

# Wage flexibility and employment resilience in the Spanish labour market over the Great Recession

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**Abstract:** The Spanish economy is characterised by strong and persistent spatial differences in regional labour markets. The Great Recession resulted in a deep and long depression, with decreasing salaries and booming unemployment levels, affected by the internal wage devaluation policy of two labour market reforms. In this paper we analyse the connection between wage flexibility and regional labour market resilience. We estimate a spatial panel wage curve using microdata from Social Security records (MCVL) for 2002-2019 applying GTWR techniques. We find that those regions with higher wage flexibility are the ones with higher resilience recovery indices, showing the relevance of wage flexibility as a short-run adjustment mechanism to labour market shocks.

**Keywords:** Employment, Unemployment, Wage curve, Resilience, Spatial panel, GTWR

**JEL Codes:** J64, J31, R23, C23

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## 1. Introduction

The concept of resilience entered economic discourse as key tool to describe responses to shocks to local economies. Martin and Sunley (2015) defined regional economic resilience as the reaction of developmental growth paths to market, competitive and environmental shocks. They describe three main interpretations of the concept: engineering resilience (the ability to recuperate from a shock), ecological resilience (changes in growth patterns after a shock), and adaptive resilience (course changes in economic activity after a shock). They also stress that resilience is a process involving several elements: vulnerability, resistance, robustness and recoverability. More recently, Evenhuis (2017) also proposed the concept of evolutionary resilience, defined as the capacity for transformation of a system, presupposing the that there is no equilibrium, but a dynamic process of constant renewal.

Evenhuis defines resilience *adaptation* as “the actual process occurring in a regional economy to deal with unforeseen changes” (Evenhuis, 2017, p.3), a mechanism linked to the *underlying capacity* to cope with disturbances more generally (also called *adaptability* or *adaptive capacity*). While the former refers to the actual reaction of the region’s economy when a shock occurs, the latter is inferred from analysing the underlying factors that appear important for successful adaptation, closer to structural changes, what we understand as determinants of regional economic resilience. When trying to explain why do regions differ in resilience, several processes arise: compositional, collective, and contextual factors, composed by several interacting subsystems: the structural and business; the financial; the governance; and the labour market subsystem. While this paper deals with the process of adaptation to a specific shock, the Great Recession in Spain, we investigate the role of the labour market as a source of regional resilience. We do so by linking two concepts: labour market flexibility and adaptability, a link already indicated in seminal works (Martin and Sunley, 2015).

Employment outcomes are commonly used as a *measure* of resilience (assuming that there are no standards for measuring resilience, Ubago Martínez et al., 2019), as employment takes longer to recuperate than output, it is not dependent on deflation,

and it is statistically stable (Martin, 2012, Di Caro, 2015 and Sensier et al., 2016).<sup>1</sup> Alternatively, considering employment allows for accounting of the *determinants* of resilience (Fratesi and Perucca, 2018) and contributes to the study of labour market conditions (Eriksson and Hane-Weijman, 2017).

The response of labour markets to any shock reducing employment is a key determinant of resilience. Besides firm cost reduction or the willingness of firms to retain labour, wage flexibility can play a key role in the adaptability of labour markets, although any growth pattern based on low wages can lead to a permanently weak growth rate (Martin and Sunley, 2015).

Following the seminal works on the wage curve of Blanchflower and Oswald (1990, 1994, 2005) and the meta-analysis of Nijkamp and Poot (2005), a consensus has emerged (an empirical law of economics, according to Card, 1995) on a stable long-term elasticity of wages with respect to regional unemployment, which has been averaged between -0.07 and -0.1, although there are substantial disparities over population and employment groups. Our paper departs from this literature,<sup>2</sup> and investigate how wage flexibility acted as a resilience determinant of local labour markets.

In this paper we investigate the connection between wage flexibility and resilience at the regional level. We do so by analysing the stability of the wage curve, i.e., the negative relationship between regional unemployment and the real wage level. Here we understand the wage curve parameter as a measurement of wage flexibility, as strong and fast wage responses to growth in unemployment can lead to lower rates of

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<sup>1</sup> Other works use alternative indicators to capture resilience: Lewin et al. (2018) use personal income data, Pontarollo and Serpieri (2020a, 2020b) use GDP per capita, and several other use composite indicators of economic and employment outcomes (Rizzi et al., 2018, Ubago Martínez et al., 2019).

<sup>2</sup> Monastiriotis and Martelli (2021) also adopt a different approach to examine adjustments to shocks in Greek regions during the Great Recession. Using micro-data from the Greek Labour Force Survey (LFS) they first estimate the contribution of various individual and household characteristics to individual unemployment risk during and after the crisis. Next, they apply a decomposition analysis to identify the relative contribution of the shock, compositional effects, and price adjustments.

unemployment, and consequently, to a faster recovery from economic shocks (Johansen et al., 2019).<sup>3</sup>

We develop our analysis for the Spanish case, partly due to the existence of very good data for the estimation of local parameters of the wage curve, and also as case study with declining real wages and increased unemployment over a deep and long recession. This process took place together with a list of institutional changes adopted during the Great Recession, aiming at increasing wage flexibility, and improving the competitiveness of the Spanish economy. While we do not aim at doing a formal evaluation of such policy, we understand that is a very good opportunity to check the link between wage flexibility and resilience in local labour markets.

Our work is innovative in several ways. First, we link the study of labour market flexibility with the literature on resilience by studying the association between wages and unemployment within the framework of the wage curve in a very interesting period from a policy perspective. Second, we implement the analysis over a full economic cycle of the Spanish economy, starting in 2002 and ending in 2019, once the economic recovery after the Great Recession was fully stabilised. And third, it is the first to implement a flexible approach to the wage curve, both in terms of all spatial and time units, using Geographical and Temporal Weighted Regression (GTWR) techniques.

Our main findings show a positive association between labour market flexibility and regional resilience. We find that the elasticity of wages to regional unemployment is associated with the business cycle and the changes in labour market institutions, including two labour market reforms in 2010 and 2012. We also find large heterogeneities in the elasticity of wages to regional unemployment rates, and also in the changes in the parameters. The wage curve can be seen as a measure of regional efficiency of local labour markets and associated with recovery resilience, as less dynamic regions have less elastic wage curve parameters—a result that clearly establishes the relevance of structural characteristics of regional labour markets in Spain.

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<sup>3</sup> Interestingly, most analysis of the impact of the Great Recession has concentrated on the analysis of output or employment measures and not on unemployment, with the exception of those estimating the so-called Okun's law (see, for instance, Groot et al. 2011).

In relation to the literature, our paper connects, on one hand, to studies on labour market resilience, and on the other hand, to papers looking at the spatial dimension of the wage curve. Both strands are described in section 2, while section 3 describes the data used in our analysis and section 4 presents the case of study and the Spanish labour market in the context of the resilience and wage curve literatures. Section 5 presents the empirical strategy, and section 6 discusses the results. Finally, section 7 concludes with the main findings and implications of this study.

