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 is particularly interesting due to the sharp effect that economic shocks have on unemployment. The purpose of this study is to analyse the relationship between unemployment and economic growth for the Spanish provinces between 1985 and 2013, a period characterized by economic booms and recessions that had a great impact on unemployment. After testing the time series properties of provincial GDP and unemployment, we specify and estimate the difference version of Okun's law using VAR and panel VAR techniques. The obtained results point out that Spain's provinces show large differences in their unemployment sensitivity to economic variations. In particular, provinces that show less diversified industries, a more developed services sector and higher rates of labour participation suffer from higher variations in unemployment rates.

Keywords: Okun's law, Unemployment, Output fluctuations, Spanish provinces

JEL classification: C32, C33, J23, R11

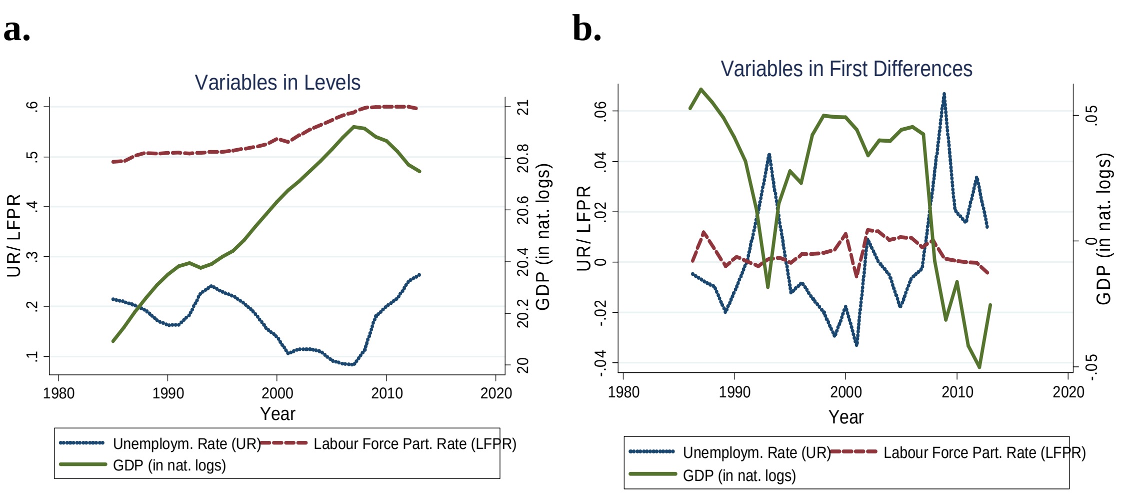
I gratefully acknowledge helpful comments and suggestions from Raul Ramos and Vicente Royuela and three anonymous referees. I am also grateful to the participants of the 55th ERSA Congress (Lisbon, Portugal), XVIII Encuentro de Economía Aplicada (Alicante, Spain), V Time Series Workshop (Zaragoza, Spain), XL Reunión de Estudios Regionales (Zaragoza, Spain) and UB Economics Workshop (Barcelona, Spain). I acknowledge financial support from the Catalan government. All the remaining errors are mine.

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 recent 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 active population. However, this phenomenon is not confined to recession periods. Before this economic crisis, the Spanish economy experienced a continuous growth from middle nineties, reducing unemployment rates from 20 percent of the labour force to levels slightly above the European average, which was around 7 percent of the active population.

Thus, as Figure 1 shows, the economic cycles in Spain have their counterpart in the unemployment rate. In Figure 1.b., it is clearly observed the opposite pattern for first differenced GDP and unemployment rate whereas labour force participation remains much more stable to economic fluctuations. This indicates that unemployment rate mostly absorbs the effect of GDP variations.

FIGURE 1: DESCRIPTIVES



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 (NUTS 2), in others the unemployment rate varies to a much lesser extent. However, the analysis for autonomous communities could be hiding certain patterns due to the great internal heterogeneity they show. Autonomous communities internally differ in their levels of economic activity, labour force participation and industrial structure which may result in unemployment response disparities. In this regard, the provincial approach (NUTS 3) implies a more thorough and rigorous analysis that clarifies the patterns and differences in unemployment sensitivity to economic variations. Besides, it is important to consider provinces because they prove to be the regional units that are closer to the concept of local labour markets and this is the territorial dimension that really matters to firms and workers.

The aim of this paper is to analyse the provincial differences in the response of unemployment rates to economic variations. In order to do so, we resort to the commonly known Okun's law, which is an empirical relationship relating unemployment to GDP. The initial statement of this law (Okun, 1962) supposes that a 3 percent of increase in output corresponds to a 1 percent of decline in the rate of unemployment. However, a more recent literature review shows that authors agree to accept the negative sign of the Okun's coefficient but it is generally obtained that the value of this coefficient varies over time and among countries. In our analysis, we aim to observe the effect of economic growth on unemployment for all Spanish provinces. In order to do so, we consider the difference version of Okun's law and then, the analysis is complemented with the use of VAR and panel VAR 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 there are great differences among provinces in the sensitivity of unemployment to variations in economic conditions. The analysis of the underlying causes behind the provincial heterogeneity points towards a higher unemployment response in the provinces that show less diversified economies, a more developed services sector and higher rates of labour participation.

One of the contributions of this work concerns the consideration of a provincial approach. Provincial analyses have not been carried out previously in studies examining Okun's law for Spain and, to the best of our knowledge; we find that Spanish autonomous communities are internally heterogeneous in the unemployment response to economic variations. The second contribution is to analyse the relationship between GDP and unemployment through VAR and panel VAR 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), Moosa (1997, 1999), Knotek (2007), Owyang and Sekhposyan (2012), Ball et al. (2013), and Perman et al. (2015), among others.

The authors have defined both static and dynamic specifications of the aforementioned empirical relationship. Evans (1989) considered three lagged periods to observe how past variations in Gross National Product (GNP) and unemployment influenced quarterly values of these variables. Moosa (1999) considered a dynamic version with different lag lengths to check the results obtained for the U.S. economy.

Economists have also analysed the relationship between GDP and unemployment rate in three additional directions. First, whereas Okun’s seminal study considered unemployment as the exogenous variable, other relevant analyses have placed it endogenously. 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. Oberst and Oelgemoller (2013) and Palombi et al. (2015a) introduced spatial effects. And finally, a third set of studies, among we find Silvapulle et al (2004) and Palombi et al. (2015b), distinguished among expansive and recessive periods to account for the effect of economic variations on unemployment.

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. Galí et al. (2012) ensured that Okun’s law holds for the U.S. economy and he attributed the low job creation in recent economic recoveries to the slowness at which these recoveries occurred.

In this regard, Perman et al. (2015) 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. 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 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. 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 found that only six of thirteen have a significant relationship between unemployment and the business cycle. Aspergis and Rezitis (2003) also analysed the case of Greece and obtained that unemployment has become more responsive to output changes for most regions right after 1981, period when Okun's relationship underwent a structural change, probably due to hysteresis phenomena.

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 (Jimeno and Bentolila, 1998).

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 (Bentolila and Jimeno, 2006). 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 again the Spanish economy. The cycle change came 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 (Ball et al., 2013; Dixon et al., 2016). 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 and the recent recessive periods. 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[1] (López-Bazo et al., 2002, 2005; Bande and Karanassou, 2008, 2009, 2014; López Bazo and Motellón, 2013), but also in the unemployment elasticity to business cycles. Pérez et al. (2002) and Amarelo (2013) analysed unemployment sensitivity for Andalusia and Catalonia respectively and compared their results to the Spanish ones. Pérez et al. (2002) obtained for Andalusia lower unemployment variability to business cycles during the 1984 to 2000 period than they obtained for Spain. Amarelo (2013) observed the opposite for Catalonia; unemployment variability was found higher than that obtained for Spain. Villaverde and Maza (2007, 2009), who analysed Okun's law for all Spanish regions (NUTS 2), confirm the great heterogeneity among regions in the unemployment response to business cycles. Regarding the underpinning causes behind the unemployment sensitivity disparities among regions, little has been said until now for the Spanish case. Only the work of Villaverde and Maza (2009) relates unemployment sensitivity to other factors and find a strong correlation between productivity growth and unemployment response to economic cycles. However, the descriptive way in which the analysis is performed limits the credibility of the results.

By contrast, the analysis of the determinants behind the regional differences in unemployment rates in Spain has been more frequently carried out in the literature. Bande and Karanassou (2008) point to the imitation effect in wage bargaining as a factor determining the high unemployment rates in regions with low productive

[1] In appendix 1, we highlight the differences in regional unemployment rates for Spain over the period. Maps show that unemployment rate differences among provinces are great and persistent.

sectors. Furthermore, Bande and Karanassou (2009, 2014) also acknowledge that regions with lower unemployment rates are those that show higher levels of capital accumulation. López-Bazo and Motellón (2013) explore the role of individual and household characteristics on regional unemployment rates. The decomposition of the regional gap in unemployment rates allows them to observe that the differences among regions are not only due to the endowment disparities, but also due to the impact of these personal characteristics. However, the high value assigned to the intercept in the regression leads the authors to recognize the relevance of regional factors to explain unemployment.

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[2]: 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 2013. 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, 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[3] IPC (Consumer Price Index CPI) dataset to deflate nominal output and obtain a proxied measure of real GDP. Besides, unemployment and labour force participation

[2] Detailed information about the required data sets, the components and the sources of information are compiled in the table 5 in the Appendix 2.

[3] 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. Hence provincial CPIs become the most suitable indicator to remove the effect of prices from the output. CPI is only available for provinces after 1993; we use the index for the provincial capitals for the previous years.

information[4] is provided by the Encuesta de Población Activa EPA (Labour Force Survey).

Furthermore, the data to obtain the determinants of unemployment sensitivity is also provided by the EPA, from which we get the information on working age population and the percentage distribution of employment by industry.

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[5] of Okun's law and then we conduct VAR and panel VAR analyses[6].

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

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

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 logarithms that takes place between t and t-1 periods, c is the constant and ε_t represents the idiosyncratic error term. The large

[4] The EPA provides non homogeneous panel datasets. Occupation and participation data are furnished according to 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.

