Regional unemployment and cyclical sensitivity in Spain

Alejandro Almeida¹ · Aida Galiano¹ · Antonio A. Golpe² · Juan M. Martín¹

Received: 22 December 2019 / Accepted: 15 June 2020 / Published online: 2 July 2020
© Springer-Verlag GmbH Germany, part of Springer Nature 2020

Abstract

Unemployment has been routinely used as a measure of the economic cycle. In addition, regional unemployment rates are characterized by, among other factors, their relation to the national unemployment rate. In this regard, the literature on regional sensitivity to the economic cycle has analyzed how fluctuations in the national unemployment rate affect the regions. In recent years, due to the great impact of past crises, the development of new econometric techniques and the possible arrival of new crises, the debate on how sensitive regions are to the economic cycle has reopened. In Spain, this debate is necessary since unemployment rates are very high and display a great deal of heterogeneity. We analyzed regional unemployment rates in Spain between 1978 and 2018 through a recently developed dynamic spatial econometric model with common factors and found that some regions are more sensitive than others to the economic cycle. The results seem to show that in Spain, the sensitivity to the economic cycle displays a geographical pattern where the most sensitive regions are those located on the Mediterranean coast. Specifically, we find that the sensitivity to the economic cycle of unemployment is not determined by the fact that regions have high or low unemployment; it seems that geographical location plays an important role. These results can be useful for the national and regional governments when they implement countercyclical policies.

Keywords Cyclical sensitivity · Regional unemployment · Spatial dependence · Common factor · Spain

JEL Classification C21 · E24 · E32 · R23

✉ Alejandro Almeida
alejandro.almeida@unir.net

Extended author information available on the last page of the article

1 Introduction

Many studies since the 1960s have researched the topic of the cyclical sensitivity of the unemployment rate. In the beginning, this literature paid attention to the common component, which is dominant in explaining movements in regional unemployment rates (Martin 1997). The idea to link the regional to the national unemployment rate and to estimate this relationship for each individual region dates back to Thirlwall (1966) and Brechling (1967), in what is known as the regional cyclical sensitivity literature. Recently, Vega and Elhorst (2016) bring the cyclical sensitivity literature back to the analysis of regional disparities by considering in their methodology serial dynamics, spatial dependence and common factors. Traditionally, dynamic panel data models only accounts for spatial dependence (also called weak spatial dependence) which is an observed correlation across space because of local interactions between regions generating spill-over effects. This new model also allows to account for common factors (also known as strong spatial dependence) that is an observed correlation across space as a result of shared factors such as aggregated economic fluctuations, where outcomes change together as these factors change. This modeling opens a new line of interest for analyzing unemployment among regions considering the presence of common factor and ensuring, that way, unbiased results.

Briefly, the literature on regional unemployment disparities identifies four stylized facts that defines regional unemployment disparities: (1) regional unemployment rates are strongly correlated over time, (2) regional unemployment rate behaves in parallel to the national unemployment rate, (3) are correlated across space and (4) display heterogeneity among regions.

Focusing on Spain, there are large differences in the unemployment rate among regions (Bande et al. 2008; Cuéllar-Martín et al. 2019) becoming more persistent over time, and bigger after the last economic crisis (Jimeno and Bentolila 1998; Albulescu and Tiwari 2018). So that, it is necessary to pay attention to these differences and address them in terms of cyclical sensitivity. Thus, analyzing regional unemployment rate disparities, the dependence between different regions and the relation to the national rate simultaneously is a requirement to implement appropriate policies. The last economic recession in Spain after 2009, reinforced this need, so that many studies had focused on analyzing the regional disparity in unemployment rates since that economic crisis. Nowadays, this necessity reappears due to the dramatic effects produced in the Spanish economy and its labor market because of the COVID-19 pandemic (McKibbin and Fernando 2020).

