment and Planning B: Planning and Design*, 36, 12-29.

Morlet, O. (2001). *Coûts et avantages des basses densités résidentielles: etat dex lieux*, ADEF, Paris, France.

Moss, T. (2008). “Cold spots´ of urban infrastructure: ´Shrinking´ processes in Eastern Germany and the modern infrastructural ideal.” *International Journal of Urban and Regional Research*, 32(2), 436-451.

Naess, P. (2001). “Urban planning and sustainable development.” *European Planning Studies*, 9(4), 503-524.

Najafi, M., Mohamed, R., Tayebi, A.K, Adelaja, S. and Lake, M.B. (2007). Fiscal impacts of alternative single-family housing densities, *Journal of Urban Planning and Development*, 10.1061/(ASCE)0733-9488(2007)133:3(179).

Les coûts des infrastructures augmentent avec la dispersion des constructions. (2000). Office Fédéral du Developpement Territorial, Berna, Switzerland.

Paulsen, K. (2009). *The effects of land development on municipal finance a conceptual overview*, Working Paper, Lincoln Institute of Land Policy, Cambridge, USA.

Peiser, R.B. (1989). “Density and urban sprawl.” *Land Economics*, 65(3), 193-204.

Puig-Ventosa, I. (2008). “Charging systems and PAYT experiences for waste management in Spain.” *Waste Management*, 28, 2767-2771.

The costs of sprawl. Environment and economic costs of alternative residential development patterns at the urban fringe. (1974). Real Estate Research Corporation (RERC), US Government Printing Office, Washington DC, USA.

Richardson, H.W. (1971). *Urban economics,* Penguin Books Ltd., Harmondsworth, UK.

San Martín, R. (1985). *Manuals de auditoría energética i enllumenat públic,* Diputación de Barcelona, Barcelona, Spain.

Solé-Ollé, A. and Bosch, N. (2005). "On the relationship between authority size and the costs of providing local services: Lessons for the design of intergovernmental transfers in Spain." *Public Finance Review*, 33(3), 343-384.

Solé-Ollé, A. (2006). "Expenditure spillovers and fiscal interactions: Empirical evidence from local governments in Spain." *Journal of Urban Economics,* 59, 32-53.

Speir, C. and Stephenson, K. (2002). "Does sprawl cost us all?.*" Journal of the American Planning Association,* 68(1), 56-70.

Stone, P. A. (1973). *The structure, size and costs of urban settlements*, Cambridge University Press, Cambridge, UK.

Tähkämö, L., Ylinen, A., Puolakka, M. and Halonen, L. (2012). "Life cycle cost analysis of three renewed street lighting installations in Finland." *International Journal of Life Cycle Assessment,* 17, 154-164.

Tellier, G. (2006). "Public expenditures in Canadian provinces: An empirical study of politico-economic interactions." *Public Choice,* 126(3-4), 367-385.

Costs of sprawl-2000. (2002). Transport Cooperative Research Program, Washington DC, USA.

The effects of large lot size on residential development. (1958). Urban Land Institute, Washington DC, USA.

Vallés, J. and Zárate, A. (2012). “Fiscal devolution and green tax administration.” *Urban Public Economics Review,* 16, 60-92.

Wheaton, W. and Schussheim, M. (1955). *The cost of municipal services in residential areas*. U.S. Government Printing Office, Washington DC, USA.

Windsor, D. (1979). “A critique of the costs of sprawl.” *Journal of the American Planning Association*, 45, 279-292.

Wong, J.D. (1996). “The impact of tourism on local government expenditures.” *Growth and Change*, 27(3), 313-326.