[5] Okun's seminal work defined three different versions of the empirical relationship: the gap version, the specification in first differences and the dynamic one. In our analysis, we select the version in first differences. Literature has frequently resorted to the gap version, however it requires making strong assumptions on the unobserved macroeconomic variables (potential output and NAIRU). In addition, there is no agreement on the proper procedure to extract the trend component from the series and observe the effect of the cycle. These problems lead us to resort to the difference specification. Also, it is easier to reach stationary series when this version is used. Many analyses have resorted to this version. Among them, we find Mankiw (1994), Sogner and Stiassny (2002), Perman and Tavera (2005) Kosfeld and Dreger (2006), Knotek (2007), Gali et al (2012) and Palombi et al. (2015a, 2015b).

[6] 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 3 shows further information about the methodology and results obtained.

variability in the unemployment rate observed for Spain and many of its provinces over the selected period makes the difference specification more accurate than the gap approach. The estimation of the coefficient of the provincial series is performed using the ordinary least squares (OLS) method, while the panel that integrates all provinces requires estimating by fixed effects (FE).

However, estimating the relationship between the aforementioned variables does not allow us to take into account the potential endogeneity of GDP and the unemployment rate. In order to consider this, we resort to the VAR and panel VAR techniques and the Impulse Response Functions (IRFs) associated. VAR and panel VAR 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:

$$\begin{aligned} \Delta u_t &= c + \alpha(L)\,\Delta u_t + \beta(L)\,\Delta y_t + v_t^u \\ \Delta y_t &= c + \gamma(L)\,\Delta y_t + \eta(L)\,\Delta u_t + v_t^u \end{aligned} \qquad (2)$$

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 changes in the variables associated with current values; c is the constant and v_t^u and v_t^y are vectors of the idiosyncratic terms.

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[7]. 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[8] also obtain that considering one lag in the VAR analysis is optimal for most series[9]. After performing the estimation, associated Impulse Response Functions (IRFs) show the response of

[7] 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.
[8] AIC, HQIC and SBIC are repectively the Akaike, Hannan-Quinn and Schwarz information criteria.
[9] More lags have also been included in the specification and results are mostly the same.

both variables to shocks. We obtain IRFs for all provinces by orthogonalising[10] the variables as Sims (1980) proposes.

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[11] for the provinces and the panel that integrates all of them. The results of the estimation of the Okun's relationship for the Spanish provinces and the panel are shown in Table 1. Coefficients point out the unemployment rate variation when GDP changes in one percentage point. 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 and Cádiz, one percentage point of GDP variation is accompanied by a change in the opposite direction of unemployment rates with values higher than 0.5, for Guadalajara, Salamanca and Soria, 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.

[10] As we orthogonalize the variables as Sims (1980) proposes and, thus, we assume that a GDP shock affect unemployment in the same period, we should express the VAR in the following way: $\Delta u_t = c + \lambda \Delta y_t + \alpha(L)\, \Delta u_t + \beta(L)\, \Delta y_t + v_t^u$; $\Delta y_t = c + \gamma(L)\, \Delta y_t + \eta(L)\, \Delta u_t + v_t^u$

[11] 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 4 shows that both versions provides us a similar province ordering regarding the value of the coefficient.

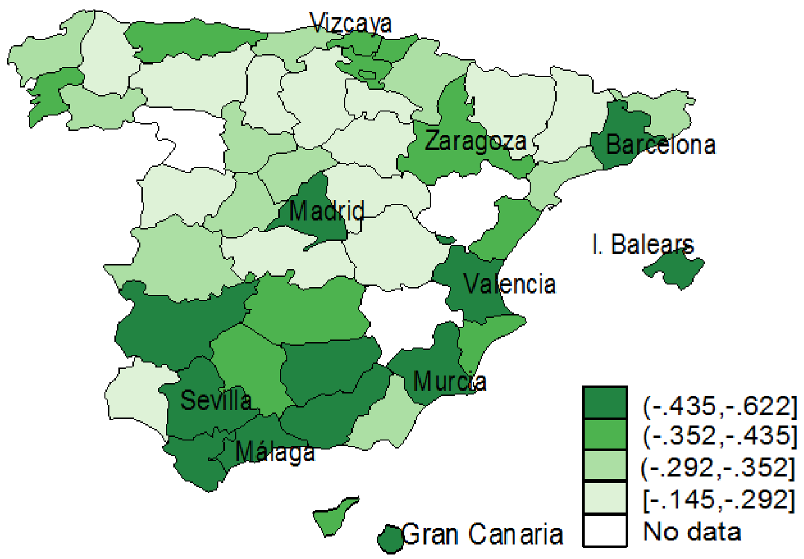
TABLE 1: FIRST-DIFERENCE ESTIMATION RESULTS

Province	$\ln GDP_t - \ln GDP_{t-1}$			
	Coeff.	St. Error	Obs.	R-squared
Cádiz	-0.622***	(0.0809)	28	0.604
Barcelona	-0.548***	(0.115)	28	0.590
Palmas, Las	-0.535***	(0.145)	28	0.478
Valencia/València	-0.530***	(0.129)	28	0.545
Granada	-0.515***	(0.127)	28	0.457
Murcia	-0.514***	(0.124)	28	0.399
Sevilla	-0.494***	(0.0993)	28	0.546
Málaga	-0.481***	(0.118)	28	0.536
Jaén	-0.458***	(0.0815)	28	0.430
Badajoz	-0.453***	(0.0704)	28	0.532
Balears, Illes	-0.439***	(0.131)	28	0.435
Madrid	-0.436***	(0.0823)	28	0.605
Álava	-0.424***	(0.0970)	28	0.559
Zaragoza	-0.423***	(0.106)	28	0.487
Ciudad Real	-0.420***	(0.109)	28	0.486
Asturias	-0.407***	(0.0737)	28	0.476
Córdoba	-0.405***	(0.0750)	28	0.442
Sta. Cruz de Tenerife	-0.399***	(0.133)	28	0.350
Castellón/Castelló	-0.390***	(0.128)	28	0.403
Pontevedra	-0.382***	(0.0672)	28	0.554
Alicante/Alacant	-0.367**	(0.140)	28	0.339
Guipuzcoa	-0.366***	(0.0697)	28	0.518
Vizcaya	-0.353***	(0.0889)	28	0.411
Ourense	-0.351**	(0.128)	28	0.181
Almería	-0.336***	(0.0818)	28	0.389
Ávila	-0.333***	(0.102)	28	0.266
Navarra	-0.332***	(0.0499)	28	0.621
Cantabria	-0.323***	(0.0984)	28	0.413
Tarragona	-0.322***	(0.0819)	28	0.354
Segovia	-0.316***	(0.0875)	28	0.447
Valladolid	-0.310***	(0.0652)	28	0.371
Girona	-0.309***	(0.0843)	28	0.353
Coruña, A	-0.302***	(0.0866)	28	0.313
Cáceres	-0.294**	(0.135)	28	0.125
Burgos	-0.291***	(0.0869)	28	0.285
Toledo	-0.291***	(0.0715)	28	0.367
Lugo	-0.290***	(0.0596)	28	0.516
Rioja, La	-0.281**	(0.117)	28	0.211
León	-0.276***	(0.0886)	28	0.276
Cuenca	-0.264**	(0.107)	28	0.217
Huelva	-0.261**	(0.114)	28	0.101
Huesca	-0.253***	(0.0730)	28	0.282
Lleida	-0.243**	(0.108)	28	0.205
Palencia	-0.201***	(0.0579)	28	0.183
Guadalajara	-0.192***	(0.0506)	28	0.289
Salamanca	-0.169*	(0.0892)	28	0.070
Soria	-0.145**	(0.0704)	28	0.157
Albacete	-0.226	(0.137)	28	0.102
Zamora	-0.157	(0.105)	28	0.064
Teruel	-0.131	(0.0881)	28	0.101
Spain	-0.530***	(0.0990)	28	0.711
Panel Spain	-0.346***	(0.0168)	1,400	0.315

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Figure 2 clearly shows a different unemployment response among provinces between and within regions. Provinces such as Madrid, Barcelona, Valencia, Sevilla, Málaga, Murcia, Cádiz, Las Palmas and Baleares show the highest levels of unemployment sensitivity to economic variations. These provinces present high levels of economic activity and labour force participation. In contrast, the peninsular centre, excepting Madrid, remains the geographical area where lower effects of GDP shocks on unemployment are observed. This area shows a very ageing population and low levels of economic activity. Figure 2 also highlights a north-south distinction. The south of Spain is a traditionally depressed area that shows high unemployment rates whereas peninsular north performs relatively better. The industrial structure in these areas also differs to a great extent. Northern provinces show higher shares of employment in manufacturing while in southern economies, service sector plays a more relevant role.

FIGURE 2: UNEMPLOYMENT SENSITIVITY TO ECONOMIC VARIATIONS



Furthermore, panel estimation indicates that one percentage point of GDP variation is accompanied by an unemployment rate change in the opposite direction that is quantified by 0.346 percentage points. This value is not comparable to that obtained from the national data of Spain, which is significantly higher. Such difference is due to panel estimation gives equal weight to all regions and 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. The great difference between the national and panel estimations also highlights the great heterogeneity that Spanish provinces show in terms of unemployment sensitivity.

