The ability of regional economies to adjust their temporal dynamics to changing circumstances is a phenomenon recently included within the concept of resilience. This paper attempts to test the hypothesis that the different responses of regional economies to the present recession are conditioned by their production and income generation structure. More specifically, we will try to verify whether the relative weight of the public and private service sector in the production structure of Spanish regions has a decisive influence on their reaction to the economic crisis. To verify the hypothesis about the influence of the service sector in Spanish regional economic resilience we will use a time series of GVA and employment for the seventeen Spanish regions during the period 1986-2009. Besides the descriptive analysis, we utilised Time Series Regression with ARIMA Noise Missing Observations, and Outliers (TRAMO) to forecast the evolution of series in 2010.

1. Introduction

1.1. Defining Resilience

From a static point of view economic resilience can be defined as the ability or capacity of a system to absorb damage or loss or to cushion against them (Holling, 1973; Perrings, 2001). The ability of a system to recover from a severe shock could be considered a more general definition that incorporates dynamic considerations, including stability.

We distinguish two types of resilience:

- Inherent – ability under normal circumstances (e.g., the ability to substitute other inputs for those curtailed by an external shock, or the ability of markets to reallocate resources in response to price signals).

- Adaptive – ability in crisis situations due to ingenuity or extra effort (e.g., increasing input substitution possibilities in individual business operations, or strengthening the market by providing information to match suppliers without customers to customers without suppliers).
Resilience emanates both from internal motivation and the stimulus of private or public policy decisions. Also, resilience refers to post-disaster conditions and response, which are distinguished from pre-disaster activities to reduce potential losses through mitigation. The consequences of these two approaches are not mutually exclusive.

The concept of resilience emanates from several sources. For example, Holling (1973) and other ecologists, as well as Perrings (2001) and other ecological economists, have defined it in terms of the broader concept of sustainability as the capacity to absorb stress and shocks. Several similar measures could be enumerated including: stability, persistence, resistance, non-vulnerability, stochastic return time and resilience.

However, Perrings (2001; p. 323) notes: “The property that most closely connects with the idea of sustainability as conservation of opportunity is resilience.”

Further, in an economic context, resilience can be divided into three aspects. First is reduced failure probability, as equivalent to mitigation. Second is reduced consequences from failure, which corresponds to a basic static definition of resilience. Third is reduced time of recovery, which adds a temporal dimension to the basic definition.

In this sense, Bruneau et al. (2003) have offered a very broad definition of resilience to cover all actions that reduce losses from hazards, including mitigation and more rapid recovery. These refer to how a community reduces the probability of structural or system failure, in the case of the former, and how quickly it returns to normal in the case of the latter.

1.2. Regional Economic Resilience

The notion of ‘resilience’ would thus seem to be highly relevant to understanding the process and patterns of uneven regional development. Regional and local economic development is far from a smooth and incremental process but is subject to all sorts of interruptions and disruptions such as periodic economic recession.

Nevertheless, there is, as yet, no universally agreed on definition of resilience in economics or social science. Some initial studies have recently appeared that attempt to outline how the idea of resilience might be defined in economics and in regional studies (Rose and Liao, 2005; Briguglio et al., 2006; Foster, 2007; Pendall et al., 2008; Hill et al., 2008; Ormerod, 2008).

The so called “equilibrist” definitions restrict the idea of resilience to the ability of a regional or local economy—either to return to a pre-existing stable or equilibrium state or to move quickly to a new one. Other authors (Simmie and Martin, 2010) are interested in the idea of resilience as “adaptive ability”, that is, the differential ability of a region’s or locality’s firms to adapt to changes and shocks in competitive, market, technological, policy and related conditions that shape the evolutionary dynamics and trajectories of that regional or local economy over time.

Most uses of the term in regional or urban applications refer to this idea of the ability of a local socio-economic system to recover from a shock or disruption. Thus, Foster (2007, 14) defines “regional resilience as the ability of a region to anticipate, prepare for, respond to, and recover from a disturbance”. Hill et al. (2008, 4) see resilience as
“the ability of a region ... to recover successfully from shocks to its economy that either throw it off its growth path or have the potential to throw it off its growth path”.

In accordance with Simmie and Martins (2010), beyond these rather broad statements, there is much ambiguity. For one thing, should the notion refer not just to a regional economy’s ability to recover from a shock but also to the degree of resistance to that shock in the first place? For another thing, there is the issue of whether the concept refers to the ability of a regional or urban economy to retain its structure and function despite the shock or disturbance to it or to the ability of a region or urban system to change its structure and function rapidly and successfully in response to a shock.

Another issue is that the resilience of a region’s economy is unlikely to be invariant over time: it may depend on the nature of the shock and may change over time as the structure and nature of a region’s economy evolves. The ambiguity that surrounds the concept of regional economic resilience is compounded by the fact that two definitions of the notion can be found in the ecological literature. The first and more traditional definition, so-called “engineering resilience”, concentrates on the stability of a system near an equilibrium or steady state, where resistance to disturbance and the speed of return to the pre-existing equilibrium are used to define the idea of resilience (Holling, 1973; Pimm, 1984). This seems closest to the notion of ‘elasticity’ or the ability of a system to absorb and accommodate to perturbation without experiencing major structural transformation or collapse (McGlade et al., 2006).

