

# DRIVERS OF WATER SUPPLY COSTS IN MEDITERRANEAN SPAIN

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## ABSTRACT

This work analyses the drivers of water supply costs relying on a panel data model within a sample of Spanish Mediterranean municipalities between 2014 and 2016, in the provinces of Alicante and Murcia. These provinces have been chosen due to their common feature: water scarcity in the Southeast of Spain. The source of the dependent variable of the econometric model (costs) is a new dataset called actual cost of services of local entities (CESEL, in Spanish), which is published by Ministry of Finance and Civil Service. This new source emerged in response to financial problems experienced by local entities after the global crisis. Bearing in mind the homogeneity of municipalities studied in terms of water management, selected drivers of the equation focus on urban growth and demographic factors. The findings show that urban variables, such as higher net urban density, have a significant impact on the decrease of water supply costs.

*Keywords: water supply costs, urban factors, scarcity, South-eastern Spain, Mediterranean cities, panel data econometrics.*

## 1 INTRODUCTION

During the most recent economic downturn in Spain, Head of State established the concept of actual cost of local services and the obligation to provide this information in public platforms via the “Ley 27/2013, de 27 de diciembre, de racionalización y sostenibilidad de la Administración Local” (27/2013 Act, dated 27 December, of rationalization and sustainability of local administration).

After the implementation of this new source of information, called actual cost of services of local entities (CESEL, in Spanish and hereinafter), which is published by Ministry of Finance and Civil Service [1], the costs of most of the public services provided at municipal scale could be analysed. Accordingly, this study analyses the drivers of water supply costs in the provinces of Alicante and Murcia, two Mediterranean areas in Southeast Spain which suffer from a structural or permanent water shortage [2]. In this sense, several studies have dealt with the determinants of water demand, but water supply costs have been less studied in the literature, presumably due to a lack of consistent input data.

Water supply costs depend on a number of factors, such as business models, level of outsourcing, regulations, infrastructure or water sources, among others. Nevertheless, these factors are very homogeneous in the selected area of study and there are two differential items which could be analysed: urban pattern and level of population supplied.

Urban sprawl has increased rapidly in Europe in recent decades, despite various efforts to address this problem, and leads to higher greenhouse gas emissions, higher infrastructure costs for transport, water and electrical power, the loss of open landscapes, and the degradation of various ecosystem services [3], with special relevance to Mediterranean's sprawl of cities along the Spanish coastline [4]. Thus, the aim of this study is to quantify the impact of a particular urban housing density pattern on the costs of water supply service, controlling for population.

Relying on a panel data model and considering municipal statistics between 2014 and 2016, selected drivers of the equation focus on urban growth and demographic factors, as high-density housing schemes are expected to reduce provision and maintenance costs of



Table 1: Representativeness of the information. (Source: National Institute of Statistics [7].)

Variable	Figure	Percentage (%)
Number of municipalities of the provinces studied	186	100
Total population of the provinces studied	3,301,306	100
Number of municipalities of the sample	104	56
Population of the municipalities of the sample	2,121,648	64

water supply services, contrary to urban sprawl patterns [4]. The findings show that urban variables, such as higher net urban population density, have a significant impact on the decrease of water supply costs.

## 2 AREA OF STUDY

Provinces of Alicante and Murcia are located in Southeast Spain, between Segura River Basin and Júcar River Basin, although most of the area (nearly 80%) is included in the Segura River Basin. This area is defined by an intense water deficit due to some climatic, geographic and hydrological factors: aridity; scarce, inefficient and irregular rainfall; elevated level of sunshine exposure and persistent drought [5].

Regarding water management and making the difference between water distribution (first stage or primary phase of the urban water provision cycle) and water supply (secondary phase or second stage of the urban water provision cycle), the aforementioned water distribution in the area of study is mainly carried out by an organisation called *Mancomunidad de los Canales del Taibilla* (MCT, hereinafter), which covers the 81% of the registered population in Alicante and Murcia considered together [6]. With respect to water supply, its management depends on political decisions taken by each municipality, but this local public service is provided indirectly for 79% of the population of the area of study [1].

As shown in Table 1, municipalities considered of the area of study represents the 64% of the total population (local entities that reported unreliable data on the costs of the water supply service were omitted from the dataset).

