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Spatial income and public capital: a case of a Spanish region

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Abstract

The objective of this paper is to analyse major determinants of disposable per capita income at a local municipality level for a territory of Spain: the Valencian region. A cross-sectional spatial study for an averaged period (2010-2013) will allow us to control for intraregional correlation, paying special attention to the role of real public investment and its possible effects on disposable personal income. A reference framework for economic and social policy makers will be provided by the specification of the model.

Keywords: spatial econometrics, personal income, public capital, Valencian region, economic policy.

JEL: C21, O8, R58

I. Introduction

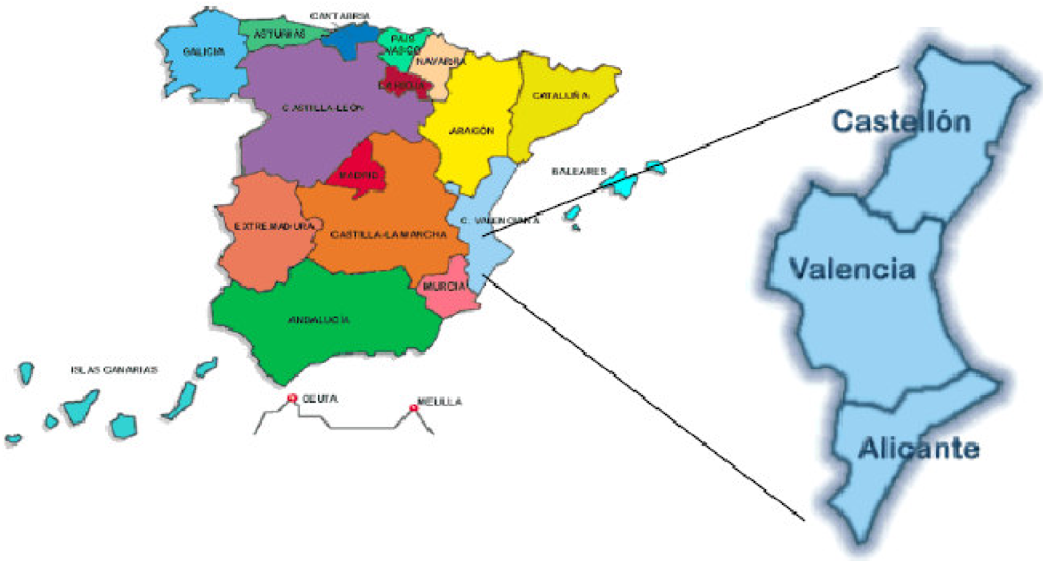
Economic well-being is part of global social welfare which in turn mostly depends on per capita income. A range of goods and services can be provided through real personal income. That is why we may say that most social welfare stems from income. Nevertheless, sub-optimization of some market results may justify the intervention of public institutions. In this context, the objective of this paper, then, is to analyse the major determinants of per capita disposable income at a local municipality level for the Valencian region in Spain. Particular emphasis will be placed on the role of public investment given the growing attention provided in the literature since Romer (1986). Then, we will consider possible consequences arising from public performance in order to asses policy decision making processes.

The municipality level is the administrative level closest to citizens and according to Tobler (1970) in the first law of geography "everything is related to everything else, but near things are more related than distant things". Regarding this theory, the development of a region would be correlated with other regions and the shorter the distance between regions the larger would the correlation be among them. The most appropriate unit to target the spread of spillovers over the territory should be at local level. Indeed, local infrastructures in a region, for example, are also used by population of neighbouring regions and contribute to increase the local income due to the commuting of public jobs between neighbouring regions. We will carry out this analysis through a cross-sectional study for and averaged period between 2010 and 2013. This will allow us to control for correlated effects among municipalities and stressing, at the same time the role of local public capital and its impact on per capita household income.

It is compelling to examine the Valencian region due to the fact that its Administration (regardless of the political party in power) has continuously claimed to have received less public financing over the last decade regarding the rest of the Spanish regions. Municipalities, in turn, have demanded more public funding. This situation has been despite of being a net recipient of population since the sixties and therefore the increasing needs for the provision of more services in general. A growing population has affected, in the end, local public finances. Thus, it is interesting to study whether or not the current level of public investment is central to changes in per capita income. The results may indicate if political complaints are meaningful.

In terms of population, Valencian region (Figure 1 in pale blue colour) has five million inhabitants which is the eleven percent of Spain's population (the 4th largest region in Spain). Geographically it has an extension of 23.254 square meters and it is located on the east side of the Iberian Peninsula, along the Mediterranean sea (518 Km2 of coastline) where the population density is higher than in the mountainous interior. Administratively, the Valencian region is divided into three provinces: Alicante, Castellón and Valencia, and 500 municipalities which are the object of this research:

Figure 1. Maps of Valencian region and Spain



Source: Informe Cámara Comercio de Valencia 2010

Its economy produces 10 percent of the Spanish GDP which is about 100,000 million euros, ranking the fourth out of seventeen regions. The GDP per capita is 21,296 euros a year less than the Spanish average of 24,000 euros and the Euro area that amounts to 31,600 euros. Data refer to most recent year available (2016) according to the Instituto Nacional de Estadística (www.ine.es).