In this line, one of the articles that has focused on the analysis of the reactions of regional unemployment to changes in the economic cycle for Spain is Bande et al. (2008). This paper concludes that there is a positive relationship between the regional dispersion of unemployment and the economic cycle, which guarantees that fluctuations in the economic situation of the country directly affect to regional unemployment. Since that study, many papers have focused on analyzing the reason for these disparities, assuming that unemployment is sensitive to the economic cycle. For example, a group of papers make the analysis of regional

cyclical sensibility based on dividing regions with high and low unemployment (Bande and Karanassou 2009; Sala and Trivín 2014). Other block of researches focuses on doing spatial analyses of unemployment disparities to find clusters of similar behaviors (Cuéllar-Martín et al. 2019). Finally, some papers have focused on looking for regional characteristics that motivate regional differences (López-Bazo and Motellón 2013; Melguizo 2017).

However, none of the articles have analyzed trends of regional unemployment while simultaneously considering that regional unemployment rates are persistent, heterogeneous, parallel to the national rate and spatially dependent. According to Vega and Elhorst (2016), isolated analysis can potentially lead to biased results, since series dynamics, spatial dependence and common factors are more likely to be interdependent. To the best of our knowledge, this paper is the first to simultaneously analyze, for the Spanish case, the persistence, heterogeneity, spatial dependence and heterogeneity in economic cycle sensitivity of regional unemployment.

The main objective of this work is to provide new evidence about how Spanish regions react to economic fluctuations as a requirement to implement appropriate policies. The economic and labor implication due to public and private containment measures against the COVID-19 pandemic, such as school, shops and factory closures, travel restrictions and quarantines, with the corresponding cut in domestic demand, (Baldwin and Tomiura 2020) make this knowledge to be crucial. As a result, heterogeneous behaviors will reveal the necessity to introduce regional perspectives against future economic fluctuations.

Our paper contribute to the literature as follow. As the main contribution, we use Vega and Elhorst (2016) methodology to simultaneously consider all components of the stylized fact that defines the disparities in regional unemployment rates. Another contribution is that we show evidence that sensitivity has a geographic pattern since we find that the regions located on the Mediterranean coast are the most sensitive and that as we go inland and northwest, this sensitivity decreases. This pattern reveals, moreover, that regions with higher unemployment rates are not the most sensitive. Our results are in line with the new side of the literature indicating that the regional-specific unemployment rate is not important at all in the unemployment trend but that geographical factors do matter (Cuéllar-Martín et al. 2019). In this vein, Camacho et al. (2018) also find a geographical pattern in the propagation of economic crisis and the way the unemployment rate reacts to recessions.

Fig. 1 Regional and national unemployment rate

2 Data and method

2.1 Data

The data used in this work, extracted from de la Fuente (2019),¹ are the annual unemployment rates for the 15 autonomous communities of Spain from 1978 to 2018 and the annual Spanish unemployment rate, treated as a common factor following Bailey et al. (2016).²

Regional unemployment rates tend to have some specific characteristics. In particular, many works have found that regional unemployment is characterized by being correlated in time, in space and with the national rate.

Figure 1 shows the evolution over time of regional unemployment rates for the 15 autonomous communities of Spain analyzed together with the national rate. This figure shows how, in general, the regional and national unemployment rates

¹ We replicate the results by using the data set most used by specialists in the Spanish labor market (Spanish Statistical Office). However, in 2002, the Spanish Statistical Office survey changed its methodology to measure unemployment rate which have consequences on the estimates. Nevertheless results are similar and are available upon request.

² The Balearic Islands, Canary Islands and Ceuta and Melilla have been extracted from the sample since these areas are treated as islands, as is usual in the spatial econometric literature to avoid complete zero problems in the contiguity matrix (we adopt this matrix since it outperforms other specifications to which we come back later).

Fig. 2 Spatial distribution of unemployment over time. Dark colors for high unemployment rates

have a similar trend throughout the analyzed period. Some special situations can be observed where, despite behaving similarly to the national rate, the regional rate is always higher than the national unemployment rate, as in the case in Andalucía or Extremadura. On the other hand, La Rioja and Navarra always seem to stay below the national rate.