## 3 METHODS AND CALCULATION

The analysis is based on a panel data model spanning a term of three years, 2014–2016, in Alicante and Murcia provinces. This period is considered as a consequence of the availability of data provided by the new source of information called CESEL [1], operational since 2015 with 2014 data.

The econometric analysis deals with unitary water supply costs per household as dependent variable and two control variables (Table 2): net urban density and population, according to eqn (1).

$$\log Y_{it} = \beta_0 + \beta_1 \log X_{1it} + \beta_2 \log X_{2it} + \varepsilon. \quad (1)$$

- Y: dependent variable.
- $X_z$ : independent variables.
- i: municipality.
- t: year.

- $\beta_0$ : constant term.
- $\beta_z$ : regression coefficients.
- $\varepsilon$ : error term.

Dependent variable, costs per dwelling of water supply service, has been obtained from CESEL [1], as well as the number of dwellings connected to the water supply service which have been used for calculating net urban housing density, one of the independent variables. This first independent variable has been calculated with net urban area (in hectares) as denominator, gathered from Spanish Property Assessment Office [8], and is defined as the number of dwellings per urban hectare (not total municipal surface area, but built-up areas of municipality identified as urban land in local planning).

The second independent or control variable is related to the amount of registered population which demand water supply service and it has been collected from National Institute of Statistics [7].

#### 4 RESULTS AND DISCUSSION

As a result of the panel data regression, a high R-square has been obtained (Table 3). According to Hair et al. [9], with 2 independent variables and more than 250 observations, a minimum R-square value of 3 is considered as statistically significant. A panel data calculation method should be chosen by testing for the presence of individual effects using a Breusch-Pagan Lagrange multiplier test and considering the possibility of adding fixed or random effects by means of Hausman test [10].

The above-mentioned tests confirm that Generalized Least Squares (GLS) method with fixed effects must be used and results verify the main hypothesis: a low density urban growth pattern impacts on the increase of the provision and maintenance costs of urban water supply. Specifically, a 1% increase in net urban density, in terms of number of dwellings per hectare, is associated with a 0.906% decrease in water supply costs.

With regard to the control variable associated to population, the coefficient is not significant, which means that registered population is not a determinant factor in water supply costs. This result could be linked with the absence of real registers of population from official data sources, taking into account tourists and visitors as water consumers because leisure, tourism and second residence activities have acquired great importance in the evolution of water demand in many Spanish provinces, including Murcia and Alicante [11].

Table 2: Summary statistics of dependent and independent variables (312 observations).

Variable (unit)	Mean	Standard deviation	Minimum	Maximum
Cost (euros/household)	185.12	427.53	2.25	7459.24
Density (dwellings/hectare)	30.53	52.27	2.57	578.24
Population (inhabitants)	20,482	58,529	52	441,003

Table 3: Estimation results of eqn (1) (t-statistics in parentheses). The statistical significance is expressed through \* = 1%.

Independent variable	Coefficients
log(Density)	-0.906* (-9.22)
log(Population)	0.990 (0.63)
Constant	-0.498 (0.97)
$R^2 = 0.36$ $F(2, 103) = 45.89^*$ Number of observations = 312  Breusch-Pagan test Chi-square (1) = 98.34 Prob > chi-square = 0.0000 Hausman test Chi-square (2) = 21.87 Prob > Chi-square = 0.0000	

## 5 CONCLUSIONS

This work has analysed the empirical relation between low-density urban patterns and the consequent increase in costs of water supply services in the Southeast of Spain, by using a panel data model between 2014 and 2016, considering 104 Mediterranean municipalities.

Results confirm the main hypothesis and an increase of 1% urban density generates a decrease of 0.906% in water supply costs. Bearing in mind that tariffs paid by users in Spain do not fully cover costs of water services, outcomes of this analysis could help to develop policy strategies to promote cost-efficiency by encouraging denser urban areas, with their associated environmental benefits and positive externalities [12].

Finally, further research could develop new models considering a bigger sample of municipalities and gathering other complementary independent variables whose inclusion makes the estimation results convenient to generalise policy conclusions in other parts of Spain or Europe.

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