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The Role of Spillovers in Okun's Law: Empirical Evidence from Spain

Summary: The Great Recession of the late 2000s has brought to the fore, once again, the relevance of the relationship between output performance and labour market developments all over the world. This paper analyses the validity of Okun's law in Spain by using regional data from 2000 to 2014, which roughly encompasses a complete business cycle. By estimating a Spatial Panel Durbin Model, the results not only show that a robust, inverse relationship between unemployment and output holds for Spain but also the existence of regional spillovers (indirect effects). In addition, they reveal that there are no time asymmetries between the expansion and recession phases of the business cycle and that human capital, the share of the construction sector, and the share of temporary workers are key factors in explaining unemployment changes. From a policy perspective, our findings support the idea of implementing region-specific policies, since indirect effects are less relevant than direct ones. In any case, national policies would also be effective. These policies, whatever their scope, should be mainly supply-side oriented in expansions (largely labour market policies) and demand-side focused in contractions.

Keywords: Unemployment, Output, Spanish regions, Spatial econometrics.

JEL: R11, R15.

Due to the Stabilization Plan launched in 1959 to increase its competitiveness, the Spanish economy abandoned protectionism and public intervention in favour of a more market-oriented economy. Then, Spain opened up to the rest of the world and engaged in some key structural reforms that gave way to what later came to be known as the "Spanish economic miracle". The labour market, however, was left out of these positive transformations, so it is no wonder that the Spanish economy has experienced continuous trouble in its management. Factors such as inefficient labour market institutions, wage rigidity, employment inertia, and a peculiar labour force dynamics could help to explain it. Either way, this fact is mainly shown in two respects. First, it shows in the fact that the national unemployment rate has been traditionally very high (more than 20% from 2011 to 2015, with a peak over 26% in 2013), even in boom times (over 8% in the mid-00s). The second respect is that disparities in regional unemployment rates have always been very large, especially in recessions (e.g. Andalucía registers, as a rule, unemployment rates being about twice as high as those of the País Vasco; as a way of illustration, unemployment rates for Andalucía and País Vasco in 2014 were, respectively, 34.8% and 16.3%).

Both problems point to the link between the level of economic activity and labour market developments, commonly referred to as Okun's law. Due to the recent and deep economic crisis, not just academics but also Spanish policy-makers have shown a keen interest in better understanding this relationship. This is because, as Francisco Carballo-Cruz (2011) pointed out, unemployment is one of the main factors that has delayed economic recovery in Spain after the economic downturn.

This paper has two main, closely related aims. The first one is to analyse the validity of Okun's law in Spain, using regional data, between 2000 and 2014 and, if so, the stability or not of Okun's coefficient over time; the period under study is chosen to cover roughly a complete business cycle. The second aim, this being the main contribution of the paper, is to estimate the extent of regional spillovers by using spatial panel data econometric techniques. We do so given that, when it comes to deciding the nature of policies addressed to improve labour market outcomes, an understanding of the relationship between output and unemployment and of the presence of regional spillovers will be helpful.

The remainder of the paper is organised as follows. Section 1 offers a short review of Okun's law research that uses regional data, highlighting the main contributions of this paper to the existing literature. Section 2, along with some descriptive tables included in the Appendix, describes the data used, whereas Section 3 specifies the model. Section 4 estimates the model and performs various robustness tests. Finally, Section 5 concludes the paper and, based on its findings, offers some policy recommendations.

1. Okun's Law at the Regional Level: A Short Literature Review

Okun's law refers to the existence of an inverse relationship between output fluctuations and unemployment rate changes (Arthur M. Okun 1962). It is important to note that, although Robert J. Gordon (1984) and Martin F. J. Prachowny (1993) tried to provide some theoretical underpinnings for this law based on a Keynesian perspective and the use of a production function, the fact remains that it lacks a strong theoretical basis. Therefore, most researchers consider it more a rule of thumb than a true economic law. Whatever the case, there is no doubt that it is widely used in economic-policy debates.

Its original formulation, for the US case and the middle of the 20^{th} century, holds that for every percentage point decline in real output the unemployment rate increases by 0.3 percentage points. Additional empirical evidence for different countries and periods, however, has shown that Okun's coefficient varies significantly across space and over time (see the meta-analysis developed by Roger Perman, Stephan Gaetan, and Christophe Tavéra 2015). Subsequently, the use of new methodological tools revealed that the value of the coefficient also depends on the estimation method employed (Perman, Gaetan, and Tavéra 2015).

It is also important to highlight that in his original contribution Okun did not pay any heed to the direction of causality although it is obvious that, depending on the issue at hand, it can be analysed one way or another. In other words, it can be interpreted, as in the Okun's rule of thumb, as a labour demand function (from output to employment), but it can also be interpreted as reflecting a production function (the causality running from employment to output). In any case, and regardless of causality, Okun stated that there are two possible specifications of the law: the first-differences model and the gap model (for a short review, see José Villaverde and Adolfo Maza 2009).

Although research regarding Okun's law has evolved in different directions, one of the most interesting is related to the use of data at the regional instead of the national level. This is important because as it happens mostly in some South European countries that have been hit hardest by the crisis (such as Greece, Italy and Spain), there are large and rather persistent regional disparities in unemployment rates, which clearly point to structural differences (industry mix, for example) among them. Hence, there is a bunch of papers that, adopting a regional perspective, test the validity or non-validity of Okun's law in many different respects and settings. Among them, the papers by these authors stand out: Donald G. Freeman 2000 (assessing the situation of the US over the period 1977-1997); Dimitris K. Christopoulos 2004 (Greece, 1971-1993); Kwami Adanu 2005 (Canada, 1981-2001); Aki Kangasharju, Tavéra, and Peter Nijkamp 2012 (Finland, 1976-2006); Richard Durech et al. 2014 (Czech Republic and Slovakia, 1995-2011); Silvia Palombi, Robert Perman, and Tavéra 2015 (the UK, 1970-2002); Amy Y. Guisinger et al. 2018 (the US, 1977-2012).

Regarding our case study, the importance of using regional data turns out to be evident. It not only happens that the business cycle is not the same in all Spanish regions (e.g., there are remarkable differences between Madrid and Baleares or between Extremadura and País Vasco) but also that differences in output growth rates are, quite often, huge (we refer the reader to Roberto Bande and Ángel L. Martín-Román 2018, for further discussion)[1]. Consequently, it happens that the response of unemployment to output changes (captured by Okun's coefficient) varies a lot from one region to another (Villaverde and Maza 2009; Miquel Clar-López, Jordi López-Tamayo, and Raúl Ramos 2014; Celia Melguizo 2017), which reflects that the sensitivity of unemployment to output depends on the region. This is the main reason that, in Section 4 of this paper, a robustness check based on the inclusion of control variables to take into account the idiosyncrasies of each region is carried out.

