An analysis of Okun's law for the Spanish provinces

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Abstract:

The inverse relationship between unemployment and Gross Domestic Product (GDP), commonly known as Okun's law, has been traditionally analysed in the economic literature. Its application to Spain has been carried out at the national level and for the autonomous communities, but it has not been analysed for provinces, the territorial level closer to local labour markets. This study analyses the relationship between unemployment variation and GDP growth for the period spanning 1985 to 2011. After testing the time series properties of provincial GDP and unemployment, we specify the difference version of Okun's law and then we apply VAR and panel VAR techniques in order to check the robustness of the results under a framework that takes into account the endogeneity of GDP and unemployment. Results from the analysis lead us to determine that the Spain's provinces show large differences in their unemployment sensitivity to GDP shocks. In particular, provinces where economic activity is concentrated and southern provinces suffer from higher cyclical variations in unemployment rates.

Key words: Unemployment, Output fluctuations, Spanish provinces

JEL classification: C32, C33, J23, R11

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1. Introduction

The strong impact of business cycles on unemployment is a particular feature of the Spanish economy. The high increase in unemployment during the current economic downturn is a clear example of the great variability of the unemployment rate. Since 2008, in just six years the unemployment rate has more than tripled, accounting in 2013 for 26 percent of the working population. However, this phenomenon is not confined to recession periods. Before this economic crisis, the Spanish economy had experienced continuous growth, reducing unemployment rates from 20 percent of the labour force to levels slightly above the European average.

Nevertheless, the sensitivity of unemployment rates to Gross Domestic Product (GDP) shifts is not the same for all regions. Villaverde and Maza (2009) found that while a great unemployment response to changes in the economic cycle is observed in some autonomous communities, in others the unemployment rate varies to a lesser extent. They attributed these differences to the unequal growth of productivity between regions. However, analysing the differences in the impact of GDP on unemployment for autonomous communities can be misleading. It is important to consider regional units that are closer to local labour markets, as this is the territorial dimension that really matters to firms and workers. In fact, autonomous communities show great internal differences in their levels of economic activity, degree of urbanization, and degree of uniformity in their productivity levels and productivity growth. In this regard, the provincial approach implies a thorough and rigorous analysis that clarifies the patterns and differences in unemployment sensitivity to economic variations.

The aim of this paper is to analyse the provincial differences in the response of unemployment rates to GDP variations. In order to do so, we perform the difference version of Okun's law to observe the effect of GDP growth changes on unemployment for all Spanish provinces. The analysis is complemented with the use of VAR and PVAR models to check the robustness of the results obtained from the difference specification in a framework that takes into account the endogeneity of GDP and unemployment.

Our results show that among provinces there are great differences in the sensitivity of unemployment to variations in economic conditions. Provinces where economic activity is concentrated and southern provinces suffer to a higher extent the impact of GDP shocks on unemployment. VAR analysis and cumulative impulse response functions (IRFs) confirm these results.

Our findings justify resorting to a provincial approach, as we also find that autonomous communities are internally heterogeneous. One of the contributions of this paper concerns the need to consider a provincial approach when we analyse the Spanish labour market from a regional perspective. Provincial analyses have not been carried out previously in studies examining Okun's law for Spain. This new scope of analysis offers interesting results that should be taken into account when economic policies are defined. The second contribution is to analyse the relationship between GDP and unemployment through VAR and PVAR techniques, which have not yet been applied at the Spanish provincial level.

The rest of the paper is organized as follows. In section 2, we briefly gather the contributions to Okun's law, including specific analysis for Spain. In section 3, we describe our methodology and in section 4, we present our main results. Finally, section 5 concludes.

2. Literature review

2.1. General overview

The relationship between economic activity and unemployment has been traditionally analysed by using the specifications of Okun's law. Okun (1962) formulated the well-known rule of a thumb that assigns approximately a 3 percentage point of GDP decrease to a 1 percentage point of unemployment rate increase. Since then, Okun's law has been the focus of discussion and analysis. Many authors have submitted it to transformations in order to modify certain theoretical foundations and to achieve a more accurate statistical fit. Furthermore, it has been applied to different economic contexts. It is worth noting the work of Gordon (1984), Evans (1989), Prachowny (1993), Weber (1995), Attfield and Silverstone (1997), Knotek (2007), Owyang and Sekhposyan (2012), Ball et al. (2013), and Perman et al. (2014), among others.

The authors have defined both static and dynamic specifications of the aforementioned empirical relationship. For instance, Evans (1989) considered three lagged periods to observe how past variations in Gross National Product (GNP) and unemployment influenced quarterly values of these variables.

Economists have also analysed the relationship between GDP and unemployment rate in two additional directions. First, whereas Okun's seminal study considered unemployment as the exogenous variable, other relevant analyses have placed it endogenously. Okun's coefficient comparisons of both kinds of studies turn out to be worthless. Second, other studies have introduced new variables to the original formula. For instance, Gordon (1984) introduced as explanatory variables the changes in capital and technology regarding their potential level, in addition to unemployment variations. Prachowny (1993) also considered labour supply, workers weekly hours and capacity utilization deviations from the equilibrium.

All these transformations have contributed to the fact that there is no consensus about the value of Okun's coefficient. Some authors have confirmed the value initially presented by Okun. Others obtain that the magnitude of the impact of business cycle on unemployment is closer to two instead of three. Other analyses show that Okun's coefficient varies over the period selected and among the countries considered.

Weber (1995) analysed the U.S. economy during the period of 1948 to 1988 and obtained that the long-term coefficient was close to three. However, he acknowledged there was a breakdown in the third quarter of 1973. In the same line, more recent studies, such as Knotek (2007) and Owyang and Sekhposyan (2012), consider this empirical relationship to be a good approximation in the long term. Belaire and Peiró (2015) obtained that U.S. unemployment responds to cycles to a higher extent in recessions than in expansions. Galí et al. (2012) ensured that Okun's law holds for the U.S. economy and but he attributed the low job creation in recent economic recoveries to the slowness at which these recoveries occurred.

In this regard, Perman et al. (2014) conducted a meta-analysis to obtain the "true value" of the Okun's law coefficient. They used a sample of 269 estimates, among which they discarded those that did not fulfil the pre-established requirements and distinguished between analyses that considered changes in GDP as the independent variable and those that considered unemployment variations exogenously. They quantified the impact of unemployment rate on GDP at -1.02 points. This value is far from the three point coefficient and clearly demonstrates that the period and countries selected matters. In the same vein, Lee (2000) acknowledged that Okun's law could be considered valid qualitatively but not quantitatively. He selected 16 OECD countries to observe in an effort to determine if the so called rule of thumb holds. Lee obtained that, although all countries present a negative relationship between GDP and unemployment, the coefficient that relates these variables varies significantly across countries. Moosa (1997), who considered the G7 countries, obtained the same result. Sögner (2001) analysed the case of Austria and obtained that the relationship has kept stable over time. Finally, Ball et. al. (2013) overcame these discrepancies and showed that Okun coefficient has remained relatively stable for the U.S. but it has experimented variations over time in some other OECD countries, among which is Spain.

2.2. From the national to the regional perspective

The main criticism of Okun's law, based on the divergence in its coefficient, has become a tool to compare the labour market performance in different countries and regions. The regional analysis further allows for the isolation of the impact of labour market institutions. For this reason, many authors have determined the patterns of unemployment and business cycle by region and their relationship to recommend appropriate economic policies.

Freeman (2000) was one of the first authors to apply Okun’s law at the regional level. He applied it to eight U.S. areas and obtained, unlike the studies mentioned below, a similar and stable coefficient for all regions. This result shows high flexibility in the U.S. labour market, which favours regional convergence in unemployment rates. However, Adanu (2005) did not observe this level of convergence among Canadian provinces. He obtained that the law did not hold for three of the ten provinces analysed. Adanu analysed how unemployment affects GDP during the 1981to 2001 period for the Canadian provinces and observed that GDP varies considerably in the most industrialized provinces when changes in labour occur, mainly because productive jobs are concentrated to a greater extent in industrialized provinces.

In European countries, Okun's law holds at the national level, but when regions are analysed, some authors obtain that variations in the business cycle do not always explain the changes in the unemployment rate. Binet and Facchini (2013) applied the relationship to the twenty-two French regions and obtained that it is significant for only fourteen of them. They conclude that this finding is due to high unemployment rates coexisting in some regions with above average per capita GDP levels. According to the authors, such a situation of disequilibrium is partly a result of the rapid growth of a working-age population that has not been absorbed by an employment increase. Also, the great percentage of public sector employment in the regions where Okun's law does not hold hampers the adjustment to equilibrium.

A lack of significance of Okun's law is even more evident in the Greek regions. Christopoulos (2004) applied a similar analysis to Greek regions and obtained that only six of thirteen have a significant relationship between unemployment and the business cycle. Moreover, the coefficients point out much higher unemployment sensitivity to GDP variations than in North America. Contrarily to results obtained for the Canadian provinces, few industrialized regions in Greece show a significant relationship between unemployment and GDP, probably due to hysteresis in unemployment.

