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Forecasting heterogeneous regional data: The case of Spanish employment

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Forecasting heterogeneous regional data: the case of Spanish employment

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Abstract

Forecasting regional variables provides very important information for political, institutional and economic agents. However, in the present context characterized by important decline of economies, heterogeneous data and regional interdependencies, it is even more difficult to carry out accurate forecasts for any economic variable. In this paper, we use the predictions of spatial panel data models to evaluate the impact of the present economic crisis on employment. Furthermore, we evaluate whether the impacts are different depending on the level of specialization of the Spanish regions at NUTS III administrative level in terms of Eurostat.

Keywords: Forecasting regional data, heterogeneity, interdependencies, the Spanish economic crisis.

JEL Classification: C21; C22; C23; C53; R15.

1. Introduction

The field of panel data models has received considerable attention during the last decade. Panel data literature offers the opportunity of allowing for unobservable cross-sectional and time-period specific effects. Other advantages of panel data are that they are generally more informative and contain more variation and less collinearity between variables. The use of panel data leads to a greater availability of degrees of freedom and, hence, increases the efficiency of the estimation. Panel data also allow for the specification of more complicated behavioural hypotheses, including effects that cannot be addressed using pure cross-sectional or time-series data (Wooldridge, 2002; Arellano, 2003; Hsiao, 2003; Baltagi, 2005).

When cross-sectional data refers to spatial units (municipalities, provinces, regions or countries) the spatial dependence between cross-sectional units at each point in time is also important. Spatial dependence implies that, due to spillover effects (e.g., commuter labour and trade flows), neighbouring regions may have similar economic performance. Hence, we expect to improve traditional panel data models by paying attention to the location of the spatial units. There has been growing interest in the estimation of panel data models with spatial dependence: see Kelejian and Prucha (2002), Elhorst (2003), Yang et al. (2006), Baltagi et al. (2006), Kapoor et al. (2007), Kelejian et al. (2006) or Pesaran (2006). Prediction with these types of models is analysed in Baltagi and Li (2004, 2006) for predicting per-capita cigarette and liquor consumption in the United States, respectively, in Longhi and Nijkamp (2007) for forecasting the regional labour market in West German regions, while Baltagi et al. (2012) make performance comparison of different spatial panel data models.

Since there is a consensus on the good performance of spatial panel data model for forecasting purpose, the main purpose of this paper is to evaluate the impact of the actual Spanish economic crisis on total employment, as well as on the employment of the main economic sectors: i) agriculture; ii) energy and manufacturing; iii) construction; iv) distribution, transport and communications; v) finance and other services; and vi) non-market services. Since the economic crisis started in Spain at the end of 2007, we estimate and check the models estimated for the period 1980-2006. In a second step, estimation results are used to forecast the series of employment by

provinces for the period 2007-2010. Comparison between forecast employment and real one offers us a clear measure of the effect of the present economic crisis. Furthermore, the analyses are carried out with the purpose of identifying certain differences in responses according to different degrees of specialization of Spanish regions. The degree of specialization is measured through the localization quotient.

The structure of the present paper is as follows. In Section 2, we provide a description of the spatial panel data model we consider in our application. Section 3 is devoted to the presentation of the data. In Section 4, we present the main estimation results as well as the measure of the effect on employment of the present economic crisis. Finally, the paper finishes with a section of concluding remarks.

2. Methodology

2.1. Specification and estimation of the proposed model

We start with the panel specification:

$$y_{it} = x_{it}\beta + \varepsilon_{it} \quad i = 1, \dots, N; t = 1, \dots, T \quad (1)$$

where y_{it} is the employment (in log) for region i at time t ; x_{it} is a $(1 \times K)$ vector of explanatory (exogenous) variables, which included the gross value added (in log) and a set of dummies variables to capture the effect of specialization on employment; β represent a $(K \times 1)$ vector of parameters to be estimated; finally, w_{ij} is the (i, j) element of the matrix W , which is an $(N \times N)$ known spatial weight matrix, which we will define as the row-normalization of the four-nearest neighbor binary matrix.

From a simple to general strategy, after estimating the pooled model (1), the null of no spatial autocorrelation is tested through the corresponding Lagrange Multiplier (LM) tests. In our context, it is likely to obtain evidence in favor of the alternative hypotheses. In such a case, a spatial panel specification should be adopted.