The second definition, so-called “ecological resilience”, focuses on whether disturbances and shocks cause a system to move into another regime of behaviour. In this case, resilience refers to the magnitude of the shock or disturbance that can be absorbed before the system changes its structure and function and becomes shaped by a different set of processes (Holling, 1973). This definition opens up space for linking resilience with the idea of adaptability and is thus much richer in evolutionary scope (McGlade et al., 2006). Thus, a resilient regional economy would be one capable of absorbing and accommodating to extreme shocks without any significant change to its form or function.

Recently, some resilience theorists have begun to move closer in this direction of an evolutionary perspective and to consider the nature of constantly changing non-equilibrium systems (Carpenter et al., 2005). Here resilience is regarded as an ongoing process rather than a recovery to a (pre-existing or new) stable equilibrium state.

In more policy oriented research, the term resilience is used similarly in relation to external change: it connotes both the ability of a (regional) economy to remain in its current state and to return to the previous state (Hill et al., 2008; Rose and Liao, 2005; Rose, 2004); this form of resilience is referred to as ‘(regional) economic resilience’. A similar concept of resilience is used in more traditional economic research by Elmeskov et al. (2007) and Wantanabe et al. (2004) independently of each other. Elmeskov uses the term to analyse the size and duration of business cycle fluctuations across the OECD, whereas Wantanabe uses the term when analysing the effect of the business cycle on the profitability of selected high-tech Japanese industries.

Industries evolve differently across regions. It appears that some regions provide better conditions for the growth of particular industries, while other regions are not able to provide the industry with the needed inputs (Boschma and Knaap, 1999). Some of
these differences relate to differences in the regional stock of inputs, such as knowledge, skills, natural resources and urban size, while others stem from the initial structure of the industry, such as size of firms and level of specialisation (Henderson et al., 1995; Feldman and Audretsch, 1999; Beardsell and Henderson, 1999).

Frenken et al. (2005) argue that while specialisation enhances employment growth it also creates greater vulnerability to external shocks. Therefore regions that have a more diverse industry structure might experience less growth, but they are also more resilient to external shocks.

Jacob Rubæk Holm and Christian Richter Østergaard (2010) analysed the sources of resilience in the Danish ICT sector from 1992 to 2006. They found that the resilience in the Danish ICT sector varies across the regions and that the variability depends on industry structure. Regions with more diversity tend to have a growth rate of ICT employment that is counter-cyclical to the ICT business cycle, whereas regions with less diversity tend to have a growth rate of ICT employment that is pro-cyclical to the ICT business cycle. These authors finally concluded that diversity is beneficial for both the growth rate and resilience up to a certain point beyond which it is still good for growth but decreases resilience.

1.3. Service sector and economic growth

Regarding the counter-cyclical role of services, in particular of public services, Atkinson and Noord (2001) pointed out the existence of a clear counter-cyclical model of public spending in most OECD countries with strong increases in the 1975, 1982 and first 1990s recessions. Also Domínguez and Rueda (2005) confirm referred counter-cyclical behaviour for the OECD countries in the period 1991-2003. In all surveyed countries except one (New Zealand), minimum economic growth rate recorded was related to increases in public spending /GDP ratio variation. In turn, the highest rate of growth during this period coincides with a decrease in public spending /GDP ratio in the vast majority of countries.

Outside of the public sector, services have been configured within innovation systems as an additional dimension of those, interlaced to the whole economic system, especially through the knowledge-intensive services (Rubalcaba 2007). The prominent position of services in the more developed economies, accounting for 70% of both employment and added value generated, together with their ability to produce knowledge and disseminate it to all parts of the economy, has made services an essential factor in the determination of innovation processes and economic growth.

In spite of the traditional idea that services occupy a low innovative position within the economy, the most recent literature about progress carried out in several activity sectors seems to contradict such a condition (Miles, 1995; Haukens, 1996; Howells, 2001; Green et al., 2001; den Hertog et al., Howells and Tether, 2003, 2004). Some authors have even proposed that greater support in promoting innovation in the service sector is an essential policy to increase economic growth in Europe (Gallego, 2007).

Relationships between services and economic growth have been well summarised by Maroto-Sánchez (2010).
2. Objectives

The above paragraphs show that the economy production structure and degree of specialisation can influence the economic resilience against external shocks. Moreover, the dominant role of the service sector in developed economies, its traditional counter-cyclical dynamics and newly recognised ability to generate and disseminate knowledge in the rest of the production system, leads us to wonder whether those regional economies with greater specialisation in the service sector have increased capacity to cope with the current economic crisis. In this sense, some studies (Maroto and Cuadrado, 2008) suggest that the main source of the observed convergence in labour productivity comes from the convergence of regional productive structures.

As a consequence, this paper attempts to test the hypothesis that the different responses of regional economies to the present recession are conditioned by their production and income generation structures. More specifically, we will try to verify whether the relative weight of the public and private service sector in the production structure of Spanish regions has a decisive influence on their reaction to the economic crisis.

In the next section the most important methodological issues relating to the data sources and the analytical tools utilised are explained. Then we present the results differentiating two sections: descriptive analysis results and parametric analysis results. Different techniques of time series data are used for the estimation of 2010
GVA and employment series. Once TRAMO forecasts have been calculated we analyse the behaviour of four specific regions (Andalusia, Madrid, Basque Country and Navarre) in 2008-2010 where the service sector has a greater dimension. We finish the work with some conclusions aimed at responding to our goal.

3. Methodology

3.1. Data

All data used in this work have been obtained from the Spanish National Statistics Institute (INE\(^1\)). We use quarterly data on Gross Value Added (GVA) and employment for each of the Spanish Autonomous Communities. The availability of statistical information limited the study period to the years 1986 to 2009.