2.3. The case of Spain

The Spanish economy has been characterized by a strong impact of business cycles on unemployment since 1975. In fact, the unemployment rate has experienced an upward trend that has only undergone two breakdowns during the 1986 to 1991 and 1995 to 2007 expansion periods. This unemployment uptrend cannot be justified by the moderate increase in labour force participation at the national level.

The economic depression, which affected Spanish economy in 1975, was mainly attributable to the great instability that accompanied the transition to democracy, the shocks to industry as a result of the delayed effect of the oil price increase, and the social measures partly geared to augment wages. As a consequence, in 1985 the unemployment rate reached 21.4 percent and only 47 percent of the population was occupied. In 1986, Spain's entry into the European Union caused widespread optimism that affected the economy and led to a decrease in the unemployment rate. This lasted until 1991, when a generalised recession affected the Spanish economy. The cycle change came again in 1995 when labour law reforms favoured wage moderation and boosted temporary jobs. Low interest rates following the adoption of the Euro fuelled housing and promoted economic growth; convergence with European levels of unemployment occurred. In 2007, whereas the average unemployment rate was around 7 percent in Europe, in Spain it was at 8 percent. This degree of unemployment rate variation illustrates the strong impact of GDP on unemployment in Spain, resulting in a greater Okun's coefficient for this country than for most OECD countries. Since 2007, the bursting of the housing bubble triggered an unprecedented recession, and in three years, an increase in the unemployment rate of nearly 12 percentage points occurred. This unemployment increase was accompanied by only a 7.8 percentage point GDP drop, which reinforces the assumption of high unemployment variability in Spain.

On the other hand, labour force participation seems to be alien to these cycles, maintaining a growing trend that just stalled during the 1991 to 1996 period. This is illustrated by Jimeno and Bentolila (1998), who acknowledge that changes in the Spanish economy have been reflected in the unemployment rate. They argue that this Spanish feature is neither commonly observed in the U.S. nor most European countries, where shocks have a greater impact on migration flows and participation respectively.

But this is not the whole story. National data fail to reflect the great diversity of the Spanish regions. There are large disparities between regions in terms of unemployment rates and unemployment elasticity to business cycles. This is shown by Pérez et al. (2002) and Amarelo (2013). They analysed the cases of Andalusia and Catalonia respectively and compared them to the Spanish results. Pérez et al. (2002) obtained for Andalusia lower unemployment variability to business cycles during the 1984 to 2000 period than they obtained for Spain, although when the employment rate was taken into account instead the unemployment rate, they did not find significant differences from the Spanish value. Amarelo (2013) observed that unemployment variability in Catalonia was higher than that obtained for Spain. Villaverde and Maza (2007, 2009), who analysed Okun's law for all Spanish regions, attributed the differences between regions to productivity growth. They obtained that neither development degree nor spatial patterns can explain these differences.

3. Data sources and methodology

3.1. Data sources and variable definition

The analysis of the effect of the output variation on the unemployment rate requires three macroeconomic datasets[1]: real GDP, unemployment and labour force participation data. The analysis is carried out annually at the provincial level, and we focus on the period spanning 1985 and 2011. The selected period allows us to consider the entry of Spain into the European Union and the subsequent industrial reconversion; the creation of the welfare state; the economic expansion, partly dependent on an oversized housing sector; and the recent crisis that began in 2008. Using provinces as the unit of analysis allows for a thorough study that specifically takes into account each area's weaknesses and the impact of individual policies. We selected 50 Spanish provinces for analysis, excluding Ceuta and Melilla. The information has been taken out from the Spanish National Institute of Statistics (INE). We resort to the Contabilidad Regional de España CRE (Spanish Regional Accounts) to obtain nominal GDP by province and the Índice de Precios al Consumo IPC (Consumer Price Index CPI) dataset to deflate nominal output and obtain a proxied measure of real GDP. Using CPI as a GDP deflator is a consequence of the lack of data on GDP deflation at the provincial level for part of the considered period. The INE only supplies information about rates of variation of real GDP by region, hence provincial CPIs become the most suitable indicator to remove the effect of prices from the output. Furthermore, unemployment and labour force participation information, which is required to determine the unemployment rate, is provided by the Encuesta de Población Activa EPA (Labour Force Survey).

The INE provides non homogeneous panel datasets. Nominal GDP is in different year basis and we have to homogenize it taking 2011 as the year basis. Moreover, CPI is only available for provinces after 1993; we use the index for the provincial capitals for the previous years. Occupation and participation data are furnished according to

[1] Detailed information about the required data sets, the components and the sources of information are compiled in the table A.1 in the Appendix 1.

different criteria based on the time the information was collected. In this case, we follow De la Fuente (2012), who makes the required adjustments to link the 1976 to 1995 and 1996 to 2004 occupation and participation series to the 2005 to 2013 series. Differences are mainly due to sample replacement and methodological changes, such as questionnaire modifications and adjustments in the definition of occupation and unemployment. Annual and state adjustments are distributed among the provinces considering their weighting in the state occupation and labour force participation data.

3.2. Methodology

In order to observe the differences in the degree of sensitivity of unemployment to GDP fluctuations among Spain's provinces, we use the difference version of Okun's law and then we conduct VAR and PVAR analyses[2].

The difference version of Okun's law provides information on the relationship between GDP and unemployment rate variations. It is specified as:

$$(u_t - u_{t-1}) = \alpha + \beta_1(y_t - y_{t-1}) \quad (1)$$

where $u_t - u_{t-1}$ represents the difference between unemployment rates in periods t and t-1, $y_t - y_{t-1}$ is the variation of the GDP natural logarithm that takes place between t and t-1 periods. This specification is considered in our analysis due to the large variability in the unemployment rate observed for Spain and many of its provinces over the selected period makes our specification more accurate than the gap approach. The estimation of the coefficient of the provincial series is performed using the OLS method, while the panel that integrates all provinces requires estimating by FE.

However, estimating the relationship between the aforementioned variables does not allow us to take into account the potential endogeneity of GDP and the

[2] Before estimating we need to perform unit root tests to know whether the series and panels with which we work are stationary. Stationarity ensures that the obtained results are not spurious. We obtain the panels and most series are generated by I(1) processes. Appendix 2 shows further information about the methodology and results obtained.

unemployment rate. In order to consider this, we resort to the VAR and PVAR techniques and the Impulse Response Functions (IRFs) associated. VAR and PVAR techniques allow us to determine the effect of an output or unemployment innovation regarding past values of these variables. We write the VAR representation as follows:

$$\begin{aligned} \Delta u_t &= \alpha(L)\Delta u_{t-1} + \beta(L)\Delta y_{t-1} + v_t^u \\ \Delta y_t &= \gamma(L)\Delta y_{t-1} + \eta(L)\Delta u_{t-1} + v_t^y \end{aligned} \quad (2)$$

where Δu_t and Δy_t represent respectively unemployment rate and GDP natural logarithm variations between periods t and $t-1$; $\alpha(L)$, $\beta(L)$, $\gamma(L)$ and $\eta(L)$ are respectively the vectors of the coefficients relating past values of the variables associated with current values; v_t^u and v_t^y are vectors of the idiosyncratic errors.

VAR models treat GDP and unemployment variables as endogenous and interdependent and analyse the transmission of idiosyncratic shocks across time. Meanwhile, the panel that includes all provincial series requires the PVAR technique[3]. The lag order selected in these analyses is one, because we work with annual data and we expect that the variables considered will keep some correlation with the same variable lagged one period. The AIC, HQIC and SBIC criteria also obtain that considering one lag in the VAR analysis is optimal for most series[4]. After performing the estimation, associated Impulse Response Functions (IRFs) show the response of both variables to shocks. We obtain IRFs for all provinces by orthogonalising the variables.

[3] In order to apply PVAR technique, we resort to the Ryan Decker program, which is an update version of the Inessa Love original package, used in Love and Zicchino (2006), among others.
[4] More lags have also been included in the specification and results are mostly the same.