In addition, this unemployment rate is relatively stable over time, except in different periods of economic growth and downturns. Specifically, three major economic crises can be distinguished in Spain (Cancelo 2004; Gadea et al. 2012; Camacho et al. 2018): the first in 1983–1985, the second in 1991–1994 and the third and most recent in 2008–2014. Several conclusions can be drawn by observing Fig. 1. First, all crises seem to have a strong national component, since regional rates fluctuate similarly to the national rate. Second, there is clear heterogeneity in the trends

of regions. For example, during the pronounced crisis of 2008–2014, the highest rate of the regions in Spain was in Andalucia at 35.65%, and the lowest was in Pais Vasco at 9.79%.

To analyze the spatial distribution of unemployment rates and to determine the possible correlation in space, Fig. 2 maps unemployment rates over the period analyzed every eight years (1978, 1986, 1994, 2002, 2010 and 2018). A clear north/south contrast that has been accentuated in recent years, in addition, shows a pattern of spatial correlation, where neighboring regions have similar rates. To test that space matters in our case study, we have estimated global spatial autocorrelation through the Moran's I statistic from 1978 to 2018. The results of these tests show that, for most of the years, the null hypothesis (absence of global spatial autocorrelation) is rejected.³⁴

2.2 Method

Our methodological strategy involves the application of the recently developed model by Vega and Elhorst (2016), which simultaneously accounts for serial dynamics, spatial dependence and common factors; their study also shows how not simultaneously including these effects for the regional unemployment rate can produce biased results.

We use the CD test (Pesaran 2004) in its local version (Moscone and Tosetti 2009, eq.22) to test for the presence of cross-sectional dependence in our panel data. If the null hypothesis is rejected, we can corroborate the existence of cross-sectional dependence. This test is carried out by specifying the relationship matrix of the 15 Spanish regions (W). The result of this test applied to the data shows the presence of cross-sectional dependence in regional unemployment rates ($Z = 29.987$ with p value = 0.000). This outcome is highly statistically significant, indicating that cross-sectional dependence needs to be accounted for.

For this purpose, we have used a row-normalized binary contiguity matrix, which is an $N \times N$ matrix describing the arrangement of the regions in space, with 1 if two regions are neighbors and 0 if not. We use this alternative based on the empirical results explained in Vega and Elhorst (2014) and Elhorst (2017) where they find that this specification outperforms the other alternatives. We tried first and second order binary contiguity matrix. However, second order binary contiguity seems not to reflect well the relations between the Spanish regions since having 15 regions the average number of links in each region is 8.667. This result implies that, for example, Andalusia, a region located in the far south of Spain, would have spillovers with Aragon located in the far north of Spain.

³ Only for years 1979–1985 and 2009–2016 the null hypothesis cannot be rejected. It is interesting that these years match approximately with two periods of the Spanish economics crisis which have been detected by several authors.

⁴ A panel data unit root test have been also estimated finding that regional unemployment rate are stationary.

On the other hand, to determine if the nature of this spatial dependence is weak or strong (in other words, if it is due or not to the presence of common factors), we apply the α -test exponent of Bailey et al. (2016).⁵ This test can take values between 0 and 1, where values below 0.5 indicate the presence of weak spatial dependence and values equal to 1 indicate the presence of strong spatial dependence. The result of this test applied to the data gives $\alpha = 1.003$ ⁶ and std. err. = 0.034 which points to the presence of strong spatial dependence, common factors needs to be accounted for.

Our target model is the one proposed by Vega and Elhorst (2016) that reads as follows:

$$U_t = \tau U_{t-1} + \delta WU_t + \eta WU_{t-1} + \Gamma_1 U_t^n + \Gamma_2 U_{t-1}^n + \mu + \epsilon_t \quad (1)$$

where U_t is a column vector with one observation of the dependent variable (unemployment) for every unit (i) at every point at time (t). U_{t-1} , WU_t and WU_{t-1} are vectors of temporal, spatial and spatiotemporal lags, respectively, with τ , δ and η autoregressive coefficients. W is the row-normalized binary contiguity matrix. U_t^n and U_{t-1}^n are the unemployment rates of the whole country at times t and $t - 1$, and Γ_1 and Γ_2 column vectors with unit-specified coefficients of response to the common factors. μ represent the spatial fixed effect added to the model and ϵ_t is the $N \times 1$ vector independently and identically distributed error term with zero mean and constant variance σ^2 . The parameter of the region's sensitivity to the economic cycle (γ) can be estimated by dividing the elements of Γ_1 by $1 - \delta$ or by dividing the elements of Γ_2 by $-\tau - \eta$.