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[12]. The orthogonal IRF representations for all Spanish provinces are reported in Figure 3. The effect of GDP growth shocks is observed for 10 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

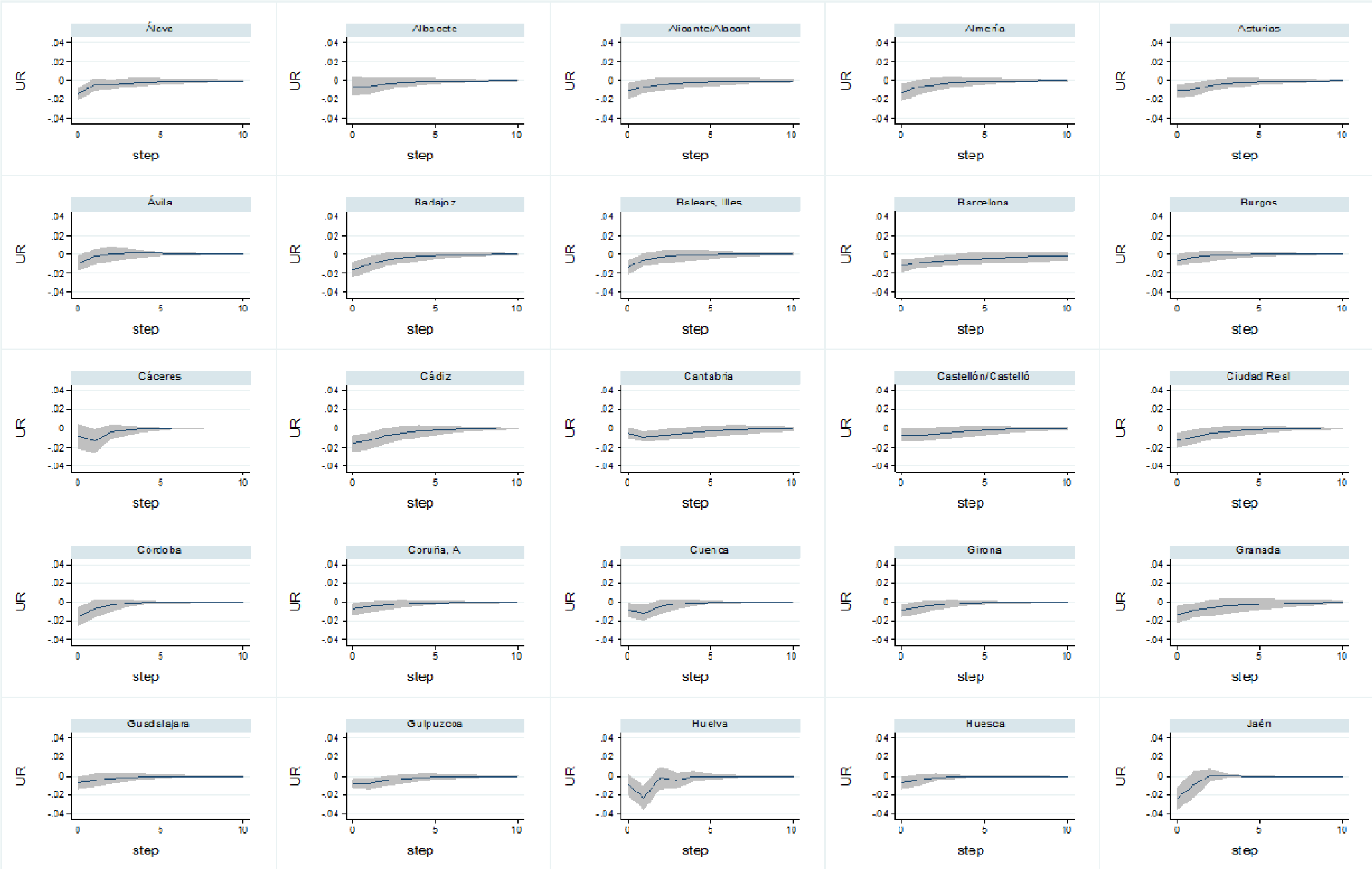
[12] The ordering of the variables in the VAR model could determine the results obtained. For this reason, and in order to check GDP growth causes unemployment rate variations for most provinces, we show the results obtained when we change the ordering of the variables in the Appendix 5.

and the persistence varies across provinces. In provinces such as Illes Balears, Jaén and Málaga, the initial effect of shocks is very sharp, whereas in Asturias, Barcelona and Cantabria, 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 Palencia, Soria 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, 6 and 10 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 10. We get results comparable to those obtained in the estimation of the Okun's law difference version. We can see in the first positions of the table the provinces for which the Okun's difference version acknowledged a higher impact of GDP on unemployment. The bottom is composed of the provinces for which the Okun's coefficient was relatively low or not significant.

Figure 4 gathers, in a clearer way, the cumulative effect of GDP growth shocks on unemployment. In this case, Illes Balears and Málaga do not fall among the provinces with higher sensitivity to GDP shifts. Contrarily, Asturias, Cantabria, Castellón and some southern provinces join this group. The peninsular centre remains the geographical area where lower effects of GDP shocks on unemployment are observed.

FIGURE 3. PROVINCIAL OIRF REPRESENTATIONS



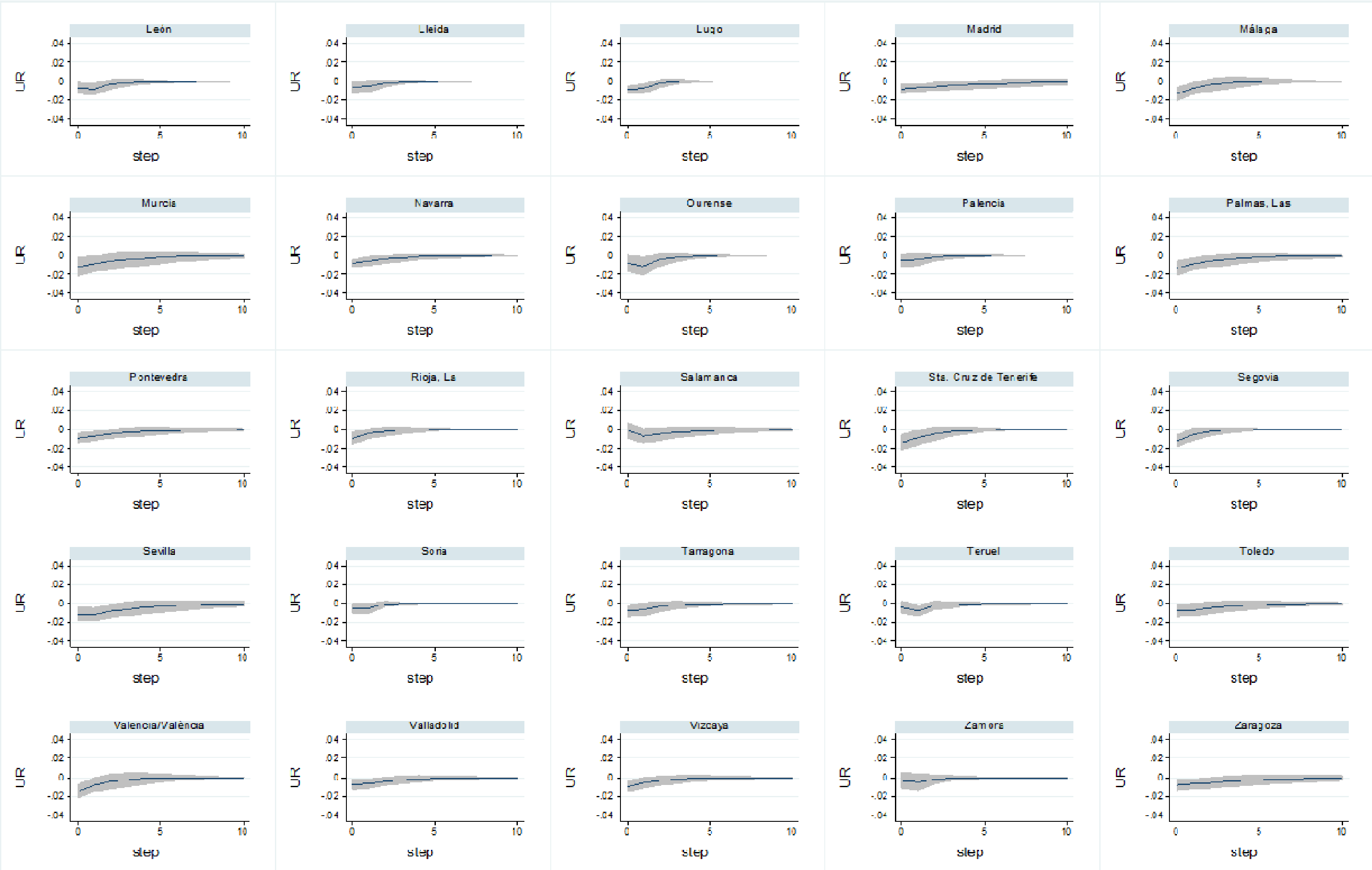
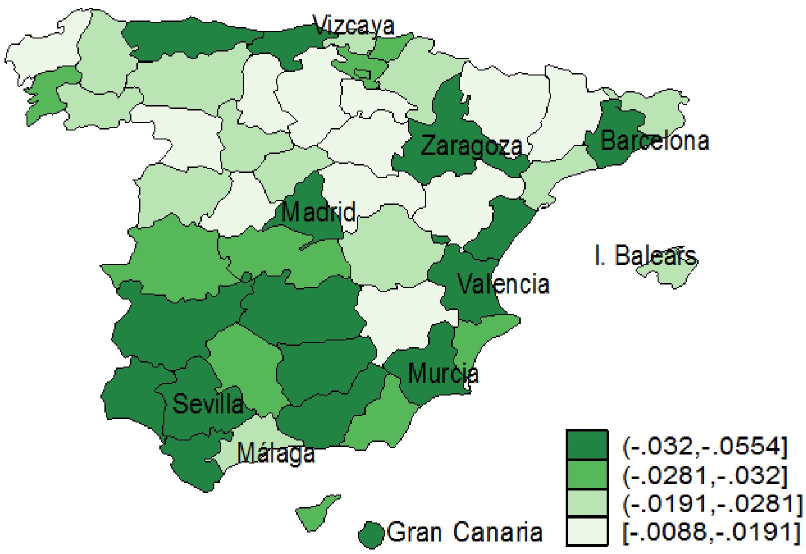

León
Lleida
Lugo
Madrid
Málaga
Murcia
Navarra
Ourense
Palencia
Palmas, Las
Pontevedra
Rioja, La
Salamanca
Sta. Cruz de Tenerife
Segovia
Sevilla
Soria
Tarragona
Teruel
Toledo
Valencia/València
Valladolid
Vizcaya
Zamora
Zaragoza
UR
step