4. Empirical results

4.1. Okun's law difference version

In this section we estimate the relationship between GDP and unemployment. We construct a first difference specification[5] for the provinces and the panel that integrates all of them. The results of the estimation of the Okun relationship for the Spanish provinces and the panel are shown in Table 1. Coefficients point out the influence that one percentage point of GDP variation has on the rate of unemployment. We have ordered the provinces attending the value of this coefficient and we can observe great differences between them. Whereas for some provinces, such as Barcelona or Cádiz, one percentage point of GDP variation is accompanied by a change in the opposite direction of unemployment rates with values higher than 0.6, for Palencia, Cáceres, or Guadalajara GDP shifts barely affect unemployment. The absolute value of the relationship coefficient does not reach 0.2 percentage points. This is a clear example of divergence in the Spanish labour market. In some provinces, unemployment highly varies when shifts in economic activity occur, whereas other provinces show low variability or do not present any relationship. Map 1 shows that some southern provinces and those in which economic activity is concentrated present greater unemployment sensitivity to GDP variation. This distinction presents, because sensitivity to business cycles in these two groups of provinces presumably result from different causes. Madrid, Barcelona, Valencia, and Zaragoza are provinces in which the autonomic capital city is. These provinces also have large populations, they are mostly urban, and have a high level of economic activity. The south is a traditionally depressed area in which unemployment is accompanied by a lack of economic activity. It is observed that in the peninsular centre, with the exception of Madrid, and in the north of Spain unemployment remains much more stable. These provinces are affected to a lesser extent by cyclical changes in the economy. Panel estimation indicates that one percentage point of GDP variation is accompanied by an unemployment rate change in

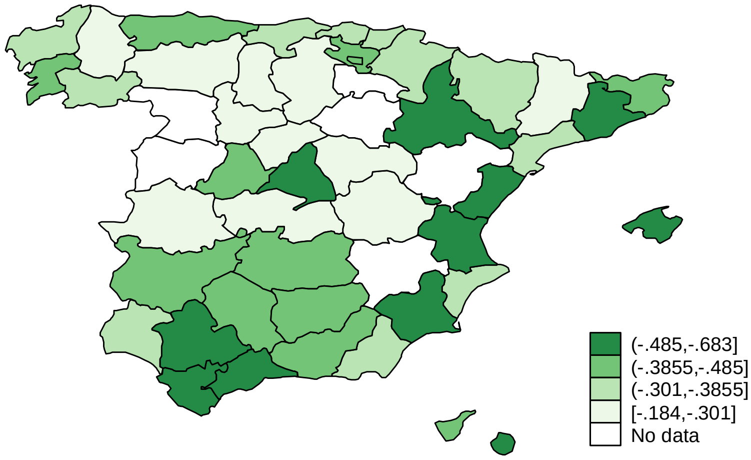
[5] We have estimated the gap version of Okun's law using the Hodrick Prescott filter in order to check our specification. We aim to know if the results obtained are comparable with those obtained by the authors that consider the gap version. Appendix 3 shows that both versions provides us a similar province ordering regarding the value of the coefficient.

the opposite direction that is quantified by 0.353 percentage points. This value is not comparable to that obtained by other authors for Spain, as panel estimation gives equal weight to all regions; in this case, it yields a downward biased value of Okun's coefficient. This is because very populous provinces that present higher unemployment and economic activity in absolute terms are among those with greater unemployment sensitivity to GDP variations.

TABLE 1: ESTIMATION RESULTS

Province	$\ln GDP_t - \ln GDP_{t-1}$			
	Coeff.	St. Error	Observations	R-squared
Cádiz	-0.683***	0.0905	26	0.599
Barcelona	-0.648***	0.133	26	0.645
Valencia/València	-0.629***	0.153	26	0.591
Palmas, Las	-0.612***	0.171	26	0.518
Balears, Illes	-0.561***	0.131	26	0.578
Málaga	-0.555***	0.156	26	0.381
Murcia	-0.528***	0.139	26	0.555
Zaragoza	-0.528***	0.111	26	0.543
Castellón/Castelló	-0.522***	0.134	26	0.549
Sevilla	-0.510***	0.124	26	0.518
Madrid	-0.486***	0.109	26	0.619
Granada	-0.484***	0.137	26	0.421
Ciudad Real	-0.458***	0.0962	26	0.574
Álava	-0.450***	0.0979	26	0.599
Jaén	-0.449***	0.107	26	0.358
Córdoba	-0.447***	0.103	26	0.442
Ávila	-0.435***	0.124	26	0.351
Asturias	-0.427***	0.0954	26	0.395
Badajoz	-0.425***	0.0778	26	0.445
Sta. Cruz deTenerife	-0.419**	0.172	26	0.323
Pontevedra	-0.411***	0.0835	26	0.535
Girona	-0.386***	0.101	26	0.445
Guipúzcoa	-0.385***	0.0851	26	0.473
Vizcaya	-0.364***	0.128	26	0.363
Almería	-0.356***	0.0884	26	0.41
Alicante/Alacant	-0.355*	0.177	26	0.293
Cantabria	-0.353**	0.139	26	0.366
Navarra	-0.328***	0.0725	26	0.541
Tarragona	-0.328***	0.117	26	0.307
Coruña, A	-0.319**	0.118	26	0.253
Huesca	-0.317***	0.0904	26	0.34
Huelva	-0.312**	0.134	26	0.113
Ourense	-0.302*	0.153	26	0.11
Valladolid	-0.300***	0.0863	26	0.286
Segovia	-0.284***	0.101	26	0.362
Toledo	-0.256***	0.0875	26	0.302
Lleida	-0.255**	0.109	26	0.212
Burgos	-0.254**	0.115	26	0.177
Lugo	-0.230***	0.0508	26	0.446
Cuenca	-0.224*	0.129	26	0.173
León	-0.223**	0.1	26	0.167
Palencia	-0.199**	0.0761	26	0.132
Cáceres	-0.195**	0.0895	26	0.066
Guadalajara	-0.184***	0.0554	26	0.273
Rioja, La	-0.268	0.161	26	0.159
Albacete	-0.155	0.125	26	0.048
Soria	-0.15	0.11	26	0.132
Teruel	-0.113	0.0995	26	0.081
Salamanca	-0.0743	0.112	26	0.011
Zamora	-0.055	0.109	26	0.008
Panel Spain	-0.3529***	0.0219	1300	0.2859

MAP 1: UNEMPLOYMENT SENSITIVITY TO ECONOMIC SHOCKS - STATIC ANALYSIS.



4.2. VAR and Panel VAR analysis

The VAR and PVAR methodology provides us additional information regarding the relationship between GDP and unemployment. The simple OLS estimation reports no much more than the correlation between the two variables considered. It does not allow us to take into account the potential endogeneity of GDP and unemployment. IRFs associated to the VAR and PVAR methodology respond to this question.

Moreover, this methodology shows the effect of shocks over time. In this analysis, we resort to the VAR technique to identify the impact of GDP growth innovations on unemployment rate regarding past values of both variables. The associated Impulse Response Functions (IRFs) show the effect of these shocks over time. IRFs isolate the effect of a GDP growth specific shock and allow us to observe this effect on unemployment.

Thus, we estimate a bivariate VAR for all provinces and we obtain their orthogonal IRFs[6]. The orthogonal IRF representations for all Spanish provinces are

[6] The ordering of the variables in the VAR model could determine the results obtained. For this reason, and in order to check GDP growth causes unemployment rate variations for most provinces, we show the results obtained when we change the ordering of the variables in the Appendix 4.

reported in Figure 1. The effect of GDP growth shocks is observed for 6 periods. Confidence bands are defined by the grey shaded area around the line that points out the effect of GDP growth shocks on unemployment. We can observe that for all provinces the effect of shocks on unemployment are negative, but the magnitude of these shocks and the persistence varies across provinces. In provinces such as Cádiz, Jaén, or Valencia, the initial effect of shocks is very sharp, whereas in Barcelona, Madrid, or Sevilla the initial effect is not so steep, but the shock is more persistent. There are also provinces for which we cannot observe any impact on unemployment. This is the case for Albacete and Zamora, among others. As in the contemporary analysis, we observe that provinces greatly differ in their unemployment response to economic shifts.

Table 2 shows for the Spanish provinces the impact of these shocks in the period in which they occur as well as the cumulative effect after 2, 4 and 6 periods. We have ordered the provinces according to the magnitude of the impact of the shock. At the top of the table are the provinces for which the cumulative effect of the shock is higher at period 6. Again, we find in the first positions of the table the provinces in which economic activity is concentrated and some southern provinces. The bottom is composed of the provinces for which the Okun's difference version acknowledged that the impact of GDP on unemployment was relatively low or not significant.

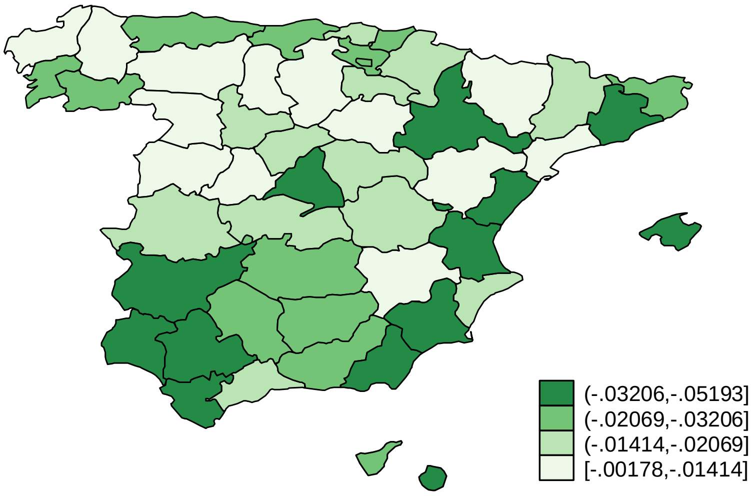
Map 2 gathers, in a clearer way, the cumulative effect of GDP growth shocks on unemployment. As previously mentioned, we get results comparable to those obtained in the estimation of the Okun's law difference version. In this case, Murcia does not fall among the provinces with higher sensitivity to GDP shifts. Contrarily, Almería, Badajoz, and Huelva join this group. The peninsular centre remains the geographical area where lower effects of GDP shocks on unemployment are observed.