We also need to know the breakdown of the quarterly series for each of the production branches in order to calculate the share of public and private services in each region for each quarter.

The demanding information requirements (25 years, quarters, regions, production sectors) compelled us to use data published in various modules of the National Accounts of Spain.

The GVA and employment regional annual series were obtained from Spanish Regional Accounting. In this module, the INE provides annual data for each of the Spanish regions and breakdowns by industry. However, to cover the studied time period, series based on two different base years: 1995 and 2000, should be utilised. The series using 1995 as base year covers the period 1986-1994. The series using 2000 as base year covers the period 1995-2009. The use of two statistical series with different base years explains the breakdown of the series in 1995. However, we consider that this disruption does not prevent the achievement of our goal in this work.

The quarterly evolution of the studied series is published in a specific module known as the National Accounting Quarterly, where the quarterly data are disaggregated by industry. But this disaggregation is available only at a national level, not for the Spanish regions. As in the previous case, we needed to use two series with different base years, 1995 and 2000 for the periods 1986-1994 and 1995-2010 respectively.

Given that the INE does not publish Quarterly Regional Accounts for the studied period, we have combined the modules of the Regional Accounts and Quarterly National Accounts by introducing a simplifying assumption which consists of applying the quarterly progress of each branch of national aggregate economic activity equally to all regions. This simplification involves a partial methodological limitation. We are assuming that all regions follow the same quarterly progress within each year, which would prevent us from studying those phenomena related to regional economic resil-

\(^1\) www.ine.es.
ience lasting less than one year. Since the Regional Accounting offers annual regional data, the methodological limitation is corrected in four quarters. Therefore, the resulting series after the combination of both modules allows us to determine the different regional reactions to external shocks in which recovery continues for periods longer than a year.

3.2. Analytical tools

3.2.1. Descriptive analysis

The descriptive analysis is divided into two sections. First various key items such as regional specialisation, counter-cyclical behaviour of the service sector and correlation between the evolution of total GVA and the GVA generated by the services sector in the 1986-2009 national series are discussed. Then the same analysis is replicated with the regional series. Regional analysis is extended by examining the relationship between the impact of the economic crisis and the size of the service sector at a regional level. The graphical analysis of the series is very useful in this phase of the study.

3.2.2. Intervention analysis and transference function model

The Box-Jenkins stochastic time series models approach typically distinguishes five types of models: univariate intervention models, transfer function models, multivariate stochastic models and multivariate transfer functions models. Vectorial autoregressive models (VAR) are also usually included in this group.

The so called "intervention analysis" consists in evaluating the effect of specific interventions on the behaviour of a time series of one variable. Interventions may be derived from known point events (strikes, leap years, legal changes, accidents, holidays, etc ...), and they are incorporated into models so as to improve the accuracy of the estimates.

From an operational point of view, the incorporation of an intervention involves adding a dummy variable with a value equal to one in the period of intervention and zero in the remaining periods. The inclusion of these dummy variables in the series models was called "intervention analysis" by Box and Tiao (1975). These variables can be of two types: impulse variables, which represent events that occur in an instant (e.g. an accident, a strike ....) and step variables which are events that begin in a known moment and continue from there (e.g higher prices, legal change, change based on an index, ...). Usually the moment of occurrence of the event is known, but not the moment in which that event begins to take effect. Outliers are often used to detect this moment.

There are various types of outliers. Additive Outliers (AO) affect the series in a single instant of time. The Innovational Outliers (IO) are events whose effect is spread in accordance with the ARIMA model of the process, influencing all the values observed after the occurrence. The Level Shift Outliers (LS) affect the series in a given period and their effect is permanent. The Temporary Change Outliers (TC) have an initial impact and their effect declines exponentially in accordance with a damping factor $\delta$. All outliers have effects independent from the ARIMA structure of the series, except in the case of IO.
To detect outliers there are iterative procedures such as those of Chang and Tiao (1983), or Tsay (1986). Recently, Chen and Liu (1990) designed a procedure to identify and jointly estimate the model parameters and the effects of outliers.

4. RESULTS

4.1. National series description

From the descriptive analysis of time series we can obtain evidence about:

- The existence of different regional patterns of productive specialisation
- The counter-cyclical behaviour of the service sector in periods of crisis
- The strong correlation between the variation of total and service sector GVA

In terms of GVA there is a clear difference between the productive specialisation of different regions in relation to the services sector (Table 1). While the service sector accounts for 72.12% of GVA at a national level, some regions far exceed this percentage. In the top position of the ranking are the autonomous cities of Ceuta and Melilla, where the service sector generates over 86% of GVA. This position, however, should be considered an atypical case explained by the small size of these regions, their outermost geographical position, and the high burden of public administration in these economies. The Canary and Balearic islands also hold advanced positions in the regional ranking, with over 83% of their GVA generated by the service sector, in both cases, for services related to tourism activities.

Balearic Islands, Canary Islands, Madrid, Catalonia and Valencia are the four areas where private services contribute a larger share of regional GVA. The position of these regions in the global ranking of the service sector is heavily dependent on the participation of public services in each of them. For example, in the cases of Catalonia, Madrid and Valencia, the provision of public services is very low.