## **2. Literature review**

The notion of regional resilience has found currency among those interested in economic geography. In economics, resilience has been defined as the return to a status of equilibrium (Christopherson et al., 2010). Labour market resilience usually refers to the deviation of unemployment from its pre-crisis structural level, usually proxied by a counterfactual trend considering potential employment rates and demographic outcomes (Hitzen, et al., 2017).

The interest of scientists and policy makers has recently moved to analyse the factors that have allowed some regions and cities to resist and/or to recover from the large shock experienced by the Great Recession in 2008. From a spatial perspective, resilience in the labour market is among other things linked to traditional adjustment mechanisms: migration and changes in wages are the ways workers and firms adapt to changing conditions (Mian and Sufi, 2014), with resulting unemployment levels in rigid labour markets. National labour markets that are more flexible from a spatial point of view are those in which people move *between* local labour markets, looking for more and better job opportunities, while *within* labour markets wages adapt to increasing unemployment rates, making regions and cities more competitive. While we interpret labour market flexibility as one of the sources of resilience, as it helps regions to recover faster, Martin and Sunley (2015) debate about the advantages and disadvantages of wage flexibility on resilience. They argue that “in some equilibrium accounts of economic resilience, falling real wages due to a negative demand shock are seen as a mechanism for ensuring resilience and a way to restore pre-shock growth rates. However, this view makes strong and questionable assumptions about the demand for workers, and in many circumstances reduced real wages may lead to a

permanently reduced rate of growth” (p 33). In next sections we investigate if, indeed, wage flexibility is associated with unemployment decline. In this paper we proxy wage flexibility by looking at the association between wages and unemployment rates, the so-called wage curve. This empirical regularity is backed by several theoretical approaches, described by Blanchflower and Oswald (1995). In a proposal based on the work of Shapiro and Stiglitz (1984), the efficiency wage approach, employers will offer a premium to workers in order to minimize costs related to monitoring workers' productivity. In the labour turnover model, employers use higher wages to discourage current employees from quitting (Campbell and Orszag, 1998). Other authors assume this positive correlation between wages and unemployment in the long run, as the case of Card (1995), who criticises the labour contract model for its inconsistency with the compensating differentials model.

All of these previous theories do not consider explicitly the role of space. The possibility of migration ensures spatial equilibrium in wages and the erosion of the wage curve, for instance, due to compensatory wage differences (also in line with Harris and Todaro, 1970). Still, as migration is a costly and slow process, regional disparities slowly fade away, and the wage curve becomes a short run phenomenon (Blien, 2001) reinforced by the existence of costs associated with job searching or commuting. In this vein, Longhi et al. (2006) remember that in many occasions the spatial unit may not coincide with local labour market areas, and consequently commuting flows can be a source of spatial dependence. Elhorst et al (2007) also justify the spatial dependence models by the role of migration mechanisms, and Longhi (2012) remember these workers flows could affect wage bargaining in the considered region.

Suedekum (2006) provides a justification for the negative association between wages and unemployment by considering a theoretical model based on increasing returns in production in several regions. Large and affluent regions enjoy higher wages and employment levels, while poorer and smaller areas deal with the bad side of the curve. According to this model, such a relationship holds both in the short run and in the long run. Also, from a spatial perspective, Longhi et al. (2006) consider the theory of monopsonistic competition and assume that local labour markets are not isolated islands: workers can commute and migrate, and consequently unemployment elasticity may depend on employment opportunities in neighbouring areas. Longhi et al. (2006) argue that local monopsony power due to fewer job opportunities can result in more

pronounced wage curve relationships. Similarly, Baltagi et al. (2012), Baltagi and Rokicki (2014), and Cholezas and Kanellopoulos (2015) find lower elasticities in larger cities than in smaller cities or rural regions, although Jokinen (2020) finds that the impact of agglomeration disappears when accounting for unobserved worker heterogeneity.

One can also expect to observe changes in labour market institutions or in other global characteristics affecting the functioning of the labour market. Local wage responsiveness to unemployment is contingent on labour market institutions, such as the (de)centralisation of wage bargaining systems. These characteristics are usually shared by all regions in a country, and still, there is evidence of heterogeneous slopes of the wage curve across regions of the same country (Deller, 2011). Changes in labour market institutions have been considered drivers of changes in wage curve elasticity. Devicienti et al. (2008) and Daouli et al. (2017) analyse the change in elasticity as a result of labour market reforms in Italy and Greece: both works find that legislative changes played a role in promoting labour market flexibility. Examples of these reforms are changes in the bargaining process or declines in the level of minimum wages.

Consequently, due to spatial arbitrage, geographic increasing returns, monopsonistic competition or to a spatial differentiated impact of global labour market reforms, we expect to observe spatial patterns in the wage curve. It is worthwhile, then, to study the association between labour market resilience and the wage flexibility, in light of institutional changes in the labour market and over the business cycle. Alternative and competing theories stress the differentiated short versus long run dimension of the wage curve. Consequently, we inspect the evolving changes of elasticities over time in order to gain further knowledge of tidal movements of spatial labour markets.

### **3. Data**

In this paper, we use information from the Continuous Sample of Working Histories (*Muestra Continua de Vidas Laborales*; MCVL). In particular, we use data from the 2006 to 2019 waves. Every wave provides information on more than one million individuals (being representative of around 4% of the total population) who have had relationships with the Social Security system during that year, regardless of the duration or the nature

of the type of relationship (work, unemployment benefits, pensions, among other). In fact, the MCVL is an administrative longitudinal matched employer-employee dataset that reproduces the labour history of affiliated workers (for more details, see Arranz et al., 2013). In our sample we have merged the 2019 wave with the waves from 2018 to 2006. Although we know the full work history of these workers, we have limited our analysis to the period 2002-2019.<sup>4</sup> We have limited our analysis to individuals between 16 and 65 years old without disabilities who are observed as employees for at least two quarters during the considered period. The total number of observations considered in the analysis is 35,646,678 covering 52 provinces, the NUTS III level regional units in Spain that provide a good approximation to local labour markets. This is also the maximum regional level of detail for which unemployment rate data is available from the Labour Force Survey carried out by the Spanish National Institute of Statistics (INE).

MCVL provides information on monthly wages, type of contract (permanent/fixed-term), part-time/full-time, occupation (*grupo de cotización*), and the number of workers, the activity sector, and the location of the firm. It also contains information about the worker such as gender, country of birth, age, and schooling levels, that can be transformed into schooling years and allow us to compute potential labour market experience by applying the usual expression, age-schooling years - 6.

Regarding wages, as provincial unemployment rate data from the Labour Force Survey is only available at the quarterly frequency, we construct earnings by averaging monthly wages considering the time worked by each individual. If the individual had more than one job during the considered period, we took the job with the greatest earnings. We use quarterly averages of provincial Consumer Price Indexes provided by the INE to deflate quarterly wages, expressed in real terms and transformed using natural logarithms.<sup>5</sup>

Finally, we have also constructed a quarterly indicator of aggregate regional productivity using provincial Gross Domestic Product (GDP) per Worker from the *Contabilidad Regional de España* carried out by the INE. However, as these data are only provided at the annual frequency, we have applied Denton's (1971) method using as indicator the

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<sup>4</sup> Considering years before 2002 increases the risk of attrition, because the database is not representative in this time frame, except for in the years where extraction is done. However, from 2002 to 2006, the Spanish economy was in an expansionary phase with no significant regional differences. Besides, the actual series of unemployment from the labour force survey are based in 2002, and extending the series beyond that year could imply some comparability drawbacks.