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

Unemployment rate (First Difference)					
Provinces	0	2	4	6	10
Barcelona	-0.01174	-0.02836	-0.03943	-0.04691	-0.05539
Sevilla	-0.01140	-0.03120	-0.04143	-0.04682	-0.05116
Cádiz	-0.01613	-0.03727	-0.04552	-0.04880	-0.05063
Palmas, Las	-0.01382	-0.02903	-0.03658	-0.04055	-0.04377
Murcia	-0.01207	-0.02706	-0.03499	-0.03919	-0.04260
Granada	-0.01302	-0.02810	-0.03548	-0.03912	-0.04181
Huelva	-0.00896	-0.03433	-0.03995	-0.04120	-0.04154
Cantabria	-0.00515	-0.02196	-0.03205	-0.03735	-0.04152
Badajoz	-0.01568	-0.03169	-0.03725	-0.03920	-0.04012
Madrid	-0.00812	-0.02042	-0.02859	-0.03401	-0.03998
Zaragoza	-0.00761	-0.01984	-0.02770	-0.03262	-0.03760
Ciudad Real	-0.01276	-0.02772	-0.03370	-0.03612	-0.03750
Castellón/Castelló	-0.00741	-0.02070	-0.02804	-0.03180	-0.03468
Jaén	-0.02407	-0.03293	-0.03260	-0.03261	-0.03261
Asturias	-0.01084	-0.02520	-0.03005	-0.03175	-0.03254
Valencia/València	-0.01454	-0.02673	-0.03042	-0.03156	-0.03203
Santa Cruz de Tenerife	-0.01341	-0.02638	-0.02996	-0.03092	-0.03125
Pontevedra	-0.00889	-0.02017	-0.02581	-0.02863	-0.03075
Álava	-0.01452	-0.02327	-0.02736	-0.02912	-0.03018
Alicante/Alacant	-0.01104	-0.02149	-0.02630	-0.02858	-0.03017
Toledo	-0.00785	-0.01958	-0.02508	-0.02766	-0.02944
Cáceres	-0.00802	-0.02534	-0.02848	-0.02909	-0.02924
Almería	-0.01253	-0.02347	-0.02711	-0.02832	-0.02886
Guipuzcoa	-0.00771	-0.02123	-0.02623	-0.02795	-0.02874
Córdoba	-0.01565	-0.02594	-0.02776	-0.02808	-0.02815
Ourense	-0.00810	-0.02389	-0.02716	-0.02788	-0.02807
Cuenca	-0.00807	-0.02422	-0.02712	-0.02763	-0.02774
Málaga	-0.01350	-0.02475	-0.02733	-0.02764	-0.02748
Navarra	-0.00819	-0.01830	-0.02246	-0.02417	-0.02515
Balears, Illes	-0.01354	-0.02238	-0.02421	-0.02461	-0.02474
Valladolid	-0.00725	-0.01766	-0.02188	-0.02364	-0.02469
Vizcaya	-0.00926	-0.01815	-0.02160	-0.02294	-0.02366
Salamanca	-0.00114	-0.01291	-0.01872	-0.02147	-0.02339
Tarragona	-0.00820	-0.01784	-0.02080	-0.02171	-0.02208
Segovia	-0.01249	-0.02009	-0.02162	-0.02192	-0.02199
León	-0.00720	-0.01837	-0.02088	-0.02148	-0.02166
Girona	-0.00881	-0.01766	-0.02029	-0.02107	-0.02138
Lugo	-0.00887	-0.01889	-0.01917	-0.01911	-0.01911
Albacete	-0.00591	-0.01486	-0.01778	-0.01869	-0.01907
Coruña, A	-0.00720	-0.01499	-0.01768	-0.01860	-0.01903
Guadalajara	-0.00738	-0.01479	-0.01719	-0.01792	-0.01820
Rioja, La	-0.00935	-0.01538	-0.01704	-0.01751	-0.01769
Teruel	-0.00404	-0.01363	-0.01614	-0.01683	-0.01707
Lleida	-0.00656	-0.01386	-0.01518	-0.01544	-0.01549
Huesca	-0.00725	-0.01324	-0.01427	-0.01445	-0.01449
Palencia	-0.00552	-0.01171	-0.01318	-0.01355	-0.01366
Burgos	-0.00643	-0.01135	-0.01264	-0.01298	-0.01310
Zamora	-0.00300	-0.01010	-0.01154	-0.01184	-0.01192
Soria	-0.00509	-0.01069	-0.01114	-0.01117	-0.01118
Ávila	-0.00958	-0.01163	-0.00993	-0.00908	-0.00881
Spain	-0.01258	-0.02647	-0.03497	-0.04125	-0.05001

FIGURE 4: UNEMPLOYMENT SENSITIVITY TO ECONOMIC SHOCKS: CUMMULATIVE EFFECT AFTER 10 PERIODS



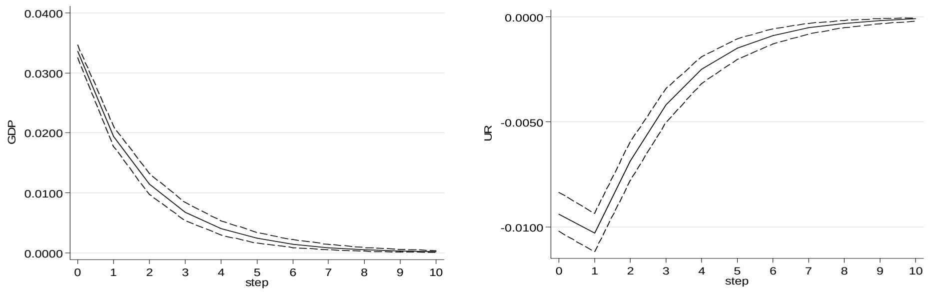
After observing for all provinces the effect of economic growth shocks, we apply the PVAR technique to observe the effect of shocks for the panel that integrates all Spanish provinces. It should be mentioned that variables have been orthogonalized such that an economic growth shock affects unemployment rate contemporaneously, but the effect of an unemployment rate growth shock on economic growth takes place after one period. Results from the PVAR analysis can be observed in Figure 5. 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. In this figure, we observe that the effect of a GDP growth shock on unemployment peak after one period and then the effect decreases to zero.

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

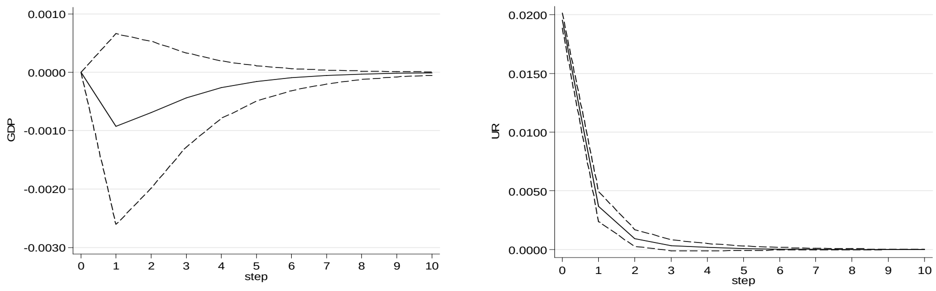
	0	2	4	6	10
UR response to a UR Shock	0.0195	0.0241	0.0247	0.0249	0.0249
GDP response to a UR Shock	0	-0.0016	-0.0023	-0.0026	-0.0027
UR response to a GDP Shock	-0.0094	-0.0266	-0.0333	-0.0357	-0.0368
GDP response to a GDP Shock	0.0336	0.0644	0.0752	0.079	0.0808

FIGURE 5: RESPONSE TO SHOCKS FOR THE PANEL OF PROVINCES

Response to GDP growth shocks



Response to shocks in unemployment rate variation



4.3. The factors determining unemployment sensitivity

Once we have checked the heterogeneity among provinces regarding the effect of growth in unemployment, it is also interesting to determine the underlying causes behind this different degree of unemployment response to economic variations. In this regard, only a few studies have analysed the factors affecting unemployment sensitivity at regional level. Herwartz and Niebuhr (2011), in an analysis for EU15 regions, obtain that regional factors such as industrial composition, employment density, regional age structure and the role of trade unions influence unemployment responsiveness. Authors such as Robson (2009), Gali et al. (2012) and Dixon and Shepherd (2013) also find evidence on the influencing role of industrial structure, whereas Congregado et al. (2011) focuses on the effect that labour market participation exerts on unemployment over the cycle.

In our analysis, we take into account these variables[13] to analyse the differences between Spanish provinces on unemployment sensitivity. Disparities on labour force participation and regional industry composition in terms of employment, besides urban and geographical variables[14], are included in the analysis as potential determinants of unemployment sensitivity[15].

The estimation is performed using the weighted least squares methodology (WLS). This methodology allows us to consider the standard errors of the unemployment sensitivity estimation by OLS as weights to perform a more efficient estimation of the influencing factors. Thereby, we give more influence to the provinces for which unemployment sensitivity has been more precisely measured. Table 4 shows the estimation results. Several combinations of variables have been considered in order to avoid the multicollinearity problem, which arises when certain correlated variables are considered at the same time. As it is shown in Table 4, levels of industrial diversification[16] as well as variables related to industry composition significantly affect unemployment sensitivity to economic growth. Labour activity and the urban dummy have also been found influencing factors. Besides, geographical controls are also significant. The results point out that the provinces that show a lower level of diversification in its industry structure suffer to a higher extent from the effect of shocks on unemployment, thus diversified industries keep unemployment more stable to economic shocks. Regarding the industry mix composition, a higher share of employment in services and manufacturing is positively related to unemployment sensitivity. The opposite occurs when we consider the share of employment in agriculture. The high magnitude of the services coefficient points towards a higher response of unemployment in provinces such as Madrid, Barcelona, Valencia, Sevilla and Baleares, among others, which show a

[13] Detailed information about the required data sets, the components and the sources of information are compiled in the table 5 in the Appendix 2.

[14] Urban, south and coast are dummy variables. Urban variable takes the value 1 if one of the ten biggest Spanish municipalities is located in the province; and 0 otherwise. South variable takes the value 1 for the provinces belonging to Andalucía, Extremadura, Castile-La Mancha and Canary Islands NUTS 2 regions; and 0 otherwise. These regions are located in the south of Spain and are those that have traditionally had higher rates of unemployment over the years. Finally, coast takes the value 1 if the province is located in the coast; and 0 otherwise.