<table>
<thead>
<tr>
<th>Service Sector</th>
<th>Private Services</th>
<th>Public Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceuta y Melilla</td>
<td>Baleares (Islas)</td>
<td>Ceuta y Melilla</td>
</tr>
<tr>
<td>Baleares (Islas)</td>
<td>Canarias</td>
<td>Extremadura</td>
</tr>
<tr>
<td>Canarias</td>
<td>Madrid (Comunidad de)</td>
<td>Castilla - La Mancha</td>
</tr>
<tr>
<td>Madrid (Comunidad de)</td>
<td>Cataluña</td>
<td>Andalucia</td>
</tr>
<tr>
<td>Andalucia</td>
<td>Comunidad Valenciana</td>
<td>Castilla y León</td>
</tr>
<tr>
<td>SPAIN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comunidad Valenciana</td>
<td>Andalucia</td>
<td>Galicia</td>
</tr>
<tr>
<td>Cataluña</td>
<td>Murcia (Región de)</td>
<td>M urcia (Región de)</td>
</tr>
<tr>
<td>Murcia (Región de)</td>
<td>Cantabria</td>
<td>Aragón</td>
</tr>
<tr>
<td>Extremadura</td>
<td>Asturias (Principado de)</td>
<td>Asturias (Principado de)</td>
</tr>
<tr>
<td>Cantabria</td>
<td>Aragón</td>
<td>SPAIN</td>
</tr>
<tr>
<td>Asturias (Principado de)</td>
<td>País Vasco</td>
<td>País Vasco</td>
</tr>
<tr>
<td>Galicia</td>
<td>Galicia</td>
<td>Galicia</td>
</tr>
<tr>
<td>Castilla y León</td>
<td>Castilla y León</td>
<td>Roja (L)</td>
</tr>
<tr>
<td>Aragón</td>
<td>Roja (L)</td>
<td>Comunidad Valenciana</td>
</tr>
<tr>
<td>Castilla - La Mancha</td>
<td>Navarra (Comunidad Foral de)</td>
<td>Madrid (Comunidad de)</td>
</tr>
<tr>
<td>País Vasco</td>
<td>Castilla - La Mancha</td>
<td>B aleares (Islas)</td>
</tr>
<tr>
<td>Navarra (Comunidad Foral de)</td>
<td>Extremadura</td>
<td>País Vasco</td>
</tr>
<tr>
<td>Rioja (La)</td>
<td>Ceuta y Melilla</td>
<td>Cataluña</td>
</tr>
</tbody>
</table>

Table 1: Share of service sector in the regional gross value added (2009)
The relative position of regions did not undergo major changes during the study period, even though there was a narrowing of differences over time. Regions at the head of the national ranking maintained their leadership from 1986, except in the case of Andalusia which started from a position below the national average and experienced one of the most significant advances in service sector participation in the GVA (Figure 2).

The share of employment generated by the service sector has a similar regional ranking to that discussed for the GVA (Table 2). Participation rates in total employment are somewhat lower than in the entire service sector and private services. However, the employment generated by public services stands at 21.37% in the national average while the GVA generated is 16.39%. Catalonia occupies the last position in the participation of public services in both the GVA and employment.
The counter-cyclical role of the service sector has been widely discussed in the economic literature, especially in the case of public services (Domínguez and Rueda, 2005; Atkinson and Noord, 2001; Beyers, 1991; Beyers, 1992; Beyers and Lindahl, 1996; Harrison, 1994). Figure 1 shows the growth of service sector participation in the total GVA in the two critical periods included in our analysis: 1991-94 and 2008-09. In both cases, the increasing specialisation trend in the services sector experienced an evident upturn.

Figure 3 provides a comparison between the rate of GVA change (left scale) and the share of GVA generated by the service sector in the national aggregate (right scale).

The counter-cyclical process of specialisation in the service sector is observed in regions where the service sector has the highest relative size (Andalusia, Madrid) and in regions with relatively smaller sizes (Basque Country, Navarre) as well.

The quarterly variation rate of total GVA maintains a high correlation with the quarterly variation rate of GVA generated by the service sector in the national economy as a whole. The econometric estimates support the results of descriptive analysis. The model based on the two explanatory variables in the service sector (private and public services) explains 99.9% of the variation of total GVA in the period 1986-2009. Both independent variables have a statistically significant relationship and positive sign.
Table 3: GVA National Model

With regard to quality of the econometric model above some details must be pointed out. The normality test of the residuals presents some observations that do not fit the normal distribution function, but their statistics would lead us to accept the null hypothesis of normality. As to the homoskedasticity requirement the heteroskedasticity correction of White was applied to the model. An autoregressive AR scheme (1) was also applied to correct the initially detected autocorrelation. Since in principle the model fails the exogeneity test for the independent variables, we used the two steps least squares method to correct it.

Finally the model is formulated in logarithmic scale, so that the coefficients can be interpreted as elasticities. Thus, the elasticity of value added in private services would finally be 0.63 and 0.19 in the no market service sector, indicating that the service sector as a whole would be responsible for 82% of variation in total value added (Table 3)

We obtain similar results from the variable "employment." The resulting model, once corrected for heteroskedasticity and autocorrelation problems, based on the explanatory variables (employment in private and public services) explained 99.9% of total employment variation with an acceptable degree of compliance with the econometric quality requirements. As in the case of GVA, the independent variables both separately and jointly considered in the model are statistically significant and have positive signs.
4.2. Regional series description

The study of regional specialisation and industry counter-cyclical behaviour of services from regional series relies on the description of the time profiles of regional GVA and employment.

First, we show the profiles of the regional evolution of GVA in private and public services (Figures 4 and 5):

![Graphs showing regional profiles of private services participation in GVA](image)

Fig. 4: Regional profile of the participation of private services in the GVA
Private services series exhibit regional profiles very similar to national ones. The greater or smaller relative size of each regional economy does not seem to have a decisive influence on its time evolution. In all regions there is a counter-cyclical growth of the service sector in the two crisis periods indicated.