In this context, a panel data model with error component proposed by Kapoor et al. (2007) could be a flexible specification. They propose a linear specification with a Spatial Autorregressive- Random Effect (SAR-RE) specification for the disturbance ε_{it} , as follows:

$$\begin{aligned}
y_{it} &= x_{it}\beta + \varepsilon_{it} \\
\varepsilon_{it} &= \rho \sum_{j=1}^N w_{ij} \varepsilon_{jt} + u_{it} \\
u_{it} &= \mu_i + \nu_{it}
\end{aligned} \tag{2}$$

As shown in (2), the disturbance term ε_{it} is contemporaneously correlated according to the spatial autoregressive (SAR) error model, which implies complex interdependences across regions in employment levels, so that a shock to the employment in region j is simultaneously transmitted to his neighbour regions. Taking one cross-sectional regression at time t , it is possible to show that:

$$\varepsilon_t = I_N - \rho W^{-1} u_t = B_N^{-1} u_t = u_t + \rho W u_t + \rho^2 W^2 u_t + \rho^3 W^3 u_t + \dots \tag{3}$$

with $W^2 = W \cdot W$ and, in general, $W^r = W^{r-1} \cdot W$. Consequently, u_t is the direct effect that a shock to region j has on j , while $\rho W u_t$ is the indirect effect that affect the neighbour locations to j , as given by the non-zero element in W . Hence, shocks are transmitted all around the country in what we can say a global effect.

Furthermore, as shown in (2) the remainder term u_{it} follows the following error component structure (RE: $u_{it} = \mu_i + \nu_{it}$), where $\mu_i \sim \text{i.i.d. } (0, \sigma_\mu^2)$ and $\nu_{it} \sim \text{i.i.d. } (0, \sigma_\nu^2)$, being both independent of each other and among themselves. The term μ_i refers to the permanent error component as they differ for each region, but are constant for each region at any time (individual-specific time-invariant effect). The term ν_{it} refers to the transient error component as they differ for each region and for each time. The advantage of this specification is that it lets identification of time-invariant covariates, and it can capture long-run effect, while within-effect estimation focuses on short-run variation (Baltagi, 2005; Partridge, 2005; Elhorst, 2010). The RE specification allows the disturbances to be correlated over time, as can be observed for a covariance matrix of perturbances for one cross-sectional regression for region i :

$$E u_i u_i' = \begin{bmatrix} \sigma_\mu^2 + \sigma_\nu^2 & \sigma_\mu^2 & \dots & \sigma_\mu^2 \\ \sigma_\mu^2 & \sigma_\mu^2 + \sigma_\nu^2 & & \sigma_\mu^2 \\ \dots & & & \\ \sigma_\mu^2 & \sigma_\mu^2 & \dots & \sigma_\mu^2 + \sigma_\nu^2 \end{bmatrix} \tag{4}$$

Hence, the Spatial Autorregressive-Random Effect (SAR-RE) is a flexible specification, since it allows the disturbances to be correlated over time and across spatial unit. For the full (NT x 1) vector of disturbances:

$$\varepsilon = \iota_T \otimes B_N^{-1} \mu + I_T \otimes B_N^{-1} \nu \quad (5)$$

and the corresponding (NT x NT) covariance matrix is given by:

$$E \varepsilon \varepsilon' = \sigma_\mu^2 J_T \otimes B_N B_N^{-1} + \sigma_\nu^2 I_T \otimes B_N B_N^{-1} = \Omega \quad (6)$$

with $J_T = \iota_T \iota_T'$ is a (T x T) matrix of ones.

To estimate this, model Kapoor et al. (2007) proposed three generalized moments (GM) estimators of ρ and the variance components, σ_ν^2 and $\sigma_1^2 (= \sigma_\nu^2 + T\sigma_\mu^2)$, based on six moment conditions. The estimated model is useful, among others, for forecasting future employment.

2.2. Forecast performance of the different models

Goldberger (1962) shows that the best linear unbiased predictor (BLUP) for the cross-sectional units in a linear regression model with covariance matrix Ω at a future period T+C is given by:

$$\hat{y}_{i,T+C} = x_{i,T+C} \hat{\beta}_{GLS} + \omega' \Omega^{-1} \hat{\varepsilon}_{GLS} \quad (7)$$

where $\omega = E \varepsilon_{i,T+C} \varepsilon$ is the covariance between the future disturbance $\varepsilon_{i,T+C}$ and the sample disturbance ε ; $\hat{\beta}_{GLS}$ is the GLS estimator of β from equation (2) based on Ω and $\hat{\varepsilon}_{GLS}$ denotes the corresponding GLS residual vector.