<sup>5</sup> Table A1 in the appendix shows basic descriptive statistics of variables computed from MCVL.

quarterly data on GDP per worker at the national level as provided by the *Contabilidad Trimestral de España* (INE).

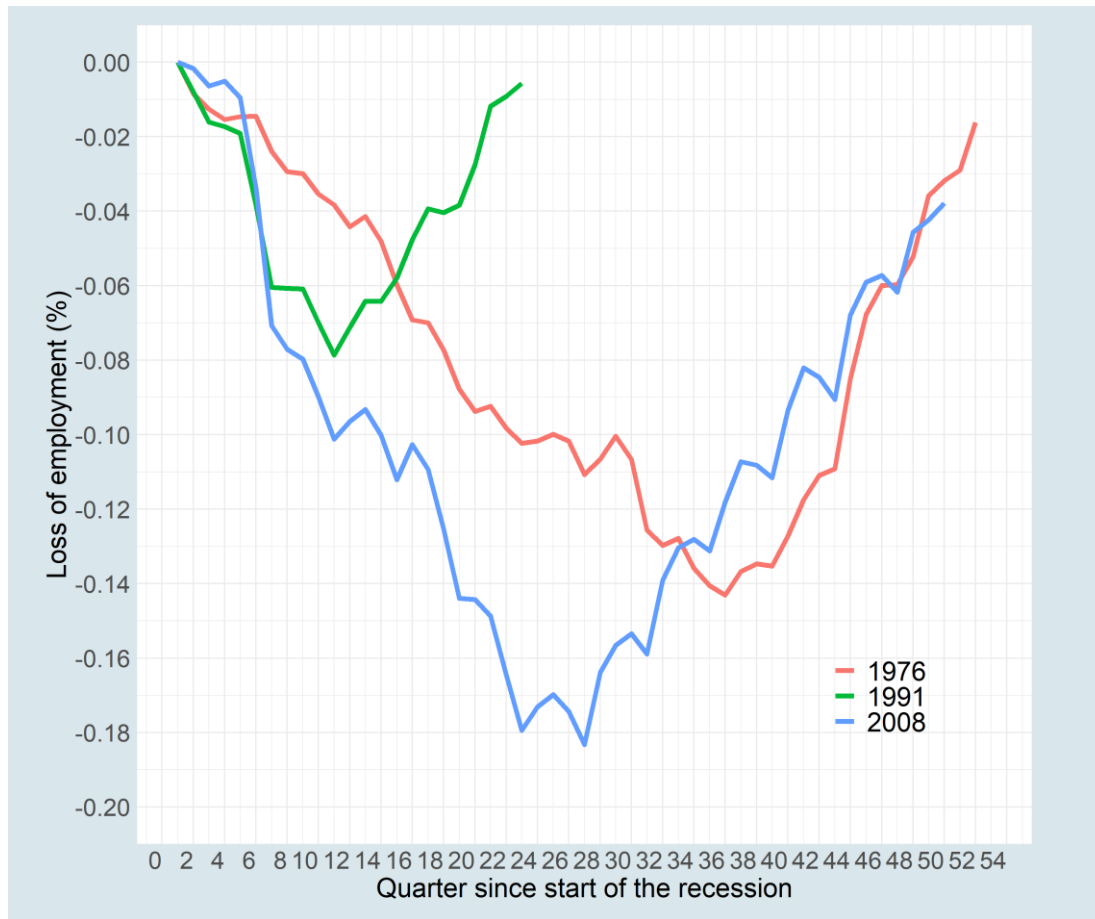
#### **4. The Spanish labour market**

Ramos et al. (2015) describe the Spanish labor market as a high firing cost, high-coverage collective bargaining system and a generous benefit system. They describe the outcomes of such labour framework as very high employment volatility, and with very high rates of unemployment during economic crisis. Melguizo and Royuela (2020) and Álvarez and Royuela (2022) describe the active role of migration in the spatial labour market equilibrium. Several other authors confirm that there are persistent and wide employment growth disparities linked to the business cycle (Bande and Martín-Román, 2018; Sala and Trivín, 2014). The limited flexibility of wages is compensated by a large share of fixed-term contracts, which are linked to the monopsonistic power of firms to settle wages and, subsequently, to the existence of a wage curve. This empirical law has been confirmed in a number of studies (García-Mainar and Montuenga-Gómez, 2003, 2012, Sanromá and Ramos, 2005). The spatial dimension of the wage curve has been analysed by Bande et al. (2012) and Ramos et al. (2015). Both articles reinforce the importance of spatial spillovers and the need to deepen the analysis of the spatial heterogeneity of the association.

Looking at the data we see how the impact of the Great Recession on the Spanish economy has been huge, particularly in a European context. It was the deepest and longest crisis since the civil war in the 1930s: unemployment rates climbed to 25% and 3.5 million jobs were destroyed. Despite these catastrophic outcomes, the recovery has been formidable, averaging some 400,000 net jobs created per year from 2014 to 2019.

Several authors have studied resilience in Spanish regions. According to Cuadrado-Roura and Maroto (2016), the most resilient Spanish regions are those previously specialised in dynamic and productive industries, which are reinforced by location advantages (Angulo et al, 2018). Ríos et al. (2017) remark on the role of social and demographic factors as resilience predictors, while Geelhoed et al. (2021) emphasise the role of inequality in employment resilience.

**Figure 1.** Net job losses with respect to the quarter with the maximum level of employment



Note: updated from Conde-Ruiz and Jansen (2014). The vertical axis represents the net losses in employment (%), with respect the peak in the business cycle, while the horizontal axis shows the number of quarters since the start of the crisis. Every line calls for three business cycles of the Spanish economy since 1976.