The role of public capital has always been a sensitive subject of economic policy to address regional economic growth. Traditional neo-classical growth models argued that steady-state income per capita was independent of initial conditions on capital stock. This is what is known as exogenous growth (Solow 1956). Nevertheless, later authors such as Romer (1986), Lucas (1988, 1993) and Barro (1990) introduced the endogenized growth and asserted that increasing returns would be caused by the use of public, private and human capitals. Along the same lines are the works by Aschauer (1989) and Barro and Sala-i-Martí (1992) who emphasized the relevant effect of public capital in an economy's growth. In this context, the level of real investment, for example, might become a significant variable in order to explain a territory expansion regarding per capita income. The development of infrastructures, for instance, among different local areas means the possibility to procure a competitive advantage that economically encourages a region. A general belief is that public capital could enhance the productivity of private factors and lead in the end to a positive impact on economic growth.

One of the key strengths of this paper is specifically the implementation of the analysis of per capita income at the lowest level of disaggregation of a territory that the Spanish regulation allows, that is, the municipal level. We move, then, from a more general vision (Valencian region) to a local approach (Valencian municipalities). Thus, we can handle differences across space and avoid at the same time the Simpson's Paradox (Simpson 1951) who highlights the dangers of analysing aggregate data sets. We are aware that municipalities that are neighbours share common infrastructures as well as economic, social, political and even cultural aspects. This may lead, as said before, to positive synergies among them which are based on two different forms of spatiality. The first kind has either endogenous or exogenous direct effects. Thus, spatial income growth, for example, could be the result of capital (natural, physical, human) movement along neighbouring areas bringing about the possibility of causing some concentration. At the same time, near municipalities might also compete for common resources and generate some dispersion. These would be the exogenous effects, whereas the endogenous ones would take place when the economic expansion of a location drives the rest. Indirect spatial effects, on the other hand, would happen whenever a shock such as natural disaster, a social turmoil or an armed conflict, for example, to a specific region have spillover effects (negative or positive) over others within its sphere of influence. The existence of spatial dependence in its different forms compels us to carry out a thorough analysis when considering a variable observation (per capita income) for a specific area (municipality of Valencian region).

The rest of this paper is organized as follows. Section 2 reviews the literature on studies that basically deal with economic growth and public capital. Section 3 reports data sources and specifies the model to be implemented. Section 4 shows results and provides interpretation to them and finally, Section 5 provides main conclusions.

II. Literature review

The authors just mentioned in the introduction section, such as Romer (1986), Lucas (1988, 1993), Aschauer (1989) and Barro (1990), basically dealt with the theorization of capital stock with some reference to public capital and its influence on economic growth. Most of empirical studies in the mid-eighties used cross-section methods but included an aggregate measure of investment without distinguishing between private and public capital. We could say that the first empirical growth model with public investment was that of Easterly and Rebelo (1993) who found a positive impact between the two variables of interest. From then up to now, there has been an abundant legacy of this literature in which different econometric techniques were applied to cross-section, time series, panel and pool data. A current paper by De Jong et al. (2017), through a time series VAR methodology, examines the consequences of the downward trend of public expenditure in 20 OECD countries due to the recent financial and debt crisis. They find a positive impact of public capital on short-run and long-run output (1960-2014). However, the authors assert that keeping public underinvestment may bring about growth difficulties in the future. Most attention has been devoted to the specification of global models represented by individual countries.[1] Although it is a controversial issue, most of results put emphasis on the idea of the positive influence of public capital investment on economic growth. In this sense, the elasticities broadly vary between 0.05 and 1.4 depending on the method, country, sample and type of public capital. Mostly, they have a significant positive impact regardless space and period. However, results of aggregate data do not show the real regional consequences of public investment in infrastructures. That is the reason why the calibration of local models would provide a better picture of the influence of public capital on economic growth when they differ over space. After all, regional estimates are fundamental for regional policy decision making. We have to take into account that any local development may have spillover effects over the rest municipalities with a broader influence on those that are neighbours.

We focus on those papers that take the regional approach for the influence of public capital on economic growth and then concentrate on those related to the Spanish regional case studies. Holtz-Eakin and Schwartz (1995) using panel data for the 48 contiguous states in the US between 1971 and 1986 show that infrastructure accumulation (highways) on economic growth has a positive effect but not an exaggerated productivity rise as suggested by earlier papers. Boarnet (1998) finds a negative spillover from public capital investment on economic growth for Californian counties between 1969 and 1988. He asserts that investments in one area draw

[1] For a comprehensive review we can refer, for example, to the surveys carried out by Sturm et al. (1998) for earlier papers; Elburz et al. (2017) who integrates recent main findings on public investments and economic growth through a meta analysis and Roca-Sagalés and Sala (2009) to show some Spanish case studies.

production away from other areas. The positive effects are only given within the same county.