[15] In addition to these variables, we consider wages, levels of education, trade unions and the employment share in the public sector as independent variables in the analysis. Results point out that these variables do not significantly affect unemployment sensitivity.

[16] Diversification index is expressed as: $D_i = -\sum_{j=1}^{J}\left[\frac{X_{ij}}{X_i}\ln(\frac{X_{ij}}{X_i})\right]$, where X_{ij} represents the total employment in industry j and province i, whereas X_i is the total employment in province i.

high share of employment in services. As opposed, provinces in the peninsular centre of Spain, which show the lowest levels of unemployment sensitivity, have a relatively high share of employment in agriculture and lower levels of employment in services and industry. Moreover, with respect to labour market variables, we find that labour force participation display a significant role as determinant of unemployment sensitivity. The positive sign of the estimated coefficient and its high magnitude show that those provinces with a higher active population rate suffer to a greater extent from the effects of economic variations on unemployment. Besides, the urban dummy has been also found significant and its positive sign indicates that unemployment sensitivity is higher in provinces with bigger cities, although the magnitude of the coefficient implies that the effect is not very high. Geographical controls also point out to higher unemployment sensitivity in the southern and coastal provinces.

TABLE 4: WEIGHTED LEAST SQUARE REGRESSION MODEL

Variables	Dep variable: Unemployment Sensitivity to GDP Shocks				
	(1)	(2)	(3)	(4)	(5)
Divers. Index	-0.250*				
	(0.134)				
LFP		0.727**			
		(0.329)			
Agric.			-0.558**		
			(0.241)		
Manuf.				0.273*	
				(0.143)	
Serv.					0.611***
					(0.191)
Urban	0.0835**	0.122***			
	(0.0400)	(0.0253)			
South		0.0964***	0.0876***	0.0996***	0.0389**
		(0.0140)	(0.0207)	(0.0224)	(0.0162)
Coast	0.0565**		0.0589*	0.0758**	0.0579*
	(0.0230)		(0.0284)	(0.0289)	(0.0319)
Constant	0.574***	-0.0810	0.370***	0.237***	-0.0460
	(0.153)	(0.173)	(0.0342)	(0.0388)	(0.107)
Observations	50	50	50	50	50
R-squared	0.438	0.488	0.402	0.282	0.392

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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 2013. This analysis has been carried out considering the Okun's law difference version and the VAR and panel VAR methodology.

The results obtained in this study stress the importance of analysing unemployment sensitivity at provincial level. We find that provinces within regions show a different response in unemployment rate with respect to GDP variations. Our analysis provides more information than previous studies for Spain, which considered the region (NUTS 2) as its geographical scope of analysis. Moreover, we obtain that provinces like Madrid, Barcelona, Valencia and Sevilla are among those which suffer to a higher extent from the effect of economic shocks on unemployment. In contrast, 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 show the great differences within Spanish territory in the unemployment sensitivity to output variations.

An analysis of the underlying causes behind this different degree of unemployment response to economic variations highlights that industry composition as well as labour force participation are the main determinants of this different unemployment response to economic variations. Provinces that show higher shares of employment in services and manufacturing suffer to a greater extent from the effect of economic shocks. Besides, higher levels of labour force participation also boost unemployment sensitivity whereas industrial diversification reduces the effect of economic shocks on unemployment.

These results are interesting from the economic policy perspective as in some provinces active population is suffering to a higher extent from the effects of the business cycle, whereas there are other provinces less affected by the economic contingencies. In addition, provinces within the same autonomous communities are heterogeneous in their unemployment sensitivity, which is also relevant from the policy perspective as the main decisions about employment are taken at the national and autonomous community levels and our results suggest that policy makers should consider the local labour markets peculiarities and apply differentiated policies.

In our future research we will continue analysing the unemployment sensitivity phenomenon in Spain. One research line that we aim to explore regards the inclusion of spatial spillovers in the Okun's law regression. The significance of the urban and geographical controls in the analysis of the underlying causes of the unemployment sensitivity differences among provinces highlights that spatial effects may have some influence. Thus, identifying the effect that provincial economic variations may have on the neighboring provinces unemployment resulting from commuting flows, migration and trade may also provide interesting results to consider in the policy recommendations.

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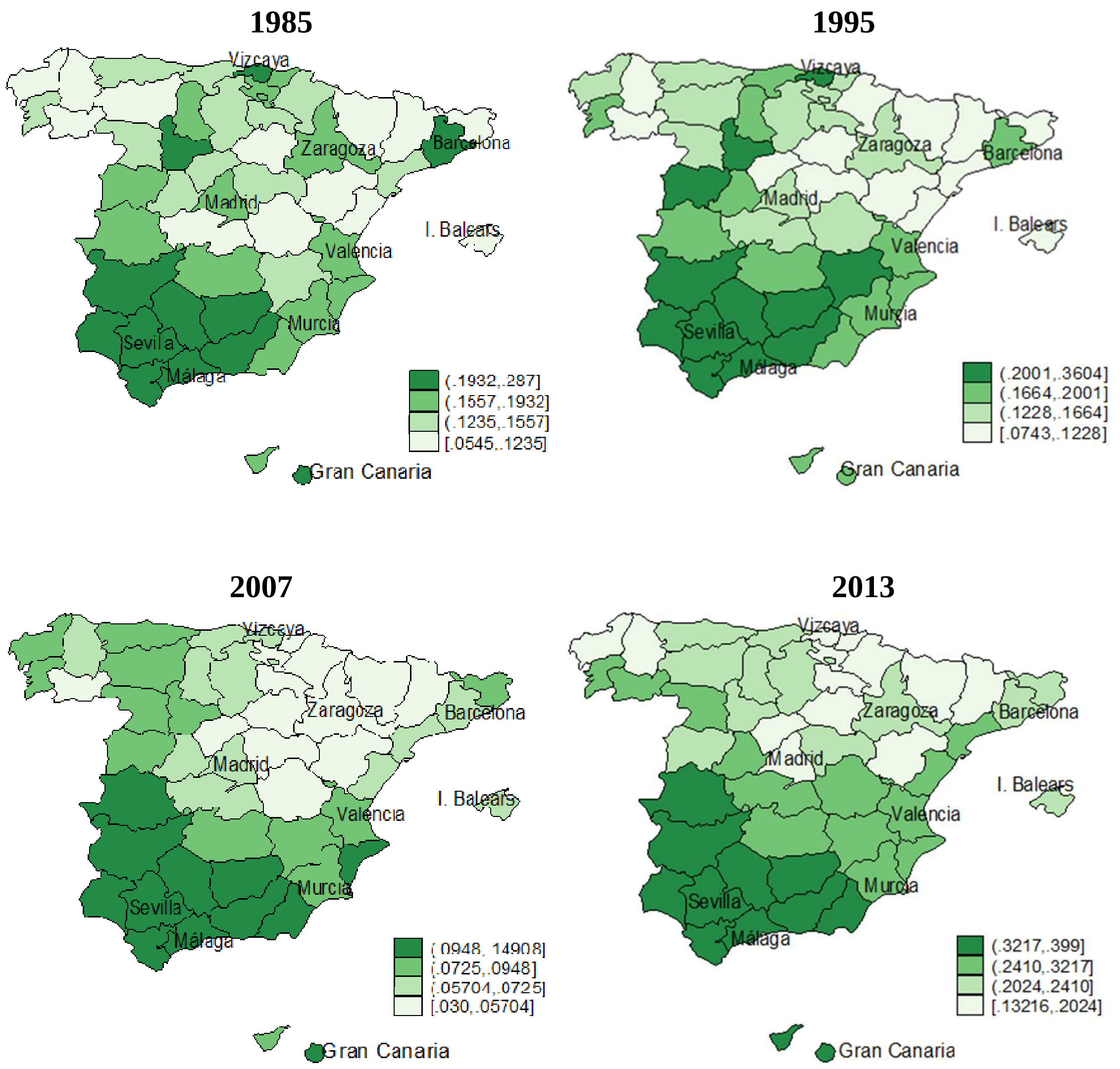
Appendix 1

FIGURE 2: REGIONAL UNEMPLOYMENT RATES



Appendix 2

TABLE 5: 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
Working Age Population	Working age population is the overall number of people aged 16 and older.	-	EPA
Industry Structure	The industrial structure is a measure of the relative importance of each economic sector in the economy. It is calculated by dividing the number of people employed in each economic sector by total employment.	-	EPA

Appendix 3:

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.[17]

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

[17] 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[18] 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[19] 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 6. 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 provincial series in first differences at the conventional levels of significance. When we test the first differenced unemployment rate variable, we find that none of tests can reject the null hypothesis of the presence of unit roots for any province. In the case of GDP, in 18 of the 50 provinces both tests find problems in rejecting the null hypothesis. These exceptions

[18] 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.