FIGURE 1. PROVINCIAL OIRF REPRESENTATIONS

TABLE 2: CUMULATIVE EFFECT OF SHOCKS IN GDP (FD)

Unemployment rate (First Difference)				
Provinces	0	2	4	6
Barcelona	-0.01213	-0.03223	-0.04463	-0.05193
Cádiz	-0.01774	-0.03764	-0.04381	-0.04577
Palmas, Las	-0.01461	-0.03126	-0.04023	-0.04531
Sevilla	-0.01194	-0.02955	-0.03726	-0.04071
Almería	-0.01326	-0.02869	-0.03623	-0.03991
Zaragoza	-0.00954	-0.02376	-0.03291	-0.03876
Málaga	-0.01143	-0.02637	-0.03407	-0.03798
Huelva	-0.01135	-0.03367	-0.0368	-0.03727
Madrid	-0.00895	-0.02212	-0.02982	-0.03432
Badajoz	-0.01369	-0.02807	-0.03243	-0.03378
Castellón/Castelló	-0.01215	-0.02534	-0.03106	-0.03355
Valencia/València	-0.01529	-0.02787	-0.03151	-0.03256
Balears, Illes	-0.01496	-0.02677	-0.03079	-0.03228
Pontevedra	-0.00824	-0.02092	-0.02777	-0.03153
Ciudad Real	-0.01201	-0.02518	-0.02956	-0.03104
Cantabria	-0.00621	-0.02225	-0.02841	-0.0304
Córdoba	-0.01657	-0.0273	-0.02887	-0.0291
Girona	-0.01045	-0.02321	-0.02672	-0.02772
Santa Cruz de Tenerife	-0.01372	-0.02456	-0.0268	-0.02726
Jaén	-0.02075	-0.02482	-0.02475	-0.02475
Asturias	-0.01134	-0.02202	-0.02362	-0.02388
Granada	-0.01125	-0.0203	-0.02255	-0.02301
Álava	-0.0148	-0.02054	-0.02171	-0.02194
Ourense	-0.00769	-0.02056	-0.02172	-0.02184
Guipuzcoa	-0.00846	-0.01938	-0.02109	-0.02128
Valladolid	-0.00756	-0.01666	-0.01932	-0.0201
Alicante/Alacant	-0.00971	-0.017	-0.01917	-0.01986
Murcia	-0.01388	-0.02188	-0.0209	-0.01964
Toledo	-0.00742	-0.01513	-0.01779	-0.01871
Cuenca	-0.00716	-0.01704	-0.01834	-0.01852
Cáceres	-0.00587	-0.01661	-0.0182	-0.01846
Guadalajara	-0.00732	-0.01485	-0.01727	-0.018
Vizcaya	-0.00959	-0.01595	-0.01729	-0.01758
Navarra	-0.00745	-0.01425	-0.01638	-0.01705
Rioja, La	-0.00856	-0.01454	-0.01609	-0.01649
Segovia	-0.01049	-0.01433	-0.01468	-0.01471
Lleida	-0.00648	-0.01309	-0.01405	-0.0142
Coruña, A	-0.00726	-0.01287	-0.01393	-0.01414
Tarragona	-0.00792	-0.01277	-0.01364	-0.0138
Teruel	-0.00412	-0.01177	-0.01324	-0.01352
León	-0.00621	-0.01211	-0.01277	-0.01285
Lugo	-0.00741	-0.01322	-0.01284	-0.01282
Huesca	-0.0084	-0.01137	-0.01162	-0.01164
Albacete	-0.00317	-0.00897	-0.01078	-0.01132
Palencia	-0.00544	-0.01018	-0.01097	-0.0111
Salamanca	0.000246	-0.00746	-0.00956	-0.01011
Soria	-0.00557	-0.00954	-0.00973	-0.00975
Ávila	-0.0098	-0.00988	-0.00905	-0.00887
Zamora	-0.00039	-0.00272	-0.00288	-0.00289
Burgos	-0.00426	-0.00254	-0.00184	-0.00178

MAP 2: UNEMPLOYMENT SENSITIVITY TO ECONOMIC SHOCKS - DYNAMIC ANALYSIS.



After observing for all provinces the effect of economic growth shocks, we apply the PVAR technique to observe the effect of shocks for the panel that integrates all Spanish provinces. In this case, we show the effect of unemployment and GDP shocks on themselves and on the other variable. As expected, the effect that a shock in the output growth generates on itself is positive. The same occurs for the first differences of the unemployment rate variable. The effect of shocks on the other variable is negative. It should be mentioned that the effect of an unemployment rate growth shock on economic growth takes place after one period, because we have orthogonalized the variables. GDP growth affects unemployment rate variation contemporaneously, but unemployment rate variation affects economic growth with a lag. Results from the PVAR analysis can be observed in Figures 2 and 3. They show the IRF representations when a shock in economic growth and a shock in unemployment rate variation are respectively produced. Standard errors are calculated using Monte Carlo simulations with 500 replications. From these figures, we conclude that GDP growth shocks have a higher effect on unemployment variation than unemployment shocks on GDP growth. This is also observed in Table 3, which shows the cumulative effect of shocks for the panel of provinces.

FIGURE 2. RESPONSE TO GDP GROWTH SHOCKS FOR THE PANEL OF PROVINCES

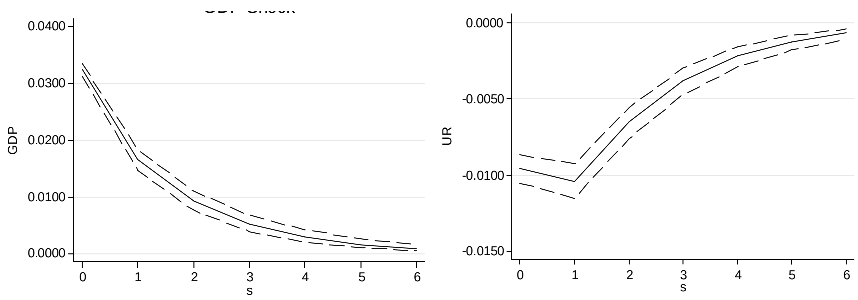


FIGURE 3. RESPONSE TO SHOCKS IN UNEMPLOYMENT CHANGES FOR THE PANEL OF PROVINCES

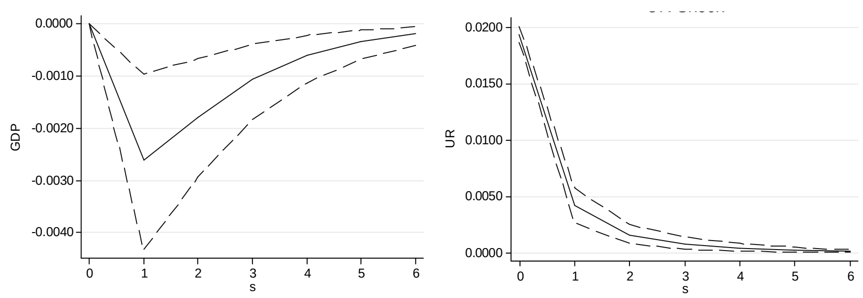


TABLE 3: CUMULATIVE EFFECT OF SHOCKS FOR THE PANEL OF PROVINCES

	0	2	4	6
UR response to a UR Shock	0.0194	0.025	0.0264	0.0268
GDP response to a UR Shock	0	-0.0044	-0.0061	-0.0066
UR response to a GDP Shock	-0.0096	-0.0265	-0.033	-0.0344
GDP response to a GDP Shock	0.0325	0.058	0.0665	0.0692

5. Final remarks and future research

This paper examines the relationship between economic activity and unemployment rates for the Spain’s provinces during the period of 1985 to 2011. This analysis has been carried out considering the Okun’s law difference version and the VAR and PVAR methodology.

The main results obtained in this study indicate that the provincial analysis matters. Our analysis provides more information than previous studies for Spain, which considered the region as its geographical scope of analysis. We find that provinces within regions show a different response in unemployment rate with respect to GDP variations. Moreover, we obtain that provinces that suffer to a higher extent the economic shocks on unemployment are those where economic activity is concentrated and those located in the south. The peninsular centre, excepting Madrid, is the geographical area where unemployment is the least affected by economic shifts. In this regard, the comparison of the provincial coefficients of Okun’s law first difference estimation and the results from the IRFs shows the great differences within Spanish territory in the unemployment sensitivity to output variations. This is interesting from the economic policy perspective as in some provinces working population is suffering to a higher extent the effects of the business cycle, whereas there are other provinces less affected or even unaffected by the economic contingencies.

From these results, we can assume that the North-South pattern and the degree of economic activity play a fundamental role in unemployment sensitivity to changes in GDP. However, an analysis of determinants of the sensitivity of unemployment to variations in the economic activity would provide more insight into this issue. Therefore, our research in the near future will focus on determining the influencing factors that provoke unemployment sensitivity to GDP variations differ across Spanish provinces.