However, and in spite of the methodological advances previously mentioned, there is a point in the analysis of Okun's law at regional level that has been fully neglected: none of the contributions already mentioned pays much attention to the importance of regional interactions and spillovers. To put it differently, none of these studies seems to be concerned about the fact that what happens in one region can significantly affect other regions and *vice versa*. This is precisely the main contribution of this paper, as the methodology used addresses the potential existence of spillover effects, and the results demonstrate that these effects are instrumental when it comes to assessing the validity of Okun's law.

Some of the reasons for including these spatial spillover effects are the existence of metropolitan areas of different regions with common labour markets and the

[1] In a nutshell, Bande and Martín-Román (2018) use the Hodrick-Prescott filter (HP) and the Quadratic Trend (QT) approach to obtain estimates for the output and unemployment cyclical components. The results "unveil a clear negative relationship between output and unemployment gaps, even though with notorious regional differences in the intensity of such relationship" (Bande and Martín-Román 2018, p. 146).

presence of congestion effects (see James LeSage and R. Kelley Pace 2009). Other reasons, which may also cause the reaction of one region to developments in another, are the sharing of similar demographic characteristics, as well as unobserved or latent common properties across neighbouring regions.

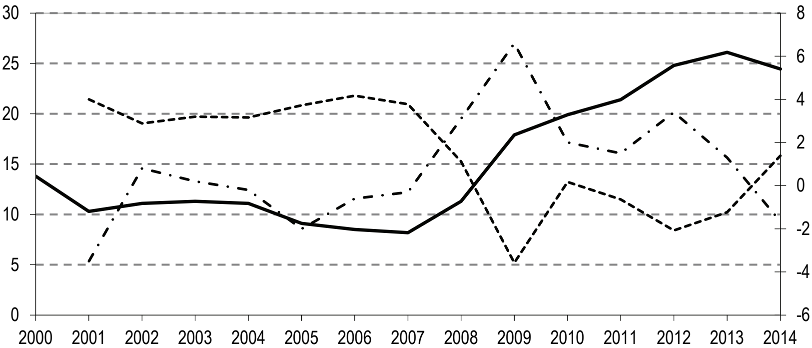
What is clear is that, whatever the source, the presence of spillover effects can have remarkable consequences on the results obtained about the validity of Okun's law and the value of its coefficient. Indeed, and as indicated in a more general context, failure to account for spatial dependence in the relevant variables "*can lead to inconsistent estimates of the regression parameters for models with spatially lagged dependent variables, inconsistent estimation of the spatial parameters, and inconsistent estimation of standard errors*" (LeSage and Pace 2009, p. 60); therefore, policy recommendations directly drawn from this type of analysis can be seriously flawed. As a result, and to make more accurate policy proposals, the standard specification of Okun's law needs to be extended to address spatial dependence, this likely being the latest challenge for researchers.

To accomplish this aim, there are two different approaches: on the one hand, modelling spatial dependence by employing spatial econometric techniques; on the other, dealing with the presence of spatial effects using a filtering procedure. Although the second one has been used to deal with different topics (see e.g. Anna Iara and Iulia Traistaru 2004; Maza and Villaverde 2009a, b; Roberto Patuelli et al. 2012), recent advances in spatial econometrics have enhanced the reliability of the first approach so we employ it in this paper. To the best of our knowledge, however, just a few recent papers (Christian Oberst and Jens Oelgemöller 2013; Casto M. Montero Kuscevic 2014; Rui M. Pereira 2014; Arabinda Basistha and Montero Kuscevic 2017; Palombi, Perman, and Tavéra 2017) have explicitly analysed Okun's law by using spatial panel data models, and none of them studied the Spanish case. Anyway, as all these papers reveal the importance of spatial spillovers, here we not only apply this approach to the Spanish case but also try to enrich it. Specifically, we do not use point estimates but the so-called direct, indirect and total effects. Additionally, we run a battery of robustness tests.

2. Data Description

In the paper, we use annual Spanish regional data on unemployment rates and output growth. Spanish regions are equivalent to NUTS2 level of the EU regional classification for socio-economic analysis and the framing of EU regional policies. As for the time span, we consider the period 2000-2014, roughly covering a full business cycle with two clearly differentiated sub-periods: 2000-2008 for high and sustained growth, and 2008-2014 for economic crisis (although in 2014 the Spanish economy grew, the growth rate was only 1.4%; in 2015, however, it was 3.6%, so we decided not to include this year). This makes a panel data set of 255 observations. The data for unemployment comes from the Labour Force Survey (LFS) and those for real output (Gross Added Value) growth from the Spanish Regional Accounts (SRA), both provided by the Spanish National Statistics Institute (INE in the Spanish acronym).

Figure 1 shows that, as a whole, Spain presents an extremely high unemployment rate, which peaked during the recession period at nearly 26%. Figure 1 also provides a general idea of the relationship between output growth and changes in the unemployment rate at the aggregate level between 2000 and 2014. Specifically, it shows that one is the mirror image of the other. In the first years, when the output growth rate was positive and high (between 2 and 4% per year), the unemployment rate generally decreased, whereas when the rate of growth of output became negative (from 2008 onwards), changes in the unemployment rate tended to be positive, i.e. the unemployment rate increased. Put another way, what Figure 1 seems to show is that Okun's law holds for the overall Spanish economy.



Notes: *U* refers to unemployment rate while *Y* refers to output in year 2000 constant (thousand) euros; *U* in left-hand axis (bold line); Δ*U* (line) and Δ*Y* (broken line) in right-hand axis.

Source: Authors' estimation.

Figure 1 Output Growth and Changes in the Unemployment Rate in Spain

From a regional point of view, Table 1 offers some descriptive statistics for the unemployment rate and output for the whole period and its two sub-periods; pre-crisis (2000-2008) and crisis (2008-2014). By using regional data, we compute descriptive statistics (mean, standard deviation, minimum, median and maximum) every year and, then, the mean of each one for the whole period and the two sub-periods. Three results are worthy of mention. First, as indicated in the introduction, there are remarkable differences between regions with regard to unemployment rates. For the whole period, the ratios between the region with the highest and lowest rates of unemployment and the standard deviation are very high (the first is almost 4 and the second is over 4). Second, the decrease in the standard deviation between the first and second sub-periods (fourth column of Table 1) indicates that the improvement of the labour market in the first period was more heterogeneously distributed than its deterioration during the second one. Third, the opposite appears to have happened in relation to output growth. Discrepancies between output growth rates have been larger over the crisis sub-period. Although the standard deviation is slightly lower, it must be taken into account that this happens when growth rates are close to zero.