This model allows us to simultaneously measure the four remarkable stylized facts that often arise from analyzing the evolution of regional unemployment rates. First, the presence of time correlation of the regional unemployment rates by incorporating the regional unemployment rate lagged in time as well as in time and space and the common factor (the national unemployment rate) lagged in time. Second, the model allows us to account for the presence of spatial dependence by adding the spatial lag and the spatiotemporal lag. Third this model includes the common factor and its lag in time, which allows for the estimation of an individual sensitivity parameter for each region and fourth we include spatial fixed effects which allow us to account for spatial heterogeneity.

⁵ A xtscse2 stata routine have been used (Ditzen 2019)

⁶ Values above the upper bound of the interval (0,1] may occur when not all the asymptotic properties are fully met (Bailey et al. 2016). However, since the hypothesis $\alpha = 1$ cannot be rejected we can conclude that α estimated lies within the interval. Similar results can be also found in Vega and Elhorst (2016).

Table 1 Dynamic spatial panel data models

Models		
	(A)	(B)
τ	0.891 (0.019)	0.929 (0.021)
δ	0.825 (0.019)	0.165(0.062)
η	- 0.739 (0.026)	-0.131(0.054)
Time-period fixed effects	No	No
Regional fixed effects	Yes	Yes
Common factors	No	Yes
$CorrR^2$	0.834	0.970
Log-likelihood	-873.419	-714.377
CD_{local} [p value]	- 0.838 [0.402]	1.196 [0.232]
α test (standard error)	0.920 (0.048)	0.255 (0.055)

Standard errors are reported in parentheses

3 Results

We begin by estimating the basic dynamic spatial panel data model with regional fixed effects and without including common factors (model A), and we apply both tests (CD local test and α test) to the residuals of the model. These results are shown in Table 1, column A, where it can be seen that the residuals of the model continue to point to the presence of strong spatial dependence, with $\alpha = 0.920$ and std.err. = 0.048. However, the local CD test points to the fact that weak spatial dependence is no longer present ($Z = -0.838$ and p value = 0.402), because the null hypothesis of spatial independence between neighboring regions cannot be rejected. Results shows a highly and very significant temporal, spatial and spatiotemporal lag ($\tau = 0.891$, $\delta = 0.825$ and $\eta = -0.739$).

Next, we estimate the model proposed by Vega and Elhorst (2016) incorporating common factors (model B).⁷ Through this model, it seems that both the local spatial dependence ($Z = 1.196$, p value = 0.232) and the presence of common factors ($\alpha = 0.255$, std.err. = 0.055) appear to have been effectively covered.⁸ As seen in column B, the serially lagged unemployment rate ($\tau = 0.929$) is highly significant, reflecting the strong correlation of unemployment rates over time. In addition, the spatially lagged coefficient ($\delta = 0.165$) is positive and significant, reflecting the presence of spatial dependence between regions, and the lagged spatial autoregressive coefficient seems to be significant and negative.

⁷ We have also estimated the two-stage approach developed by Bailey et al. (2016). An LR test comparing both models shows that the simultaneous model fits the data better and the Brechling-Thirwall type of cyclical sensitivity estimated seems to show long-lasting problems (Brechling 1967; Domazlicky 1980) where regions with estimates greater than one are those with unemployment rates persistently higher than national average.

⁸ The model also seems to be stationary and stable since $\tau + \delta + \eta < 1$