6. References

Adanu, K. (2005): “A cross-province comparison of Okun’s coefficient for Canada”, *Applied Economics, 37*, pp. 561–570.

Amarelo, C. (2013): “La relació entre el creixement econòmic i la taxa d'atur en el cas català”, Generalitat de Catalunya, Departament d’Economia i Finances, Direcció General d’Anàlisi i Política Econòmica.

Attfield, C. L. F., Silverstone, B.(1997): “Okun’s Coefficient: a Comment”, *The Review of Economics and Statistics, 79*, pp. 326-329.

Ball, L., Leigh, D., Loungani, P. (2013): “Okun’s law: Fit at 50?” IMF Working Paper WP/13/10. Washington, DC, IMF.

Belaire-Franch, J., Peiró, A. (2015): “Asymmetry in the relationship between unemployment and the business cycle”, Empirical Economics, 48,, pp.683-697.

Binet, M.E., Facchini, F. (2013): "Okun's law in the french regions: a cross-regional comparison", *Economics Bulletin, 33(1),* pp. 420-433.

Christiano, L.J. (1992): “Searching for a Break in GNP”, *Journal of Business and Economic Statistics*, 10, pp. 237-249.

Christopoulos, D. (2004): “The relationship between output and unemployment: Evidence from Greek regions”, *Papers in Regional Science, 83,* pp. 611–620.

Clemente, J., Montañés, A., Reyes, M. (1998): “Testing for a unit root in variables with a double change in the mean”, *Economics Letters, 59 (2),* pp. 175-182.

Congregado, E., Golpe, A., van Stel, A.A. (2011): "Exploring the big jump in the Spanish unemployment rate: Evidence on an 'added-worker' effect", *Economic Modelling, Elsevier, vol. 28(3),* pp. 1099-1105

De la Fuente, A. (2012): "Series enlazadas de los principales agregados nacionales de la EPA, 1964-2009", Working Papers 1221, BBVA Bank, Economic Research Department.

Evans, G. W. (1989): “Output and Unemployment Dynamics in the United States: 1950-1985”, *Journal of Applied Econometrics, 4*, pp. 213-237.

Freeman, D. (2000): “A regional test of Okun’s Law”, *International Advances in Economic Research, 6,* pp. 557–570.

Galí, J., Smets, F., Wouters, R. (2012): “Slow Recoveries: A Structural Interpretation” *Journal of Money, Credit and Banking, 44 (SUPPL. 2)*, pp. 9-30.

Glynn, J., Perera, N., Verma, R. (2007): "Unit root tests and structural breaks: A survey with applications", *Revista de Métodos Cuantitativos para la Economía y la Empresa , 3*, pp 63-79

Gordon, R. J. (1984): "Unemployment and potential output in the 1980s", *Brookings Papers on Economic Activity, 2,* pp. 537–586.

Im, K. S., Pesaran, M. H. and Shin, Y. (2003). "Testing for Unit Roots in Heterogeneous Panels", *Journal of Econometrics, 115(1),* pp. 53-74.

Jimeno, J. F., Bentolila, S. (1998): "Regional unemployment persistence (Spain, 1976-1994)", Labour Economics, 5(1), pp. 25-51.

Knotek, E. (2007): "How Useful is Okun's Law?". *Federal Reserve Bank of Kansas City Economic Review, Fourth quarter,* pp. 73–103.

Lee, J. (2000): "The Robustness of Okun's Law: Evidence from OECD Countries", *Journal of Macroeconomics, 22(2)* , pp. 331-356.

Levin, A., Lin, C. F. (2002): "Unit Root Test in Panel Data: Asymptotic and Finite Sample Properties", *Journal of Econometrics, 118(1),* pp.1-24.

Love, I., Zicchino, L. (2006): "Financial development and dynamic investment behavior: Evidence from panel VAR "",Quarterly Review of Economics and Finance, 46 (2), pp. 190-210.

Maddala, G.S., Wu, S. (1999): "A comparative study of unit root tests with panel data and a new simple test" *Oxford Bulletin of Economics and Statistics,* 4, pp. 631-652.

Moon, H.R., Perron, B. (2004): "Efficient estimation of the seemingly unrelated regression cointegration model and testing for purchasing power parity", *Econometric Reviews 23 (4),* pp. 293-323

Moosa, I. A. (1997): "A cross-country comparison of Okun's coeficient", *Journal of Comparative Economics, 24,* pp. 335–356.

Okun, A. M. (1962): "Potential GNP: its Measurement and Significance.", *Proceedings of the Business and Economic Statistics Section of the American Statistical Association,* pp. 98-104.

Österholm, P. (2004): "Killing four unit root birds in the US economy with three panel unit root test stones", *Applied Economics Letters, 11(4),* pp. 213-216.

Owyang, M. T., Sekhposyan, T. (2012): “Okun’s Law Over the Business Cycle: was the Great Recession All That Different?”, Federal Reserve Bank of St. Louis 94, N°5, pp. 399–418.

Pérez, J. J., Rodríguez J., Usabiaga, C. (2002):“Análisis dinámico de la relación entre ciclo económico y ciclo del desempleo en Andalucía en comparación con el resto de España”, D.T. E2002/07, CentrA, pp. 1-29.

Perman, R., Stephan, G., Tavéra, C. (2014): “Okun's law-a meta-analysis”, Manchester School Working Papers.

Perron, P. (1989): "The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis", *Econometrica, 57(6),* pp. 1361-1401.

Perron, P., Vogelsang, T.J.(1992): “Nonstationarity and level shifts with an application to purchasing power parity”, *Journal of Business and Economic Statistics*, 10, pp. 301-320.

Pesaran, M.H. (2007): “A Simple Panel Unit Root Test in the Presence of Cross Section Dependence”, *Journal of Applied Econometrics, 22(2),* pp.265-312.

Prachowny, M. F. J. (1993): “Okun’s Law: Theoretical Foundations and Revised Estimates”, *The Review of Economics and Statistics, 75(2) ,* pp. 331-336.

Sögner,L.(2001): “ Okun's Law: Does the Austrian Unemployment - GDP Relationship exhibit Structural Breaks?'”, *Empirical Economics, 26,* pp. 553 - 564

Villaverde, J., Maza, A. (2007): “Okun’s Law in the Spanish Regions”, *Economics Bulletin, 18,* pp. 1–11.

Villaverde, J. and Maza, A. (2009): “The Robustness of Okun’s Law in Spain, 1980–2004: Regional Evidence”, *Journal of Policy Modeling, 31(2),*pp. 289–297.

Weber, C. E.(1995): “Cyclical Output, Cyclical Unemployment and Okun’s Coefficient: A New Approach”, *Journal of Applied Econometrics, 10,* pp. 433-445.

Zivot, E., Andrews, K. (1992): “Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis” *Journal Business and Economic Statistics*, 10 (3), pp. 251-270.

Appendix 1

TABLE A.1.1: SOURCES OF INFORMATION

Data	Information	Detailed Components	Source
Real GDP	Real GDP is obtained from the nominal GDP deflated by CPI. We construct a homogeneous series for the aforementioned data sets for the period spanning 1985-2010.	Nominal GDP (CRE 86, CRE 00, CRE 08) IPC (IPC 83, 92, 11)	CRE IPC
Unemployment	Unemployment is the overall number of people aged 16 and older who have not worked for at least one hour during the reference week for money or other remuneration. Unemployment does not include people who are temporarily absent from work due to illness, vacation, etc.	-	EPA
Labour Force	Labour force is the overall number of people aged 16 and older, who supply labour for the production of goods and services or are available and able to work.	-	EPA

Appendix 2:

A.2.1. Unit Root Testing methodology

Unit root testing allows us to know whether the processes generated are stationary and guarantees that the obtained results have economic sense. The Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests are two of the most often applied. However, these traditional unit root tests do not consider the existence of structural breaks in the series. In the presence of structural breaks, the ADF and PP tests tend to have low power. Glynn et al. (2007) establish that structural breaks generate a bias in the ADF and PP tests that reduces their ability to reject a false unit root hypothesis. Perron (1989) was the first author to mention this, and he developed a procedure based on the ADF test that accounted for only one exogenous break. However, the Perron procedure is severely criticised by many economists. Among the critics, Christiano (1992) established that a pre-test analysis of the data could lead to bias in the unit root test. Zivot and Andrews (1992) proposed an endogenous determination of the break to reduce this bias. The Zivot-Andrews test allows for an endogenous structural break, which is registered the time period in which the ADF t-statistic is the minimum. Later versions, such as Perron and Vogelsang (1992), distinguish between additive and innovative outliers. Clemente, Montañés, and Reyes (1998) contemplate this break distinction, but go further to consider the existence of two breaks. In our study, we conduct the ADF and PP traditional tests, but we also apply the Zivot-Andrews and Clemente-Montañés-Reyes tests. Applying both sets of tests guarantees robustness in determining if the series are stationary. The lag length selection criterion differs for each test. For the ADF test, we check that for every province the lags are significant at the 90% level, and we chose the maximum number of significant lags. Meanwhile, we resort to the default number of Newey-West lags to calculate the standard error for the PP test.[7]

After conducting individual unit root tests, panel-data unit root tests are applied to complete our analysis and obtain an overall view of the GDP and the unemployment

[7] This number of lags is given by the following formula: $\text{int}\{4(T/100)^{2/9}\}$.

rate of the Spanish provinces. The test results provide additional information and increase the value of unit root tests based on single series.