For Kapoor et al. (2007) model, the BLUP for the SAR-RE also modifies the usual GLS forecasts by adding a fraction of the mean of the GLS residuals corresponding to the *i*th individual. More specifically, the predictor is given by:

$$\hat{y}_{i,T+C} = x_{i,T+C} \hat{\beta}_{GLS} + \left(\frac{\sigma_\mu^2}{\sigma_1^2} \right) b_i \iota_T' \otimes B_N \hat{\varepsilon}_{GLS} \quad (8)$$

Where b_i is the *i*th row of the matrix B_N^{-1} .

3. Data

In the application that follows, we use data on total employment of 47 Spanish regions (NUTS III administrative spatial unit in terms of Eurostat). As said before, employment will be explained by gross value added. The model also included six dummies variables, which capture the effect of region specialization on the following economic activities: i) agriculture; ii) energy and manufacturing; iii) construction; iv) distribution, transport and communications; v) finance and other services; and vi) non-market services. The data for all the variables are gathered, for the period 1980 to 2010, from the Cambridge Database.

Firstly, we show the evolution of total employment along the analysed period. As observed in the graph, there is a clear decrease in employment around years 2007 and 2008 due to the important Spanish economic crisis.

(Insert Figure 1)

If we pay attention to the evolution of employment by the different economic activity sectors (Figure 2) we observe similar pattern. However, important differences seem to exist among sectors. For instance, in the finance and other services sector the level of employment in such years has even increased, while a strong decrease takes place in the cases of construction, energy and manufacturing or non-market services.

(Insert Figures 2)

As indicated before, we want to analyse the role of specialization on the level of employment. To cope with this objective, we calculate the localization quotient, $QL_{i,r}$, which is defined as follows:

$$QL_{i,r} = \frac{E_i^r / E_i^\bullet}{E_i^\bullet / E_i^r} \quad (9)$$

where E_i^\bullet measures the number of employees in sector i ; E_i^\bullet , the total number of employees in Spain (the 47 regions as a whole); E_i^r , the number of employees in sector i and municipality r ; and E_i^r , the total number of employees in municipality r .

The localization quotient is a relative measure in that it measures the regional share of workers in a specific sector relative to the national share of workers in that

sector. If the localization quotient is larger than one the interpretation is that the industry has a larger share of the employees in a region than the country as a whole, implying that the municipality is more specialized than average in that specific sector.

The localization quotients are calculated along the considered period 1980-2010. From them, we have generated the corresponding dummy variables that take a value of one if the corresponding region has a value greater than one; that is, in the case that the region is specialized in such specific sector. An example on the information derived is shown in Figure 3.

(Insert Figure 3)

4. Estimation results

We start by estimating the pooled panel data model expressed in (1). Results are shown in the first column of Table 1. Next, we test the null of no spatial autocorrelation, concluding on the rejection of the null in all the cases. However, according to the magnitudes of the respective statistics, spatial autocorrelation should be modeled by means of the Spatial Error Models (SEM) specification. Results for the SEM-RE following the third alternative proposed by Kapoor et al. (2007), denoted as weighted estimators, are shown in the second column of the table.

(Insert Table 1)

Elasticity of total employment to gross value added is close to unity. Hence, the increase in gross value added affects nearly proportionally to total employment. Regarding differences in employment by degree of specialization, Table 1 shows that all the estimated parameters are negative, with the only exception for that related to distribution, transport and communications. Hence, only the specialization on this sector generates a positive increase in total employment, which reaches around the 1%.

As regards the measure of the effect of Spanish economic crisis, Table 2 shows the average percentual change in total employment due to the economic crisis for the period 2007-2010. The first row of the table shows the effect on all the regions, while the rest of the table shows the effect on only the specialized regions. As regard the average for all the regions, Table 2 shows that in 2007, the reduction of employment due to the economic crisis accounts only for the 0.59%. However, this percentage has

increased in the following years, mainly in 2009 and 2010. Regarding differences due to specialization in different activities, results indicates that only those regions specialized in construction; distribution, transport and communications; and in non-market services activities suffers from a decrease in total employment less than the average.