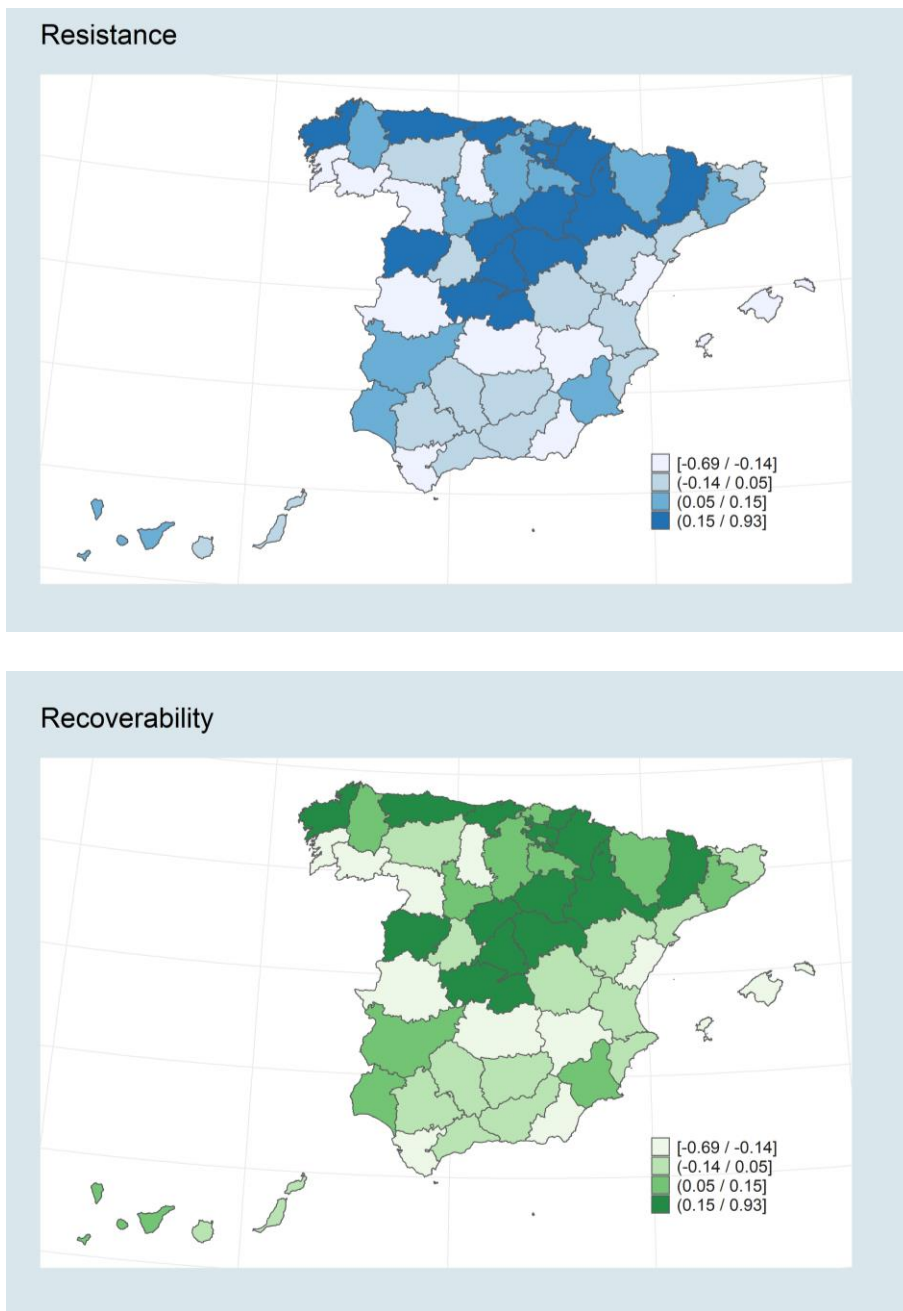
To construct measures for resilience, we follow Martin and Gardiner (2019) and compare the change in employment at the provincial level with the change at the national level. We allow employment contraction and expansion periods specific for each province  $p$  and for the entire country. The indices for resistance and recoverability are defined as follows:

$$Resistance_p^{t,t-k} = \frac{\Delta Y_p^{contraction} - \Delta E(Y_p^{contraction})}{|\Delta E(Y_p^{contraction})|}$$

$$Recoverability_p^{t,t-k} = \frac{\Delta Y_p^{expansion} - \Delta E(Y_p^{expansion})}{|\Delta E(Y_p^{expansion})|}$$

Where  $\Delta E(Y_p)$  is the expected change of employment in a province during a recession or recovery, following the national standard as a reference. Figure 2 display the indices for the Spanish provinces, considering 2008 and 2013 as the peak and trough of employment levels in the country (as in Cuadrado and Maroto, 2016 or Geelhoed et al., 2020). Strong differentiated patterns arise: while North provinces were more resistant, in Southern and Eastern provinces the recovery was more intense. These spatially heterogeneous outcomes might be associated to a list of underlying factors driving to successful adaptation, being the labour market aspects, including wage flexibility, potentially a major driver.

**Figure 2.** Measures of Resilience Resistance and Recoverability of Spanish provinces. 2008-2019.



Note. Self-computed. Resistance and recoverability indicators are computed over the 2008-2013 and 2014-2019 periods, respectively.

From a historical perspective, the Spanish labour market displays inadequate adjustment mechanisms, with strongly volatile cyclical responses, important contract duality, weak and rigid growth in real wages, massive job losses during recessions, and high structural unemployment rates. The persistence of these circumstances helps to affirm that it is simply not true that the weaknesses of the Spanish labour market are due to temporary or cyclical circumstances (Hidalgo, 2012). In the context of labour market regulations, two important reforms were undertaken in 2010 and 2012. Both reforms, developed by governments of different political parties, tried to improve labour market efficiency (see Doménech et al., 2016, 2018, for further details). These transformations mainly sought to improve internal flexibility in terms of wages and worked hours rather than in terms of employment and deriving collective agreements that aligned with the changing economic conditions. The reforms focused on extending the decentralisation of the collective bargaining system, prioritising agreements at the firm level; reducing the cost of dismissal; and increasing internal flexibility mechanisms. We expect that these reforms should have increased the responsiveness of wages to labour market conditions in the different labour markets, with greater effects on regions that were more affected by the crisis.

## **5. Empirical strategy**

We focus on the analysis of wage curve elasticities as a measure of the efficiency and adaptation resilience of Spanish local labour markets by estimating local responses to the changing labour market conditions. Our empirical approach involves estimating local wage curves, assuming spatial heterogeneity in local labour markets.

Our approach starts following Ramos et al. (2015). As they stress, Blanchflower and Oswald's (1990, 1994) specification of the wage curve involved a regression of individual wages (in logs) on regional unemployment rate, plus a list of control variables capturing individual and job characteristics. In order to avoid the potential upward bias of the test of significance of individual variables, as the variable of interest

(unemployment rate) is defined at a higher level of aggregation than the dependent variable (individual wages), the standard approach in more recent literature consists of applying a two-step procedure, as in Bell et al. (2002) and more recently in Ramos et al. (2015) for the Spanish case. The first step considers a Mincerian estimation, using information of wages at the individual level, which are regressed against a list of controls at the individual and the firm level and time-varying regional dummies. The estimates of the dyadic region-time parameters capture the adjusted wages in the local labour market, adjusted for composition effects. The first step of the procedure considers the following equation:

$$\ln(w_{irt}) = \alpha Z_{irt} + \delta_{rt} + \varepsilon_{irt} \quad (1)$$

where  $\ln(w_{irt})$  is the logarithm of the wage of individual  $i$  who lives in region  $r$  at time  $t$ ;  $Z_{irt}$  is a vector of individual characteristics affecting the individual's wages; and  $\delta_{rt}$  are region-period dyadic specific effects that can be interpreted as average wages in region  $r$  at time  $t$  free of composition effects. Lastly,  $\varepsilon_{irt}$  is an idiosyncratic random error.