Through a vector autoregressive (VAR) model for the seventeen regions in Spain Pereira and Roca-Sagalés (2003) demonstrate that there are positive spillovers among regions. Disaggregated effects of public capital formation on economic growth go in the same line as those stemming from aggregate data. By following the same approach, Roca-Sagalés and Sala (2006) measured the spillover effects of public investment on economic growth for both Spain as a whole and all its Spanish regions between 1970 and 1998 using a VAR methodology. The direct influence of public capital on output accounted for two thirds of total effects leaving the resulting third part for the spillover effects stemming from different regions. This result disclosed a geographical pattern. Nevertheless, other authors such as Martínez López (2006) Moreno-López Bazo (2007) they even find a negative influence of regional public investment in infrastructures on final output. By using a structural vector autoregressive (S-VAR) model to Spanish regions Márquez et al. (2010) conclude that most regions receive positive public capital external effects in the short run through the core area. In the long-run, however, there are either positive or negative spillover effects. Gómez and Angulo (2012) apply a production function for the industry sector at a province level in Spain, 1985-2004, through spatial panel data techniques and obtain not significant results when public capital stock is disaggregated at a local and transport components.

The heterogeneity of results on the public capital economic growth relationship together with the focus that we want to take on spatial matters and smaller units such as those at municipality level of a specific region led us to undertake a research based on different approaches of spatial analysis trying to shed more light to the empirical literature.

III. Data, analysis and model specification

Data

It is important to indicate that the analysis is implemented for an averaged period (2010-2013) which corresponds to a cycle where the level of public expenditure in Spain had not yet been recovered from both the last global financial crisis and the particular sovereign debts crisis in the euro area initiated in 2008. Not only economic but political factors are behind the decisions on having a certain level of public budget and a discretionary public expenditure.

The following are the variables we use in the model specification: per capita households' disposable income (*y*), in current euros, is collected from the Consejería de Economía Sostenible, Sectores Productivos, Comercio y Trabajo (www.indi.gva.es), and comprises different sources of income such as that from work, capital, social benefits and current transferences. Income taxes and social security contributions are deducted from total personal revenues. It is the total amount that households have to spend and save divided by total members of the family (per capita). Thus, it is a different measure from per capita gross domestic product and/or gross added value. The other variables that explain municipal disposable income are: public investments (*pi*) which are real investments corresponding to liquidation of budgets in local entities in current euros gathered from the Ministerio de Hacienda y Administraciones Públicas (www.minhafp.gob.es); private contracts (*pr*) that are the labor contracts for population older than sixteen compiled from Servicio Valenciano de Empleo y Formación (SERVEF) (www.servef.gva.es) and used as a proxy variable for real private investments provided that these data are not available for the years of study; distance (*di*) measured in kilometres between the corresponding municipality and the capital of its province was taken from Instituto Nacional de Estadística (INE) (INE) (www.ine.es); human capital (*hc*) defined as a ratio of population with secondary and superior education over total population, these data stemmed from the population census of Instituto Nacional de Estadística (INE) (www.ine.es); and unemployment (*un*) is the ratio of unemployed people over population older than 16 years old, data collected from Servicio Valenciano de Empleo y Formación (SERVEF) (www.servef.gva.es).

Table 1. Description of variables and sources

Variables	Description	Source	Expected sign
y	Per capita households' disposable income.	Consejería de Economía Sostenible, Sectores Productivos, Comercio y Trabajo (www.indi.gva.es)	Dependent variable
pi	Public investments. Real investments corresponding to liquidation of budgets in local entities.	Ministerio de Hacienda y Administraciones Públicas (www.minhafp.es)	(+)
pr	Private contracts over population older than 16 years old.	Servicio Valenciano de Empleo y Formación (SERVEF) (www.servef.gva.es)	(+)
di	Distance from province head.	Instituto Nacional de Estadística (INE) (www.ine.es)	(-)
hc	Human capital (secondary and superior education) over total population.	Instituto Nacional de Estadística (INE) (www.ine.es)	(+)
un	Unemployment over population older than 16 years old.	Servicio Valenciano de Empleo y Formación (SERVEF) (www.servef.gva.es)	(-)

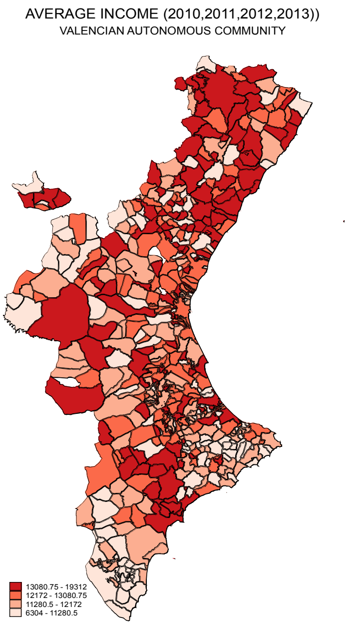
Data analysis

The following is an analysis of our data regarding its distribution over space. In the first place, we are aware of the possibility that a spatial interconection may exist among local units given that we work at the highest level of a territory disaggregation. This could be due, for example, to the mobility of production factors and capital. It is relevant to highlight that at a local level dependence and conexions among territories are stronger than at a higher level. This interdependence generate spatial spillovers that should be considered and integrate in policy makers decisions linked to public investment, for example, all of it in spite of the independence among local entities. In the second place, we have to prove our understanding of interterritorial links and check the existance of such interconnections. To do this, spatial analysis techniques (ESA) are to be used.