There is some literature about panel-data unit root tests and many attempts to remove cross-sectional dependence such as Pesaran (2007), Moon and Perron (2004), Maddala and Wu (1999), Levin-Lin (2002), and Im Pesaran Shin (2003). In our work we apply the Fisher-type, Levin Lin Chu, Im Pesaran Shin, and Hadri LM tests. In the first three tests, the null hypothesis considers the presence of unit roots in, at least, one of the series that form the panel and stationarity is assumed under the alternative hypothesis. The Hadri LM test considers in its null hypothesis that the series are generated by stationary processes.

In all the tests the lag length[8] is chosen according to Österholm (2004), who selects the maximum number of lags from individual tests. The maximum significant number of lags obtained in the individual ADF test is that which we use to determine the lag length for the panel unit root tests.

A.2.2. Results of unit root tests

We conduct two types of tests over the variables in levels[9] and first differences in order to check that the series with which we are working are stationary. The traditional ADF and PP tests are applied, as are the Zivot-Andrews and Clemente-Montañés-Reyes tests, which consider structural breaks. Results from the ADF and PP tests over variables in first differences are shown in Table A.2. In this table, we can observe the model that we consider, which is individually chosen, and the statistical value of the test, which allows us to accept or reject the null hypothesis.

In light of the results, both tests lead us to reject the null hypothesis of the presence of unit roots for most series in first differences at the conventional levels of significance. When we test the first differenced unemployment rate variable, for only one province we find that none of tests can reject the null hypothesis of the presence of unit roots. In the case of GDP, in 14 of the 50 provinces both tests find problems in rejecting the null hypothesis. These exceptions may be due to the presence of structural

[8] Other criteria are also used in order to obtain robust results. We consider the AIC criterion in the Levin Lin Chu and Im Pesaran Shin tests to select the lag length.
[9] Unit root tests of the variables in levels are available from the author on request.

breaks in the series that are not detected by the ADF and PP tests. We apply the Zivot-Andrews and Clemente-Montañés-Reyes tests in order to check whether the results remain the same or change when structural breaks are taken into account. Tables A.3 and A.4 show the results of the Zivot-Andrews and Clemente-Montañés-Reyes tests for the variables in the first differences. According to these results, the unemployment rate and GDP provincial series are mostly stationary in first differences. This allows us to estimate the relationship between the variables considered, as seen in most of the literature.

We also carry out panel unit root tests. Results are shown in Table A.5. They confirm the results obtained for provincial series: unit root processes are found in the levels of the variables, but we cannot reject stationarity in first differences. In particular, the Levin Lin Chu, Im Pesaran Shin, and Fisher Type (conducted as an ADF test) tests reject the null hypothesis of unit root processes in the first differenced variables at a 99 percent confidence level. Meanwhile, the Hadri LM test cannot reject stationarity at any of the conventional confidence levels.

TABLE A.2.1: UNIT ROOT TESTS OVER VARIABLES IN FIRST DIFFERENCES

Province	Unemployment Rate				GDP (Natural logarithm)			
	ADF-t		*PP-t*		*ADF-t*		*PP-t*	
	Model	t-Stat.	Model1	*t-Stat.*	Model	t-Stat.	Model1	*t-Stat.*
Álava	NT,C,0L	-4.3401**	NT,C	-4.3152**	NT,C,0L	-2.9184**	NT,C	-2.9414**
Albacete	NT,C,0L	-2.9747**	NT,C	-3.0240**	T,C,0L	-4.6703**	T,C	-4.6670**
Alicante/Alacant	NT,C,0L	-3.0620**	NT,C	-3.0354**	T,C,0L	-1.9603	T,C	-2.0225
Almería	NT,C,0L	-2.8541*	NT,C	-2.7565*	T,C,0L	-2.5549	T,C	-2.5640
Asturias	NT,C,0L	-3.9725**	NT,C	-3.9472**	NT,C,0L	-3.0955**	NT,C	-3.1020**
Ávila	NT,C,0L	-2.6123*	NT,C	-2.7139*	NT,C,0L	-3.5218**	NT,C	-3.5223**
Badajoz	NT,C,0L	-3.5773**	NT,C	-3.6150**	T,C,0L	-3.0489	T,C	-3.2314*
Balears, Illes	NT,C,0L	-2.9158**	NT,C	-2.9390**	T,C,0L	-2.6417	T,C	-2.7743
Barcelona	NT,C,0L	-2.7529*	NT,C	-2.8135*	NT,C,0L	-1.4944	NT,C	-1.5516
Burgos	NT,C,1L	-4.3130**	NT,C	-3.2502**	NT,C,0L	-3.5531**	NT,C	-3.4834**
Cáceres	NT,C,0L	-5.5945**	NT,C	-5.6300**	NT,C,0L	-2.9549**	NT,C	-3.0063**
Cádiz	NT,C,0L	-3.0025**	NT,C	-3.0438**	NT,C,0L	-2.8506*	NT,C	-2.9086**
Cantabria	NT,C,0L	-3.0156**	NT,C	-3.0829**	T,C,0L	-2.7936	T,C	-2.9649
Castellón/Castelló	NT,C,0L	-2.1541	NT,C	-2.2915*	NT,C,0L	-3.2087**	NT,C	-3.3164**
Ciudad Real	NT,C,0L	-2.7521*	NT,C	-2.7197*	NT,C,0L	-2.7974*	NT,C	-2.6942*
Córdoba	NT,C,0L	-3.3545**	NT,C	-3.4207**	T,C,0L	-4.2576**	T,C	-4.3211**
Coruña, A	NT,C,0L	-3.4540**	NT,C	-3.4690**	NT,C,0L	-2.6861*	NT,C	-2.6191*
Cuenca	NT,C,0L	-3.4739**	NT,C	-3.4459**	NT,C,0L	-3.8879**	NT,C	-3.9059**
Girona	NT,C,0L	-3.0999**	NT,C	-3.1304**	NT,C,1L	-1.4340	NT,C	-2.9063**
Granada	NT,C,0L	-2.4437	NT,C	-2.5567*	NT,C,0L	-1.9032	NT,C	-1.8953
Guadalajara	NT,C,0L	-2.6211	NT,C	-2.6615*	NT,C,0L	-3.0171**	NT,C	-3.0790**
Guipúzcoa	NT,C,0L	-3.3379**	NT,C	-3.3918**	NT,C,0L	-2.8571*	NT,C	-2.9089**
Huelva	NT,C,0L	-4.7314**	NT,C	-4.7313**	NT,C,0L	-4.2095**	NT,C	-4.2311**
Huesca	NT,C,1L	-4.1560**	NT,C	-3.7785**	NT,C,0L	-4.1637**	NT,C	-4.2276**
Jaén	NT,C,0L	-4.5335**	NT,C	-4.5484**	T,C,0L	-5.5028**	T,C	-5.5530**
León	NT,C,0L	-3.5080**	NT,C	-3.4897**	NT,C,0L	-4.4714**	NT,C	-4.5412**
Lleida	NT,C,1L	-4.2100**	NT,C	-3.4461**	NT,C,0L	-3.5335**	NT,C	-3.4752**
Lugo	NT,C,0L	-3.6691**	NT,C	-3.6798**	NT,C,0L	-3.9376**	NT,C	-4.0086**
Madrid	NT,C,0L	-2.5025	NT,C	-2.5369*	NT,C,0L	-1.8478	NT,C	-2.0250
Málaga	NT,C,0L	-2.6864*	NT,C	-2.7921*	NT,C,0L	-1.4259	NT,C	-1.4573
Murcia	NT,C,0L	-2.4461	NT,C	-2.5271*	NT,C,0L	-1.8913	NT,C	-2.0157
Navarra	T,C,1L	-3.6520**	T,C	-3.1516**	NT,C,1L	-1.9620	NT,C	-3.1012**
Ourense	NT,C,2L	-5.0280**	NT,C	-3.7997**	NT,C,0L	-4.1791**	NT,C	-4.2379**
Palencia	NT,C,0L	-3.2371**	NT,C	-3.2467**	T,C,0L	-5.3529**	T,C	-5.3341**
Palmas, Las	NT,C,0L	-2.6309*	NT,C	-2.6195*	NT,C,0L	-1.9159	NT,C	-2.0075
Pontevedra	NT,C,0L	-2.3506	NT,C	-2.5137	NT,C,0L	-1.7539	NT,C	-1.8881
Rioja, La	T,C,0L	-3.7760**	NT,C	-3.2703**	T,C,0L	-3.2922**	T,C	-3.3368*
Salamanca	NT,C,0L	-4.1156**	NT,C	-4.1050**	T,C,0L	-3.7084**	T,C	-3.7651**
Sta. Cruz deTenerife	NT,C,0L	-3.1854**	NT,C	-3.1877**	NT,C,1L	-1.5230	NT,C	-3.4959**
Segovia	NT,C,0L	-3.9177**	NT,C	-3.8861**	NT,C,0L	-3.3546**	NT,C	-3.3590**
Sevilla	NT,C,0L	-2.5063	NT,C	-2.6326*	NT,C,0L	-2.4388	NT,C	-2.4352
Soria	T,C,0L	-4.5460**	T,C	-4.5363**	NT,C,0L	-5.6521**	NT,C	-5.6604**
Tarragona	NT,C,0L	-3.0756**	NT,C	-3.0471**	NT,C,0L	-4.1084**	NT,C	-4.1696**
Teruel	NT,C,1L	-1.8340	NT,C	-4.1201**	NT,C,0L	-4.0569**	NT,C	-4.0484**
Toledo	NT,C,0L	-2.7404*	NT,C	-2.7707*	NT,C,0L	-2.5388*	NT,C	-2.7592*
Valencia/València	NT,C,0L	-2.6687*	NT,C	-2.7276*	NT,C,0L	-1.9302	NT,C	-1.9216
Valladolid	NT,C,0L	-3.2225**	NT,C	-3.2559**	NT,C,0L	-3.1913**	NT,C	-3.0225**
Vizcaya	NT,C,0L	-3.5781**	NT,C	-3.5990**	NT,C,0L	-2.5256*	NT,C	-2.6269*
Zamora	NT,C,0L	-3.9595**	NT,C	-3.9143**	NT,C,0L	-4.5428**	NT,C	-4.5422**
Zaragoza	NT,C,0L	-2.5406*	NT,C	-2.5320*	NT,C,0L	-1.2897	NT,C	-1.3290