In the next step, we estimate the wage curve using as endogenous variable the corrected wages obtained from equation (1),  $\hat{\delta}_{rt}$ , while the explanatory variable is the logarithm of unemployment  $\ln(u_{rt})$  at the regional level. This second equation includes time fixed effects,  $\gamma_t$ , that control for all common shocks to the considered regions; regional fixed effects,  $\delta_r$ , capturing unobservable regional heterogeneity; and additional time varying regional characteristics  $Z_{rt}$  that can also affect regional wages, such as aggregate regional productivity:

$$\hat{\delta}_{rt} = \beta \ln(u_{rt}) + \theta Z_{rt} + \gamma_t + \delta_r + v_{rt} \quad (2)$$

Usually, this second equation is estimated by OLS or instrumental variables procedures, depending on the assumption of the endogeneity of the level of unemployment on wage formation. There is a vast body of literature developing spatial analysis in order to capture the spatial nature of the association. Thus, the use spatial econometrics to account for inter-regional spillovers, due to the existence of employment opportunities in neighbouring regions, plus commuting and migration flows between regional labour markets. In this line, several works have found the existence of spatial spillovers:

Longhi et al. (2006) for Western Germany, Elhorst et al. (2007) for East Germany, Falk and Leoni (2011) for Austria, and Ramos et al. (2015) for Spain.

Still, as highlighted above, there are also theoretical explanations to expect spatial heterogeneity in the parameter of the wage curve. Longhi et al. (2006) hypothesise that the cause of spatial non-stationarity is differentiated labour market accessibility, and that this parameter can be stronger in rural than in urban areas. Both Longhi et al. (2006) and Deller (2011) estimate cross section Geographic Weighted Regressions (GWR) to show local heterogeneity in the wage curve, finding important differences over the space. Other works consider heterogeneity from different points of view, including rural-urban (Baltagi and Rokicki, 2014; Jokinen, 2020), level of development (Bande et al., 2012), and time (Devicienti et al., 2008, Daouli et al., 2017).

At this stage, we assume that both approaches, spatial dependence and spatial heterogeneity, can adapt to the spatial nature of the data. Besides, there are theoretical reasons justifying both empirical approaches. Still, given that we are studying if regions with higher wage flexibility are the ones reporting higher levels of resilience, we aim at obtaining spatially differentiated measures of wage flexibility. Consequently, we are not interested in the estimation of the elasticity of the wage curve alone, but in the local heterogeneity of such elasticity.

An additional argument to opt for modelling spatial heterogeneity is the use of GTWR, which is also flexible in terms of time. Specifically, we use a GTWR approach to simultaneously account for spatial and time heterogeneity in the estimation of equation (2).<sup>6</sup> GTWR (Huang et al., 2010, Wu et al., 2014, Fotheringham et al., 2015) is an extension of GWR accounting for local effects in both space and time. The main advantage of the chosen approach is that time effects are not constrained to being constant over space. This technique extends the traditional regression framework and assumes the existence of non-stationarity. In addition to GWR, time is also a variable considered in the weighting scheme of the estimation. It allows us to inspect the evolution of wage flexibility over the business cycle and particularly at the light of the institutional labour market reforms. The GTWR can be expressed as:

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<sup>6</sup> Our decision of estimating a GTWR prevents us to deal with the potential endogeneity of unemployment in the wage regression.

$$\widehat{\delta}_{rt} = \beta(u_i, v_i, t_i) \ln(u_{rt}) + \theta(u_i, v_i, t_i) Z_{rt} + \gamma_t(u_i, v_i, t_i) + \delta_r(u_i, v_i, t_i) + v_{rt} \quad (3)$$

The parameters will vary in space, according to the spatial coordinates  $(u_i, v_i)$ , and time  $(t_i)$ , and the estimation is based on a weighting scheme in which the weighting matrix depends on the spatial and time distance between observations. In the traditional GWR framework, weights are defined as spatial kernels based on the physical distance,  $d_{ij}$  (computed as linear distance based on the coordinates of every spatial unit), and are usually transformed following Gaussian or bi-square functions, which can be fixed or adaptative. In GTWR models, distances are also complex, as they include time distance. Wu et al. (2014) propose a spatio-temporal distance between observations  $i$  and  $j$ , observed in different locations and times, labelled as  $t_i$  and  $t_j$ :

$$\begin{cases} d_{ij}^{ST} = d_{ij}^S \otimes d_{ij}^T = \lambda d_{ij}^S + \mu d_{ij}^T + 2 \sqrt{\lambda d_{ij}^S \mu d_{ij}^T} \cos(\xi), & t_j < t_i \\ d_{ij}^{ST} = \infty & t_j > t_i \end{cases} \quad (4)$$

where  $d_{ij}^{ST}$  is the spatio-temporal distance,  $d_{ij}^S$  and  $d_{ij}^T$  are the physical and time distance respectively, and  $\lambda, \mu$  and  $\xi \in [0, \pi]$  are adjustment parameters that can be optimised with cross validation procedures in terms of  $R^2$  or AIC values. The interaction between space and time is governed by parameter  $\xi$ : when  $\xi = 0$ , space and time have the maximal effects, while if  $\xi = \pi/2$ , there is no interaction between both dimensions. In practical terms, the weight assigned to the spatial ( $\lambda$ ) versus the time distance ( $\mu$ ) can be normalised assuming  $\mu = 1$ , which leaves parameter  $\lambda$  with the relative weighting role. Consequently, in addition to the usual spatial kernel parameters, two additional parameters,  $\lambda$  and  $\xi$ , need to be chosen.

## 6. Results

### 6.1. Basic results: wage flexibility

In this section, we present the results of estimating the models discussed in the previous section. The results of estimating equation (1), the Mincerian wage model, are

shown in Table 1. As we can see in this table, the results are well in line with those in the literature. There is a wage gender gap of around 10 log points in favour of men in the Spanish labour market after controlling for several characteristics. Coefficients related to schooling year and potential experience are statistically significant at the usual level and show the expected signs, detecting a positive relationship between human capital and wages. Individuals who worked only part-time received significantly lower wages than those who worked full-time. The dummy variables related to fixed-term contracts also show the penalisation that these workers experience in the labour market compared to those with permanent positions. Workers in publicly-owned firms also have a positive wage premium compared to those employed by private firms. Occupational dummies also have the expected sign, as the reference category corresponds to high-skilled occupations while firm size also has a positive effect on wages. Information related to industry sectors (not reported but available from the authors on request) permitted us to control for the effect of the various productive and employment structures in the various provinces. Time dummies allowed us to control for common shocks to all regions in each quarter (also not reported but available from the authors on request), while province dummies control for permanent differences in local labour markets.

