The Annals of Regional Science (2023) 71:415–435
https://doi.org/10.1007/s00168-022-01171-5

ORIGINAL PAPER

Ranking the Spanish regions according to their resilience capacity during 1965–2011

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Received: 15 September 2021 / Accepted: 26 July 2022 / Published online: 17 August 2022

Abstract
We rank the economic resilience capacity of the 17 Spanish regions by observing the evolution of the components of the rate of profit. To this aim, we analyze the differential evolution of the two components of the profit rate: (i) the productivity of capital and (ii) the gross operating surplus share on national income. The first component rests on the dynamics of aggregate demand and technical efficiency, while the second one informs on the dynamics of income distribution. We consider that the dynamics of these two variables are relevant to rank the economic resilience capacity of the Spanish regions.

JEL Classification E01 · N14 · O47

1 Introduction

The term "resilience" is perceived as a positive attribute of an object, entity or system having the capacity to overcome or at least react to some kind of unexpected event (Cuadrado-Roura and Maroto 2016, p 2). The concept of resilience originally belongs to the field of psychology and environmental sciences. In the sphere of psychology, resilience is understood as the human capacity to cope with and overcome extreme situations. For environmental sciences, resilience is the biological capacity to adapt and prosper in adverse conditions.

The notion of resilience has gained interest in the economic analysis from the Great Recession onwards (Wrobel 2015; Di Caro 2015; Martin and Sunley 2015; Giannakis and Bruggeman 2017; Di Caro and Fratesi 2018; Martin and Gardiner 2019). Extreme situations (in the psychological sphere) or adverse ecological

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conditions (under the environmental prism) find their economic expression in the shocks caused by economic crises (Foster 2007; Hill et al. 2008).

The economic resilience of a regional economy can be defined as its capacity to adapt better than others to the economic difficulties caused by periods of crisis. Thus, regional economic resilience is the ability of a region to anticipate, prepare for, respond to and recover from a disturbance (Foster 2007, p 14). Output and employment performances are the most commonly used indicators to measure resilience capacity (Cuadrado-Roura and Maroto 2016; Di Caro et al. 2018). However, we measure regional resilience capacity by observing the differential behavior of the profitability of productive investments between regions in phases of economic downturn. Due to the relevance of profit maximization for the survival of the firm sector in the long run, we believe that a firm-oriented approach can complement the approach based on output and employment performance (see Iftikhar et al. 2021).

We analyze the resilience capacity of the Spanish regions during the period 1965–2011. The Spanish case is relevant because the country experienced relevant political changes, such as the end of the dictatorship, the entry into the European Union and the development of the new State of the Autonomies (Martínez et al. 2019, p 2211). On the other hand, the country presents a marked history of unequal regional development (Murua and Ferrero 2019; Pérez-Montiel et al. 2021). In fact, regional problems have always taken up a very important place among the concerns of the Spanish society (Cuadrado-Roura 2020, p 327).

We propose a new method to rank the 17 Spanish regions according to their resilience capacity: the positive differential growth of the profit rate (r) with respect to the growth of r in the whole Spain. Thus, in periods of falling r in the whole Spain, we consider that the regions with a positive differential growth rate of r with respect to that of the whole Spain are resilient. The better differential regional behavior of r is explained by the better differential regional behavior of its explanatory variables: capital productivity (π_K) and the share of gross operating surplus in national income (q). This will be detailed in the second section of the paper.

The research is organized as follows: In Sect. 2, we present the methodology of our research. Next, in Sect. 3, we rank the 17 Spanish regions according to their resilience capacity. Section 4 tests whether the results can be associated with the productive specialization of the regions. Section 5 concludes.

2 Methodology

Our objective is to provide an alternative method that serves to rank the 17 Spanish regions according to their economic resilience capacity. This method relies on the approach developed by Labini and Casasnovas (1988) and recently updated by Manera et al. (2019a, 2022).

2.1 The profit share and capital productivity as key factors of resilience

Using the BdMores database, we analyze the resilience capacity of the 17 Spanish regions by looking at the differential evolution of the rate of profit and that of its components. Thus, unlike other analysis of resilience (Martin et al. 2016; Cuadrado-Roura and Maroto 2016; Cellini et al. 2017; Mustra et al. 2017; Doran and Fingleton 2018; Holl, 2018; Angulo et al., 2018; Giannakis and Bruggeman 2019; Martínez et al. 2019; Cainelli et al. 2019), we do not exclusively focus on the behavior of employment.

Not focusing exclusively on employment avoids the bias caused by the public sector employment dynamics. Likewise, we elude the differences in the stable structure of quality employment derived from the presence of large companies, thereby avoiding regional overestimations of resilience in recession periods. Additionally, we also avoid underestimations of resilience capacity in those regional economies which benefit from an extraordinarily flexible labor market; this is, for example, the case of the Balearic Islands, which has always been the leader in flexible hiring, based on permanent–intermittent (seasonal) contracts. However, our focus may also cause overestimations in the cases in which the excessive weight of sectors linked to public prices, such as energy, imposes an “artificial” overestimation of the gross operating surplus (GOS) and the profit rate. This might be the case in regional economies with an excessive preponderance of the energy sector in their regional production structure, such as Extremadura.[1]

The profit rate (r) is the ratio between the gross operating surplus (GOS) and the net capital stock (K). By means of an accounting identity, we can also express r as a product of two factors:

1. The surplus share (q), which represents the weight of GOS in national income at the factor cost (Y), i.e., $q = \frac{\text{GOS}}{Y}$; and
2. The productivity of capital (π_K), defined as the ratio that measures the relationship between Y and K, i.e., $\pi_K = \frac{Y}{K}$.

Thus, the profit rate can be defined as:

$$r \equiv \frac{\text{GOS}}{K} \equiv \frac{\text{GOS}}{Y} \cdot \frac{Y}{K} = q \cdot \pi_K \quad (1)$$

In this simple accounting identity, π_K represents the main underlying trend of an economy, as it incorporates technological change and innovation over time. On the other hand, q shows the dynamics of income distribution and, thus, informs about the evolution of the participation of wages and profits in national income.