(Insert Table 2)

A replication of these analyses has been carried out for the employment in the six economic activities considered in this paper. Tables 3 to 8 gather the obtained results.

(Insert Tables 3 to 8)

Table 3 shows that the economic crisis affects negatively to employment in agriculture along the four years. Furthermore, the negative impact in even higher than the average for those regions specialized in distribution, transport and common services. Table 4 shows that the economic crisis also affects negatively the level of employment in the energy and manufacturing sector, being the regions specialized in finance and other services mostly affected. As regards, effect of economic crisis on employment in construction sector (Table 5), it is remarkable the fact that the negative effect does not take place till 2009, when the crisis reduces employment by 15%. In 2010, the reduction has been larger, reaching the 22%. The regions mostly affected by the reduction in employment of construction sector are those regions specialized in distribution, transport and common services. Table 6 shows that the employment in distribution, transport and communications itself, in general, doesn't have suffered from the effect of economic crisis. The only negative effect relates to the regions specialized in the finance and other services. Table 7 shows that the employment in finance and other services has been reduced only in those regions specialized in the sector itself, and mainly in 2007 (-33%). Finally, Table 8 shows that employment in non-market service sector has decreased in 2009 (-5.30%) and in 2010 (7.71%). The decreases in those regions specialized in agriculture; constructions, distribution, transport and common services; and, non-market services have been greater than the average.

5. Concluding remarks

Econometric literature clearly accepts the good performance of panel data models, in general, and spatial panel data models, in particular, for capturing the unobservable heterogeneity of data. Obtained results can be used for analyzing or

predicting an economic variable. In this paper, we show the potential of these models as a measure of the effect of Spanish economic crisis on employment. A SAR-RE spatial panel model proposed by Kapoor et al. (2007) has been estimated for Spanish region data for the period 1980-2006. Forecasts have been generated for the period 2007-2010. The comparison between such forecasted value and the real ones constitutes a measure of the effect of the crisis on Spanish employment.

On average and until 2010, the economic crisis has reduced the level of employment in all sectors except for finance and other services one. However, employment reduction differs by sectors in magnitudes as well as on the starting period. The highest reductions take place in the agriculture sector, followed by energy and manufacturing and construction sectors. Furthermore, while reduction in employment in agriculture and energy and manufactured sector started in 2007; in the construction sector, the reduction in employment started in 2009.

Among the effect of region specialization on employment impacts, it is remarkable the following results: i) the effect of crisis on employment in AGRICULTURE is suffered strongly by those regions specialized in distribution, transport and communications; ii) the effect of crisis on employment in ENERGY AND MANUFACTURING; DISTRIBUTION, TRANSPORT AND COMUNICATION; and FINANCE AND OTHER SERVICES is suffered strongly by those regions specialized in finance and other services; iii) the effect of crisis on employment in CONSTRUCTION is suffered strongly by those regions specialized in non-market services and agriculture sectors; and iv) the effect of crisis on employment in NON-MARKET SERVICES is suffered strongly by those regions specialized in agriculture; distribution, transport and communications; and construction sectors.

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Figure 1. Evolution of total employment in Spain