Table 1 Descriptive Statistics

Variables	Time period	Mean	Standard dev.	Min	Median	Max
U	2000-14	14.2	4.1	8.6	13.4	23.1
	2000-08	9.7	3.3	5.2	9.5	17.4
	2008-14	19.5	5.1	12.6	17.9	29.7
ΔU	2001-14	0.8	1.2	-1.6	0.7	3.2
	2000-08	-0.8	1.3	-3.3	-0.9	1.6
	2008-14	2.4	1.1	0.4	2.3	4.7
ΔY	2001-14	1.4	0.7	0.0	1.4	2.7
	2000-08	3.2	0.7	1.8	3.2	4.5
	2008-14	-0.7	0.6	-2.0	-0.7	0.6

Notes: *U* refers to unemployment rate while *Y* refers to output in year 2000 constant (thousand) euros.

Source: Authors' estimation.

Additional information at the regional level for the main variables included in the analysis is reported in Table 2 (for the control variables employed in the empirical analysis, see the Appendix). A simple look at the table confirms that the previous conclusion regarding the fulfilment of Okun's law at the country level, that is, the existence of a negative relationship between the unemployment rate changes and output growth, also seems to hold individually for each region. The case of Andalucía is valid as a reference: over the expansion period, the unemployment rate decreased by 0.8% per year and output grew by 3.4%; on the contrary, over the contraction period the first increased by 3.1% while the latter fell by 0.9% yearly.

Table 2 Main Variables: Raw Data per Region

Regions	U			ΔU			ΔY		
	2000-2014*	2000-2008*	2008-2014*	2000-2014*	2000-2008*	2008-2014*	2000-2014*	2000-2008*	2008-2014*
Andalucía	22.8	17.0	29.5	0.8	-0.8	3.1	1.5	3.4	-0.9
Aragón	10.6	6.0	16.1	0.9	0.0	2.1	1.6	3.5	-0.7
Asturias	13.8	10.3	17.5	0.3	-1.1	1.8	0.8	2.7	-1.3
Baleares	12.9	7.5	19.4	1.1	0.6	1.8	1.0	2.1	-0.2
Canarias	19.6	12.3	28.5	1.3	0.4	3.1	1.3	2.7	-0.4
Cantabria	11.9	8.9	15.1	0.4	-0.8	1.9	0.8	2.5	-1.1
Castilla y León	13.2	10.0	16.9	0.5	-0.5	2.0	1.0	2.6	-0.8
Castilla-la Mancha	15.9	9.7	23.2	1.2	-0.1	3.0	2.0	4.4	-0.6
Cataluña	13.0	8.4	18.3	0.8	0.0	2.0	1.3	3.1	-0.8
C. Valenciana	16.0	10.2	23.0	1.0	0.1	2.4	1.2	3.2	-1.2
Extremadura	20.9	16.5	25.8	0.4	-1.1	2.4	1.6	3.3	-0.3
Galicia	13.9	11.0	16.8	0.5	-0.8	2.0	1.5	3.5	-0.8
Madrid	11.4	7.6	15.9	0.5	-0.4	1.8	1.9	3.7	-0.3
Murcia	16.0	9.8	23.4	1.1	0.1	2.7	1.8	3.9	-0.5
Navarra	8.9	5.3	13.2	0.8	0.3	1.6	1.5	3.2	-0.3
País Vasco	10.7	8.5	12.8	0.3	-0.7	1.4	1.2	2.8	-0.6
Rioja	10.6	6.3	15.8	0.7	0.0	1.8	1.4	3.3	-0.7

Notes: *U* refers to unemployment rate while *Y* refers to output in year 2000 constant (thousand) euros; (*) annual average.

Source: Authors' estimation.

3. Okun's Law Specification

As mentioned before, Okun did not address the issue of causality. Given the aim of this paper, we specifically examine the response of the unemployment rate to output performance. Accordingly, we interpret Okun's law as a labour demand function in which causality runs from output to unemployment. Regarding the specification, we here adopt the first-differences model, as the gap model implies the use of potential output and the natural rate of unemployment which, being non-observable variables, need to be estimated and then verified empirically. As there is always a hot debate about the validity of these estimates, we prefer working with observable data. Thus, the simplest version of the first-differences model, for panel data, is given by the following equation:

$$\Delta U_{it} = \alpha + \beta \Delta Y_{it} + \epsilon_{it}, \tag{1}$$

where ΔU represents the percentage point change in the unemployment rate in region i at time t, ΔY is the percentage growth rate (computed as the difference in logs) of real output for the same region and period, and ϵ_{it} is the corresponding error term. In Equation (1) β is Okun's coefficient whereas (α/β) is the rate of output growth needed to keep the unemployment rate stable.

Although Equation (1) is static, it can be easily augmented to obtain a dynamic version. If we assumed, for illustration (but also because the estimates revealed this was the best option in this case), that only the previous period change in both the unemployment rate and output affect the unemployment rate in the current period, the equation would read as follows:

$$\Delta U_{it} = \alpha + \beta \Delta Y_{it} + \gamma \Delta Y_{it-1} + \delta \Delta U_{it-1} + \epsilon_{it}. \tag{2}$$

Neither Equation (1) nor Equation (2) reflects, however, the fact that the change in the unemployment rate in a region can be affected by changes in output and unemployment in neighbouring regions. Therefore, as said in the previous section, we have to extend the model to include spatial effects, for which we introduce into Equation (2) the so-called spatial distance/weight matrix (W). Following Waldo R. Tobler's (1970, p. 236) law of geography that states "*everything is related to everything else, but near things are more related than distant thin*gs", we attach a higher weight to the nearest regions than to the most distant ones. Specifically, we consider an inverse distance matrix in which any element *ij* is given by $W_{ij} = {}^{1}/_{d_{ij}}\ \forall i \neq j$, where d is the distance (in km) between the capitals of the regions i and j since they certainly are, in the majority of cases, the most dynamic cities that create the biggest part of the region's output. The matrix is row-standardized so that the elements of any row add one.

Hence, assuming there is a spatial correlation in both the dependent and independent variables as well as the error term, the unconstrained, general spatial model with random effects can be written as follows:

$$\Delta U_{it} = \alpha + \beta \Delta Y_{it} + \theta \textstyle\sum_j W_{ij} \Delta Y_{jt} + \gamma \Delta Y_{it-1} + \rho \sum_j W_{ij} \Delta U_{jt} + \delta \Delta U_{it-1} + \varepsilon_{it}, \tag{3}$$

where W_{ij} refers to the elements of the spatial weight matrix, ρ is the spatial autoregressive coefficient, θ is a vector of fixed, unknown parameters, and ε_{it} is the spatially dependent error term:

$$\varepsilon_{it} = \lambda \sum_j W_{ij} \varepsilon_{jt} + \xi_{it}, \quad \xi_{it} = \mu_i + v_{it}, \tag{4}$$

where λ is the spatial autocorrelation coefficient in the error term, and ξ_{it} is an element (innovation) that combines a time-invariant region-specific component μ_i, and a time-varying component v_{it}.