Through accounting identity, we also now that Y is equal to the sum of salaries (W) and the gross operating surplus (GOS), i.e.:

[1] Extremadura generates approximately three times more energy than it needs to supply its territory (see Díaz and Roche 2020).

$$Y = W + \text{GOS}, \tag{2}$$

from which:

$$1 \equiv \frac{W}{Y} + \frac{\text{GOS}}{Y} = \omega + q,$$

and

$$1 - q \equiv \omega \equiv \frac{W}{Y} \equiv \frac{W/L}{Y/L} = \omega^* / \pi_L,$$

where $q \equiv \frac{\text{GOS}}{Y}$ = gross operating surplus share; W = total wages; ω = $\frac{W}{Y}$ = wage share;

L = employment; $\omega^* \equiv W/L$ = labor cost per worker or wage rate; $\pi_L \equiv Y/L$ = labor productivity;

At the same time, the condition to keep ω stable (and thus also q) is $g\left(\frac{W}{Y}\right) = 1$; a condition that is fulfilled if $g(\omega^*) = g(\pi_L)$, where g is the growth rate of these variables. Thus, if ω^* grows less than π_L, then q will augment, taking place an income distribution change in favor of capital income and in detriment of labor income (see Manera et al. 2019a, b, 2022). Thus, for a certain income distribution to remain stable the wage rate and labor productivity must grow at the same rate.

In terms of economic resilience, we positively evaluate the regions with a positive differential growth rate of r in comparison with that of the whole Spain in periods of downturn of r in the whole Spain. This is our first criterion. Next, we also evaluate whether this positive differential growth rate of r in comparison with that of the whole Spain is due to a positive differential growth rate of πk, or if it is due to a positive differential growth rate of q.

As we explain in Sect. 2.3, we consider it positive that the differential increase of r comes from a differential increase in πk, which, following Weisskopf (1979), means that the incremental capital output ratio has decreased (and therefore there has been a technical improvement) or that degree of productive capacity utilization has increased (which means that aggregate demand, and thus employment, has increased) in comparison with the whole Spain.

On the other hand, we do not evaluate so positively that the differential increase of r comes from a differential increase in q. Since the 1970s, the working class has experienced a generalized stagnation of its incomes and the wage share has substantially decreased (Stirati and Meloni 2021), in what nowadays is considered one of the main problems of western economies (Perez-Montiel and Manera 2022; Taylor 2020): The stagnation of the labor incomes has led to an increasing households' debt, which has acted as a substitute of wages and has starred a debt-led growth regime (also called financial capitalism) which collapsed in 2008 (Manera et al. 2022, p 2). Thus, we positively evaluate differential increases in the wage share in periods of downturn of r in the whole Spain; so wages are more able to maintain the purchasing power and aggregate consumption without appealing to an increasing households' indebtedness (Kohler et al. 2019).

In sum, we will argue that the most (least) resilient regions are those who present the highest (lowest) differential increase of r with the highest (lowest) differential increase of πk and the lowest (highest) differential increase of q. We explain it in detail in Sect. 2.3.

2.2 The rate of profit and its downturn periods

To carry out our analysis, we consider only periods of economic recession, which is where one can really evaluate the regional capacity of economic resilience. However, we do not look at aggregate production or employment; instead, we focus on recessive phases of the profit rate in the whole Spain. We identify the recessive phases of the profit rate by means of the Hodrick–Prescott filter with a lambda equal to 72 (λ= 72) to the original series of the profit rate of the Spanish economy for the period 1965–2011. We analyze this period because the last observation that the BdMores database provides of the profit rate, capital productivity and the profit share at a regional level is 2011.

We use the Hodrick–Prescott filter to detect the periods in which the profit rate in the whole Spain presents a negative evolution with respect to its long-run tendency. We have applied the method of Franconetti (2016) to select the lambda value (λ). This method is suitable for our purposes because it guarantees that the comparison between the time series of the different regions shares the same "relative error" between the tendency and the original data. We have determined the relative error by observing the impact in the tendency of the application of various types of relative errors and selected the one that collects the signal of the tendency in the most uniform way. Nevertheless, for different relative errors, and thus different values of λ, the conclusions of our research do not qualitatively change. We do not present the different studies with different values of λ for reasons of space, but they are available upon request.

Once we select the value of λ, we obtain the signs of the trend and the cycle of r (Fig. 1), which enable us to identify six periods: three of recovery of r (1968–1975, 1982–1989 and 1997–2005) and three of fall of r (1975–1982, 1989–1997 and 2005–2011). Based on this periodization, we can define complete cycles with an average duration of 14 years, with periods of recover and recession of 7–8 years.

2.3 A method to rank the resilience capacity of the Spanish regions

Having identified the periods of decreasing r in the whole Spain, we apply our method to rank the relative resilience capacity of the Spanish regions during each of these periods. We assume the Arrow's impossibility theorem (1963) which shows that no perfect aggregation convention can exist; thus, several alternatives arise for building composite indexes, such as principal components analysis, averaging the standardized variables, etc. We use the van der Waerden (VdW) ranking score to rank the resilience capacity of the Spanish regions. The VdW is a ranking score, a type of fractional rank, defined as:

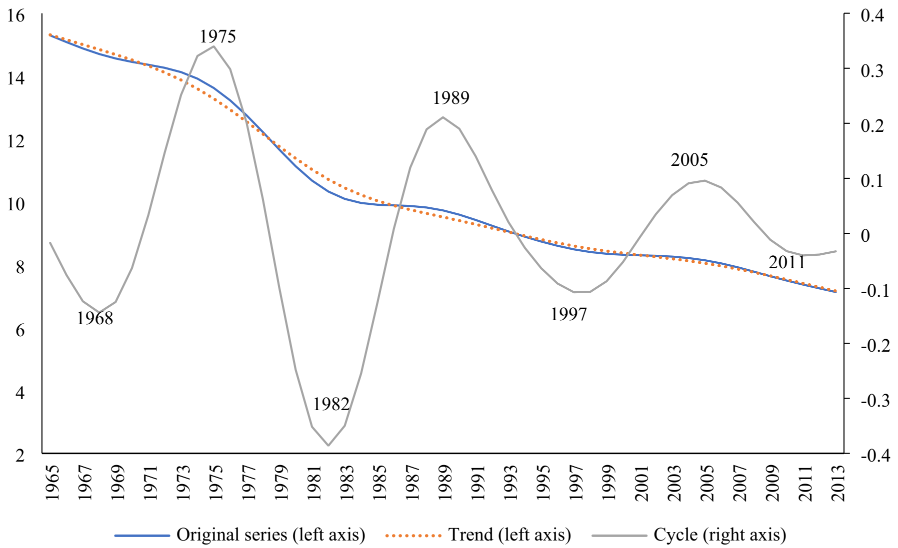

Fig. 1 The profit rate in Spain (1965–2013). Hodrick–Prescott filter (Lambda 72). Source: Own elaboration with BdMores data

$$\mathrm{VdW}^{R}_{i,t} = \frac{R^{R}_{i,t}}{(N+1)}, \tag{3}$$

where $\mathrm{VdW}^{R}_{i,t}$ is the van der Waerden rank of resilience for region i in period t and $R^{R}_{i,t} \in (1,17)$ is the rank of resilience of region i in period t, being 17 the best position and 1 the worst position.

The VdW fractional rank is a simple method for standardizing scores so that they range from $1/(N+1)$ (minimum score) to $N/(N+1)$ (maximum score). Then, the region ranked in the highest position has the highest $\mathrm{VdW}^{R}_{i,t}$ (i.e., $\mathrm{VdW}^{R}_{i,t} \equiv 17/18 = 0.94$), while the region ranked in the lowest position has the lowest $\mathrm{VdW}^{R}_{i,t}$ (i.e., $\mathrm{VdW}^{R}_{i,t} \equiv 1/18 = 0.06$). The advantage of the VdW metrics is that it combines the efficiency of the ANOVA analysis with the robustness of the Kruskal–Wallis metrics when the normality assumptions do not hold. Methods based on rankings are not affected by outliers and allow to follow over time the performance of different units in terms of relative positions, which is the aim of this research.

How do we rank each Spanish region i according to its resilience capacity in each recessive period t? We assign $R^{R}_{i,t}$ according to the performance of the two components of r, namely πk and q, in period t. To this aim, we evaluate the 8 possible combinations of the dynamics of πk and q, which we call *resilience modalities*. Each resilience modality is associated with a higher or lower position in the ranking of resilience. Table 1 shows the eight resilience modalities, and Graph 2 represents them.

We have defined regional resilience with the aim of positively discriminating those regions which, in periods of decreasing r in Spain, have maintained a positive growth differential of their regional r. Thus, we can classify the modalities 1 to 4

Table 1 Classification of the modalities of resilience

Modalities	Expression	$g(r)$
Modality 1	$g(\pi_K) > \lvert -g(q)\rvert$	>0
Modality 2	$g(\pi_K) > g(q)$	>0
Modality 3	$g(\pi_K) < g(q)$	>0
Modality 4	$\lvert - g(\pi_K)\rvert < g(q)$	>0
Modality 5	$g(\pi_K) < \lvert -g(q)\rvert$	<0
Modality 6	$\lvert -g(\pi_K)\rvert < \lvert -g(q)\rvert$	<0
Modality 7	$\lvert -g(\pi_K)\rvert > \lvert -g(q)\rvert$	<0
Modality 8	$\lvert -g(\pi_K)\rvert > g(q)$	<0

Source: own elaboration

$g(\pi_K)$: Differential growth rate of regional capital productivity in comparison with that of the whole Spain

$g(q)$: Differential growth rate of the regional gross operating surplus share in comparison with that of the whole Spain

$g(r)$: Differential growth rate of the regional profit rate in comparison with that of the whole Spain

(both included) in this positive resilience category as those that are above the diagonal separation line of the profit differential rate in Fig. 2. If the contrary is the case, i.e., negative resilience capacity, we find modalities 5 to 8 (both included), which are located below the diagonal separation line.

We now move on to determine the scores of the eight different regional resilience modalities and assign them a rank ($R^R_{i,t}$) according to their higher or lower level of regional resilience. We rank in the first position (highest $R^R_{i,t}$) the regions belonging to modality 1 and in the last position (lowest $R^R_{i,t}$) the regions belonging to modality 8. If two regions belong to the same modality, the region that has a higher profit rate ranks first. This applies to all modalities. The eight modalities are as follows:

- **Modality 1:** ***g(r); g(π$_K$) >|−g(q)|***. We rank regions belonging to this modality in the first place. Regions in this modality are "super resilient" because, in a recessive period, their firm sector is capable of increasing r despite a fall in q. Thus, the positive differential growth of r is exclusively explained by the positive differential growth of π_K. At the same time, there is a distributional change in favor of the working class, which is economically and socially desirable.
- **Modality 2:** ***g(r); g(π$_K$) > g(q)***. Regions in this resilience modality are "highly resilient." We rank regions in this modality below regions in modality 1, but above regions belonging to modality 3. This modality presents a positive differential growth of r which comes mainly from the positive differential growth of π_K. At the same time, there is a differential increase of q, but at a lower rate than that of the growth of π_K.
- **Modality 3:** ***g(r); g(π$_K$) < g(q)***. We consider that the regions in this modality are "resilient": These regions present a positive differential growth of r which is mainly explained by the regional positive differential growth of q, which is higher than the differential increase of π_K. Regions in this modality are ranked below regions in modality 2, but above regions belonging to modality 4.