NT: No trend; T: Trend; NC: No Intercept; C: Intercept; 0L: 0 lags included; 1L: 1 lag included; 2L: 2 lags included.
(**) We can reject the null hypothesis of unit roots with, at least, 95% confidence level.
(*) We can reject the null hypothesis of unit roots with 90% confidence level.

TABLE A.2.2: UNIT ROOT TESTS OVER UNEMPLOYMENT IN FIRST DIFFERENCES

	Zivot-Andrews			Clemente-Montañés-Reyes						
	t-statistic	Year	Outliers	t-statistic	Years		Outliers	t-statistic	Years	
Álava	-5.4415***	1995	0 AO				2 IO	-7.0608**	1993	2007
Albacete	-4.6138*	1994	1 AO	-3.9399**	2005		2 IO	-5.0296	1992	2007
Alicante/Alacant	-4.2939	1995	1 AO	-4.5730**	2007		1 IO	-4.2610**	2007	
Almería	-5.5579***	2008	1 AO	-5.1773**	2005		1 IO	-5.7720**	2006	
Asturias	-5.3707***	2009	0 AO				2 IO	-5.4224	2000	2007
Ávila	-3.9956	2008	1 AO	-3.4886	2004		1 IO	-3.8457	2006	
Badajoz	-5.1635**	1996	1 AO	-4.3963**	2005		2 IO	-5.6946**	1993	2007
Balears, Illes	-4.1136	1995	1 AO	-6.4611**	2007		1 IO	-5.8571**	2007	
Barcelona	-3.5999	1995	1 AO	-4.3400**	2005		1 IO	-4.1322	2006	
Burgos	-5.9221***	2008	1 AO	-6.0052**	2005		1 IO	-3.6211	2006	
Cáceres	-6.2679***	2008	0 AO				0 IO		2000	
Cádiz	-4.9084**	2008	2 AO	-5.4411	1995	2007	2 IO	-5.1404	1993	2007
Cantabria	-5.4721***	1997	2 AO	-3.2812	1994	2005	1 IO	-597.5612**	2007	
Castellón/Castelló	-4.5756*	2008	1 AO	-4.1231**	2005		1 IO	-4.5277**	2006	
Ciudad Real	-4.1883	2008	1 AO	-3.2304	2005		1 IO	-7.8294**	2006	
Córdoba	-5.3384***	2008	1 AO	-5.7231**	2007		2 IO	-5.6849**	1998	2007
Coruña, A	-4.3977	1995	1 AO	-4.0982**	2008		2 IO	-4.8523	2003	2007
Cuenca	-5.2320**	2008	1 AO	-1.8110	2005		1 IO	-15.0459**	2007	
Girona	-4.9410**	1998	1 AO	-3.5961**	2007		1 IO	-4.6705**	2006	
Granada	-3.7159	2007	2 AO	-5.9275**	1995	2004	1 IO	-4.7254**	2005	
Guadalajara	-5.0698**	2008	1 AO	-5.5498**	2005		1 IO	-4.0469	2006	
Guipuzcoa	-5.7113***	1997	1 AO	-3.8839**	2005		0 IO		1992	
Huelva	-5.9192***	2008	1 AO	-6.0639**	2007		2 IO	-3.2378	2000	2007
Huesca	-6.1900***	1997	0 AO				1 IO	-5.3170**	2007	
Jaén	-5.9625***	1997	2 AO	-4.9246	1996	2007	2 IO	-5.7242**	1997	2007
León	-4.9960**	2008	1 AO	-4.1172**	2004		1 IO	-5.2780	1998	2007
Lleida	-6.6024***	2008	1 AO	-3.7742**	2005		1 IO	-5.6932**	2006	
Lugo	-5.3509***	2009	2 AO	-5.0417	1996	2005	2 IO	-7.1998**	1993	2007
Madrid	-3.7719	1997	1 AO	-3.1380	2005		1 IO	-3.1825	2006	
Málaga	-4.7478*	2008	1 AO	-3.4002	2005		1 IO	-3.9655	2006	
Murcia	-4.1512	2008	1 AO	-3.3468	2005		1 IO	-4.0197	2006	
Navarra	-5.0212**	1997	2 AO	-5.1918	1991	2005	1 IO	-4.7737**	2006	
Ourense	-7.1934***	2000	0 AO				2 IO	-5.6535**	1998	2008
Palencia	-5.1847**	1997	1 AO	-4.4056**	2005		1 IO	-4.4989**	2006	
Palmas, Las	-4.6299	2008	1 AO	-5.0404**	2005		1 IO	-4.2150	2006	
Pontevedra	-4.1383	2008	1 AO	-3.2259	2009		1 IO	0.2588	2006	
Rioja, La	-5.5148***	1996	1 AO	-4.6449**	2005		1 IO	-4.4076**	2007	
Salamanca	-4.7899*	1995	0 AO				0 IO			
Santa Cruz de Tenerife	-5.1820**	2008	1 AO	-5.1308**	2005		2 IO	-7.4914**	1992	2006
Segovia	-4.6547*	2008	1 AO	-4.6549**	2005		1 IO	-5.2629	1989	2006
Sevilla	-3.3781	2008	1 AO	-3.1059	2007		1 IO	-3.3450	2006	
Soria	-6.8873***	2009	1 AO	-5.9716**	2006		1 IO	-6.7424**	2007	
Tarragona	-4.4937	2008	1 AO	-3.1315	2005		1 IO	-4.5842**	2006	
Teruel	-4.0441	1997	1 AO	-5.0337**	2005		2 IO	-6.0361**	1993	2007
Toledo	-4.7128*	2008	0 AO				2 IO	-5.8984**	1994	2006
Valencia/València	-3.6519	1995	1 AO	-3.2389	2005		1 IO	-3.5603	2006	
Valladolid	-4.6401*	2008	1 AO	-0.0889	2005		1 IO	-4.2834**	2007	
Vizcaya	-5.2280**	1996	2 AO	-4.2814	1995	2005	1 IO	-4.3991**	2007	
Zamora	-5.0068**	1995	1 AO	-4.7609**	2008		2 IO	-7.1788**	1996	2007
Zaragoza	-4.3899	1995	1 AO	-3.3316	2006		1 IO	-3.5758	2006	

NT: No trend; T: Trend; NC: No Intercept; C: Intercept; 0L: 0 lags included; 1L: 1 lag included; 2L: 2 lags included.
(***) We can reject the null hypothesis of unit roots with 99% confidence level.
(**) We can reject the null hypothesis of unit roots with 95% confidence level.
(*) We can reject the null hypothesis of unit roots with 90% confidence level.