[19] Unit root tests of the variables in levels are available from the author on request.

may be due to the presence of structural 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 7 and 8 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. The same occurs for the national data series. After performing Clemente-Montañés-Reyes tests, we observe that both GDP and unemployment rate series can be considered stationay if we take into account an innovative break in 2006, 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 9. 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 6: ADF AND PP UNIT ROOT TESTS OVER VARIABLES IN FD

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	-4.605***	NT,C	-4.583***	NT,C,0L	-2.331	NT,C	-2.308
Albacete	NT,C,0L	-3.469***	NT,C	-3.474***	T,C,0L	-4.649***	T,C	-4.638***
Alicante/Alacant	NT,C,0L	-3.374**	NT,C	-3.312**	T,C,0L	-2.786	T,C	-2.838
Almería	NT,C,0L	-3.371**	NT,C	-3.322***	T,C,0L	-3.368*	T,C	-3.397**
Asturias	NT,C,0L	-3.751**	NT,C	-3.722***	NT,C,0L	-2.477	NT,C	-2.368
Ávila	NT,C,0L	-2.715*	NT,C	-2.809*	T,C,0L	-3.613**	T,C	-3.653**
Badajoz	NT,C,0L	-3.713***	NT,C	-3.728***	T,C,0L	-3.366*	T,C	-3.474**
Balears, Illes	NT,C,0L	-3.065*	NT,C	-3.088**	T,C,0L	-2.922	T,C	-3.021
Barcelona	NT,C,0L	-2.897**	NT,C	-2.914**	NT,C,0L	-1.522	NT,C	-1.545
Burgos	T,C,1L	-4.057**	NT,C	-3.065**	T,C,0L	-3.136*	T,C	-3.120*
Cáceres	NT,C,0L	-5.432***	NT,C	-5.432***	NT,C,0L	-3.084**	NT,C	-3.113**
Cádiz	NT,C,0L	-2.978*	NT,C	-2.994**	NT,C,0L	-2.585*	NT,C	-2.574*
Cantabria	NT,C,0L	-2.806*	NT,C	-2.868**	T,C,0L	-2.782	T,C	-2.909
Castellón/Castelló	T,C,1L	-3.328*	T,C	-2.384	NT,C,0L	-2.772*	NT,C	-2.864**
Ciudad Real	NT,C,0L	-3.382**	NT,C	-3.314**	NT,C,0L	-2.145	NT,C	-1.927
Córdoba	NT,C,0L	-3.547***	NT,C	-3.592***	T,C,0L	-4.357***	T,C	-4.414***
Coruña, A	NT,C,0L	-3.421**	NT,C	-3.436***	NT,C,0L	-2.566*	NT,C	-2.444
Cuenca	T,C,0L	-3.404*	T,C	-3.307*	T,C,0L	-4.342***	T,C	-4.339***
Girona	NT,C,0L	-3.503***	NT,C	-3.511***	NT,C,0L	-2.757*	NT,C	-2.689*
Granada	NT,C,0L	-2.744*	NT,C	-2.742*	NT,C,0L	-1.943	NT,C	-1.892
Guadalajara	NT,C,0L	-2.869**	NT,C	-2.869**	NT,C,0L	-2.937**	NT,C	-2.980*
Guipúzcoa	NT,C,0L	-3.297**	NT,C	-3.335**	T,C,0L	-2.757	T,C	-2.785
Huelva	NT,C,0L	-4.890***	NT,C	-4.894***	NT,C,0L	-3.430***	NT,C	-3.491***
Huesca	T,C,1L	-4.617*	T,C	-4.308***	NT,C,0L	-3.836***	NT,C	-3.886***
Jaén	NT,C,0L	-4.230***	NT,C	-4.250***	T,C,0L	-5.738***	T,C	-5.763***
León	NT,C,0L	-3.398**	NT,C	-3.348**	T,C,0L	-4.162***	T,C	-4.239***
Lleida	NT,C,0L	-4.297***	NT,C	-4.270***	T,C,0L	-3.833**	T,C	-3.832**
Lugo	NT,C,0L	-3.087**	NT,C	-3.041**	T,C,0L	-4.174***	T,C	-4.226***
Madrid	NT,C,0L	-2.567*	NT,C	-2.55	NT,C,0L	-1.709	NT,C	-1.84
Málaga	NT,C,0L	-2.545	NT,C	-2.603*	NT,C,0L	-2.414	NT,C	-2.467
Murcia	NT,C,0L	-2.781*	NT,C	-2.866**	NT,C,0L	-1.777	NT,C	-1.768
Navarra	T,C,0L	-3.423**	T,C	-3.368*	NT,C,0L	-2.705*	NT,C	-2.632*
Ourense	NT,C,0L	-3.738***	NT,C	-3.775***	T,C,0L	-4.029***	T,C	-4.084***
Palencia	NT,C,0L	-3.356**	NT,C	-3.361**	T,C,0L	-4.504***	T,C	-4.593***
Palmas, Las	NT,C,0L	-2.773*	NT,C	-2.729*	NT,C,0L	-2.282	NT,C	-2.297
Pontevedra	NT,C,0L	-2.662*	NT,C	-2.751*	NT,C,0L	-2.072	NT,C	-2.164
Rioja, La	NT,C,0L	-3.543***	NT,C	-3.536***	T,C,0L	-3.530**	T,C	-3.538**
Salamanca	NT,C,0L	-3.976***	NT,C	-3.962***	T,C,0L	-3.489**	T,C	-3.540**
Sta. Cruz deTenerife	NT,C,0L	-3.285**	NT,C	-3.259**	T,C,0L	-3.952**	T,C	-3.999***
Segovia	NT,C,0L	-4.109***	NT,C	-4.073***	T,C,0L	-3.769**	T,C	-3.789**
Sevilla	NT,C,0L	-2.519	NT,C	-2.586*	T,C,0L	-2.849	T,C	-2.881
Soria	T,C,0L	-4.722***	T,C	-4.711***	T,C,0L	-5.764***	T,C	-5.758***
Tarragona	T,C,0L	-3.425***	T,C	-3.387*	NT,C,0L	-3.515***	NT,C	-3.535***
Teruel	NT,C,0L	-3.737***	NT,C	-3.878***	T,C,0L	-4.581***	T,C	-4.577***
Toledo	NT,C,0L	-2.598*	NT,C	-2.564	T,C,0L	-3.250*	T,C	-3.417**
Valencia/València	NT,C,0L	-2.788*	NT,C	-2.813*	NT,C,0L	-2.007	NT,C	-1.922
Valladolid	NT,C,0L	-3.156**	NT,C	-3.171**	T,C,0L	-3.580**	T,C	-3.513**
Vizcaya	NT,C,0L	-3.557***	NT,C	-3.548***	NT,C,0L	-2.203	NT,C	-2.241
Zamora	NT,C,0L	-3.708***	NT,C	-3.659***	T,C,0L	-4.519***	T,C	-4.521***
Zaragoza	NT,C,0L	-2.636*	NT,C	-2.621*	NT,C,0L	-1.694	NT,C	-1.655
Spain	NT,C, 0L	-2.347	NT,C	-2.396	NT,C,0L	-1.124	NT,C	-1.208

NT: No trend; T: Trend; NC: No Intercept; C: Intercept; 0L: 0 lags included; 1L: 1 lag included; 2L: 2 lags included.
*** p<0.01, ** p<0.05, * p<0.

TABLE 7: UNIT ROOT TESTS OVER FIRST DIFFERENCED UR

Province	Zivot- Andrews			Clemente-Montañés-Reyes						
	t-statistic	Year	Outlier	t-statistic	Year 1	Year 2	Outlier	t-statistic	Year 1	Year 2
Álava	-6.476***	1995	1 AO	-2.508	2005		2 IO	-7.412**	1993	2007
Albacete	-5.113**	1994	1 AO	-4.703**	2005		2 IO	-5.679**	1992	2007
Alicante/Alacant	-4.702*	1995	1 AO	-3.199	2007		1 IO	-4.175	2006	
Almería	-5.153**	2007	1 AO	-2.734	2005		1 IO	-4.448**	2006	
Asturias	-5.748***	2009	1 AO	-5.162**	2006		2 IO	-4.626	2000	2007
Ávila	-3.707	2008	1 AO	-3.565**	2004		1 IO	-3.544	2006	
Badajoz	-5.648***	2008	1 AO	-4.890**	2005		1 IO	-5.656**	2007	
Balears, Illes	-3.641	1994	1 AO	-6.197**	2007		1 IO	-3.562	2006	
Barcelona	-3.767	1995	0 AO				1 IO	-4.155	2006	
Burgos	-5.989***	2008	1 AO	-6.001**	2005		1 IO	-4.086	2006	
Cáceres	-6.872***	2008	1 AO	-7.032**	2007		1 IO	-6.762**	2007	
Cádiz	-5.196**	2008	2 AO	-5.788**	1995	2007	2 IO	-5.859**	1993	2006
Cantabria	-4.573*	1997	1 AO	-3.324	2010		2 IO	-6.221**	1995	2007
Castellón/Castelló	-4.615*	2008	1 AO	-1.925	2007		1 IO	-4.570**	2006	
Ciudad Real	-5.037**	2008	1 AO	-4.346**	2005		1 IO	-6.733**	2006	
Córdoba	-5.323**	2008	1 AO	-3.681**	2007		2 IO	-3.026	1998	2007
Coruña, A	-4.646*	1995	1 AO	-4.280**	2008		2 IO	-5.124	2003	2007
Cuenca	-5.379***	2009	1 AO	-6.002**	2005		1 IO	-16.499**	2007	
Girona	-4.421	1995	1 AO	-3.162	2007		1 IO	-4.351**	2006	
Granada	-4.489	2007	1 AO	-3.751**	2004		2 IO	-4.815	1996	2006
Guadalajara	-5.252**	2008	1 AO	-2.481	2005		1 IO	-5.145**	2006	
Guipuzcoa	-4.933**	1995	1 AO	-4.065**	2005		1 IO	-4.081	2007	
Huelva	-6.066***	2008	1 AO	-6.128**	2007		1 IO	-5.955**	2006	
Huesca	-6.542***	1997	0 AO				1 IO	-4.832**	2006	
Jaén	-6.248***	1997	2 AO	-5.198	1996	2007	1 IO	-5.678**	2007	
León	-5.575***	2008	1 AO	-4.282**	2006		2 IO	-5.571**	1998	2007
Lleida	-5.702***	2008	1 AO	-4.495**	2005		1 IO	-6.537**	2006	
Lugo	-2.866	2009	2 AO	-6.071**	1996	2008	1 IO	-2.043	2007	
Madrid	-3.914	1997	1 AO	-3.379	2005		1 IO	-3.397	2006	
Málaga	-4.052	2008	1 AO	-3.413	2005		1 IO	-29.904**	2006	
Murcia	-4.116	2008	1 AO	-3.376	2005		1 IO	-3.961	2006	
Navarra	-3.338	1996	1 AO	-4.938**	2005		1 IO	-4.977**	2006	
Ourense	-5.852***	2000	0 AO				2 IO	-3.080	2000	2006
Palencia	-5.319**	1997	1 AO	-4.650**	2005		1 IO	-4.696**	2006	
Palmas, Las	-4.234	2008	1 AO	-3.895**	2005		1 IO	-6.479**	2006	
Pontevedra	-4.351	2008	1 AO	-3.332	2009		1 IO	-3.919	2006	
Rioja, La	-5.29**	1996	1 AO	-4.812**	2005		1 IO	-5.452**	2006	
Salamanca	-5.001**	1995	1 AO	-4.354**	2005		2 IO	-5.415	1993	2006
Sta. Cruz de Tenerife	-5.429***	2008	1 AO	-5.280**	2005		1 IO	-5.290**	2006	
Segovia	-5.282**	2008	2 AO	-5.563**	1990	2005	2 IO	-5.899**	1989	2006
Sevilla	-3.688	2008	1 AO	-4.126**	2007		1 IO	-3.639	2006	
Soria	-6.655***	2009	1 AO	-6.197**	2006		1 IO	-6.680**	2007	
Tarragona	-4.838**	2008	1 AO	-4.199**	2005		1 IO	-4.463**	2006	
Teruel	-4.222	1997	1 AO	-5.266**	2005		1 IO	-5.462**	2006	
Toledo	-5.103**	2008	1 AO	-4.725**	2009		1 IO	-5.480**	2006	
Valencia/València	-3.707	1995	1 AO	-2.774	2007		1 IO	-3.622	2006	
Valladolid	-4.911**	2008	1 AO	-0.063	2005		1 IO	-4.768**	2006	
Vizcaya	-5.469***	1996	1 AO	-4.253**	2005		1 IO	-4.633**	2007	
Zamora	-5.446***	2009	1 AO	-5.203**	2008		2 IO	-7.234**	1996	2007
Zaragoza	-4.471	1995	1 AO	-3.5732	2006		1 IO	-4.331**	2006	
Spain	-3.812	2008	1 AO	-3.001	2005		1 IO	-4.564**	2006	