Equation (3) represents what can be considered as a General Nesting Spatial Model (GNS) – with lagged dependent and independent variables – in which both endogenous ($\sum_j W_{ij} \Delta U_{jt}$) and exogenous ($\sum_j W_{ij} \Delta Y_{jt}$) interactions plus interactions among the error terms are included. Nested in this general model are some interesting cases. In particular, if we assume $\lambda = 0$, that is, if we exclude the spatially autocorrelated error term, the model is known as the panel Spatial Durbin Model (SDM). Taking the SDM and assuming that $\theta = 0$ we have the so-called panel Spatial Autoregressive Model or Spatial Lag Model (SAR/SAM). On the other hand, if we assume that $\theta = -\rho\beta$ we obtain the panel Spatial Error Model (SEM). Finally, if we consider that $\rho = 0$ the model collapses to the panel Spatial Lag of X (SLX) model, a model with a spatial lag of the explanatory variable.

Here we adopt the SDM specification, which is the most commonly used model when it comes to evaluating Okun's law. In any case, our decision is supported by different facts. On one side, we agree and then follow J. Paul Elhorst' (2013) suggestion of excluding the spatially autocorrelated error term and only consider a model with endogenous and exogenous interactions. On the other hand, our estimates confirm that the spatial autocorrelation coefficient is not statistically different from zero. Accordingly, Okun's law equation is:

$$\Delta U_{it} = \alpha + \beta \Delta Y_{it} + \theta \sum_j W_{ij} \Delta Y_{jt} + \gamma \Delta Y_{it-1} + \rho \sum_j W_{ij} \Delta U_{jt} + \delta \Delta U_{it-1} + \epsilon_{it}. \tag{5}$$

Finally, the spatial model in Equation (5) can be extended to account for region-specific fixed effects, time effects (to control for changes at the national level), dynamic spatial effects, structural breaks (to examine the stability of Okun's coefficient over time) and control variables (Elhorst 2010b). According to the results we get from the implementation of conventional statistical tests (see below), we include regional fixed effects in the model, for which we add a term μ_i to Equation (5). As for time effects and structural breaks, in the last section of the paper we will test if the economic crisis triggered a notable change in Okun's coefficient. Concerning control variables, we will also include some of them to test for the robustness of the results.

In summary, our benchmark Okun's law model is given by the following equation:

$$\Delta U_{it} = \mu_i + \beta \Delta Y_{it} + \theta \sum_j W_{ij} \Delta Y_{jt} + \gamma \Delta Y_{it-1} + \rho \sum_j W_{ij} \Delta U_{jt} + \delta \Delta U_{it-1} + \epsilon_{it}. \tag{6}$$

This model is going to be estimated by Maximum Likelihood, an unbiased and consistent estimator for models incorporating spatial effects (Luc Anselin 1988).

Another reason supporting our choice is that, as shown below, we apply LR tests when it comes to confirming the validity of the model.

4. Baseline Model Estimation and Robustness Checks

This section consists of two parts. The first subsection explains the estimation techniques by differentiating between the ordinary point-estimates and, as a better approximation to make an inference, the new procedures for evaluating direct, indirect (i.e. spillovers) and total effects. Then we estimate the Spatial Durbin Model of Okun's law (Equation 6). Since spatial models may be quite sensitive, on the one hand, to the choice of the weighting matrix (Elhorst 2010a) and, on the other and for reasons given below, to model specification, the second subsection performs various robustness tests.

4.1 Empirical Results

4.1.1 Statistical Tests

Before the estimation of the relationship between changes in the unemployment rate and output performance for the Spanish regions, we conduct some unit root tests for these two variables to know whether they are stationary or not. First, we consider the Harris-Tzavalis (HT) (Richard D. F. Harris and Elias Tzavalis 1999), Levin-Lin-Chu (LLC) (Andrew Levin, Chien-Fu Lin, and Chia-Shang J. Chu 2002), and Breitung (B) (Jörg Breitung 2000) tests, all of which assume that the unit root process is homogenous. Second, we compute the Im-Pesaran-Shin (IPS) (Kyung S. Im, M. Hashem Pesaran, and Yongcheol Shin 2003) test, which relaxes the homogeneity assumption by allowing cross-sectional dependence in the unit root process. Table 3 shows that in all cases the null hypothesis (panels contain unit roots) is rejected at conventional levels so that all series prove to be I(0).

Table 3 Unit Root Tests

	ΔU		ΔY	
	Coef.	***p*-value**	**Coef.**	***p*-value**
LLC	-2.85**	0.002	-3.44**	0.000
HT	0.37**	0.000	0.55**	0.000
B	-6.26**	0.000	-4.86**	0.000
IPS	-2.57**	0.005	-1.70**	0.045

Notes: ** means significance at 5% level; LLC refers to the bias-adjusted *t* statistic for Levin-Lin-Chu unit root test (with 1 lag in the ADF regressions); HT refers to the rho statistic for the Harris-Tzavalis test (common AR parameter, panel means included and time trend not included); B refers to lambda statistic for Breitung unit root test (common AR parameter, panel means included and time trend not included); IPS refers to the W-t-bar statistic for Im-Pesaran-Shin unit root test (panel-specific AR parameter, panel means included and time trend not included).

Source: Authors' estimation.

We also check for the presence of regional fixed-effects on Equation (5) using the Hausman test (Jerry A. Hausman 1978). Since the previous results reject the null hypothesis that the preferred model has random effects ($\chi^2 = 42.0$ with $p - value = 0.000$), we estimate an SDM with spatial-fixed effects as in Equation (6).

Finally, some tests concerning the suitability of Equation (6) and, therefore, the reliability of the results obtained should be reported. First, we compute the corresponding conventional LR tests to see whether the SDM could be simplified into a Spatial Error Model (SEM) or a Spatial Autoregressive Model (SAR/SAM) (Elhorst 2010a). The results, reported in Table 4, confirm that these two cases can be ruled out. Regarding cross-sectional dependence and spatial dependence, we use the so-called Pesaran CD test (Pesaran 2004) and Moran's Statistic for panel data (Paul A. P. Moran 1948). The results indicate that these two problems had been properly dealt with in our estimates, as in both cases the evidence in favour of the null hypothesis (absence of cross-section dependence and spatial dependence, respectively) is strong.

Table 4 Specification Tests

	Coef.	*p*-values
LR test for spatial error model	8.70**	0.003
LR test for spatial auto-regressive model	9.23**	0.002
Pesaran cross-sectional dependence test	0.86	0.389
Spatial dependence Moran's I test	0.68	0.50

Notes: ** means significance at 5% level.

Source: Authors' estimation.