Geo-referenced data may present two features that may condition the estimation of econometric models: the spatial autocorrelation and the spatial heterogeneity. The spatial autocorrelation is exhibited when the value of a variable over a location is correlated with the value of the same variable in a neighbouring location. Heterogeneity refers to the unequal distribution of a variable across a spatial unit of reference (Anselin, 1988). Both, spatial autocorrelation and spatial heterogeneity between the values of a geo-referenced variable should be dealt in econometric modelling. Failing to do so, the estimated parameters may be unbiased due to a problem of omitted variables.

As a first approximation, we examine our data by using the exploratory spatial data analysis (ESDA) defined by Anselin (1988). This method allows us to visualize spatial dependence between locations and identify patterns of spatial association as clusters. Therefore, it is a useful technique in order to suggest the kind of spatial relationships among data. This may give us important clues about the characteristics of the data distribution. Figure 2 shows the spatial distribution of the average per capita income for Valencian municipalities. It is possible to observe a certain non-random distribution of income over space. Thus, the municipalities in the north of the autonomous community (region), inner area of centre and middle part of the south concentrate the highest levels of income. Moreover, areas nearby the coast experience in general higher income levels than other parts of the hinterland.

Figure 2. Per capita income in Valencian municipalities, average 2010-2013



Source: Own elaboration and INE

ESDA also offers statistics to reinforce the interpretation of maps. One of the most widely used by literature is Moran's I indicator (Cliff and Ord, 1981). We implement the Moran's I statistic for testing the null hypothesis that values of income in different municipalities are spatially independent. In other words, observed values are randomly assigned among locations so that no spatial autocorrelation takes place. Thus,

$$I_i = \frac{N \sum_{i=1}^{N} \sum_{j=1}^{N} w_{ij}(y_i - \bar{y})(y_j - \bar{y})}{S_0 \sum_{i=1}^{N} (y_i - \bar{y})^2} \qquad (1)$$

where y_i indicates the per capita income of municipality i, and j refers to its neighbours; $\bar{y}$ denotes the sample mean of per capita income; w_{ij} is the corresponding element for municipality i with respect to j from the spatial weight matrix W, and $S_0 = \sum_{i=1}^{N}\sum_{j=1}^{N} w_{ij}$ is a standardization factor corresponding to the sum of the weight.

In modelling spatial association, a key question is the neighbour's definition which captures the spatial proximity matrix W. The elements w_{ij} indicate the way that region i spatially connects to region j. The elements w_{ii} on the diagonal are set to zero and scaled to sum to unity in each row (standardized weights matrices) with typical elements:

$$w_{ij}^{*} = \frac{w_{ij}}{\sum_{j=1}^{N} w_{ij}} \qquad (2)$$

where w_{ij}=1 if i is linked to j and w_{ij}=0 otherwise.

The specification of the spatial weighting matrix is a crucial issue in modelling spatial dependence. The more common measures of neighbouring are based on first-order contiguity (common border) *K*-nearest neighbour matrix and *D*-distance matrix. The three ways to build the weight matrix guarantees the exogeneity of the matrix (Anselin and Bera, 1998). In this paper we have used the three measures of spatial dependence among municipalities and the results are similar. Due to some missing localities we have preferred to work with a *D*-distance weight matrix[2]. The matrix is specified as following:

$$w_{ij} = \begin{cases} 1\ if\ i\ and\ j\ share\ are\ less\ than\ 15\ km \\ 0\ if\ i\ and\ j\ are\ more\ than\ 15\ km\ \ or\ i = j \end{cases} \qquad (3)$$

[2] Distances of 15 kilometres between municipalities have been implemented.

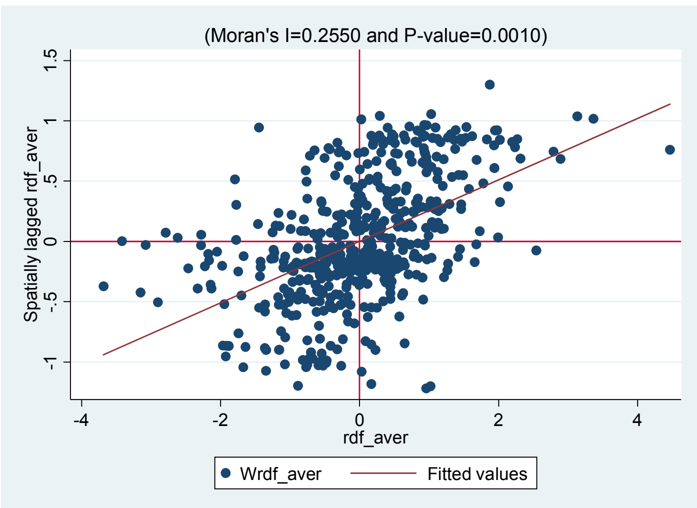
Table 2. Moran's I (*W* common border)