NT: No trend; T: Trend; NC: No Intercept; C: Intercept; 0L: 0 lags included; 1L: 1 lag included; 2L: 2 lags included.
Zivot - Andrews Test: *** p<0.01, ** p<0.05, * p<0.1
Clemente -Montañés-Reyes Test: ** p<0.05

TABLE 7: UNIT ROOT TESTS ASSUMING STRUCTURAL BREAKS OVER FD 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	-4.913**	2008	2 AO	-4.011	1996	2008	1 IO	-98.001**	2007	
Albacete	-6.456***	1998	1 AO	-5.347**	2007		1 IO	-2.718	2008	
Alicante/Alacant	-4.85**	2008	2 AO	-4.353	2005	2009	1 IO	-4.905**	2006	
Almería	-5.366***	1996	1 AO	-4.425**	2005		1 IO	-5.469**	2006	
Asturias	-3.305	2009	1 AO	-4.960**	2009		2 IO	-4.022	1996	2007
Ávila	-5.076**	1998	1 AO	-4.640**	2009		2 IO	-6.031**	1988	2006
Badajoz	-4.973**	1996	1 AO	-3.710**	2005		1 IO	-4.138	2007	
Balears, Illes	-4.916**	1997	1 AO	-3.450	2009		1 IO	-4.281**	2006	
Barcelona	-3.549	2008	2 AO	-4.499	1990	2009	2 IO	-4.715	1988	2006
Burgos	-5.027**	2009	1 AO	-2.499	2008		1 IO	0.725	2007	
Cáceres	-5.812***	1999	1 AO	-3.601**	2009		0 IO			
Cádiz	-5.078**	2008	1 AO	-3.524	2009		1 IO	-4.176	2006	
Cantabria	-4.422	1997	1 AO	-3.726**	2009		1 IO	1.821	2006	
Castellón/Castelló	-4.802**	2007	1 AO	-4.356**	2008		1 IO	-4.280**	2007	
Ciudad Real	-4.76*	1997	1 AO	-3.885**	2009		1 IO	-3.704	2006	
Córdoba	-5.762***	1998	1 AO	-17.427**	2009		1 IO	-4.953**	2006	
Coruña, A	-4.611*	2008	1 AO	-4.834**	2009		0 IO			
Cuenca	-5.295**	2008	1 AO	-4.933**	2009		1 IO	-5.493**	2006	
Girona	-4.58*	2008	1 AO	-5.482**	2008		1 IO	-5.285**	2006	
Granada	-3.858	1997	1 AO	-3.525	2004		1 IO	-3.434	2005	
Guadalajara	-4.59*	1990	1 AO	-3.742**	2009		2 IO	-5.061	1988	2006
Guipuzcoa	-4.787*	2008	1 AO	-3.714**	2009		1 IO	-4.503**	2006	
Huelva	-4.776*	2008	1 AO	-4.926**	2007		1 IO	-3.575	2007	
Huesca	-6.185***	2009	1 AO	-5.604**	2009		2 IO	-6.740**	1997	2007
Jaén	-6.498***	1997	1 AO	-6.739**	2008		1 IO	-6.323**	2008	
León	-3.456	2008	1 AO	-7.473**	2008		1 IO	-6.515**	2008	
Lleida	-4.969**	2009	1 AO	-5.428**	2008		1 IO	-4.998**	2008	
Lugo	-6.148***	2000	1 AO	-4.714**	2009		2 IO	-5.493**	1998	2007
Madrid	-4.14	2008	2 AO	-2.384	1991	2007	1 IO	-3.879	2006	
Málaga	-4.757*	2008	1 AO	-4.095**	2009		2 IO	-5.103	1995	2007
Murcia	-4.155	1997	2 AO	-4.476	1996	2007	1 IO	-3.540	2006	
Navarra	-3.002	2009	2 AO	-5.126	1987	2009	1 IO	-4.217	2007	
Ourense	-6.386***	1999	2 AO	-5.365	1998	2006	1 IO	-5.337**	2007	
Palencia	-5.82***	1998	1 AO	-2.518	2009		1 IO	-2.283	2006	
Palmas, Las	-3.765	1997	1 AO	-3.449	2005		1 IO	-4.060	2006	
Pontevedra	-4.197	2008	1 AO	-3.727**	2009		1 IO	-5.069**	2006	
Rioja, La	-5.829***	2008	1 AO	-5.059**	2009		1 IO	-0.708	2006	
Salamanca	-6.022***	2000	1 AO	-3.208	2007		2 IO	-5.485**	1989	2008
Sta. Cruz de Tenerife	-6***	2008	1 AO	-5.491**	2005		1 IO	-6.101**	2006	
Segovia	-6.018***	1997	1 AO	-4.986**	2005		1 IO	-5.738**	2006	
Sevilla	-4.099	1997	2 AO	-4.540	1991	2007	1 IO	-8.121**	2006	
Soria	-6.792***	2009	1 AO	-3.282	2009		2 IO	-7.344**	1988	2007
Tarragona	-2.101	1996	1 AO	-5.370**	2009		1 IO	-5.233	2007	
Teruel	-5.289***	2009	1 AO	-1.391	1989		1 IO	-5.254**	2007	
Toledo	-4.328	2008	1 AO	-4.204**	2009		1 IO	-4.397**	2006	
Valencia/València	-5.222**	1997	1 AO	-3.834**	2009		2 IO	-5.071	1995	2007
Valladolid	-5.106**	2008	2 AO	-4.601**	2005	2009	1 IO	-3.898	2006	
Vizcaya	-4.226	1997	1 AO	-3.975**	2008		2 IO	-4.613	1995	2007
Zamora	-7.625***	1999	1 AO	-5.155**	2009		1 IO	-5.294**	2006	
Zaragoza	-3.828	2008	2 AO	-4.607	1991	2009	1 IO	-5.291**	2006	
Spain	-3.890	2008	1 AO	-3.029	2009		1 IO	-18.462**	2006	

NT: No trend; T: Trend; NC: No Intercept; C: Intercept; 0L: 0 lags included; 1L: 1 lag included; 2L: 2 lags included.
Zivot - Andrews Test: *** p<0.01, ** p<0.05, * p<0.1
Clemente -Montañés-Reyes Test: ** p<0.05

TABLE 9: PANEL UNIT ROOT TESTS OVER FIRST DIFFERENCED VARIABLES

	Unemployment Rate		GDP NL	
Test	Model	First Diff.	Model	First Diff.
Hadri LM	c, 1lag	-0.8074	c, 0 lag	-1.0089
Levin Lin Chu	c, 1lag	-14.32***	c, 0 lag	-32.5249***
Im Pesaran Shin	c, 1lag	-17.7655***	c, 0 lag	-33.2857***
Fisher Type (conducted as a ADF)	c, 1lag	-19.5317***	c, 0 lag	-33.6617***

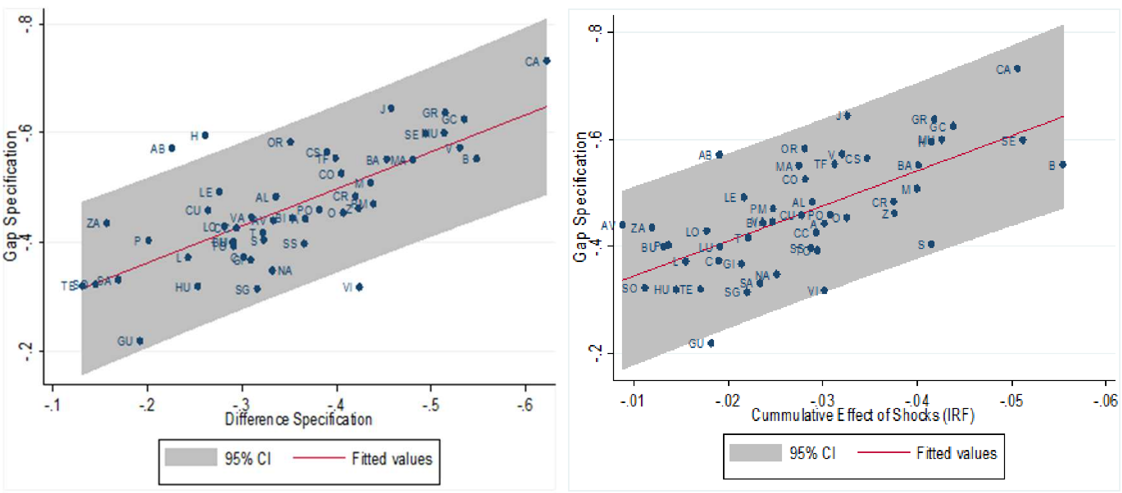
C: intercept included; 1lag: 1 lag included.