Table 2 Common factors

Regions	Γ_1	Γ_2	$\gamma_1 = \Gamma_1/(1 - \delta)$	$\gamma_2 = \Gamma_2/(-\tau - \eta)$
Andalucia	1.051 (0.090)	− 0.960 (0.104)	1.258 (0.084)	1.205 (0.085)
Aragon	0.737 (0.084)	− 0.717 (0.088)	0.883 (0.084)	0.900 (0.084)
Cantabria	0.778 (0.084)	− 0.680 (0.091)	0.932 (0.085)	0.853 (0.085)
Castilla-La Mancha	0.916 (0.086)	− 0.834 (0.095)	1.097 (0.084)	1.047 (0.084)
Castilla y Leon	0.655 (0.084)	− 0.610 (0.091)	0.785 (0.084)	0.766 (0.085)
Cataluña	0.880 (0.087)	− 0.887 (0.090)	1.054 (0.084)	1.114 (0.085)
Madrid	0.640 (0.084)	− 0.623 (0.090)	0.767 (0.084)	0.782 (0.086)
Navarra	0.550 (0.080)	− 0.556 (0.083)	0.659 (0.084)	0.698 (0.084)
Comunidad Valenciana	0.995 (0.087)	− 0.993 (0.092)	1.192 (0.085)	1.246 (0.086)
Extremadura	0.928 (0.091)	− 0.811 (0.102)	1.112 (0.085)	1.018 (0.085)
Galicia	0.630 (0.085)	− 0.550 (0.095)	0.756 (0.085)	0.690 (0.086)
La Rioja	0.661 (0.079)	− 0.654 (0.083)	0.792 (0.084)	0.820 (0.084)
Pais Vasco	0.627 (0.082)	− 0.615 (0.085)	0.752 (0.084)	0.772 (0.084)
Asturias	0.743 (0.084)	− 0.666 (0.093)	0.890 (0.086)	0.836 (0.085)
Region de Murcia	0.900 (0.090)	− 0.891 (0.098)	1.079 (0.084)	1.118 (0.084)

Standard errors are reported in parentheses

Fig. 3 Sensitivity to economic cycle

Model B seems to have perfectly covered the presence of spatial dependence and common factors based on the results provided by the test. By introducing common factors, the model correctly cover the difference between spatial dependence and common factors. The δ and η could have been overestimated in model A due to the absence of common factors.⁹ Another way to account for the presence of common factors would have been to add a time-period fixed effects to the model too.

⁹ Note that model A is measuring both types of cross-sectional dependence (spatial dependence and common factors) through δ and η parameters. When we appropriately include common factors to the model (model B), these parameters reduce their magnitude dramatically as expected.

However, this would be similar to the inclusion of common factors at time t with the unit-specific coefficients replaced by a time dummy with a common coefficient.¹⁰

In Table 2, we show the result of the coefficients of response to the national unemployment rate estimated for each of the regions (Γ). Both coefficients (Γ_1 in t and Γ_2 in $t-1$) are highly significant. The estimation of the economic cycle sensitivity parameters is shown in the last two columns (γ_1, γ_2).¹¹

The regions most sensitive to the economic cycle appear to be Comunidad Valenciana, Andalucía, Region de Murcia and Cataluña, each with parameters greater than 1.100. It seems that regions located on the Mediterranean coast share a common pattern. These communities are characterized by being the most touristic in Spain, which may be a possible explanation. Among the least sensitive communities, we find Galicia, Navarra and Castilla y Leon, each with parameters below 0.700.

To show the spatial distribution of the sensitivity of the regions, Fig. 3 shows in four shades of gray the intensity of the economic cycle sensitivity of each region (γ_2).¹² It seems that Spain has a specific sensitivity pattern where the most sensitive regions are those located on the Mediterranean coast and sensitivity decreases as we move inland to the northwest. Particularly, the economic cycle sensitivity of the regions in Spain can be divided into four groups, from the most sensitive (in darker colors) to the least sensitive (in lighter colors). The first includes the four regions most sensitive to the economic cycle of Spain, which are also those located on the Mediterranean coast (Andalucía, Region de Murcia, Comunidad Valenciana and Barcelona). The second group, formed by Extremadura and Castilla-La Mancha, are also regions that are sensitive to the economic cycle, although less so than the previous group; this second group is composed of regions located in the southern interior and neighboring the most sensitive regions. The third group is formed by regions that are not sensitive to the economic cycle and that are located in the northern interior of Spain, away from the most sensitive regions. Finally, the fourth group is formed by the least sensitive regions of Spain, Galicia and Navarra.

These results seem to point to the fact that when crises and recoveries appear, the regions located on the Mediterranean coast are the ones most affected because they are the most sensitive.