Year	Moran's I
2010	0.2106***
2011	0.2167***
2012	0.1824***
2013	0.1650***

Source: Own Elaboration

In Table 2 we report Moran's I statistics for the spatial distribution of income around municipalities in the four years. They are positive and statistically significant. The existence of significant and positive spatial autocorrelation within income at a municipal level means that municipalities with relative large (or small) levels of income have neighbours with the same characteristics. Figure 3 also shows the Moran's scatter plot for the average income. The graphic provides a useful visual relationship between income in locality *i* and income in neighbouring localities.

Figure 3. Moran's I (W 15 km distance)



Source: Own Elaboration

Taking into account that global measures of spatial autocorrelation, such as Moran's I statistics, ignore local patterns of spatial association to detect the concentration in certain local regions, Getis and Ord (1992) developed the Getis-Ord (G_i*(d)) statistics, a measure of spatial autocorrelation from a local perspective. Those statistics detect spatial clusters with either high or low values (hot and cold spots). A municipality with high (low) income is characterized as a statistically hot spot (cold spot) if it is surrounded by others municipalities with high (low) income as well. The statistics is calculated as follows:

$$G_i^*(d) = \frac{\sum_{j=1}^{N} w_{ij}(d)x_j}{\sum_{j=1}^{N} x_j} \quad (4)$$

where $w_{ij}(d)$ denotes *ij th* element of the spatial weight matrix, defined as in (3).

Table 3 reports the numbers of hot spot regions of per capita income, at the 5% and 1% levels which are 14 and 90 respectively. [3] On the other hand, the numbers of cold spot regions of personal income, at the 5% and 1% are 34 and 90 respectively. [4] Figure 4 shows a better visualization of hot (red and orange) and cold (blue) spots.

Table 3. Getis-Ord (G_i*(d)) Statistics (number of observations 538)

Variable	Z<=2.58	-2.58<Z<=-1.96	-1.96<Z<1.96	1.96<=Z<2.58	2.58<=Z

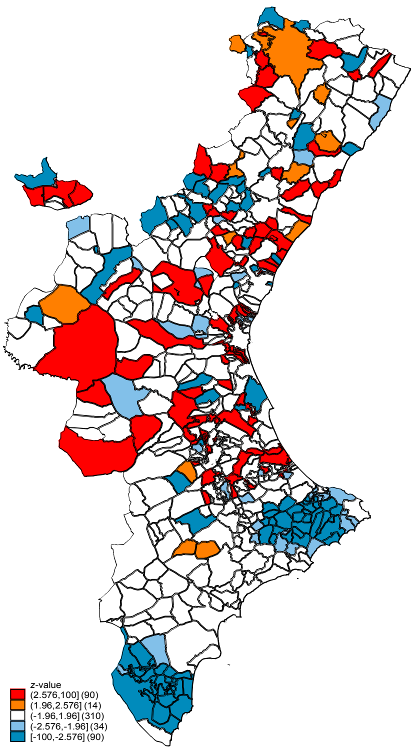
[3] Municipalities with high per capita income are surrounded by municipalities with the same feature.

[4] Municipalities with low per capita income are surrounded by municipalities with the same future.

y	90	34	310	14	90

Source: Own elaboration

Figure 4. Hot and cold spots of per capita income



In short, the ESDA analysis leads to the conclusion that a deterministic behaviour in the distribution of per capita income between nearby regions is very likely. Therefore, the presence of spatial spillovers should be considered in the specification of econometric models in order to avoid problems of bias and/or inefficient parameters.

Model specification

The fundamentals of our model are related to those that implement the theory of endogenous economic growth. In contrast to exogenous models, this approach focuses on different economic sources of effective growth such as externalities, technical skills, human capital and real public investment among others. Several studies support this theory (Romer 1986, 1990, Lucas 1988, 1993, Barro 1990). Specifically, the reference framework is that of Romer (1986) where public capital and private capital are the two factors that explain growth. He considers that positive technological externalities are closely related to the accumulation of capital, being the stock of capital not just as physical capital but also as an indicator of the stock of knowledge. The existence of increasing returns is due to the dissemination of knowledge what ultimately will determine the real economic growth.

The baseline model is the following:

$$y_i = \alpha_0 + \alpha_1 pi_i + \alpha_2 pr_i + \alpha_3 di_i + \alpha_4 hc_i + \alpha_5 un_i + \varepsilon_i \quad (5)$$

where y_i refers to the log of per capita income in municipality i; α_0 is a constant term; pi is the log of public investment; pr stands for the log of labor contracts to capture the private sector activity, di represents the log of distance from each municipality to the head of province; hc typifies the log of human capital in education; un includes the log of unemployed population; lastly, ε is an error term that is assumed to be independent and normally distributed. All variables are taken as an average of years 2010, 2011, 2012 and 2013 except for the distance which is, obviously, always the same. Natural logarithms lead coefficients to be interpreted as elasticities.