In public services growth in crisis times is much more exacerbated. There is also a major decline after the crisis period 1991-1994 with a subsequent return to previous levels. This behaviour is observed in most regions, although in some cases there is continued growth of the sector after the crisis period (Navarre, Extremadura). Ceuta and Melilla also have a singular profile with a reduction in the relative size of the service sector in the period analysed as a whole.

Despite the common features identified, regional profiles provide significant differences. To test statistically the variability we performed an interregional equality test of means and variances. The results in both cases show a p-value less than 0.05, so we reject the hypothesis of equal means and variances among regions, i.e. we accept the existence of variability in the behaviour of the GVA among the Autonomous Communities.

From the labour market perspective, the employment series offer the following regional profiles (Figures 6 and 7):
Fig. 6: Regional profile of the participation of private services in employment

Fig. 7: Regional profile of the participation of public services in employment
Private services show a clear increasing trend in all regions, and even before the first crisis period 1991-1994 a marked growth of employment in this sector can be observed. The counter-cyclical behaviour of private services is less evident in the employment variable and the upward trend is mainly a response to the growing tertiarisation process of the Spanish economy.

In public services, however, after the first period of crisis, the regional profile demonstrates a decreasing tendency in most cases. Navarre again provides a different pattern, with a growing trend throughout the study period.

The statistical test of equal means and variances for employment shows a p-value less than 0.05, so we reject the hypothesis of equal means and variances among regions, i.e. we accept the existence of variability in the behaviour of employment for different Autonomous Communities.

At a regional level, the quarterly variation rate of total GVA also maintains a high correlation with the quarterly variation rate of GVA in the service sector, regardless of the varying specialisation of each region in this sector.

The results of the panel model with GVA regional data restricted to the cross-sectional fixed effects (geographical units) condition, and after heteroskedasticity problems in the cross-sections were corrected, are shown in Table 4:

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOG(VASERVICIOS)</td>
<td>0.673414</td>
<td>0.015982</td>
<td>42.13703</td>
</tr>
<tr>
<td>LOG(VASERVICIOSNM)</td>
<td>0.227445</td>
<td>0.017330</td>
<td>13.12455</td>
</tr>
<tr>
<td>C</td>
<td>2.447954</td>
<td>0.051610</td>
<td>47.43197</td>
</tr>
</tbody>
</table>

Effects Specification

| R-squared | 0.998934 | Mean dependent var | 15.19784 |
| Adjusted R-squared | 0.998923 | S.D. dependent var | 1.70916 |
| S.E. of regression | 0.038434 | Akaike info criterion | -3.668259 |
| Sum squared resid | 2.522967 | Schwarz criterion | -3.605126 |
| Log likelihood | 3189.376 | Hannan-Quinn criter. | -3.644906 |
| F-statistic | 84275.93 | Durbin-Watson stat | 0.047162 |
| Prob(F-statistic) | 0.000000 |

Table 4: GVA Regional Model

The panel data model indicates that the service sector is responsible for almost 90% of the percentage change in the value added of the Spanish economy. Operating the same way for the variable "employment" we established that the service sector is responsible for almost 78% of the variation of total employment.
In both cases, the model as a whole and each of the separate explanatory variables are statistically significant. All coefficients have a positive sign and the R2 is higher than 99.7. Neither of these two models passed the normality test. This, however, is not essential at this stage, as it will not be used for statistical inference and our analysis will focus on the ARIMA and the intervention models.

Finally we explore the relationship between the impact of the crisis in the period 1991-1994 and the degree of regional specialisation in the service sector. The overall change of GVA in the period 1991-1994 shows regional differences with respect to the relative weight of the service sector (Table 5). The regions where the relative share of the service sector is greater (Andalusia and Madrid) show higher growth rates of GVA in the indicated period than those in the regions where the relative share of the service sector is smaller (Basque Country and Navarre).

<table>
<thead>
<tr>
<th></th>
<th>VA 1991Q1</th>
<th>VA 1994Q1</th>
<th>Variation Rate</th>
<th>Negative Trim</th>
<th>Avg Var rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain</td>
<td>72,627,200</td>
<td>87,569,067</td>
<td>20.57%</td>
<td>3</td>
<td>1.21%</td>
</tr>
<tr>
<td>Andalucia</td>
<td>9,899,453</td>
<td>11,736,012</td>
<td>18.55%</td>
<td>2</td>
<td>1.34%</td>
</tr>
<tr>
<td>Madrid</td>
<td>11,401,099</td>
<td>13,963,371</td>
<td>22.47%</td>
<td>2</td>
<td>1.57%</td>
</tr>
<tr>
<td>País Vasco</td>
<td>4,702,241</td>
<td>5,500,669</td>
<td>16.98%</td>
<td>3</td>
<td>1.21%</td>
</tr>
<tr>
<td>Navarra</td>
<td>1,214,730</td>
<td>1,426,667</td>
<td>17.45%</td>
<td>2</td>
<td>1.37%</td>
</tr>
</tbody>
</table>

Table 5: Regional variation rate of AV (1991-1994)

By studying the regional behaviour in the two recent crisis periods 1992 and 2008 we observe that in both cases the service sector seems to play a counter-cyclical role in periods of more intense decrease of GVA.

This relationship can be seen more clearly for all the quarters in 1992 than for 2008. In 1992 those regions with a smaller share of service sector in the GVA evidenced a lower extent in the economic downturn.