4 Conclusion

In recent years, there has been a growing interest among academics, practitioners and policy makers in finding a pattern in Spanish regional unemployment trends. This interest emerges from the need to know how unemployment in each region

¹⁰ Results of this model (with log-likelihood function value of -753.298) are quite similar with parameter $\tau = 0.896$ (std. err. = 0.018), $\delta = 0.230$ (std. err. = 0.046) and $\eta = -0.179$ (std. err. = 0.051)

¹¹ We calculate the parameters according to the procedure proposed in Vega and Elhorst (2016). The standard errors are calculated using formulas for the sum and quotient of random variables (Mood et al. 1974, pg. 178–181).

¹² We map parameter γ_2 since it is based on the relative strength of both internal and external habit of persistence (Korniotis 2010).

will react ahead of the increasingly common occurrence of recession phases. In this context, the literature documents that unemployment is persistent, heterogeneous, spatially dependent and parallel to the national rate, but these effects have never been analyzed simultaneously.

In our paper, by applying the methodology proposed by Vega and Elhorst (2016), the persistence, heterogeneity, spatial dependence and economic cycle sensitivity of Spanish regional unemployment are analyzed simultaneously. Furthermore, this methodology allows us to estimate heterogeneous coefficients of response to aggregate fluctuations. The findings show that there is a high persistence of unemployment in Spain, that there is spatial dependence and that regions show different sensitivities to the economic cycle. Although the first findings are in line with the previous literature, the main contribution of this article is to uncover the geographical pattern of sensitivity to the economic cycle. We find that the economic cycle sensitivity of unemployment is not determined by the fact that regions have high or low unemployment; it seems that geographical location plays an important role. Specifically, the regions that have greater economic cycle sensitivity are located on the Mediterranean coast and include regions with very different unemployment rates. However, what these regions do have in common is that they are areas very focused on the tourism sector, which can be taken as a possible explanation. The findings are related to Melguizo (2017) who shows that regions with a more developed service sector suffer more variations in unemployment rates, and to Camacho et al. (2018) who find a similar pattern in how crises and recoveries begin and end in Spain.

Both findings are in line with the regional heterogeneity we observe, since they reveal that some regions suffer more from the effects of business cycle whereas other regions are less affected by economic contingencies. Consequently, the application of national inflexible policies may difficult actions devoted to smooth cyclical swing of regional economic activity. Therefore, that, as main find, we consider that this regional behaviour is indicating the necessity to apply differentiated employment policies when national economy face a crisis. Nowadays, this find become into a crucial due to the employment destruction our regions are suffering because of the economic and labour impact caused by the restrictive measures against the COVID-19 pandemic.

On the one hand, with the pattern in the trend of regional economic cycle sensitivity that this paper finds, the national government can distribute resources in an efficient way to react to future recessions or to recoveries from past crises. On the other hand, regional policies can be adapted to each geographical area depending on its sensitivity, and regional cooperation is needed since spatial dependence points to the presence of possible spillovers.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