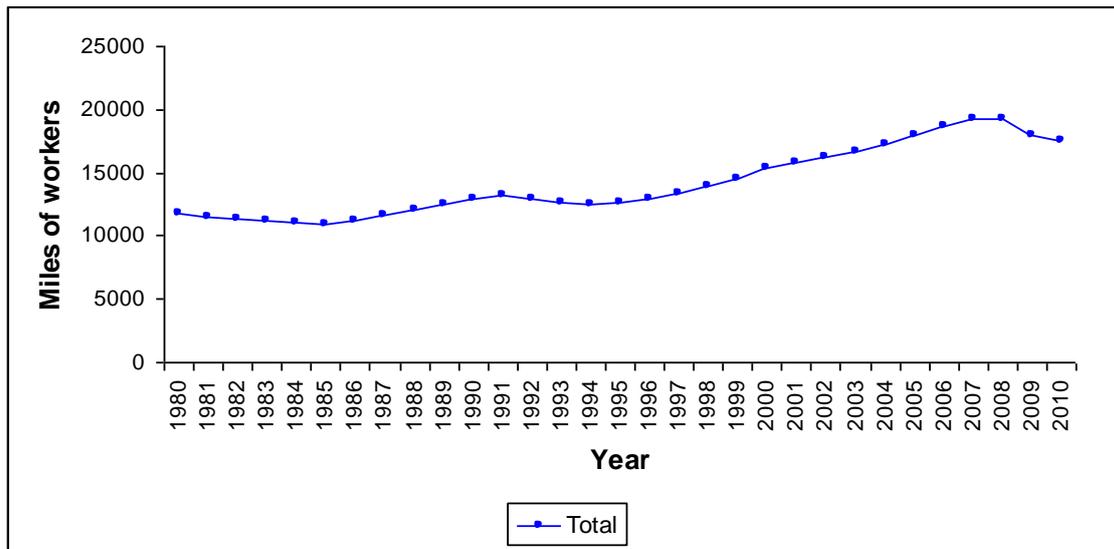


Figure 2. Evolution of employment in the different economic sectors in Spain

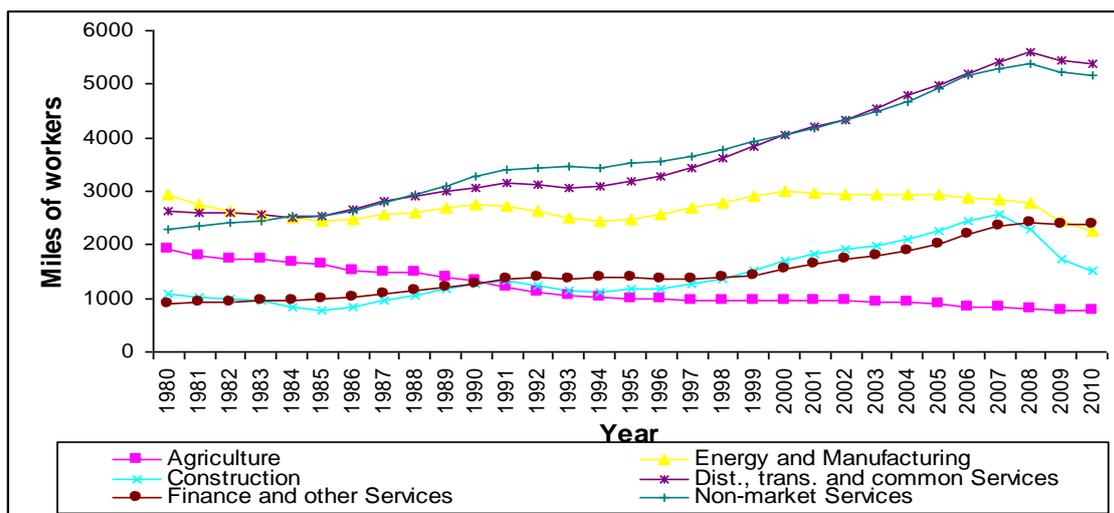


Figure 3. Location quotes by economic sectors in 2005 and 2010. Specialized regions in the different economic sector in 2010.