![Fig. 8: VA Variation Rate and Services Share (1992T1-1992T4)](image)

This relationship is not so clear when we look at the overall period from third quarter 2008 to fourth quarter of 2009. Nevertheless, by analysing each quarter separately,
the relationship is obvious. In addition, private services are a key element in this relationship as the increased spending on public services does not alter the relative position of different regions.

Fig. 9: VA Variation Rate and Services Share (2008T3-2009T4)
Regarding the employment variable, a negative relationship between job loss and relative size of the service sector is clearly visible in both periods. The size of the public sector is the variable that determines the relationship.

\[ y = 0.044x - 0.050 \]
\[ R^2 = 0.794 \]

Fig. 10: Employment Variation Rate and Services Share (1992T1-1992T4)

\[ y = 0.036x - 0.058 \]
\[ R^2 = 0.825 \]

Fig. 11: Employment Variation Rate and Services Share (2008T2-2008T4)

4.3. Intervention model and transference function

In this section we use ARIMA models that include intervention analysis. The software package Ewiews 7 incorporates the modules TRAMO (Time Series Regression with ARIMA Noise Missing Observations, and Outliers) and SEAT (Signal Extraction in
ARIMA Time Series), which automatically adjust ARIMA models to include intervention analysis.

The results of the module TRAMO/SEAT with intervention function for the GVA are based on an ARIMA (2,1,0), with the coefficients -0.2841 and -0.4422. After a logarithmic transformation and one difference, the final result gave us the following equation:

\[ y_t = (1-0.2841)y_{t-1} + (-0.2841 - 0.4422)y_{t-2} - 0.4422y_{t-3} + \mu_t \]

<table>
<thead>
<tr>
<th>Period</th>
<th>Original Serie</th>
<th>Forecast</th>
<th>Linearised Series from TRAMO</th>
<th>Interpolated Series</th>
<th>Final Trend-Cycle</th>
<th>Final Seasonally Adjusted Series</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TOTALVASEC_HAT</td>
<td>TOTALVASEC_LIN</td>
<td>TOTALVASEC_POL</td>
<td>TOTALVASEC_TRD</td>
<td>TOTALVASEC_SF</td>
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</tr>
<tr>
<td>2008T1</td>
<td>246,920,566</td>
<td>236,043,590</td>
<td>246,920,566</td>
<td>246,864,090</td>
<td>99.99</td>
<td></td>
</tr>
<tr>
<td>2008T3</td>
<td>250,366,258</td>
<td>239,337,500</td>
<td>250,366,258</td>
<td>250,079,840</td>
<td>100.07</td>
<td></td>
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<tr>
<td>2008T4</td>
<td>248,529,769</td>
<td>237,581,900</td>
<td>248,529,769</td>
<td>248,997,890</td>
<td>99.89</td>
<td></td>
</tr>
<tr>
<td>2009T1</td>
<td>247,501,815</td>
<td>236,599,230</td>
<td>247,501,815</td>
<td>246,943,470</td>
<td>100.11</td>
<td></td>
</tr>
<tr>
<td>2009T2</td>
<td>244,081,453</td>
<td>233,329,540</td>
<td>244,081,453</td>
<td>244,267,960</td>
<td>99.96</td>
<td></td>
</tr>
<tr>
<td>2009T3</td>
<td>241,859,629</td>
<td>231,205,590</td>
<td>241,859,629</td>
<td>242,240,410</td>
<td>99.96</td>
<td></td>
</tr>
<tr>
<td>2009T4</td>
<td>241,988,725</td>
<td>231,329,000</td>
<td>241,988,725</td>
<td>241,759,230</td>
<td>100.06</td>
<td></td>
</tr>
<tr>
<td>2010T1</td>
<td>242,212,140</td>
<td></td>
<td>242,297,110</td>
<td>99.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010T2</td>
<td>243,502,440</td>
<td></td>
<td>243,452,300</td>
<td>100.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010T3</td>
<td>245,147,340</td>
<td></td>
<td>245,170,260</td>
<td>99.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010T4</td>
<td>247,382,690</td>
<td></td>
<td>247,365,970</td>
<td>100.01</td>
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<td></td>
</tr>
</tbody>
</table>

Table 6: Forecast of VA from TRAMO/SEAT Models
Fig. 12: Forecast of VA from TRAMO/SEAT Models

Until the first quarter of 1995, when one level shift (LS) outlier was detected, the different types of forecasts generated by TRAMO provide identical results to those of the original series. In 1995 the differences began, although these are minimal. Moreover, from the first quarter of 2010, all forecasts indicate growth of GVA in this variable. The forecast based on the stochastic variation of the series also shows the continuance during the year 2010 of the recovery started in the last quarter of 2009.

In the TRAMO group of models a variant known as Intervention Function Type X12 ARIMA exists that responds to the methodology used by the U.S. Census Bureau. This specific methodology applied to the original GVA series fitted a stationary model type ARIMA (2,1,0) (0,1,1). GVA predictions resulting from this model were as follows [Confidence intervals with coverage probability (0.95000)]:

<table>
<thead>
<tr>
<th>Period</th>
<th>Lower</th>
<th>Forecast</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010.1</td>
<td>239,358,923</td>
<td>241,416,819</td>
<td>243,474,714</td>
</tr>
<tr>
<td>2010.2</td>
<td>238,143,667</td>
<td>241,809,334</td>
<td>245,475,002</td>
</tr>
<tr>
<td>2010.3</td>
<td>236,602,994</td>
<td>242,182,748</td>
<td>247,762,501</td>
</tr>
<tr>
<td>2010.4</td>
<td>235,203,394</td>
<td>242,763,443</td>
<td>250,323,493</td>
</tr>
</tbody>
</table>

Table 7: Forecast of VA from X12 ARIMA

The estimates predict a growing trend for 2010 close to the more recently published data.