- **Modality 4: *g(r)*; |−*g*(π_K)|<*g*(*q*)**. Regions in this modality are "moderately resilient." It is a modality in which the positive differential growth of r is exclusively explained by the regional positive differential growth of q. The differential growth of π_K is negative, but it is lower (in absolute terms) than the differential positive growth of q. Regions in this modality are ranked below regions in modality 3, but above regions belonging to modality 5.
- **Modality 5: −*g(r)*; *g*(π_K) <|−*g*(*q*)|**. This modality is the inverse of modality 4: It presents a regional negative differential growth rate of r, which is explained by a differential drop in q higher (in absolute terms) than the positive differential growth of π_K. Regions in this modality are ranked below regions in modality 4, but above regions belonging to modality 6.
- **Modality 6: −*g(r)*; |−*g*(π_K)|<|−*g* (*q*)|**. This modality is the inverse of modality 3: In this modality, the differential growth of r is also negative. The differential decrease in r is explained both by a negative differential growth of π_K and by a differential decrease of q. However, in this case the differential decrease of q is higher than that of π_K. We rank regions in this modality below regions in modality 5, but above regions belonging to modality 7.
- **Modality 7: −*g(r)*; |−*g*(π_K)|>|−*g*(*q*)|**. This modality is the inverse of modality 2: Regions belonging to this modality show a negative differential growth of r, which is explained by both negative differential growth of π_K and negative differential growth of q, although with a lower drop in q than in π_K. We rank regions in this modality below regions in modality 6, but above regions belonging to modality 8.
- **Modality 8: −*g(r)*; |−*g*(π_K)|>*g*(*q*).** This modality is the inverse of modality 1: Regions in this modality are the least resilient. Regions in this modality receive the lowest $R^R_{i,t}$ because the differential growth of r is negative, and this is explained exclusively by the differential drop in π_K, since q presents a positive differential growth.

Once we rank the regions according to the modalities they belong to and obtain the $\mathrm{VdW}^R_{i,t}$ of each region i in each recessive period t, we can shed conclusions about the resilience capacity of each region in each recessive period.

Additionally, we can construct a synthetic resilience index (SRI_i) for every region i. Our aim is to construct a resilience index that synthetizes the information contained in the VdW^R_{ti} of region i during each recessive period t. Instead of giving the same score to each VdW^R_{ti}, i.e., $\beta_1 = \beta_2 = \beta_3 = 1/3$, we try to prioritize the proximity in time of the values of the $\mathrm{VdW}^R_{i,t}$—with the aim of capturing the "lead time" of regions and, thus, rewarding those regions capable of increasing their resilience capacity over time. Thus, based on Costa (1993), we take the order 1 for 1975 and follow the chain to the order 37 for 2011, as explained in Table 2.

We define the relative synthetic resilience index (SRI) of region i as follows:

$$\mathrm{SRI}_i = \beta_1 \mathrm{VdW}^R_{1i} + \beta_2 \mathrm{VdW}^R_{2i} + \beta_3 \mathrm{VdW}^R_{3i} \tag{4}$$

where β_1, β_2 and β_3 is the weighting that the VdW *s* of region i during the recessive periods 1975–1982, 1989–1997 and 2005–2011, respectively, have on the synthetic index. We calculate β as $\beta_1 = b_1/b_T$, $\beta_2 = b_2/b_T$ and $\beta_3 = b_3/b_T$, where:

Table 2 Recessive periods under study

Period	Value of VdW^R in the period	Years	Order of the years
1	VdW^R_{i1}	1975 to 1982	1 to 8
2	VdW^R_{i2}	1989 to 1997	15 to 23
3	VdW^R_{i3}	2005 to 2011	31 to 37

Note: This table shows the three recessive periods under study. Periods 1, 2 and 3 correspond to the time spans 1975–1982, 1989–1997 and 2005–2011, respectively. VdW^R_{i1}, VdW^R_{i2} and VdW^R_{i3} correspond to the van der Waerden ranking score of region i in periods 1, 2 and 3, respectively. The respective weights for each of the periods define the consideration of each individual $VdW^R_{i,t}$ over the synthetic one, as we explain below

$$\begin{aligned} b_1 &= \sum_{t=\text{order of the first year of the period 1975--1982,}}^{T=\text{order of the last year of the period 1975--1982}} \\ b_2 &= \sum_{t=\text{order of the first year of the period 1989--1997,}}^{T=\text{order of the last year of the period 1989--1997}} \\ b_3 &= \sum_{t=\text{order of the first year of the period 2005--2011,}}^{T=\text{order of the last year of the period 2005--2011}} \\ b_T &= b_1 + b_2 + b_3. \end{aligned} \tag{5}$$

Therefore, we calculate the following values of b_1, b_2 and b_3 as:

$$b_1 = \sum_{t=1}^{T=8} = 36,\ b_2 = \sum_{t=15}^{T=23} = 171 \text{ and } b_3 = \sum_{t=31}^{T=37} = 238$$

Thus, the value of b_T is:

$$b_T \equiv b_1 + b_2 + b_3 \equiv 36 + 171 + 238 = 445.$$

Finally, we obtain the different weighting factors for the recessive periods as:

$$\beta_1 = \frac{b_1}{b_T} = \frac{36}{445} = 0.0810,$$

$$\beta_2 = \frac{b_2}{b_T} = \frac{171}{445} = 0.3843,$$

$$\beta_3 = \frac{b_3}{b_T} = \frac{238}{445} = 0.5348$$

and the expression of the synthetic resilience index (SRI) in Eq. 4 can be written as:

$$\text{SRI}_i = 0.0810\text{VdW}^R_{1i} + 0.3843\text{VdW}^R_{2i} + 0.5348\text{VdW}^R_{3i}. \quad (6)$$

3 Results

Table 3 shows the synthetic resilience index (SRI) for the Spanish regions ordered from the highest to the lowest rank over the three recessive periods under analysis. The Bask Country is ordered in the first place because it has the highest SRI (0.86), while Castilla y Leon is ordered in the last place because it has the lowest SRI (0.12). Table 2 also shows the value of the VdW^R of each region during each of the three recessive periods.