Note that spatial autocorrelation of the dependent variable and/or the error term with other observations in the space might bias the OLS estimations. Thus, we will move to the spatially extended specification with spatial econometric techniques. The extended spatial models may correct autocorrelation problems and improve estimations. They allow us to account for dependence between observations, which often arises when observations are collected from points or regions located in space. A spatial production function specification in a cross-sectional setting in the form of a linear regression model will be presented. One of its advantages is that dealing with cross-section data one does not need to be concerned with correlation between per capita income (y) and public capital (pi), for example.

Spatial econometrics has developed different specifications that basically deal with three types of interaction effects among units: (a) endogenous interaction effects of the dependent variable, (b) exogenous interaction effects among the explanatory variables, and (c) interaction effects among the error terms.

The following equation would express the general model with a spatial dimension:

$$y = \alpha\iota + \rho \mathrm{W}y + \mathrm{X}\beta + \mathrm{WX}\theta + u;\ \text{being } u = \lambda W u + \varepsilon \tag{6}$$

where W is the spatial weight matrix that describes the structure of dependence between units, Wy denotes the endogenous interaction effect of the dependent variable and accounts for possible spillovers effects deriving from neighbouring regions, WX reflects the exogenous interaction effects among the explanatory variables, and Wu captures the interaction effects among the disturbance terms in different observations. The scalar parameters ρ and λ measure the strength of dependency between units, while θ, and β is a *kx1* vector of response parameters.

We will refer to expression (6) as the general nesting spatial (GNS) model, according to Elhorst (2010), since it includes all types of interaction effects. Next equations are the extended spatial models which depend on different spatial effects: the spatial autoregressive model (SAR), the spatial error model (SEM) and the Durbin model (DURBIN):

SAR: $y = \alpha\iota + \rho W\mathrm{y} + \mathrm{X}\beta + u$ (7)

SEM: $y = \alpha\iota + \mathrm{X}\beta + \ +u,\ u = \lambda Wu + \varepsilon$ (8)

DURBIN: $y = \alpha\iota + \rho W\mathrm{y} + \mathrm{X}\beta + \ \mathrm{WX}\theta\ + u$ (9)

The SAR model extends the simple linear specification by introducing the spatial lag term WY, accounting for spatial autocorrelation effects in the dependent variable. This way, estimates of the coefficient in the models are now unbiased. The SEM specification imposes the spatial structure in the error term of the model. Finally, the Durbin model considers the spatial effect over the dependent variable as well as the independent variables. The three models have been estimated by the maximum likelihood procedure (Anselin and Bera, 1998).

Taking into account the spatial specification in equations (7), (8) and (9), equation (5) is extended by introducing spatial lagged variables as a way to control the spatial dependence and the possible bias and/or inefficiency of parameters.

$y_i = \alpha_0 + \rho W y_i + \alpha_1 p_i + \alpha_2 pr_i + \alpha_3 di_i + \alpha_4 hc_i + \alpha_5 un_i + \varepsilon_i$ (10)

$y_t = \alpha_0 + \alpha_1 p_i + \alpha_2 pr_i + \alpha_3 di_i + \alpha_4 hc_i + \alpha_5 un_i + \varepsilon_i$; where $\varepsilon_i = \lambda W\varepsilon + u$ (11)

$y_i =$

$\alpha_0 + \rho W y_i + \alpha_1 p_i + \alpha_2 pr_i + \alpha_3 di_i + \alpha_4 hc_i + \alpha_5 un_i + \alpha_1 W p_i + \alpha_2 W pr_i + \alpha_3 W di_i +$

$\alpha_4 W hc_i + \alpha_5 W un_i + \varepsilon_i$ (12)

W is the weight matrix shown in expression (3); Wy_i in equation (10) represents the spatial lag of the dependent variable (SAR); $\lambda W\varepsilon$, (equation 11) is the spatial lag of the error component (SEM), and Wp_i, Wpr_i, Wdi_i, Whc_i and Wun_i (equation 12) represents the spatial lag variables of the independent variables defined in table 4 (DURBIN).