Following the TRAMO/SEAT methodology we estimated forecasts for the four regions selected as representative of the highest (Andalusia and Madrid) and lowest (Basque Country and Navarre) service sector relative weights in comparison with the national average. The results of these estimates are presented in the following Table:

<table>
<thead>
<tr>
<th>Value Added</th>
<th>SPAIN</th>
<th>ANDALUCÍA</th>
<th>MADRID</th>
<th>P. VASCO</th>
<th>NAVARRA</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008T3</td>
<td>250,366,258</td>
<td>31,322,015</td>
<td>44,569,166</td>
<td>15,697,601</td>
<td>4,261,545</td>
</tr>
<tr>
<td>2008T4</td>
<td>248,529,769</td>
<td>31,238,949</td>
<td>44,403,173</td>
<td>15,510,187</td>
<td>4,206,135</td>
</tr>
<tr>
<td>2009T1</td>
<td>247,501,815</td>
<td>31,091,131</td>
<td>44,419,602</td>
<td>15,481,689</td>
<td>4,320,372</td>
</tr>
<tr>
<td>2009T2</td>
<td>244,081,453</td>
<td>30,786,073</td>
<td>43,918,539</td>
<td>15,210,950</td>
<td>4,238,221</td>
</tr>
<tr>
<td>2009T3</td>
<td>241,859,629</td>
<td>30,550,471</td>
<td>43,623,688</td>
<td>15,075,447</td>
<td>4,196,754</td>
</tr>
<tr>
<td>2010T1</td>
<td>242,212,140</td>
<td>30,475,941</td>
<td>43,980,133</td>
<td>15,291,824</td>
<td>4,261,527</td>
</tr>
<tr>
<td>2010T2</td>
<td>243,502,440</td>
<td>30,506,484</td>
<td>44,412,328</td>
<td>15,543,875</td>
<td>4,332,884</td>
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<tr>
<td>2010T3</td>
<td>245,147,340</td>
<td>30,615,271</td>
<td>44,765,528</td>
<td>15,800,081</td>
<td>4,405,987</td>
</tr>
<tr>
<td>2010T4</td>
<td>247,382,690</td>
<td>30,758,936</td>
<td>45,116,419</td>
<td>16,060,509</td>
<td>4,480,377</td>
</tr>
</tbody>
</table>

Table 8: VA Regional Forecast from TRAMO/SEAT Models
Figures reflected in the table are real until the fourth quarter of 2009 and estimated for 2010. In the four selected regions, as in the national aggregate, the recovery started in late 2009 has held during 2010.

However, the rates of depression and regional recovery have not been homogeneous. Forecasts indicate that the Spanish GVA will experience a decrease of 1.19% from the beginning of the crisis officially declared in the third quarter of 2008, to the end of 2010. Andalusia also will have a GVA decrease of 1.80%, while Madrid, Basque Country and Navarre at the end of 2010 will exceed the third quarter of 2008 with 1.23%, 2.31%, and 5.14% respectively.

These results do not reveal a clearly differentiated regional pattern in confronting the economic crisis depending on the relative weight of the service sector. Such evidence would lead us to conclude that regions with a lower intensity of services in their production structures have a more favourable response to the crisis.

On the other hand, the temporal sequence shows that regions with lower intensity of services (Navarre and the Basque Country) had a sharper recession in 2009 and a faster recovery in 2010 than the other regions.

By contrast, regions with a greater intensity of services (Andalusia and Madrid) experienced a significantly milder recession in 2009 and a slower recovery in 2010. Therefore, the impact of a less intense economic crisis in these two regions leads us to suspect that the service sector is playing a cushioning role in responding to the crisis.

Then we reproduced the same analysis for the employment variable. The results from intervention function model, TRAMO/SEAT, for national employment was a seasonal ARIMA $(2,1,0)\times(0,1,1)$. One outlier was detected in the LS (level shift) in 1995T1, another type AO (additive) in 2008T4 and a type TC (temporary change) in 2005T3.
We start the employment analysis from the first quarter of 2008 when the total number of employees began to decline. In this series, for the national aggregate, contrary to what happens in the GVA, no sign of recovery is seen until late 2010.

Also regarding employment the regions exhibit different behaviours. At a national level the number of employees in the period 2008T4 to 2008T1 and forecasts to end 2010 were reduced by 9.05%. However, we found that regions such as Andalusia and Navarre have experienced reductions close to 5%, while others such as Madrid and the Basque Country grew by 1% and 1.41% respectively. The Basque Country and Madrid present a similar performance in relative terms despite their significant differences in the participation of the service sector in their productive structures.

The evolution in 2008 shows very similar behaviour in the four Autonomous Communities and the national average. In all cases, job losses were more pronounced in 2008, with an increasing acceleration as the year progressed. The region with a more moderate loss of employment during 2008 was Madrid, which has an oversized service sector.
Regional developments seem to indicate that the relative size of the service sector is not related to the intensity of reduction in the number of employed, which is very similar in all cases. Moreover, when the number of employees is beginning to recover, regional responses do not show any association with the relative size of the service sector. Therefore, in terms of employment, the attenuating effect that we noted in the case of GVA does not seem to appreciate in the services sector.