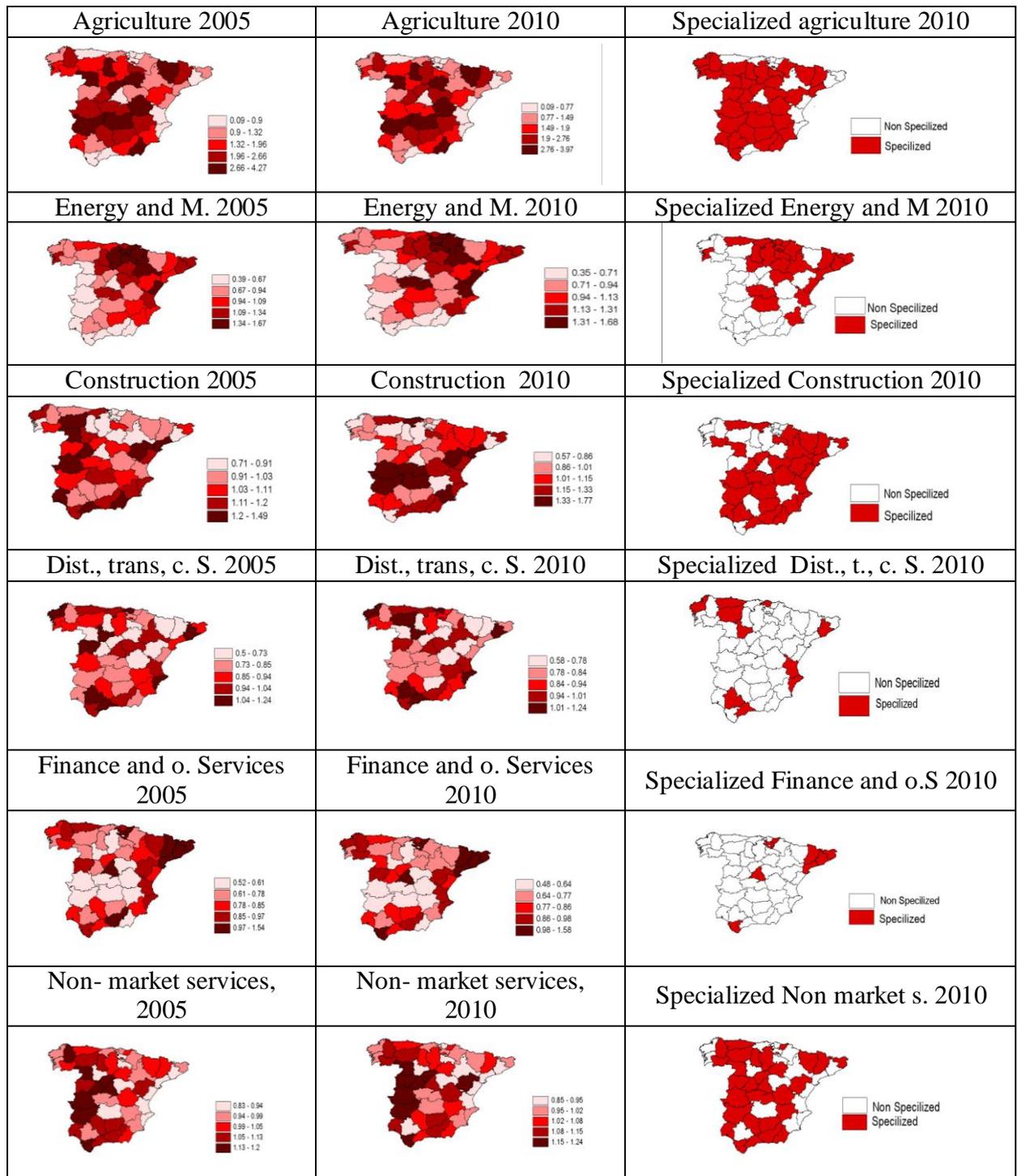


Table 1. Estimation results

Dependent Variable: ln (total employment)		
	Ordinary Least Squares	SEM-RE Weighted Estimators
Constant	-2.968* (-52.25)	-2.622* (-41.85)
Ln (gross value added)	0.959* (152.78)	0.923* (131.83)
Desp_agriculture	0.029* (2.30)	-0.023 (-1.71)
Desp_ Energy and M.	-0.148* (-14.55)	-0.132* (-12.19)
Desp_ Construction	-0.040* (-4.899)	-0.057* (-6.90)
Desp_ Dist., trans, c. S.	0.0353* (3.42)	0.012 (1.28)
Desp_Finance and o. Services	-0.062* (-4.664)	-0.050* (-3.21)
Desp_Non-market services	-0.101* (-11.313)	-0.087* (-9.66)
ρ		0.508
$\hat{\sigma}$	0.0198	
$\hat{\sigma}_v^2$		0.019
$\hat{\sigma}_1^2$		0.007
R ²	0.972	0.999
Testing for spatial autocorrelation		
LM test no spatial lag	10.81*	
Robust LM test no spatial lag	5.34*	
LM test no spatial error,	299.49*	
Robust LM test no spatial error	294.02*	

(a) T-ratios in parenthesis

Table 2. Average perceptual change in TOTAL employment due to the economic crisis (%)