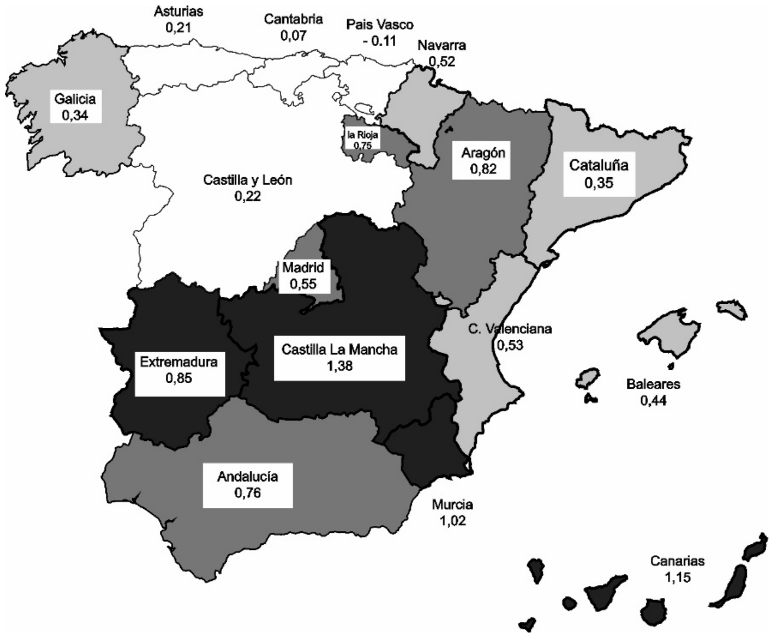
In sum, after running this battery of tests we can assert there are many important points regarding the specification of the model that have been properly addressed: stationarity, fixed effects, the "danger" of CSD and spatial dependency, etc. Although the probability of model misspecification is always present, we believe we can be confident that the results obtained are solid.

4.1.2 Point Estimates

With the foregoing explanatory remarks in mind, we first proceed to report the standard point estimates. We present them in Table 5, with the exception of those regarding fixed-effects (results shown in Figure 2). As can be seen, the β coefficient is -0.573 and highly significant, which confirms the validity of Okun's law for Spain. More specifically, it shows the existence of an intense inverse relationship between output performance and unemployment change. Regarding the inclusion of spatial effects, we find that the coefficient of the spatially lagged unemployment rate changes is positive (0.756) and statistically significant, proving the existence of strong interregional labour market linkages. The same happens with the spatially lagged output growth rate, which is also positive (0.327) and significant. This finding seems to convey the unpleasant message that the unemployment rate in one region increases when output in neighbouring regions rises. It must be pointed out, however, that if we were to take this conclusion at face value, the interpretation of the sign and then the policy advice based on it would be, as will be explained below, completely wrong.

In addition, we have to stress that the coefficients associated with temporal lags are not statistically different from zero. Accordingly, as expected, the results obtained by removing temporal lags are very similar to those shown in Table 5[2]. Anyway, following the Akaike criterion, we opted for keeping them.

[2] Results are available upon request.



Notes: Quartiles from lighter (1st quartile, lowest values) to darker (4th quartile, highest values).

Source: Authors' estimation.

Figure 2 Regional Fixed-Effects

With respect to the fixed effects not reported in Table 5, they show (Figure 2) that the difference between the regions with the highest (Castilla-La Mancha) and lowest ones (País Vasco) is 1.5 percentage points. In other words, that assuming output changes were to take place in the same direction and at the same rate everywhere, there are regions that, due to their idiosyncratic features, undergo a much worse/better evolution in their unemployment rate than others. This obviously calls for a somewhat differentiated policy response at the regional level.

Table 5 Estimation Results

Variables	Coef.	*p*-values
ΔY_{it}	-0.573**	0.000
ΔY_{it-1}	0.039	0.544
ΔU_{it-1}	-0.056	0.491
$\sum_j W_{ij} \Delta U_{jt}$	0.756**	0.000
$\sum_j W_{ij} \Delta Y_{jt}$	0.327**	0.003
R square	0.624	
Number of regions	17	
Number of years	13	

Notes: *U* refers to unemployment rate while *Y* refers to output in year 2000 constant (thousand) euros; ** means significance at 5% level.

Source: Authors' estimation.

4.1.3 Direct, Indirect and Total Effects

In any case, it is important to keep in mind that the results shown in Table 5 do not reflect what we can call "the true Okun's law". As LeSage (2008, p. 39) indicates, "*the SDM model estimates cannot be interpreted as partial derivatives in the typical regression model fashion*". The estimates in Table 5 have to be considered as a preliminary step to compute the summary measures of direct, indirect, and total effects of output changes on the change in unemployment.

The computation of these effects is quite simple; in any case, we refer the reader to LeSage and Pace (2009) for a much more detailed explanation. For any independent variable (let us take as an example the key one, ΔY_{it}) the associated matrix of effects has to be calculated. In our SDM model (Equation 6), this matrix, $S(W)$, takes the following form:

$$S(W) = V(W)(I_n\beta + W\theta), \tag{7}$$

where $V(W)$ stands for the spatial multiplier:

$$V(W) = (I_n - \rho W)^{-1}, \tag{8}$$

ρ being the spatial autoregressive coefficient, β and θ the estimated coefficients linked to the ΔY_{it} variable and its spatial lag and I_n the identity matrix (*n* = 17). Since $\rho < 1$ and the spatial matrix W is row-standardized, a "Leontief expansion" of Equation (8) follows as:

$$(I_n - \rho W)^{-1} = I_n + \rho W + \rho^2 W^2 + \rho^3 W^3 + \cdots \tag{9}$$

From the $S(W)$ matrix, we get the direct, indirect and total effects. The main-diagonal elements represent the own-partial derivatives, and their average is the average direct effect, which represents the change in the unemployment rate of any region *i* due to one unit change in the output of the same region. The off-diagonal elements represent the cross-partial derivatives and the average of their cumulative sum from each row is the average indirect effect, which indicates the cumulative effect of the changes in the output of regions other than *i* on the unemployment rate of region *i*. The total effect is the sum of the direct and indirect effects.

Table 6 displays the results. The most important one is that the total effect – that is, the true Okun's coefficient once all transmission mechanisms have been included – is extraordinarily high. In fact, it reaches a value a little over 1, which implies that for every percentage point reduction in output growth the unemployment rate increases, on average, by over one percentage point. This result is much higher than that obtained, for instance, by Pereira (2014) for the Virginia metropolitan statistical areas between 2001 and 2011 (in this case the total effect turns out to be -0.36) and Palombi, Perman, and Tavéra (2017) for the British regions over the period 1985-2011 (-0.28). In our view, two main factors could explain this discrepancy. On the one hand, the characteristics of the Spanish labour market (Samuel Bentolila et al. 2010), in particular, the relatively high share of temporary over total employment (see the Appendix), make many workers (the temporary ones) easy to hire and fire. On the other hand is the industry mix, in which the construction sector played, and still plays, a key role both in the expansionary and contractionary phases of the business cycle (as can be seen in the Appendix, the construction sector accounted for more than 10% of GDP in regions such as Andalucía, Castilla and León and Cantabria, especially in the expansion time). In any case, the high Okun's coefficient obtained for Spain matches with the extended idea that the higher the average unemployment rate the higher the Okun's coefficient (Laurence M. Ball, Daniel Leigh, and Prakash Loungani 2013). In other words, that there are common factors that can be driving both variables, among which the regulation of the labour market stands out. According to Mário Centeno and Álvaro Novo (2012, p. 8) "*the regulation of the labour market should be designed in order to facilitate the adjustment of employment to economic conditions for business, and to protect workers from unexpected fluctuations in income during periods of unemployment*". Although Spain has carried out several labour market reforms (especially the one passed in 2012 easing the process of firing and hiring workers) in its effort to achieve a better adjustment capacity to the business cycle, our results cast serious doubts about their short-term effectiveness.