5. Conclusions

The evidence about the differing impact of the recent economic crisis in the Spanish regions together with the tertiarisation process of the Spanish economy in recent decades led us to formulate the objective of this work around the concept of economic resilience. In particular, this paper attempts to test the hypothesis that the different responses of regional economies to the present recession are conditioned by their production and income generation structures. More specifically, we try to verify whether the relative weight of the public and private service sector in the production structure of Spanish regions has a decisive influence on their reaction to the economic crisis.

In the introductory section we explained that the general concept of resilience has several meanings. This conceptual diversity is enriched significantly as we look at the concept from an economic point of view and more specifically from the regional economy perspective. Obviously the more traditional definition, so-called "engineering resilience", concentrates on the stability of a system near an equilibrium or steady state, where resistance to disturbance and the speed of return to the pre-existing equilibrium are used to define the idea of resilience. Nevertheless some new nuances have been added to the primary concept, the so-called "ecological resilience", which focuses on whether disturbances and shocks cause a system to move into another regime of behaviour. This definition opens up a space for linking resilience with the idea of adaptability and is thus much richer in evolutionary scope. Recently resilience has been regarded as an ongoing process rather than a recovery to a (pre-existing or new) stable equilibrium state.

Analysis of regional economic resilience from an evolutionary perspective requires a microeconomic approach that has not been adopted in this work. Our approach responds more to the perspective of the so-called "engineering resilience." However, we are aware of the important role played by the service sector in the processes of economic growth in developed economies. Therefore, the tertiarisation process and the structural change of regional economies acquire a twofold meaning. On the one hand they affect the response of these economies to the crisis and, on the other hand, at the same time, they are the result of adaptation and response to external shocks.

In short, the approach adopted in this work is a macroeconomic approach, with the analysis unit being Spanish regional economies, but we incorporate an evolutionary element in regional behaviour as regards the relative size of the service sector.

From this approach we have analysed the evolution of GVA and employment in the Spanish regions over the period 1986-2010. In this time-frame two periods of crisis
have been found, the first evolving during the years 1991-1994, especially concentrated in 1992, and the second being the one we have been living since 2008.

The analysis of the regional response to the crisis of 1992 was conducted with real data taken from the Spanish National Accounts published by the INE. The analysis of the current economic crisis was partly implemented with real data and partly with estimates. At the time of closure of data collection for this work, GVA series of National Accounts and Quarterly Regional reached the end of 2009. The employment series, however, only provided coverage up to 2008. Therefore, it was necessary to do a forecast exercise in order to work with GVA data for 2010 and with employment data for 2009 and 2010. We use the stochastic time series analysis known as intervention analysis. The estimates were made by the module TRAMO/SEAT incorporated into the software package Eviews for econometric analysis.

This estimation process of the regional series for the closest periods in time can be considered a methodological weakness of this work, presumably because of the existence of a certain deviation between the estimated data and that finally published by the INE. However at the same time it can also be considered a strength because it allows us to anticipate the regional response to the crisis with genuine knowledge and thus help to guide economic policy decisions.

We also considered it important to re-delineate some methodological limitations noted above in the methods section. Given that the INE does not publish Quarterly Regional Accounts for the studied period, we have combined the modules of the Regional Accounts and Quarterly National Accounts by introducing a simplifying assumption which consists in applying the quarterly progress of each branch of national aggregate economic activity equally to all regions. This simplification involves a partial methodological limitation. We are assuming that all regions follow the same quarterly progress within each year, which would prevent us from studying those phenomena related to regional economic resilience lasting less than one year.

The conclusions drawn from analysis of both downturn periods can be divided into two blocks, one regarding the commonalities and the other concerning the differential features in the regional response to the crisis in each period.

First we highlight the features common to both periods: the existence of different regional patterns of productive specialisation, the counter-cyclical behaviour of the service sector in periods of crisis, and the strong association between the variation of total GVA and the VA generate by the service sector.

The study of time profiles of regional economies during the period 1986-2010 indicates that the GVA and employment series in the service sector show similar patterns. Therefore, the greater or lesser relative size of the service sector in each regional economy does not seem to have a decisive influence on its time evolution.

Both in 1992 and 2008 those regions with a relatively larger size of the service sector suffered a minor impact of the crisis in terms of GVA and employment.

Secondly, we note the existence of differential characteristics of response to the crisis in each of the periods. If we broaden the time window of our analysis of each of the periods of crisis and study the evolution of regional economies in 1991-1994 and 2008-2010, some differences appear that affect the main purpose of this study. In
particular, greater economic resilience of the most intensive service sector regional economies is maintained for the period 1991-1994, but disappears in 2008-2010.

We have studied the evolution in both periods in four regions, two intensive service sector regions (Andalusia and Madrid) and two with a relatively small size of the service sector (Basque Country and Navarre). In terms of GVA, the regions with a greater intensity of service sector experienced a much milder recession in 2009 and a slower recovery in 2010. Therefore, the service sector seems to play a cushioning role in the initial response to the crisis. Nevertheless in terms of employment service sector size does not appear to be such an attenuating effect.

We can conclude that service-intensive regions have shown greater resilience in both, the 1991-1994 and 2008-2010 economic crises, defined as resistance to the loss of GVA and jobs derived from the initial impact of the crisis. However, given that there is a great variety of regional specialisation in the branches of services when we incorporate evolutionary elements, i.e. the reaction after the initial shock, no specific pattern of behaviour is observed for regions with a higher share of services in their productive structure.

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