IV. Results and discussion

Looking at the OLS model in Table 4, we can observe that the diagnostic tests regarding multicollinearity and heteroscedasticity do not reveal problems at all. Variance inflation factors (VIFs) for all variables in the model were less than two and the value of the multicollinearity condition number (14.9) is far below the critical range (20-30), indicating that multicollinearity is not a problem. There would be multicollinearity in the case that the largest VIF were greater than 10. The diagnostic test for heteroscedasticity (Hall-Pagan LM Test) does not reject homoscedasticity (Table 4). Furthermore, all diagnostic tests for spatial autocorrelation (Moran error test, lag-LM, lag-LM robust, error-LM and error-LM robust) reject the null hypothesis of absence of spatial autocorrelation in the residuals showing evidence of spatial misspecification. The ESDA analysis done in section 3.2 also confirmed the presence of spatial effects. Under such conditions, the estimates based on OLS are either inefficient and/or biased (Anselin and Bera, 1998). Thus, the aforementioned alternative models are required. Discarding the OLS model, we concentrate on the different features of spatial models. In Table 5 we have added three spatial models: SAR, SEM and DURBIN. The value of likelihood ratio (LR) test on spatial lag dependence is significant in all models. Spatial coefficients (*rho* and *lambda*) are significant and also have the expected sign, indicating a strong correlation among observations located nearby. Each one of the specified models contributes in different ways to control the spatial dependence (spatial lag dependent variable, spatial lag error and spatial lag independent variables). Hence, the interpretation of spatial correlation is different. In the SAR model, the spatial correlation in the dependent variable together with the positive and significant value of the *rho* parameter indicates that neighbours income (less than 15 km) contributes to increase income of municipality (*i*). It should bear in mind that a distance of 15 km is considered as an employment region and therefore, the commuting could explain spatial connections. Regarding the SEM model, the positive and significant value of *lambda* shows that there are no observable elements in the error term that can explain the spatial dependence of the model. Finally, the spatial dependence in the Durbin model is being controlled by both the dependent and the independent variables.

Table 4. Cross section (OLS) estimates and classical and spatial diagnostic tests

Variables	OLS
pi	0.013**
	[0.012]
pr	0.027***
	[0.001]
di	-0.046***
	[0.000]
hc	0.022**
	[0.022]
un	-0.021
	[0.183]
α_0	9.407***
	[0.000]
Observations	538
R-squared	0.159
AIC	0.016
Multicollinearity	
- Condition number	14.9
- Variance inflation factors	1.25
Heteroscedasticity	
- Hall-Pagan LM Test	3.3*
Log likelihood	356.6***
Diagnostic tests for spatial dependence	
- Moran error test	17.80***
- Lag-LM	202.3***
- Lag-LM Robust	0.406
- Error-LM	258.7***
- Error-LM robust	110.281***

Note:***=p<0.01, **=p<0.05, *=p<0.1. The probabilities are in brackets.

Table 5. Spatial models results

	SAR	SEM	DURBIN
pi	0.017***	0.019***	0.019***
	[0.001]	[0.000]	[0.000]
pr	0.023***	0.022***	0.023***
	[0.002]	[0.003]	[0.001]
di	-0.015*	-0.033***	-0.032***
	[0.056]	[0.002]	[0.010]
hc	0.015*	0.012	0.014**

	[0.092]	[0.155]	[0.061]
un	-0.008	0.008	0.007
	[0.577]	[0.601]	[0.684]
Constant	2.829***	9.340***	5.045***
	[0.000]	[0.000]	[0.000]
Wpi			-0.028*
			[0.088]
Wpr			0.079**
			[0.017]
Wdi			-0.008
			[0.722]
Whc			0.161***
			[0.006]
Wun			-0.142***
			[0.001]
Rho	0.685***		0.483***
	[0.000]		[0.000]
Lambda		0.729***	
		[0.000]	
Observations	538	538	538
R-squared	0.098	0.147	0.276
AIC	0.017	0.016	0.014
Wald test	58.14***	91.58***	91.57***
LR test I	92.6***	116.2***	23.28***
LR test II			28.18***
Log likelihood	392***	395.4***	406.1***

Note:

-***=p<0.01, **=p<0.05, *=p<0.1.

-The probabilities are in brackets.

-Regressions have been performed on Stata 15.

-The *LR test I* checks the spatial model versus the OLS model where the null hypothesis is *rho/lambda=0*.

-The null hypothesis for the *LR test II* is *WX's =0*.

As expected, different models give different estimates but what it is most important is that they are consistent as to the direction of variables and magnitude of values. It is important to indicate that most variables are significant except for unemployment. The influence of public investment on per capita income is positive and its elasticity which is very similar, if not the same, varies between 0.17 provided by the SAR model (Table 5) and 0.019 in SEM and DURBIN models. This means that for every 100 percent increase in public investment, personal wealth would rise between 1.17 and 1.19 percent depending on the model we look at. In this sense, most local governments are always tempted to spend much money in economic and social policies basically with the objective of winning next elections. The small magnitude of our estimates suggests that local authorities should invest even larger quantities of money if they wanted to increase people's income. The danger of this behaviour is to get into debt far beyond its possibilities. The decision of spending without a specific control would endanger the finance balancing, putting into risk future required investments. Empirical evidence, anyhow, shows the positive role of public investment for the Valencian region with regard to the per capita income. The Literature Review section indicated that the elasticities for public capital were between 0'05 and 1'4 and these results were obtained from models which have a more aggregate approach. As a general reference at a regional level, the paper by Pereira and Roca (2003) based on a time series VAR model reports an elasticity for Valencian region, among others, of 0'324 but the dependent variable in this case is output and not per capita income and the implemented model is not spatial what it probably influences the final outcome.