We now check whether the presented method of ranking regional resilience capacity enables us to define a certain typology of regions and hierarchize them through the SRI, albeit differentiating their behavior by the three periods under analysis. Apparently, the different typologies are as follows:

(1) Regions with long-standing industrial tradition (Catalonia and Basque Country): Both regions present an SRI above the median (which is 0.48) and, thus, are relatively resilient. The region that obtains the best SRI is the Basque Country (0.86), representing the maximum value for all the regions, while Catalonia, with a SRI of 0.63, lies in the fifth place. The leadership of the Basque Country is due to its good differential behavior in the three explanatory variables of the SRI (profit rate, capital productivity and surplus share) over the last period (2005–2011), while Catalonia shows better results in the rest of the periods. In the case of Catalonia, we should say that it has progressively been losing industrial weight in a more accentuated manner than the Basque Country, and in exchange it has reinforced its specialization in an advanced tertiary sector with high added value (based on knowledge hubs and support for industry 4.0) and particularly in tourism, leading the rankings of the international tourism statistics in Spain.

(2) Tourism-oriented regions with negative differential growth rates of industrial activity (relative to those of the whole Spain): These regions are Andalusia, the Balearic Islands, Asturias, the Canary Islands and Murcia: The community with the highest SRI is the Balearic Islands (0.58), followed by Andalusia (0.52) and Asturias (0.48). These three regions have an SRI above the median and, thus, are relatively resilient. With an SRI below the median, we find the Canary Islands (0.39) and Murcia (0.27).

(3) Non-tourism-oriented regions with positive differential growth rates of industrial activity (Galicia, Aragon, Navarra, Castilla-La Mancha and Castilla y León): Aragon (automobile and logistics) has the highest SRI, with a value of 0.70, followed by Galicia (textile, automobile and fishing industry), with a SRI of 0.66, and Navarre (automobile and manufacturing), with a SRI of 0.48. These cases present a SRI above the median and, thus, are cases of relative "successful" late

industrialization, as compared to Castilla-La Mancha, and Castilla y León, which present a SRI below the median.

(4) There are also five singularities: Madrid, Cantabria, Extremadura, Valencia and La Rioja.

- Madrid is an exceptional case because of the effect of being a capital, which implies enjoying the maximum economies of agglomeration, being the main metropolitan area of the country. In terms of SRI, it has a value of 0.42 and is in the eleventh position, below the median. Thus, it can be considered a non-resilient region. Looking at sub-periods, however, we see that this region has experienced a progressive degradation by typology of resilience, as it passes from typology 2 in the period 1975–1982, to typology 5 in 1989–1997 and to typology 7 in 2005–2011.
- Valencia and La Rioja are also exceptions because they, joint with Catalonia, are the only tourism-oriented regions with a positive industrial index. In terms of SRI, they have a value of 0.26 and 0.43 and are ranked in the 16th and the 10th position, respectively. Valencia represents an unsuccessful case of consolidation of an industrial base and of the tourism sector, as it failed to attain a typology below 7 in any of the crisis periods. However, our method may underestimate the resilience capacity of this region because of its greater percentage of informal economy, which could result in an underestimation of profit margins.
- Cantabria is the only non-tourism-oriented region with negative differential growth rates of industrial activity: It presents an SRI of 0.36, well below the median. However, this region was relatively resilient in the periods 1975–1982 and 2005–2011. Its low SRI is mainly due to its very poor performance during the period 1989–1997.
- Finally, we have Extremadura, which presents one of the most significant differential growths of the non-manufacturing industrial sector. Its good resilience performance might be due to the predominant weight of the energy sector in its economy. This sector, which benefits from public prices, is characterized by a less cyclical and sensitive behavior of its surplus. Extremadura has played a very important strategic role for the large oligarchic electric groups in Spain, and this might explain why this region has the second highest SRI, with a value of 0.71.

Looking at the SRI, we can conclude that productive specialization does not per se affect regional resilience capacity for the case of the Spanish regions. For example, we have seen successful cases of resilience capacity in tourism-oriented regions such as the Balearic Islands and unsuccessful cases for regions that also deeply specialized in tourism, such as the Canary Islands. We can argue the same about industrial specialization: Beyond the two canonical, *first comers* industrial regions (the Basque Country and Catalonia), Aragon, Galicia and Navarre are relatively resilient regions that present positive differential growth rates of industrial activity (relative to those of the whole Spain), while Castilla-La Mancha and Castilla y León are non-resilient regions that also present positive differential growth rates of industrial activity. To deepen in this question, we econometrically analyze whether productive specialization affected regional economic resilience capacity during the last economic crisis, the Great Recession.

4 The role of productive specialization in the resilience capacity during the Great Recession

In this section, we analyze if productive specialization has determined the regional resilience capacity in Spain during the Great Recession. To this aim, we use a regression model in which VdW_{it}^{R} is explained by three variables that capture the effect that regional specialization has on VdW_{it}^{R}. According to the disposable data in the BdMores database, we consider regional specialization in the following three sectors of the Spanish economy: (i) *Manufacturing industry*; (ii) *Construction*; and (iii) *Tourism*. To construct the three productive specialization variables, we use again the VdW ranking score to rank the Spanish regions according to their productive specialization, as follows:

$$\mathrm{VdW}_{s,i,t} = \frac{R_{s,i,t}}{(N+1)}, \tag{7}$$

where $\mathrm{VdW}_{s,i,t}$ is the van der Waerden rank for region i in sector s in period t, and $\mathrm{R}_{s,i,t}$ is the rank of region i in sector s in period t. To obtain $R_{s,i,t}$, we divide the gross value added of region i in sector s in period t ($\mathrm{GVA}_{i,s,t}$) by the gross value added of sector s in period t in the whole Spain ($\mathrm{GVA}_{s,t}$), i.e., $R_{s,i,t} = \mathrm{GVA}_{i,s,t}/\mathrm{GVA}_{s,t}$.[2]

Since we are interested in the most productive and efficient manufacturing industry, we use the gross value added of the subsector *Metallurgy and manufacture of metal products* as a proxy of the gross value added of the manufacturing industry. It implies that, for example, Cantabria, which is not specialized in the industrial sector as a whole but is specialized in this subsector, will be considered a manufacturing industry-specialized region, while, for example, Valencia, which is specialized in the industrial sector as a whole but not in this subsector, will not be considered a manufacturing industry-specialized region. On the other hand, as proxy of the gross value added of the tourism sector, we use the gross value added of the subsector *commerce and hospitality*.