- Albulescu, C.T., Tiwari, A.K.: Unemployment persistence in EU countries: new evidence using bounded unit root tests. *Appl. Econ. Lett.* **25**(12), 807–810 (2018)
- Bailey, N., Holly, S., Pesaran, M.H.: A two-stage approach to spatio-temporal analysis with strong and weak cross-sectional dependence. *J. Appl. Econom.* **31**(1), 249–280 (2016)
- Baldwin, R., Tomiura, E.: Thinking ahead about the trade impact of COVID-19. In: *Economics in the Time of COVID-19*, p. 59 (2020)
- Bande, R., Fernández, M., Montuenga, V.: Regional unemployment in Spain: disparities, business cycle and wage setting. *Labour Econ.* **15**(5), 885–914 (2008)
- Bande, R., Karanassou, M.: Labour market flexibility and regional unemployment rate dynamics: Spain 1980–1995. *Pap. Reg. Sci.* **88**(1), 181–207 (2009)
- Brechling, F.: Trends and cycles in British regional unemployment. *Oxf. Econ. Pap.* **19**(1), 1–21 (1967)
- Camacho, M., Páccce, M., Ariza, C.U.: Regional business cycle phases in Spain. *Estud. Econ. Apl.* **36**(3), 857–896 (2018)
- Cancelo, J.R.: El ciclo del empleo en España: un análisis regional. *Cim. Econ.* **4**, 107–138 (2004)
- Cuellar-Martín, J., Martín-Román, Á.L., Moral, A.: An empirical analysis of natural and cyclical unemployment at the provincial level in Spain. *Appl. Spat. Anal. Policy* **12**(3), 647–696 (2019)
- de la Fuente, A.: Series largas de algunos agregados económicos y demográficos regionales: Actualización de RegData hasta 2018. (RegData y RegData Dem versión 5.0-2018). FEDEA, Estudios sobre Economía Española no. 2019-19, Madrid (2019)
- Ditzen, J.: Xtcse2: Sata Module to Estimate the Exponent of Cross-Sectional Dependence in Large Panels. Boston College Department of Economics, Boston (2019)
- Domazlicky, B.R.: Regional business cycles: a survey. *J. Reg. Anal. Policy* **10**(1100–2016–89839), 15–34 (1980)
- Elhorst, J.P.: Spatial panel data analysis. *Encycl. GIS* **2**, 2050–2058 (2017)
- Gadea, M.D., Gómez-Loscos, A., Montañés, A.: Cycles inside cycles: Spanish regional aggregation. *SERIEs* **3**(4), 423–456 (2012)
- Jimeno, J.F., Bentolila, S.: Regional unemployment persistence (Spain, 1976–1994). *Labour Econ.* **5**(1), 25–51 (1998)
- Korniotis, G.M.: Estimating panel models with internal and external habit formation. *J. Bus. Econ. Stat.* **28**(1), 145–158 (2010)
- López-Bazo, E., Motellón, E.: The regional distribution of unemployment: what do micro-data tell us? *Pap. Reg. Sci.* **92**(2), 383–405 (2013)
- Martin, R.: Regional unemployment disparities and their dynamics. *Reg. Stud.* **31**(3), 237–252 (1997)
- McKibbin, W.J., Fernando, R.: The global macroeconomic impacts of COVID-19: seven scenarios. CAMA working paper (2020)
- Melguizo, C.: An analysis of Okun's law for the Spanish provinces. *Revi. Reg. Res.* **37**(1), 59–90 (2017)
- Mood, A., Graybill, F., Boes, D.: *Introduction to the Theory of Statistics*. McGraw & Hill, New York (1974)
- Moscone, F., Tosetti, E.: A review and comparison of tests of cross-section independence in panels. *J. Econ. Surv.* **23**(3), 528–561 (2009)
- Pesaran, M.H.: General diagnostic tests for cross-sectional dependence in panels. *Empir Econ* (2004). <https://doi.org/10.1007/s00181-020-01875-7>
- Sala, H., Trivín, P.: Labour market dynamics in Spanish regions: evaluating asymmetries in troublesome times. *SERIEs* **5**(2–3), 197–221 (2014)
- Thirlwall, A.P.: Regional unemployment as a cyclical phenomenon 1. *Scott. J. Polit. Econ.* **13**(2), 205–219 (1966)
- Vega, S.H., Elhorst, J.P.: Modelling regional labour market dynamics in space and time. *Pap. Reg. Sci.* **93**(4), 819–841 (2014)
- Vega, S.H., Elhorst, J.P.: A regional unemployment model simultaneously accounting for serial dynamics, spatial dependence and common factors. *Reg. Sci. Urban Econ.* **60**, 85–95 (2016)

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Affiliations

Alejandro Almeida¹ · **Aida Galiano¹** · **Antonio A. Golpe²** · **Juan M. Martín¹**

Aida Galiano
aida.galiano@unir.net

Antonio A. Golpe
antonio.golpe@dehie.uhu.es

Juan M. Martín
juanmanuel.martin@unir.net

¹ Department of Quantitative Analysis, International University of La Rioja, Avda. de la Paz, 137, 26004 Logroño, Spain

² Department of Economics y Centro de Estudios Avanzados en Física, Matemáticas y Computación, University of Huelva, Plaza de la Merced, 11, 21002 Huelva, Spain