**Table 1. Mincerian wage equation.**

Variables	
Male	0.102*** (0.000)
Immigrant	-0.031*** (0.000)
Schooling years	0.019*** (0.000)
Potential experience	0.026*** (0.000)
Potential experience squared	-0.000*** (0.000)
Part time contract	-0.581*** (0.000)
Fixed-term contract	-0.300*** (0.000)
Publicly-owned firm	0.121***

	(0.001)
Technical Engineers, experts, and qualified assistants	-0.080***
	(0.000)
Administrative and Workshop Managers	-0.131***
	(0.000)
Assistants without official qualification	-0.274***
	(0.001)
Administrative Officers	-0.301***
	(0.000)
Subordinates	-0.521***
	(0.001)
Administrative Assistants	-0.505***
	(0.000)
First and Second Category Officials	-0.493***
	(0.000)
Third Category Officials and Specialists	-0.571***
	(0.000)
General Assistants without qualifications	-0.720***
	(0.001)
Number of workers in the firm	0.024***
	(0.000)
Constant	7.155***
	(0.001)
Observations	35,646,678
Individuals	1,056,965
R-squared	0.521

Note: Reference categories: female, native, full-time, permanent contract, private firm, Engineers, and Graduates. Fixed effects for 377 activity sectors are also included. This regression considers region-period dyadic specific effects, capturing region-time average free of composition effects. Robust standard errors in parentheses. Significance: \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ . We consider 72 periods of time (2002.q1-2019.q4) and 52 provinces.

In equation (2), we use the estimates of time-varying region-specific effects from equation (1) as the endogenous variable, and the natural logarithm of regional unemployment is introduced as an explanatory variable together with the logarithm of regional aggregate productivity and time and regional fixed effects. Table 2 presents the main results of the global model with no time or spatial varying effects. As can be seen in this table, the elasticity of adjusted wages to unemployment rate is quite weak. Once we account for regional productivity and province and period fixed effects, the parameter is significant and negative, but the size is rather small: -0.007. The total effect of unemployment of the dynamic model (column 4) increases to -0.025. These values are in line with the impact parameter in Ramos et al. (2015), although they fall below their total effect once they account for the spatial effect (-0.073).

We have also computed a list of alternative spatial models, including spatial autoregressive models, spatial Durbin models, spatial autoregressive combined models, and spatial error models. We have estimated all models with and without time-lagged wages as explanatory variables, and also considering alternative specifications of the spatial matrix, namely, the contact matrix and the inverse distance matrix. For brevity, these results are enclosed in the supplementary material. We find no significant spillovers for the spatial lag of the rate of unemployment in the dynamic spatial Durbin model, while in some regressions we find some evidence of spatial autocorrelation of wages, which significance varies with the specification of the model. These results show that there is indeed a spatial pattern in the data, which needs to be taken into account. Our preferred specification, though, considers spatial heterogeneity rather than spatial autocorrelation, as we can accommodate also time variation by means of the GTWR specification.

**Table 2. Wage curve basic models**

	(1)	(2)	(3)	(4)
ln Unempl rate $t$	-0.080*** (0.00222)	-0.00497*** (0.00184)	-0.00749*** (0.00177)	-0.014*** (0.007)
ln GDP pw $t$			0.794*** (0.043)	0.427*** (0.112)
ln adjusted wage $t-1$				0.555 *** (0.058)
Constant	0.185*** (0.00603)	0.186*** (0.00517)	-6.423 (0.347)	3.445 (0.340)
Time FE	No	Yes	Yes	Yes
Region FE	No	Yes	Yes	No
Observations	3,744	3,744	3,744	3,640
R2	0.258	0.235	0.318	0.955

Note: Robust standard errors clustered by province are in parentheses. Significance: \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ . For the fixed effects we consider 72 periods of time (2002.q1-2019.q4) and 52 provinces.

We next look at the results of estimating equation (3) applying GTWR, in which we see time and spatial varying effects of unemployment on wages. In order to balance spatial and temporal distances, we opted to work with the maximum interaction parameter ( $\xi = 0$ ), and we performed a battery of estimations to find the optimal weight for space/time. The parameter was obtained considering a fixed kernel and using a cross-validation procedure in terms of goodness-of-fit, reporting a value of parameter  $\lambda = 0.0001$  ( $\mu=10,000$ ).<sup>7</sup> We first display the results of two extreme situations of the GTWR specification. When  $\lambda = 0$ , the specification fully accounts for time varying effects. On the contrary, when  $\lambda = 1$ , all variation is spatial. Panels (a) and (b) of Figure 3 plot the results of these analysis, and panel (c) plots the results for  $\lambda = 0.0001$  and  $\xi = 0$ .

The temporal evolution of the parameter shows an increase (getting closer to zero) until the first quarter of 2006 (see Figure A4a in the appendix). Beyond that period, and close to the start of the Great Recession, we observe a negative parameter becoming stronger. Interestingly, despite the start of the recovery of the economy in 2014, there is further decline in the value of the elasticity of adjusted wages to the unemployment rate, which we interpret as an improvement in the efficiency of the labour market. We want to believe that the reforms of the Spanish labour market are somehow associated with these results.

Results in panel (a) of Figure 3 capture the strong cross section heterogeneity of the wage curve. We find negative and significant parameters in some of the more dynamic regions in Spain: Eastern regions (Balearic Islands and also continental regions, including Catalonia and Valencia and Aragon), Northern regions (such as the Basque Country, Cantabria, and Asturias), and some neighbouring Castilian provinces. These provinces are in line with the traditional negative sign of the wage curve: as

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<sup>7</sup> We have used the `gtwr` command of the `GWmodel` package in R (Gollini et al. 2015, Lu et al. 2019). Figure A1 in the Appendix displays the details of parameter selection according to goodness of fit (Adj R2) and AICc statistics, while Figure A2 displays the relative distance resulting from different parameters of  $\lambda$ . The final results using different parameters of weighting space and time did not change the main results of the basic specification. Additional results with different combinations of values for these parameters are available from the authors on request.

unemployment increases, wages experience a declining pattern, in line with the efficiency wage approach, the labour turnover model, and the spatial model based on increasing returns in production.

On the opposite side, we find the less developed south-western provinces (particularly the less dynamic region of Extremadura), other southern Andalusian provinces (including Seville), and some neighbouring provinces in Castille La Mancha. For these provinces we find non-significant and even positive parameters, a result that is opposite to findings explained in the literature by the theory of monopsonistic competition and the lack of employment opportunities. These outcomes are in line with those of Bande et al. (2012), who find a stronger negative sign for more dynamic provinces, and they are partially aligned with Melguizo (2017), who detects spatial heterogeneity in provincial parameters of the Okun's law (that there is an inverse relationship between unemployment and GDP). While the north-south divide is in line with the resilience measures plotted in Figure 2, the east-west pattern observed in Figure 3 was less clear in the measures of resistance and recoverability, particularly for the case of Balearic Islands.