Our basic panel regression model is the following pooled data model:

$$\mathrm{VdW}_{it}^{R} = \beta_1 \mathrm{VdW}_{M,i,t} + \beta_2 \mathrm{VdW}_{C,i,t} + \beta_3 \mathrm{VdW}_{T,i,t} + \varepsilon_{it} \tag{8}$$

which can be extended by the consideration of the vector $\mu\left[\mu_1, \mu_2, \ldots, \mu_{17}\right]'$:

$$\mathrm{VdW}_{it}^{R} = \beta_1 \mathrm{VdW}_{M,i,t} + \beta_2 \mathrm{VdW}_{C,i,t} + \beta_3 \mathrm{VdW}_{T,i,t} + \mu + \varepsilon_{it}, \tag{9}$$

where $\mu\left[\mu_1, \mu_2, \ldots, \mu_{17}\right]'$ is a vector that treats individual heterogeneity, which can be a vector of fixed parameters (fixed effects model) or a random vector with a

2 We use the GVA at basic prices (constant 2008 prices).

normal distribution $\mu \sim \left[0, \sigma_{\mu}^{2} I_N\right]$ (random effects model). We use the fixed effects (FE) model because we assume that omitted variables are likely to be correlated with the variables included in the model (Angulo et al. 2014, p 265). Nevertheless, we apply the Hausman (1978) test, which confirms our decision. $\mathrm{VdW}_{M,i,t}$, $\mathrm{VdW}_{C,i,t}$ and $\mathrm{VdW}_{T,i,t}$ denote the van der Waerden ranks for region i in period t of the manufacturing, construction and tourism sectors, respectively, while t refers to year (not to a recessive period of r, as in the previous section).

Additionally, to identify spillover effects, we use the dynamic spatial Durbin model (dynamic SDM), which considers two types of interaction or spillover effects: endogenous interaction effects between the dependent variable and exogenous interaction effects among the explanatory variables. It nests the dynamic spatial lag model (dynamic SLM), also known in the literature as spatial autoregressive model, SAR, and the dynamic spatial error model (dynamic SEM). With insights from Angulo et al. (2014, 2018), we first estimate all models for the period 1965–2005 and choose the specification that better fits our data. According to the corresponding likelihood ratio (LR) tests, the dynamic SLM specification is the most adequate for our data.

Once we have chosen our estimation model and have run it for the period 1965–2005, we use the results of the estimation to forecast VdW_{it}^{R} for the period 2006–2011. The forecasts are considered as the counterfactual (or projected) VdW_{it}^{R} in the absence of the economic crisis (Angulo et al. 2014, p 265). Next, we calculate the forecast error (f.e.) of VdW_{it}^{R} as the difference between the actual values of VdW_{it}^{R} and the forecasted values of VdW_{it}^{R}. The f.e. measures the effect of the economic recession.

Our aim is to analyze the role that productive specialization had on regional resilience capacity during the Great recession. To do that, we disaggregate the regressions and the forecasts by the three regional specialization categories here considered. Thus, we run the model including only the regions exclusively specialized in *Manufacturing industry*; then, we run the model including the regions specialized both in *Manufacturing industry* and in *Construction*, and so on. To determine if a region i is specialized in sector s, we calculate the location quotient (LQ) for region i and sector s in period t, $\mathrm{LQ}_{i,s,t}$. The LQ is a location measure, since it allows us to assess the relative concentration degree of a given activity or sector s in a given region i. Analytically, the $\mathrm{LQ}_{i,s,t}$ is:

$$\mathrm{LQ}_{i,s,t} = \frac{\mathrm{GVA}_{i,s,t}/\mathrm{GVA}_{i,t}}{\mathrm{GVA}_{s,t}/\mathrm{GVA}_{T,t}}, \tag{10}$$

where $\mathrm{GVA}_{i,s,t}$ is the gross value added of region i in sector s in period t; $\mathrm{GVA}_{i,t}$ is the gross value added of region i in period t. $\mathrm{GVA}_{s,t}$ is gross value added of sector s in period t (in the whole Spain), and $\mathrm{GVA}_{T,t}$ is the total gross value added of Spain. If $\mathrm{LQ}_{is,t} > 1$, the sector s has a larger share of gross value added in region i than in the country as a whole, which suggests that region i is relatively specialized in sector s. The LQ is widely used to compare regions both among themselves and to the reference territorial unit (in our case, the whole Spain). Additionally, the analysis of their evolution in time allows us to approach the regions' internal dynamics as well as their inter relationships (Fracasso and Vittucci Marzetti 2018).

Next, we proceed in the same way, but running the regressions only with the regions that are not specialized in *Manufacturing industry*, then with the regions not specialized in *Manufacturing industry* and *Construction*, and so on. The last step is to check whether the differences of the forecast errors between the specialized and non-specialized regions are statistically significant (Table 4). Table 4 allows us to conclude whether the impact of the Great Recession on specialized and non-specialized regions was significantly different.

The data in the main diagonal of Table 4 (for instance, the element on row i and column i) are the t test on the difference of the forecast errors between the regression including only the regions exclusively specialized in *Manufacturing industry* and the regression including only the regions not specialized in *Manufacturing industry*. Data outside the main diagonal (for instance, the element on row i and column j) are the t test on the difference of the f.e. between the regression including only the regions specialized both in *Manufacturing industry* and *Construction* and

Table 3 Synthetic relative resilience index (SRI) and the van der Waerden ranking score (VdW^R) of the Spanish regions for the three recessive periods under study (1975–1982; 1989–1997; and 2005–2011)