Table 6 Direct, Indirect and Total Effects of Output Growth

	Coef.	***p*-values**
Direct	-0.598**	0.000
Indirect	-0.457**	0.009
Total	-1.055**	0.000

Notes: ** means significance at 5% level.

Source: Authors' estimation.

Another point to note is that neither direct nor indirect effects coincide with the coefficients shown in Table 5. This is because, according to a Leontief expansion, direct and indirect effects incorporate feedback loop effects. As Palombi, Perman, and Tavéra (2017, p. 206) indicate, "*these arise because any given area is considered a neighbour to its neighbour, so that the spatial transmission mechanism is such that shocks to the system propagate across neighbouring areas and eventually come back to the area they originated from*".

More specifically, the difference between the response parameter (linked to ΔY_{it}) and the direct effect is very small (-0.573 *versus* -0.598), so the feedback effect here is almost negligible. On the contrary, the difference between the spatially weighted parameter (linked to $\sum_j W_{ij}\Delta Y_{jt}$) and the indirect effect is quite large (0.327 *versus* -0.457). As mentioned before, were we to consider the spatial lagged coefficient as the indirect effect, an increase in the output of regions other than *i* would increase the regional unemployment rate at *i*. However, this would be a wrong and especially risky interpretation from a policy point of view, as the correctly specified indirect effect (Table 6) shows a negative relationship between these two variables. That is, an increase in the output of neighbouring regions will reduce the unemployment rate of any region i; naturally, this result supports the use of national policies to address the unemployment issue. In any case, regional spillovers in Spain are lower than direct effects, a result that seems to be logical, although it is, once again, in some contrast with the findings of Pereira (2014) and Palombi, Perman, and Tavéra (2017). A possible explanation for this difference could lie in the fact that the Spanish regions are very different in economic size and tend to be far away (in some cases very far away) from each other. Finally, as direct effects are stronger than the indirect ones, it is worth highlighting that region-specific policies are also needed and should even prevail over policies designed at the national level.

4.2 Robustness Checks

As mentioned above, to test the robustness of our findings, we opt for two different but complementary approaches. First, we consider alternative distance matrices. Second, we include some control variables.

4.2.1 Alternative Distance Matrices

The choice of the distance (weight) matrix is a crucial point in any spatial analysis. As it is well-known, the spatial arrangement is represented by a spatial weights matrix whose non-zero off-elements (W_{ij}) represent the degree of spatial interaction between units, regions in our case. As previously mentioned, these elements lend more weight to nearby observations than to distant ones.

Therefore, and to assess the robustness of our results, we re-estimate Equation (6) with different types of row-standardized distance matrices. In all cases, we use geographical distance to define the distance matrix, as it is evident that, by doing this, the included spatial dependence structure among regions is exogenous with respect to the explanatory variables in the model. Specifically, we consider three alternative matrices. First is a distance matrix based on the inverse of the square distance in order to impose a greater penalty on distance. Second is the traditional specification of an exponential distance matrix such as $\exp^{-d}$. Third, and as is also quite common in the literature, a neighbouring distance matrix, in this case entailing (on the base of the log-marginal likelihood function criterion) five neighbours.

The results, summarised in Table 7, clearly reinforce those previously obtained: the total effect is close to unity, and the direct effect is in all cases the predominant one. Therefore, although both nationwide and region-specific policies should be implemented simultaneously, we confirm that the second ones are more relevant to tackling the situation of regional labour markets.

Finally, we want to point out another option that can be chosen when it comes to deciding the distance matrix: giving it an economic flavour. The main difficulty here has to do, obviously, with the potential problems of endogeneity that can arise. In any case, in line with Luisa Corrado and Bernard Fingleton (2012) as well as Kevin B. Proulx (2013), we could give the distance matrix an economic flavour by using, for example, migratory flows among regions in its construction (assuming that the effect of the output growth rate in region *j* on the unemployment rate in region *i* depends on the intensity of migratory flows between them). The results in this case (last row of Table 7) suggest that a relevant portion of the spillovers is offset by migratory flows so that, the greater the volume of migratory flows, the more relevant become region-specific policies.

Table 7 Robustness Check: Alternative Distance Matrices

	Coef.	*p*-values
$1/d^2$		
Direct	-0.603**	0.000
Indirect	-0.480**	0.002
Total	-1.083**	0.000
R square	0.626	
$\exp^{-d}$		
Direct	-0.590**	0.000
Indirect	-0.413**	0.002
Total	-1.003**	0.000
R square	0.631	
5 neighbours		
Direct	-0.597**	0.000
Indirect	-0.455**	0.000
Total	-1.052**	0.000
R square	0.630	
m_{ij}		
Direct	-0.659**	0.000
Indirect	-0.336**	0.010
Total	-0.995**	0.000
R square	0.648	

Notes: ** means significance at 5% level.

Source: Authors' estimation.

4.2.2 Control Variables

After having experimented with various distance matrices, we perform additional robustness checks by keeping the original distance matrix but including, now, some control variables in Equation (6). Namely, we estimate different versions of Equation (10):

$$\Delta U_{it} = \mu_i + \beta \Delta Y_{it} + \theta \sum_j W_{ij} \Delta Y_{jt} + \gamma \Delta Y_{it-1} + \rho \sum_j W_{ij} \Delta U_{jt} + \\ + \delta \Delta U_{it-1} + \vartheta X_{it} + \epsilon_{it}, \tag{10}$$

where X_{it} is a vector of control variables with associated coefficients ϑ. We specifically test four alternative versions of Equation (10). As our period of analysis covers both expansion and contraction sub-periods, we test first, as mentioned in Introduction, for the presence of asymmetries between them, a hot issue nowadays not only regarding Okun's law but also many other issues such as convergence (Jesús Ferreiro et al. 2017). Therefore, following Pereira (2014) we include in Equation (10) the variable $\phi_{crisis}*\Delta output$, in which ϕ_{crisis} is a dummy variable for the crisis period starting in 2008. The results are given in panel a of Tables 8 and 9. Second, in this case with data taken from IVIE (Valencian Institute of Economic Research), we include human capital as a control variable (panel b); unlike other papers focused on human capital (e.g. Carmen López-Pueyo, Sara Barcenilla, and Gregorio Giménez 2018), we use a standard definition (the percentage of employees with tertiary education). Third, and to evaluate the influence of the regional industry mix, we add as control variables the share of manufacturing, construction and services in output (panel c). Finally, we also include the share of temporary workers over total employment (panel d).