The rest of estimates for variables that contribute to the growth of disposable income according to our models are the following: the labour contracts variable which is the proxy for the private sector and whose elasticity is practically the same, between 0’022 and 0’023, indicates the positive influence on per capita income. Thus, increases in work opportunities lead people to earn more money in the proportion reported by its range of elasticities which are in this case larger than those of the public investment. We are talking about paid productive work. This is a relevant variable since the 80 percent of income in the Valencian region stem from labor income whereas the remaining 20 percent is derived from capital income. The distance variable which is also statistically significant with the exception of the SAR model exerts a negative influence on per capita income. Its magnitude (-0.03) in absolute terms is twice as much as public investment. This might be interpreted as the fact that people try to work as close as they can from where they live. More distance translates into a more rigid labor market. This is a common feature along the Spanish geography and one of the causes why unemployment in Spain is higher compared to other European countries. People prefer to get either unemployment benefits if they are eligible for or family help before moving to other locations in search of work. Empirically speaking, we can observe that the human capital variable (*hc*) has also a direct impact on per capita income. Its elasticity goes from 0.012 to 0.05. It is confirmed as a fundamental determinant of income. It is part of the capital stock, in this case stock of knowledge and productive abilities that allow people to generate income. Regarding the last variable unemployment, it was expected a negative relationship with per capita income given the fact that less employment generate less revenues. However only the SAR model captures the expect sign even though the magnitude is almost irrelevant. Most of all, this variable is not statistically significant although is kept in the respective models firstly because of its economic and social meaning ultimately related to a personal’s wealth and secondly because it improves all models from an econometrics point of view.

In the case of spatial lag variables, the positive and significant *rho* value, in both the SAR and the DURBIN model (0.685 and 0.483 respectively) means that per capita income in each municipality also depends on per capita income in neighbouring areas. Inter-municipality connections have positive effects on the economic growth of a municipality. The economic prosperity in a region leads others regions to also increase commuting workers, per capita income, and finally, consumption. Moreover, the use of infrastructures among municipalities allows the spatial dependence and hence the economic benefits in one municipality are to be spread across nearby areas.

Regarding the DURBIN model, significant spatial lag coefficients in independent variables indicate a spatial connection of control variables over per capita income. Note that the public investment variable (*Wpi*) carries a negative sign. We may think that public investments in one area come in direct competition with nearby municipalities instead of just being complementary. For instance, a public infrastructure such as a public swimming pool or a sport centre in a municipality is used by residents as well as by neighbours of nearby municipalities. That municipality, in this case, is performing as an urban centre that attracts most of the economic activity. This may damage investment possibilities and finally hurt the economic development of nearby municipalities. With respect to the spatial lag of number of labour contracts (*Wpr*), its coefficient is positive and significant. Spatial spillovers make possible that whenever the contracts increase in a region nearby areas benefit from this economic advantage as well. This result is related to the spatial coefficient of the unemployment rate (*Wun*) which is significant and negative. Hence, when the unemployment increases in a municipality also the neighbouring municipalities are affected by this economic downturn. The presence of employment territorial areas, then, is linked to industrial clusters. Finally, the positive and significant estimate of the spatial lag human capital

(*Whc*) would reinforce the employment argument about the final influence on per capita income in close areas.

V. Conclusions

This paper has examined major determinants of per capita disposable income at the smallest local unit level for the Valencian region in Spain. The focus has basically been on possible effects of public spending over income so that economic and social municipal policies can be implemented. The fundamentals of the model specification are to be found on the classical economic growth theory and the role of public policies but taking into account both the particular features that a local economy may offer and the limits for data information on variables of interest. A previous analysis confirmed the existence of a spatial interdependence which led us to deal with it through different spatial models (SAR, SEM and DURBIN) which provided different econometric features in order to satisfy the model specification. In general, the results that have been gathered out of the three models turned out to be very similar which supported the robustness of the original model specification.

The spatial interdependence among municipalities detected in our research suggests that spatial spillovers on income growth are reinforcing their economic activity. Some regional income disparities could also be addressed at a regional level by identifying those municipalities that generate higher intermunicipality externalities. For example, we obtained evidence about the positive influence of the stock of public investment on personal income. According to its elasticity, the effect was rather small and therefore it should play down to some degree the importance of Valencian political claims for more financing. Anyhow, this result should be taken cautiously when implementing social and economic policies given the fact that local authorities are always tempted to spend more public funds with a view to winning more votes from citizens. We have seen that public investments have statistically a positive influence on personal income but investments are not always efficient and it is important not to spend more but to spend wisely. Failing to do that, strong public deficits might hold back future public investments that a municipality might really need.

A meaningful consideration then, drawn from the results of this paper is that if economic and social policy makers of a country want to go in the direction of stimulating people's income, a first and fundamental step would be, acting locally despite they may originally have in mind acting on a more global perspective. This is the essence of going into such a disaggregated analysis when looking at the role of public performance and its possible impact on personal income at a municipality level.

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