	SRI	VdW^R (1975–1982)	VdW^R (1989–1997)	VdW^R (2005–2011)
1. Basque Country	0.86	0.22	**0.89**	**0.94**
2. Extremadura	0.71	0.06	**0.83**	**0.72**
3. Aragon	0.70	0.28	**0.61**	**0.83**
4. Galicia	0.66	**0.94**	**0.44**	**0.78**
5. Catalonia	0.63	0.39	**0.94**	0.44
6. Balearic Islands	0.58	**0.89**	**0.78**	0.39
7. Andalusia	0.52	**0.78**	**0.50**	**0.50**
8. Navarra	0.48	**0.50**	0.22	**0.67**
9. Asturias	0.48	**0.56**	0.28	**0.61**
10. La Rioja	0.43	0.44	**0.56**	0.33
11. Madrid	0.42	**0.67**	**0.72**	0.17
12. Castilla-La Mancha	0.42	0.17	**0.67**	0.28
13. Canary Islands	0.39	**0.83**	0.06	**0.56**
14. Cantabria	0.36	**0.61**	0.11	**0.50**
15. Murcia	0.27	**0.72**	0.39	0.11
16. Valencia	0.26	0.11	0.33	0.22
17. Castilla y León	0.12	0.33	0.17	0.06

Notes: This table ranks the 17 Spanish communities according to their SRI. The red line separates the regions that have an SRI above the median (0.48). It also shows the VdW^R of each region during each recessive period. The VdW^R in bold are those with a value above the median (0.50)

Table 4 *t* test on the differences in the forecast error (f.e.) between specialized and non-specialized regions

	Manufacturing industry	Construction	Tourism
Manufacturing industry	3.28*	–	–
Construction	1.04	−2.53*	–
Tourism	0.62	−2.05*	−1.04*

Notes: This table presents the values of the *t* test on the differences between the f.e. of regions specialized in sector s and regions not specialized in sector *s*. The asterisk * indicates that differences are higher (if positive) or lower (if negative) at the 5% significance level

the regression including the regions not specialized in *Manufacturing industry* and *Construction*.

The results of Table 4 suggest that the resilience capacity during the Great Recession was significantly higher for regions only specialized in the *Manufacturing industry*. In this group (i.e., regions with a LQ > 1 in this subsector), we find Galicia, Navarra and the Basque Country. These regions performed well in terms of resilience during the Great Recession (as can be seen in Table 3). Additionally, the regions specialized in both construction and Manufacturing industry (Cantabria, Aragon and Asturias) also performed well. (Table 4 shows that the differences between the f.e. are positive; however, they are statistically significative only at the 10% level.)

On the contrary, Table 4 indicates that the resilience capacity was lower during the Great Recession in the regions specialized in the following sectors: (i) construction; (ii) tourism; (iii) manufacturing and tourism, and (iv) construction and tourism 9.

In the first group (regions specialized only in construction), we find Castilla y Leon, Castilla-La Mancha and Extremadura. These regions performed poorly during the Great Recession. The only exception is Extremadura. We have already suggested that the resilience performance of this region might be overestimated due to the predominant role that the energy sector, benefited from public prices, plays in its economy.

In the second group (regions specialized only in tourism), we find the Balearic Islands, the Canary Islands and Madrid. These regions (with the exception of the Canary Islands) presented a VdW^R below the median during the Great Recession, which indicates that they performed relatively poorly in terms of resilience. These results partially contrast those of Navarro-Espigares et al. (2012) and Villaverde and Maza (2020). The exception of the Canary Islands might be explained by its special fiscal system. In the Canary Islands, the Corporation Tax is subject to several beneficial tax advantages for companies. Among these, the *Reserve for investments in the Canary Islands* (RIC), introduced in 1994, stands out (see Romero et al. 2009). The exemptions in the Corporation Tax may reflect a comparatively higher profit rate, thereby overestimating the comparative resilience capacity of this region.

In the third group (regions specialized both in manufacturing and tourism), we have Catalonia and La Rioja. In this case, Table 4 shows that the differences between the f.e. of these two regions and the rest are not significative at the 5% significance level. We see, however, that both regions presented a VdW below the

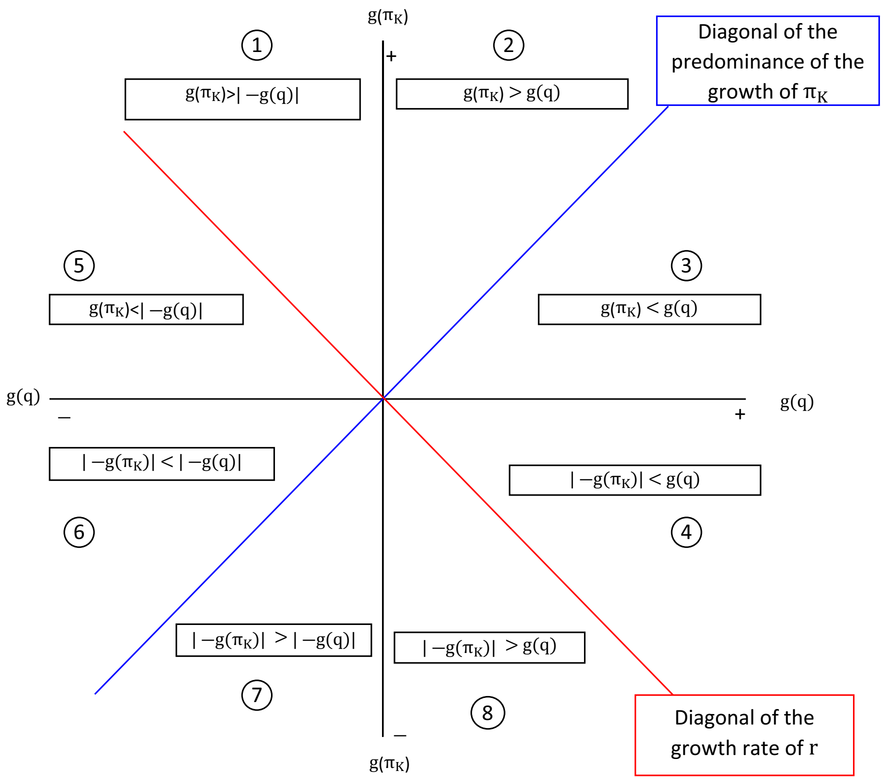

Fig. 2 Different modalities of regional resilience based on the behavior of π_K and q

median during the 2005–2011 period. These results suggest that, to tackle the great recession, the *manufacturing–construction* combination was more successful than the *manufacturing–tourism* binomial. It is because the Spanish manufacturing sector has more potential to generate backward and forward linkages with the construction sector than with the tourism sector.