The results obtained regarding the direct, indirect and total effects are shown in Table 8, while the coefficients linked to the control variables are reported in Table 9. Table 8 shows that the results are relatively similar to previous ones. The total effect – taken in absolute value – ranges from a minimum of -0.918 (when evaluating regional industry mix) to a maximum of -1.120 (when human capital is considered as a control variable). It is important to note here that, although some papers concluded there is an increase in the total effect when temporary workers are included in the analysis (e.g. Sandrine Cazes, Sher Verick, and Fares Al Hussami 2013), this effect can be considered nearly negligible here. As for the relevance of the spillover effects, the share of the indirect effect goes from 36.6% (industry mix) to 46.2% (human capital). In other words, our results seem to be robust enough for the inclusion of control variables in the standard equation. Although it should be noted that, in this case, differences are more significant than in equations where alternative distance matrices are included, the key point is that there is no doubt about the validity of Okun's law in Spain and of its suitability for policy purposes.

Table 8 Robustness Check: Control Variables

	Coef.	*p*-values
a) Crisis		
Direct	-0.568**	0.000
Indirect	-0.382*	0.078
Total	-0.950**	0.001
R square	0.619	
b) Human capital		
Direct	-0.602**	0.000
Indirect	-0.518**	0.001
Total	-1.120**	0.000
R square	0.708	
c) Industry mix		
Direct	-0.582**	0.000
Indirect	-0.336**	0.002
Total	-0.918**	0.000
R square	0.758	
d) Share of temporary workers		
Direct	-0.591**	0.000
Indirect	-0.498**	0.000
Total	-1.089**	0.000
R square	0.687	

Notes: ** means significance at 5% level; * means significance at 10% level.

Source: Authors' estimation.

Table 9 Robustness Check: Main Results Regarding Control Variables

	Coef.	*p*-values
a) Crisis		
Direct	-0.045	0.682
Indirect	-0.126	0.687
Total	-0.171	0.685
b) Human capital		
Direct	-16.304**	0.000
Indirect	-31.574**	0.007
Total	-47.879**	0.002
c) Industry mix (construction) [a]		
Direct	47.333**	0.000
Indirect	62.637**	0.011
Total	109.979**	0.001
d) Share of temporary workers		
Direct	-0.132**	0.011
Indirect	-0.265**	0.003
Total	-0.397**	0.002

Notes: ** means significance at 5% level; * means significance at 10% level; [a] only the results for construction are included.

Source: Authors' estimation.

With regard to the coefficients associated with the control variables (Table 9), the following conclusions can be drawn:

- The coefficient of the variable designed to control for the crisis is not significant at conventional levels, so there is no evidence of temporal asymmetries in the Spanish case (Table 9a). Accordingly, the impact of output performance on the unemployment rate is, regardless of the phase of the business cycle, roughly the same. This finding is in line with that obtained by Ball, Leigh, and Loungani (2013) and Jan C. van Ours (2015), as they conclude that Okun's law is a strong and stable relationship in most countries and did not change substantially during the Great Recession. This symmetry in the response of unemployment to output changes raises, however, some policy issues as it effectively results in large fluctuations of the unemployment rate over the cycle (although always around a high average). Therefore, and to maximize the reduction of unemployment in expansions and minimize its increase in recessions, it seems logical to propose differentiated strategies depending on the phase of the cycle. Although in both cases a mix of aggregate demand-side and supply-side policy measures is advised, the focus on demand (monetary and fiscal) policies seems to be more pertinent in the phases of recession, whereas in expansions supply policies (improvements in education and training, labour market flexibility, geographical mobility, etc.) can be especially advisable to reduce structural unemployment. Because of the nature of these policies, it seems those that are demand-side oriented are more feasible at the national level; as for the supply-side-focused policies, we think that both national and region-specific policies are appropriate.

- With regard to human capital (Table 9b), we get a negative and statistically significant coefficient. This means that the higher the level of human capital in a region, the lower the change in the rate of unemployment in it; in other words, a higher share of more skilled workers tends to imply more stable employment levels. In addition, the indirect effect is almost twice the direct one, reflecting the importance of spillover effects. Therefore, supply-side policies – which are more pertinent in booms – aimed at offering new skills to the unemployed and subsidizing the improvement of human capital could help to reduce the negative effects of recessions on both employment and unemployment; according to our spillover results, this type of policies should be implemented mainly at the national level.

- When the shares of manufacturing, construction and services are included in the analysis (Table 9c), the construction sector emerges as the only one presenting a statistically significant (and positive) coefficient on the unemployment rate. Therefore, regions in which this sector is critical (as reported in the Appendix, regions such as Andalucía, Cantabria, Castilla-La Mancha, and Extremadura) tend to experience higher changes in unemployment rates. This finding calls for supply-side (structural) policies aimed at permanently shifting the industry mix of the regions in favour of a more balanced one. Considering the relatively reduced weight of spillovers linked to this variable, probably this type of policies should be pursued mainly at the regional level.

- Finally, when the share of temporary over total employment is considered we get a negative and significant effect (Table 9d); it also happens with something quite similar to the case of human capital regarding the relevance of spillovers: the indirect effect (-0.265) is twice as high as the direct one (-0.132). Accordingly, we can conclude that the higher the share of temporary workers the lower the change in unemployment; in other words, temporary workers are not only a substitute for permanent workers but their share also affects unemployment evolution. According to these results, it seems that Spanish regulation, traditionally focused on easing the hiring of this sort of workers (labour market duality), helped to mitigate the consequences of the unemployment crisis. In line with Charles Wyplosz (2000), it could be stated that Spanish regulation, characterised by relatively low redundancy payments and firing restrictions, allows temporary contract workers to create jobs that would not have been occupied by permanent contract workers.

5. Conclusions and Policy Recommendations

By using data at the regional level, this paper has tested the validity of Okun's law, namely the existence of a negative relationship between unemployment rates and output growth, for Spain between 2000 and 2014. Following a spatial approach, the paper extends the standard analysis in order to control for the presence of spatial spillovers that would otherwise be undetected. The basic results reinforce the validity of Okun's law and, at the same time, reveal the existence of quite important spillover effects that are critical when it comes to using this relationship from a policy-oriented perspective.

More specifically, the regional response of unemployment to output changes is found to be very high, regardless of the phase of the business cycle. Overall, it can be said that there is a one-to-one relationship, i.e. a one-percentage-point reduction in the output growth rate increases the unemployment rate by about one percentage point. Interestingly, this result is much higher than the one obtained by Pereira (2014) as well as Palombi, Perman, and Tavéra (2017) for Virginia metropolitan areas and the British regions, respectively. Among some other reasons, this can be due to the high average unemployment rate that has characterised the Spanish labour market over recent decades.