Next, Table 3 and Panel (b) in Figure 3 report the results of the GTWR model with additional combinations of parameters optimising the adjustment criterion. Figure 3b displays the results for a selection of 4 provinces (Figure A4c in the appendix plots the results for all provinces), with a new picture of the wage curve, with some results in line and some in contrast of what we find in Figure 3a.<sup>8</sup>

On the one side, there are negative and significant parameters of the wage curve in north-eastern provinces such as Barcelona, while we hardly find any positive and significant parameters other than some periods in Castilian provinces such as Ávila. Non-significant parameters are present in large areas, including in the north-western and central provinces. On the other side, southern provinces, such as Seville and Malaga, display results that are negative and significant, in contrast with what we found in the cross-section picture resulting from Figure 3a. In addition to the spatial

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<sup>8</sup> We have computed a battery of test of spatial heterogeneity for every quarter separately. As could be expected, in the initial periods, where there are few significant parameters of the wage curve, we observe no significant spatial variability. When the number of significant estimated parameters increases, the spatial heterogeneity becomes relevant. Remarkably, it is at the end of 2009 when we start finding significant heterogeneity in the parameter estimates, and it becomes the norm by 2012.

heterogeneity, the use of GTWR allows for comparing the evolution of these parameters in every province. Overall, we see an increasing importance of labour market flexibility in the form of growing elasticity of unemployment in the formation of wages. Before the Great Recession, only 18% of the estimated parameters were negative and significant. In 2005 a mere 4% of provinces (2 out of 52, Balearic Islands and Melilla) displayed a significant and negative parameter. Over the 2008-2013 period, that percentage increased to 43%, while in the recovery period (2014-2019), 55% of the estimates displayed a negative and significant parameter, with a peak in the first two quarters of 2017, when 85% of the provinces (46 out of 52) report significant and negative wage curve parameters. By the end of 2019, that percentage declined to 42% (22 provinces). The provinces with greater elasticity (those with lower parameters), mostly located the northeast, (such as Barcelona or the Balearic Islands), saw more important declines, even becoming more elastic. Figure 4 complements the results by linking the evolution of the parameters in every province by sub-periods over the business cycle. These declines are stronger and mainly observed in the deep period of the Great Recession (2008-2014). Interestingly, we see a different direction in the subsequent period of recovery (2014-2019), when provinces with stronger elasticity in the wage curve are the ones moderating such effect.<sup>9</sup>

**Figure 3.** GTWR results.

(a)

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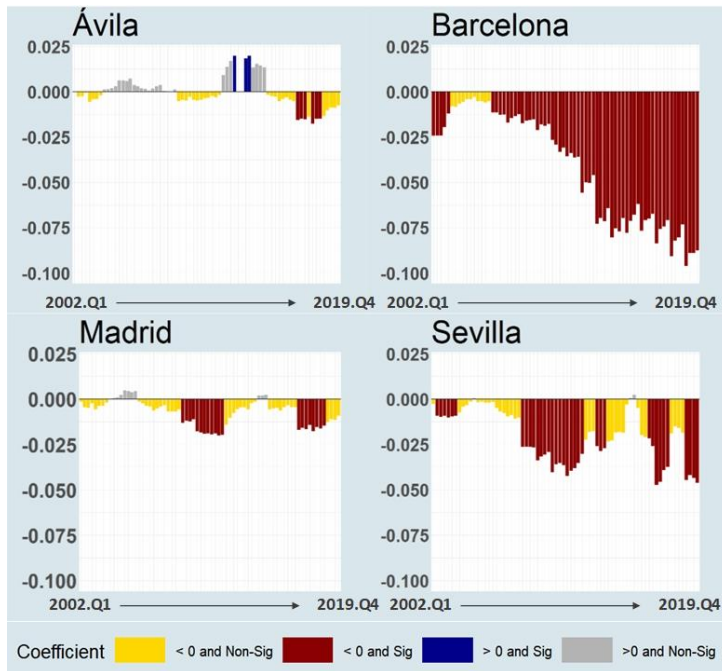
<sup>9</sup> Figure A3 in the Appendix displays the box-plot over provinces and time of the parameters considered.

Panel (b) GTWR. Log Unemployment Rate Coefficients.

Period: 2002.Q1-2019.Q4. Parameter  $\lambda=1$ .  $R^2_{Adj}=0.95729$ .



(b)



**Table 3.** GTWR results

	Min	Q1	Mean	Median	Q3	Max	St Dev		
							Overall	Between	Within
ln Unempl.	-0.218	-0.023	-0.017	-0.011	-0.004	0.035	0.025	0.017	0.018
ln GDP pc	-2.751	0.441	0.718	0.776	1.018	4.093	0.632	0.353	0.526
Constant	-33.63	-8.112	-5.659	-6.130	-3.424	22.209	5.117	2.864	4.259

Fixed Gaussian bandwidth for geographic and temporal weighting: 27.29

Number of data points: 3744

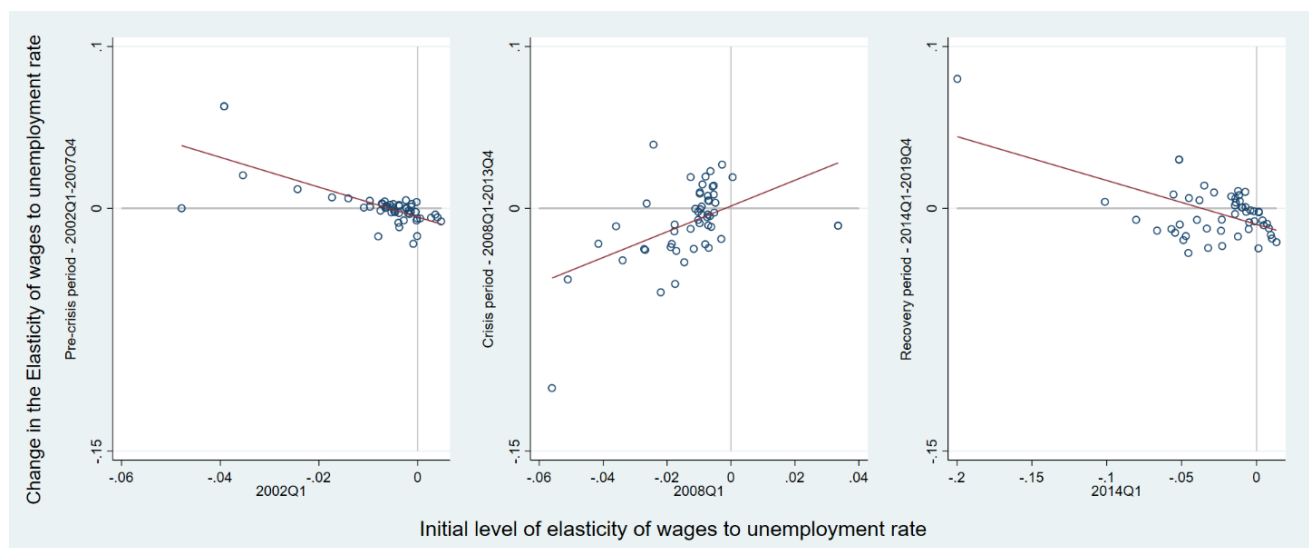
Effective number of parameters ( $2\text{trace}(S) - \text{trace}(S'S)$ ): 935.86

Effective degrees of freedom ( $n - 2\text{trace}(S) + \text{trace}(S'S)$ ): 2808.14

AICc: -23959.69

R-square value: 0.988. Adjusted R-square value: 0.984

**Figure 4.** Changes in the elasticity of wages to unemployment over time: 2002-2019.



Note: Scatterplots represent the 52 Spanish provinces. The horizontal axis displays the parameter of unemployment in the wage curve in the starting period and the vertical axis represents the change of the parameter over the subsequent years.