Regions	2007	2008	2009	2010
All region	-0.59	-1.93	-6.45	-9.58
Specialized regions				
Agriculture Specialized	-1.60	-2.16	-6.63	-10.44
Energy and M. Specialized	-2.72	-4.18	-7.43	-11.54
Construction Specialized	4.03	3.46	-4.84	-9.12
Dist., trans., common Services Specialized	2.39	3.84	-2.13	-5.02
Finance and other Services Specialized	-13.27	-10.47	-11.01	-13.56
Non- market services Specialized	3.63	1.61	-3.49	-7.24

Table 3. Average perceptual change in employment in AGRICULTURE due to the economic crisis (%)

Regions	2007	2008	2009	2010
All region	-29.37	-30.36	-36.02	-35.23
Specialized regions				
Agriculture Specialized	-28.22	-29.60	-34.66	-35.91
Energy and M. Specialized	-22.90	-23.99	-26.66	-22.62
Construction Specialized	-20.96	-23.66	-26.88	-24.77
Dist., trans., common Services Specialized	-35.09	-31.78	-42.89	-41.47
Finance and other Services Specialized	-29.41	-28.74	-34.39	-30.72
Non- market services Specialized	-27.35	-29.98	-34.98	-37.05

Table 4. Average perceptual change in employment in ENERGY AND MANUFACTURING due to the economic crisis (%)

Regions	2007	2008	2009	2010
All region	-12.02	-15.93	-21.21	-29.27
Specialized regions				
Agriculture Specialized	-9.59	-16.57	-21.60	-32.14
Energy and M. Specialized	-12.25	-15.41	-19.26	-26.94
Construction Specialized	-9.82	-13.48	-15.64	-21.85
Dist., trans., common Services Specialized	-10.91	-15.21	-23.91	-31.43
Finance and other Services Specialized	-22.12	-19.00	-31.20	-38.73
Non- market services Specialized	-11.27	-14.24	-21.23	-29.94

Table 5. Average perceptual change in employment in CONSTRUCTION due to the economic crisis (%)

Regions	2007	2008	2009	2010
All region	16.56	6.15	-14.74	-22.09
Specialized regions				
Agriculture Specialized	14.99	5.84	-14.78	-23.04
Energy and M. Specialized	19.49	8.99	-9.59	-17.65
Construction Specialized	19.85	7.02	-9.97	-15.74
Dist., trans., common Services Specialized	19.89	9.93	-14.94	-22.27
Finance and other Services Specialized	22.31	14.32	-12.34	-19.40
Non- market services Specialized	12.98	2.56	-18.79	-26.42

Table 6. Average Perceptual change in employment in DISTRIBUTION, TRANSPORT AND COMMUNICATIONS due to the economic crisis (%)

Regions	2007	2008	2009	2010
All region	12.49	3.62	1.94	-0.22
Specialized regions				
Agriculture Specialized	13.88	5.88	3.20	0.94
Energy and M. Specialized	10.91	2.48	0.85	0.19
Construction Specialized	11.90	3.01	0.10	-2.56
Dist., trans., common Services Specialized	11.69	1.74	3.38	1.05
Finance and other Services Specialized	0.02	-7.23	-1.12	-3.00
Non- market services Specialized	11.51	4.18	1.98	-0.58

Table 7. Average perceptual change in employment in FINANCE AND OTHER SERVICES due to the economic crisis (%)

Regions	2007	2008	2009	2010
All region	0.57	14.23	15.99	14.87
Specialized regions				
Agriculture Specialized	4.17	19.20	20.75	21.15
Energy and M. Specialized	-11.65	1.33	3.64	1.84
Construction Specialized	2.14	18.96	14.53	8.97
Dist., trans., common Services Specialized	-9.31	6.93	11.74	10.83
Finance and other Services Specialized	-33.54	-18.30	-5.56	-5.87
Non- market services Specialized	8.21	22.71	22.88	21.96

Table 8. Average perceptual change in employment in NON-MARKET SERVICES due to the economic crisis (%)

Regions	2007	2008	2009	2010
All region	0.81	1.29	-5.30	-7.71
Specialized regions				
Agriculture Specialized	-0.35	-0.29	-6.48	-9.16
Energy and M. Specialized	3.16	4.13	-3.18	-5.24
Construction Specialized	-0.65	1.21	-4.45	-8.54
Dist., trans., common Services Specialized	-0.16	0.17	-6.86	-9.13
Finance and other Services Specialized	10.38	10.15	1.32	-0.49
Non- market services Specialized	-0.28	-0.13	-5.86	-8.29