*** p<0.01, ** p<0.05, * p<0.1

Appendix 4

As can be observed in Figure 7, Okun's law gap version provides us a similar ordering of provinces to the version in first differences and the VAR model estimated with the first differenced data. When we compare gap and first differences specifications, we can only observe sizable differences for the Álava (VI), Albacete (AB) and Huelva (H) provinces. Gap version estimates for Albacete and Huelva a higher coefficient. The opposite occurs for Álava. With respect to the differences between the gap specification results and the results of the IRF obtained using a VAR model, we can observe notable differences for the Albacete (AB) and Guadalajara (GU). For the first province, the coefficient estimated by Okun's law gap version points out to a higher unemployment response than the results of IRFs whereas the opposite is obtained for Guadalajara.

FIGURE 7: COMPARING THE ESTIMATION RESULTS TO GAP SPECIFICATION RESULTS

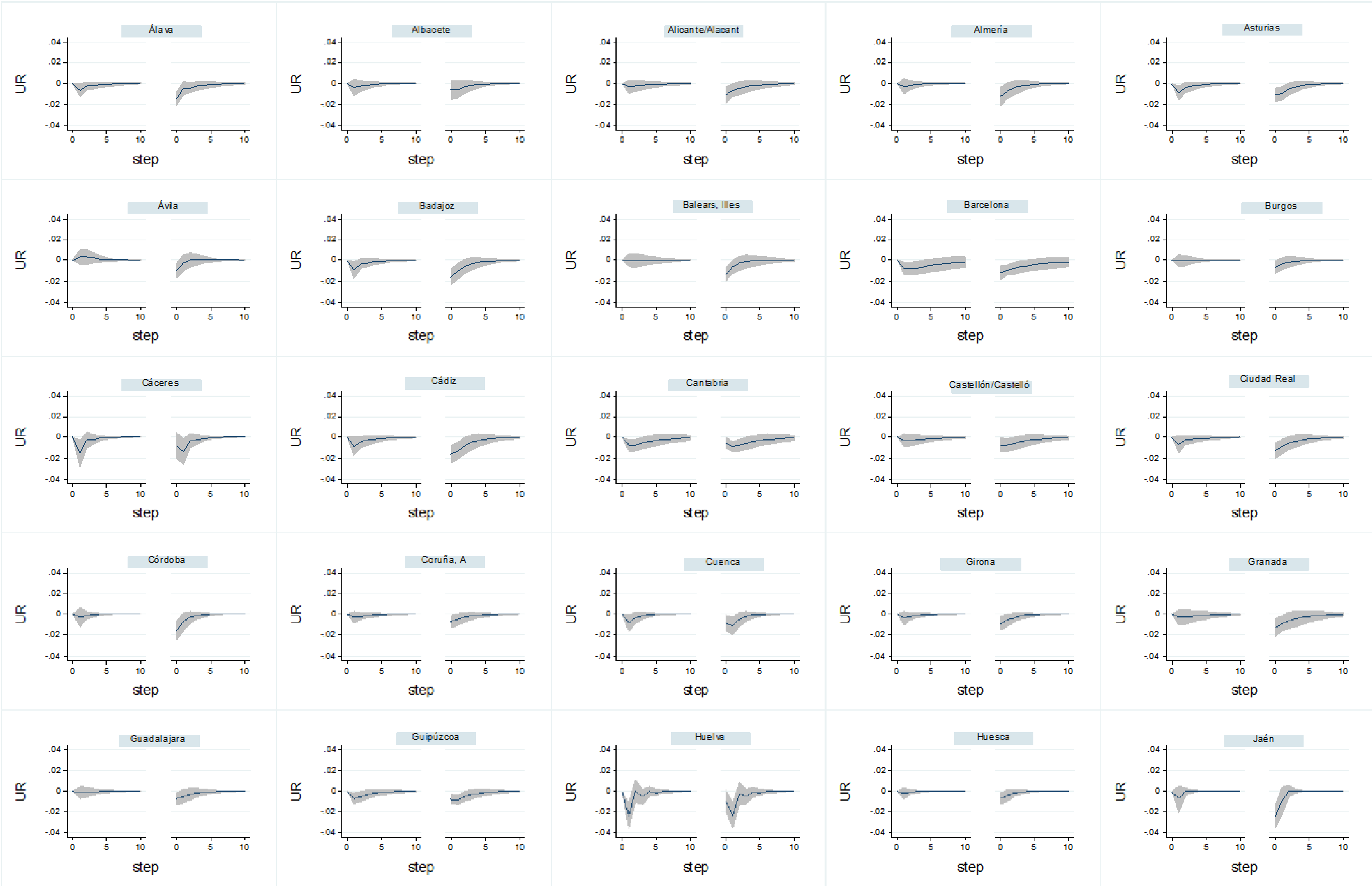


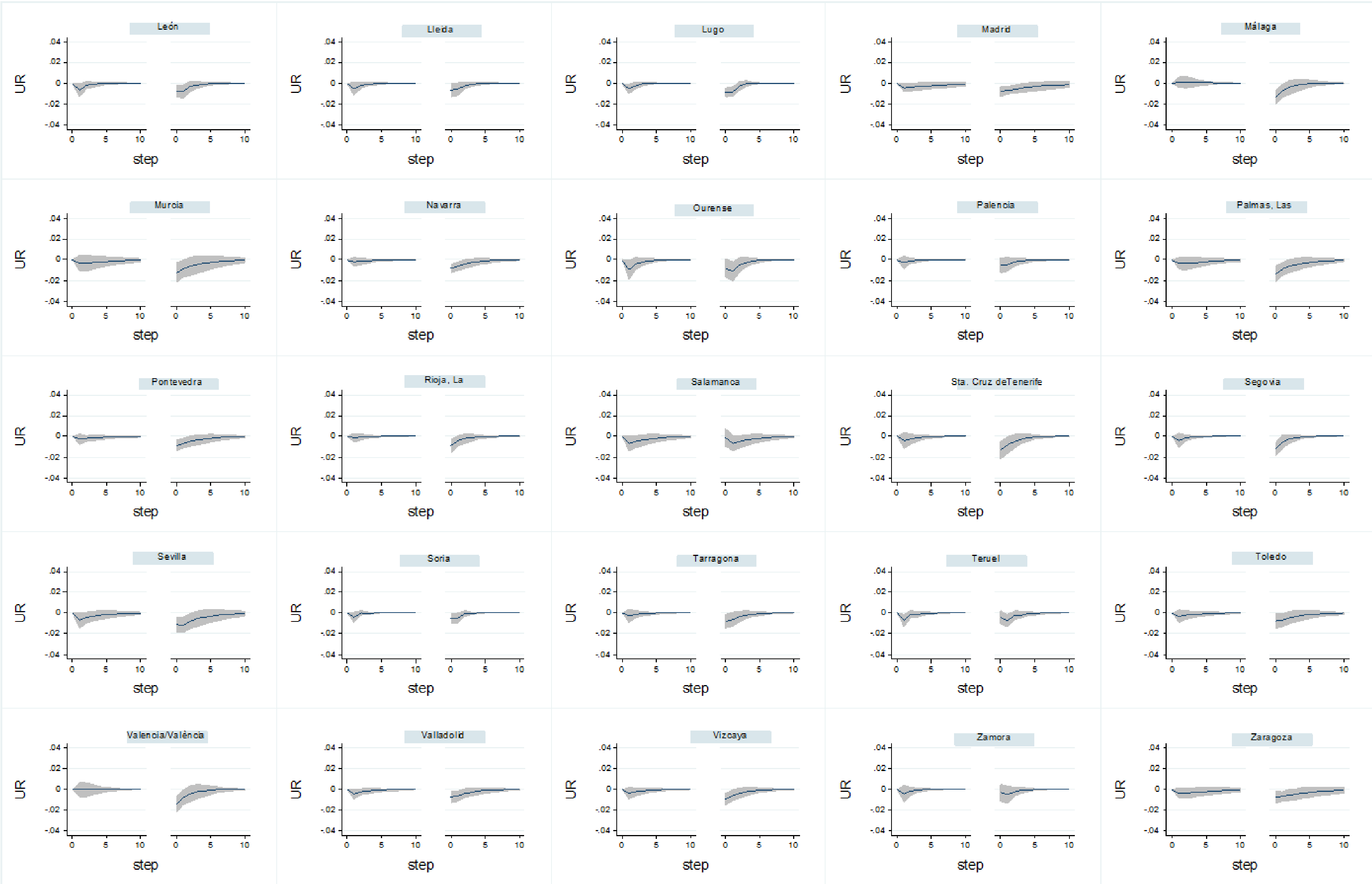
Appendix 5

We aim to know if the results obtained in Figure 5 differ from those obtained when we consider that economic growth shocks affect unemployment rate variation with a lag. We compare these results[20] in Figure 8. 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: Illes Balears, Málaga, Murcia and 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.

[20] In Figure 8, for each province we show two graphs. The second graph is the graph that was represented in Figure 5. Meanwhile, the first graph represents the Impulse Response Functions when variables are orthogonalized in the opposite direction. Thus, the first graph represent the effect that an economic growth shock has on unemployment rate variation after one period as it is indicated in the following equation: $\varDelta u_t = c + \alpha(L)\,\varDelta u_t + \beta(L)\,\varDelta y_t + v_t^u$; $\varDelta y_t = c + \lambda\varDelta u_t + \gamma(L)\,\varDelta y_t + \eta(L)\,\varDelta u_t + v_t^u$

FIGURE 8: ORTHOGONALIZING THE VARIABLES IN TWO DIRECTIONS. EFFECTS ON UNEMPLOYMENT RATE CHANGES WHEN GDP GROWTH SHOCKS OCCURS




León
Lleida
Lugo
Madrid
Málaga
Murcia
Navarra
Ourense
Palencia
Palmas, Las
Pontevedra
Rioja, La
Salamanca
Sta. Cruz deTenerife
Segovia
Sevilla
Soria
Tarragona
Teruel
Toledo
Valencia/València
Valladolid
Vizcaya
Zamora
Zaragoza
UR
step