Finally, in the fourth group (regions specialized both in construction and tourism), we find Valencia and Murcia. These regions present two of the worst performances in terms of resilience during the Great Recession. Thus, the results suggest that the worst productive specialization in terms of resilience capacity during the Great Recession was the combination of construction and tourism.

Thus, we conclude that regions specialized in manufacturing industry were more resilient than regions that did not specialized in manufacturing industry. On the other hand, regions that specialized in construction were less resilient than regions that did not specialized in construction, and regions that specialized both in construction and in tourism were less resilient than those that did not specialized both in construction and tourism. This is shown in Figs. 3 and 4.

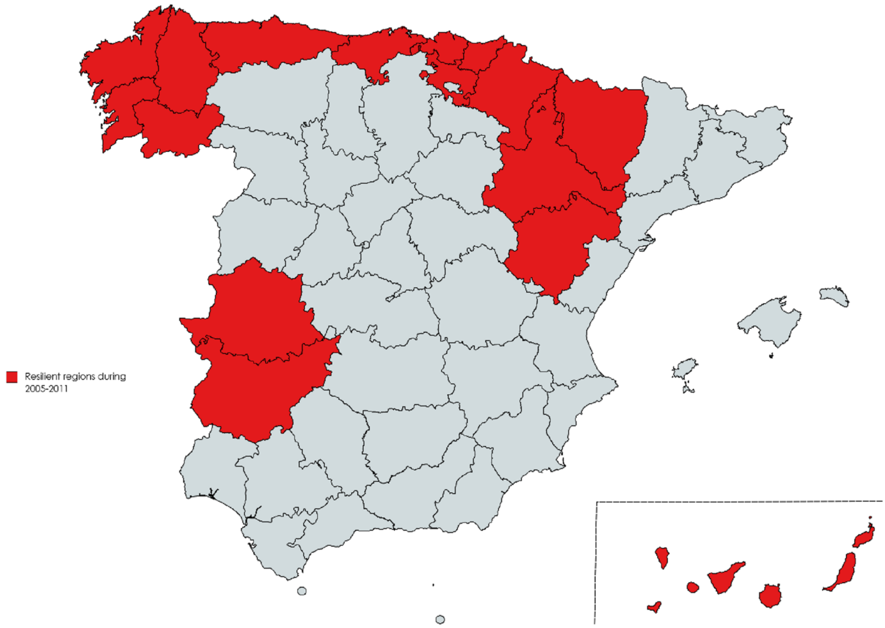

Fig. 3 Resilient regions during the Great Recession

Figures 3 and 4 suggest that the resilient regions during the Great Recession (red color in Fig. 3) were specialized only in manufacturing (purple color in Fig. 4) or in both manufacturing and construction (orange color in Fig. 4). There are two resilient regions that are exceptions: Extremadura and the Canary Islands. We have provided possible explanations for that.

The Great Recession was a crisis that particularly affected the Spanish construction sector. However, our results suggest that those regions specialized in construction that were also specialized in manufacturing, performed better than those exclusively specialized in construction and those specialized in construction and tourism. These results should not be generalized, since they might not apply to any economic recession. For example, Table 3 shows that the three leading regions in manufacturing industry (Basque Country, Catalonia and Aragon) presented values of the VdW^R well below the median during the period 1975–1982, which was characterized by an industrial crisis. It was also a crisis that particularly affected the energy sector, which explains that Extremadura ranked in the last place during this recessive period. However, we must highlight that manufacturing industry is generally more linked to high productivity (Felipe and Mehta 2016). Additionally, the manufacturing industry has important backward linkages on relevant sectors—including investment goods—and more potential to promote forward linkages to superior products and sectors (Gerschenkron 1962) and to increase the production matrix, i.e., diversify the economy, with better-than-the-domestic-average products (Pasinetti 1993). Thus, it is likely that the regions specialized in manufacturing industry are more capable to face economic adversity.

Fig. 4 Sectorial specialization. Regions specialized only in manufacturing (purple color) and regions specialized both in manufacturing and construction (orange color)

5 Conclusions

We have provided a method to rank regional resilience capacity in Spain. Our method shields results which are generally in accordance with the overall approaches to regional resilience in Spain, which focus on production and employment. However, our method focuses on the components of the rate of profit: (i) capital productivity and (ii) the profit share. The first component rests on the dynamics of aggregate demand and technical efficiency, while the second one informs on the dynamics of income distribution. We consider that the dynamics of both variables are relevant to evaluate and rank the economic resilience capacity of the Spanish regions.

First, we have proposed a method to detect the periods in which the profit rate in the whole Spain has experienced a negative deviation from its trend. Next, we have studied the performance of the Spanish regions during these periods by observing the differential evolution of the components of the profit rate. Based on this, we have ranked the resilience capacity of the Spanish regions.

The results suggest that the regions comparatively specialized in manufacturing activities are more resilient than regions comparatively focused on construction and, specially, regions comparatively focused on both construction and tourism. These results generally coincide and complement those of Angulo et al. (2014, 2018) and Cuadrado-Roura and Maroto (2016).

By emphasizing the importance of the profit rate, capital productivity and primary income distribution, our methodology can provide a complementary vision to analyze the economic resilience capacity of regions. The relevance of our analysis is that it can be applied to different economic realities, with a disparate format and different structures. The shortcomings of our resilience ranking proposal, however, are its incapability to detect important factors of resilience, such as social cohesion (Terzo 2021), the underemployment rate (see Carson 2020), territorial capital (Fratesi and Perucca 2017), gender (Di Caro 2017) and environmental sustainability (Rizzi et al. 2017; Marchese et al. 2018). Further research should be aimed at incorporating them.

Funding The fund was provided by the European Social Fund (Grant No. FPI/1866/2016), and by the Ministerio de Economía, Industria y Competitividad, Gobierno de España (Grant No. PGC2018 093896-B-100).

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