TABLE A.2.3: UNIT ROOT TESTS OVER FIRST DIFFERENCED GDP (NL)

Province	Zivot- Andrews			Clemente-Montañés-Reyes						
	t-statistic	Year	Outlier	t-statistic	Year 1	Year 2	Outlier	t-statistic	Year 1	Year 2
Álava	-4.2834	2008	2 AO	-5.3172	1996	2006	2 IO	-9.6526**	1995	2007
Albacete	-6.2632***	1998	1 AO	-4.7301**	2007		1 IO	-4.7628**	1989	
Alicante/Alacant	-4.0762	2008	1 AO	-3.6470**	2009		2 IO	-5.3703	1994	2007
Almería	-4.5901*	1996	1 AO	-3.5318	2005		1 IO	-4.2321	2006	
Asturias	-5.4985***	2008	1 AO	-4.4522**	2009		2 IO	-6.0306**	1998	2007
Ávila	-4.9596**	1998	0 AO				2 IO	-6.2950**	1988	2006
Badajoz	-3.2341	2009	1 AO	-3.4020	2005		1 IO	-3.8288	2007	
Balears, Illes	-4.6287*	1997	1 AO	-3.1821	2005		1 IO	-3.6373	2007	
Barcelona	-3.1178	2008	2 AO	-3.3226	1990	2005	1 IO	-3.1931	2006	
Burgos	-5.0130**	2009	1 AO	-1.0219	2005		1 IO	-1.7121	2007	
Cáceres	-5.4860***	1999	0 AO				2 IO	-3.5527	1993	1997
Cádiz	-4.0440	2008	1 AO	-3.9582**	2005		2 IO	-2.7857	1992	2006
Cantabria	-4.1476	1997	1 AO	-3.4478	2009		1 IO	-3.7906	2006	
Castellón/Castelló	-4.6313*	2007	1 AO	-4.6699**	2007		1 IO	-4.0232	2007	
Ciudad Real	-4.9075**	1998	1 AO	-3.6479**	2005		1 IO	-3.6566	2006	
Córdoba	-5.5630***	1998	0 AO				2 IO	-6.3215**	1990	2006
Coruña, A	-4.1480	2009	1 AO	-4.4424**	2009		2 IO	-4.1892	2000	2007
Cuenca	-4.9821**	2008	1 AO	-4.8091**	2005		1 IO	-4.8149**	2006	
Girona	-5.4883***	2008	1 AO	-3.0689	2004		2 IO	-5.4895**	1997	2006
Granada	-3.4694	1997	1 AO	-3.3460	2004		1 IO	-3.1848	2005	
Guadalajara	-4.8262**	1990	2 AO	-3.6037	1991	1996	0 IO			
Guipuzcoa	-4.5453	2008	1 AO	-3.7338**	2004		1 IO	-3.9639	2005	
Huelva	-4.9539**	2007	1 AO	-5.0940**	2007		1 IO	-4.5940**	2007	
Huesca	-5.8809***	2009	2 AO	-5.2918	1998	2006	2 IO	-6.5284**	1997	2007
Jaén	-6.1741***	1997	0 AO				0 IO		1989	
León	-6.7731***	2008	1 AO	-6.8503**	2008		2 IO	-7.2401**	2003	2007
Lleida	-5.0180**	1996	1 AO	-5.2296**	2008		1 IO	-4.7726**	2008	
Lugo	-5.7905***	2000	1 AO	-4.9848**	2007		2 IO	-5.5086**	1998	2006
Madrid	-3.8092	2008	2 AO	-4.3226	1991	2007	1 IO	-3.9343	2006	
Málaga	-3.3689	1997	2 AO	-4.2668	1996	2007	2 IO	-3.7924	1995	2006
Murcia	-4.1515	2008	1 AO	-3.7830**	2009		2 IO	-4.8448	1995	2007
Navarra	-2.9503	1996	1 AO	-3.4405	2005		1 IO	-4.4352**	2006	
Ourense	-6.4138***	1999	2 AO	-5.8580**	1998	2007	1 IO	-5.1740**	2007	
Palencia	-6.6050***	1989	1 AO	-4.8703**	2005		1 IO	-2.3002	2006	
Palmas, Las	-3.6359	1997	1 AO	-3.0454	2005		2 IO	-10.8037**	1998	2006
Pontevedra	-3.7003	2008	1 AO	-3.5483	2009		1 IO	-3.6362	2006	
Rioja, La	-5.5330***	2008	1 AO	-4.6602**	2009		2 IO	-4.2038	1995	2007
Salamanca	-6.0307***	2000	1 AO	-3.1650	2007		0 IO		2009	
Santa Cruz de Tenerife	-5.6561***	2008	1 AO	-5.2446**	2005		1 IO	-5.7461**	2006	
Segovia	-5.5680***	1997	1 AO	-4.7823**	2005		2 IO	-0.8590	1995	2006
Sevilla	-3.9509	1997	2 AO	-2.7896	1991	2007	1 IO	-6.7182**	2006	
Soria	-6.5526***	1990	1 AO	-6.4220**	1990		2 IO	-6.4457**	1988	2007
Tarragona	-1.9861	1996	2 AO	-5.7355**	1996	2004	1 IO	-5.2718**	2006	
Teruel	-4.9722**	2009	1 AO	-1.1786	1989		1 IO	-4.0805	1991	
Toledo	-3.8877	2008	1 AO	-3.8888**	2009		1 IO	-3.8538	2008	
Valencia/València	-4.8277**	1997	1 AO	-2.7838	2010		2 IO	-4.7505	1995	2007
Valladolid	-4.8147**	2008	1 AO	-4.1603**	2009		1 IO	-4.8740**	2006	
Vizcaya	-3.9874	1997	1 AO	-3.7123**	2008		2 IO	-4.4603	1995	2007
Zamora	-7.5695***	1999	1 AO	-4.8633**	2004		1 IO	-4.6554**	2005	
Zaragoza	-3.1879	2008	1 AO	-2.7833	2009		2 IO	-4.4927	1987	2006

NT: No trend; T: Trend; NC: No Intercept; C: Intercept; 0L: 0 lags included; 1L: 1 lag included; 2L: 2 lags included.
(***) We can reject the null hypothesis of unit roots with 99% confidence level.
(**) We can reject the null hypothesis of unit roots with 95% confidence level.
(*) We can reject the null hypothesis of unit roots with 90% confidence level.

TABLE A.2.4: PANEL UNIT ROOT TESTS OVER FIRST DIFFERENCED VARIABLES

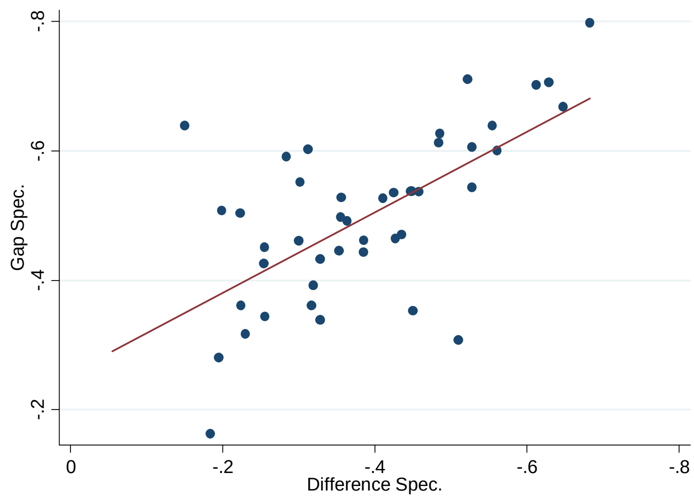
	Unemployment Rate		GDP NL	
Test	Model	First Diff.	Model	First Diff.
Hadri LM	c, 1lag	1.0001	c, 1lag	0.119
Levin Lin Chu	c, 1lag	-14.5758***	c, 1lag	-13.9239***
Im Pesaran Shin	c, 1lag	-16.7515***	c, 1lag	-18.532***
Fisher Type (conducted as a ADF)	c, 1lag	-18.5478***	c, 1lag	-20.3016***

C: intercept included; 1lag: 1 lag included.
(***) We can reject the null hypothesis of unit roots with 99% confidence level.
(*) We can reject the null hypothesis of unit roots with 90% confidence level.

Appendix 3

As can be observed in Figure A.3.1, Okun's law gap version provides us similar results to the difference version. We can only observe sizable differences for the Huelva and Santa Cruz de Tenerife provinces. When a GDP shock occurs, unemployment rate in Huelva highly deviates from the potential level. Gap version estimates for Huelva a higher coefficient. The opposite occurs for Santa Cruz de Tenerife.

FIGURE A.3.1.: COMPARING OKUN'S LAW GAP AND DIFFERENCE SPECIFICATIONS



Appendix 4

We aim to know if the results obtained in Figure A.1 differ from those obtained when we consider that economic growth shocks affect unemployment rate variation with a lag. The orthogonalization of variables in the opposite direction than previously assumed implies that shocks similarly affect unemployment rate variation for most provinces, but after one period. There are clear exceptions such as: Castellón, Murcia, Santa Cruz de Tenerife, Tarragona or Valencia. They are unaffected by the GDP shocks when the order of the variables is changed. In these provinces, GDP shocks do not cause unemployment variations. We can't observe a causality relationship in this way in the sense of Granger.

FIGURE 4. ORTHOGONALIZING THE VARIABLES IN TWO DIRECTIONS. EFFECTS ON UNEMPLOYMENT RATE CHANGES WHEN GDP GROWTH SHOCKS OCCURS