Additionally, it is crucial to point out that, in general, more than 40% of the total effect is explained by the presence of spillover effects. In other words, the increase in unemployment triggered by an output reduction in region *i* is shared by this region and its neighbours, and *vice versa*. That is to say, the evolution of the unemployment rate in any given Spanish region *i* is heavily dependent not only on its own output change but also on other regions' growth experiences.

The paper also reveals that the link between output growth and changes in the unemployment rate is quite stable over time and that human capital, the share of the construction sector and the share of temporary workers are key additional factors behind the evolution of regional unemployment rates.

As previously stated, the findings of this paper have important policy implications. First, whether or not Okun's law holds is instrumental from the point of view of policymakers, as it helps to understand and tackle changes in unemployment rates. As the paper has shown its validity and stability over time, it follows that policymakers should use it in the design and implementation of their policies.

Second, due to the significant weight of regional spillovers in the total effect, it seems that, apart from policies implemented by regional governments (more supply-side oriented), both aggregate demand and supply policies at a higher, national (or even European) level, as well as regionally coordinated demand and supply policies, would have a positive impact on the dynamics of unemployment in the Spanish regions. As it happens, however, that the direct effect is stronger than the indirect (spillover) effect, we consider that the stress should be on region-specific policies. More in particular, the results regarding fixed effects unveiled that there are some regions (Castilla-La Mancha, Canarias, Murcia and Estremadura) that, in relative terms, are much worse prepared than others to face negative output changes; this being the case, the above-mentioned region-specific policies should be addressed mainly to favour these regions.

Third, considering more in-depth the policy implications of our findings, it can also be stressed that the symmetry of Okun's coefficient is not good news for an economy like the Spain's, which is subjected to large output fluctuations. To properly tackle this issue and, in particular, reduce the impact of output decline on unemployment, a mix of demand- and supply-side policies is again suggested, but with the emphasis on the demand side over recessions and the supply side in expansions. In fact, if supply-side policies were designed to produce structural changes in favour of a more flexible labour market, increase competition, unlock business potential and help to diffuse innovation (see Irina Syssoyeva-Masson and Joao-Sousa Andrade 2017), the situation could be reversed. This being so, there would be asymmetries over the business cycle and, then, a higher Okun's coefficient in expansions than contractions.

Finally, the inclusion of control variables in our analysis also conveys an additional message, which allows us to be more precise: supply-side policies mainly implemented in expansions, devoted to simultaneously fostering human capital and keeping the share of the construction sector within reasonable limits, would be very helpful. Indeed, these policies would also help to lessen the increase in regional unemployment rates during recessions.

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Appendix

Table A1 Variables Included in the Robustness Check of Okun's Law: Per Region and Annual Averages for the Whole (1), Pre-Crisis (2) and Crisis (3) Periods

Regions	Human capital (%)			Wage (thousand)			Manufactures (%)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Andalucía	20.5	18.8	22.6	25.0	22.6	28.1	9.0	9.7	8.1
Aragón	24.0	22.1	26.8	27.6	25.0	31.1	17.9	19.2	16.2
Asturias	23.0	19.8	27.0	28.2	25.6	31.8	16.0	17.0	15.1
Baleares	16.5	14.8	18.6	26.2	23.8	29.3	4.0	4.4	3.4
Canarias	18.7	17.3	20.4	25.6	23.3	28.5	4.6	5.1	4.1
Cantabria	21.1	18.7	24.3	27.0	24.5	30.4	17.4	17.6	17.2
Castilla y León	22.8	20.7	25.4	26.5	24.2	29.7	15.3	15.6	14.9
Castilla-la Mancha	17.9	16.1	20.4	25.3	22.5	29.0	15.7	16.3	14.8
Cataluña	22.3	20.4	24.6	29.2	26.4	32.9	18.3	19.8	16.2
C. Valenciana	20.6	18.6	23.1	25.7	23.4	28.9	15.1	16.4	13.4
Extremadura	20.0	18.4	22.2	24.1	21.6	27.5	7.1	7.2	7.1
Galicia	19.6	17.2	23.0	25.1	22.6	28.3	15.0	15.8	14.2
Madrid	33.5	30.5	37.4	31.3	28.5	35.0	8.3	9.4	6.7
Murcia	19.6	17.9	21.6	23.6	21.2	26.8	13.3	14.0	12.3
Navarra	26.1	25.0	27.5	29.8	26.9	33.8	25.6	25.7	25.4
País Vasco	28.1	25.3	31.7	31.6	28.7	35.4	23.3	24.3	22.0
Rioja	21.9	19.5	25.2	26.8	24.2	30.2	23.5	23.5	23.4

Source: Authors' estimation.

Table A1 Variables Included in the Robustness Check of Okun's Law: Per Region and Annual Averages for the Whole (1), Pre-Crisis (2) and Crisis (3) Periods *(Cont.)*

Regions	Construction (%)			Services (%)			Temporary workers (%)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Andalucía	10.1	11.7	8.4	63.7	60.9	67.3	12.5	10.4	15.3
Aragón	8.7	9.6	7.8	55.3	53.0	58.2	11.6	10.1	13.5
Asturias	9.8	11.1	8.2	57.8	54.8	61.5	9.4	7.4	12.0
Baleares	9.0	10.3	7.4	74.2	72.1	76.7	10.5	8.7	12.6
Canarias	8.2	9.9	6.3	73.5	71.6	76.0	11.3	9.5	13.4
Cantabria	10.2	11.6	8.7	58.1	55.8	61.2	9.1	7.1	11.7
Castilla y León	8.7	9.8	7.5	56.6	54.1	59.8	11.6	10.1	13.6
Castilla-la Mancha	10.4	11.7	9.1	53.1	50.4	56.6	10.5	9.0	12.7
Cataluña	7.6	8.7	6.3	61.3	58.3	65.2	11.1	9.5	13.3
C. Valenciana	9.7	11.0	8.4	61.4	58.6	64.9	14.0	11.7	16.7
Extremadura	10.9	12.2	9.6	60.7	58.1	63.9	11.8	10.2	13.9
Galicia	9.8	10.9	8.5	57.3	54.8	60.4	10.5	9.0	12.4
Madrid	7.4	8.8	5.8	72.5	69.7	76.1	10.1	8.5	12.4
Murcia	9.8	11.1	8.4	60.0	57.4	63.5	11.8	9.7	14.4
Navarra	8.0	8.9	6.9	51.6	50.2	53.5	13.3	11.8	15.1
País Vasco	8.1	8.8	7.4	55.8	53.6	58.5	13.1	11.5	15.3
Rioja	8.7	9.6	7.7	50.1	48.1	52.8	10.5	7.7	14.4

Source: Authors' estimation.