From a spatio-temporal perspective, our results clearly display a heterogeneous behaviour of the main parameter in the wage curve. Clearly, we see cyclical behaviour in the elasticity of wages, as there is an important decline since the start of the crisis, reporting higher flexibility, which continued until the start of the recovery in 2014.

In our view, the labour market reforms in 2010 and 2012 reinforced the increase in labour market flexibility, as the economic recovery initiated in 2014 did not stop the declining trend of the parameter. On the contrary, the lowest values of the wage curve are observed in more recent periods (2018), which can be interpreted as an indication that labour market reforms have been effective, although with some delay. From a spatial perspective we do not observe marked differences in the impact of the labour market reform, despite the important structural differences in local Spanish labour markets.

## **6.2. Wage flexibility and employment resilience**

Next, we compare the results of the wage curve with the indicators of employment resilience. Figure 5 presents the association between the elasticity of the wage curve and the measures of resistance and recovery. Panel (a) displays the average of wage flexibility between 2002 and 2011 and the resistance of provincial employment, while panel (b) shows the average of wage flexibility between 2012 and 2019 and the recovery of provincial employment in that period.<sup>10</sup> These figures connect the resilience measures (as those plotted in Figure 2) with wage flexibility estimates (the ones reported in Figure 3), what allows to evaluate the role of the labour market as a source (adjustment mechanism) of regional economic resilience. The first graph shows a lack of connection between the mild wage flexibility before and at the start of the Great Recession and the resistance of local labour markets. On the contrary, the higher levels of wage flexibility after 2011 are clearly associated with employment recovery: all provinces with a wage curve parameter beyond -0.05 had a recovery higher than the national average, and almost all provinces with a parameter above -0.02 experienced lower recovery.

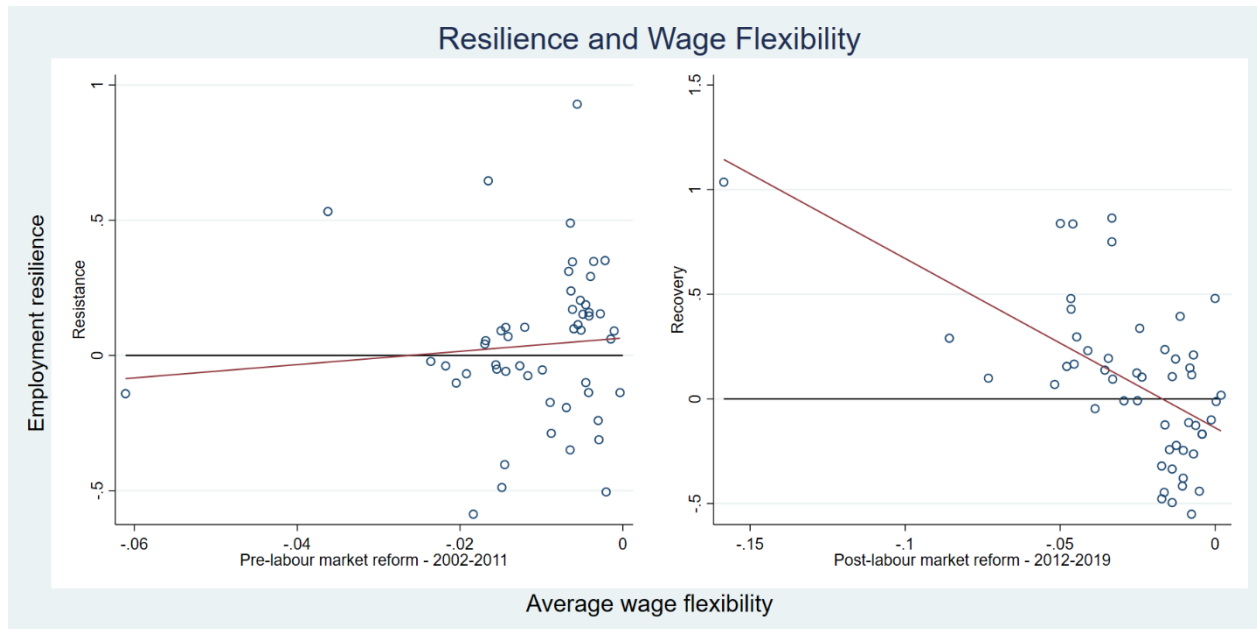
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<sup>10</sup> Such periods try to capture the average wage flexibility anticipating subsequent resilience (resistance and recovery). We considered alternative periods, such as the average between 2002 and 2007, or just 2007 for resistance period, and the average between 2010 and 2012, 2012 and 2014, or just 2014 for the recovery period. The results did not report major changes.

**Figure 5. Wage flexibility and employment resilience**

(a)

(b)



Note: we have computed the resilience measures (resistance and recoverability) by means of the formulas reported in section 3.

We understand our results in terms of wage flexibility to changes in local labour market conditions. Our picture is very similar to the one drawn in Cuadrado-Roura and Maroto (2016), and it is also in line with the results of Deller and Watson (2016). While these authors devote their work to connecting resilience to sectoral specialisation, we add as an explanation the heterogeneous behaviour of local labour markets, which might be determined by the industry mix, and also by firms and labour force characteristics. From an institutional labour market perspective, we see how a non-spatial policy, such as the labour market reforms in 2010 and 2012, had limited effects in terms of improving the conditions in all local labour markets.

Specific attention to Madrid, the strongest and most dynamic province in Spain, is warranted. We find few significant and negative results for this region (see panel (b) of Figure 3). In this case, we interpret the results as a combination of the dynamic effect of

the province itself and the weaknesses of surrounding provinces, which are being *absorbed* by the capital of the country. One can argue that Madrid can be understood as having the opposite situation of monopsonistic competition in the labour market, as firms face a very competitive environment and difficulties in lowering salaries.

Finally, Figure A5 in the appendix plots the GTWR results for the log of GDP per worker. The results are positive and significant, and consequently the adjusted wages respond to changes in our measure of productivity, although this effect declines in more recent periods for many provinces.

We checked the robustness of our results to several estimation techniques. We have inspected the role of the spatial bandwidth in our results. While we have mainly opted for Gaussian kernels, we considered spatially adaptative rather than fixed kernels. While there were some alternative results, the overall picture and our main conclusions do not change.<sup>11</sup>

## 7. Concluding remarks

In this paper, we have studied the association between wage flexibility and employment resilience in Spain during the Great Recession. We use the wage curve as our measure of labour market flexibility, a characteristic that helps local labour markets to achieve a faster recovery from economic shocks—a key dimension of resilience. We have used microdata from the Continuous Sample of Working Lives, a random sample of 4% of all individuals who contributed to the social security system, and we have computed adjusted wages free of personal characteristics for all Spanish provinces (NUTS-III), our main unit of analysis. We have analysed the responsiveness of the locally adjusted wages to unemployment rates between 2002 and 2019 and considered the spatial heterogeneity in a dynamic wage curve by means of a Geographic and Time Weighted Regression (GTWR).

Our findings show weak elasticity of wages to the unemployment rate, particularly before the start of the Great Recession. Since then, we observe an increasing pattern in

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<sup>11</sup> These results are available in the Supplementary Material.

the absolute value of the wage curve during the Great Recession, which continues over time despite the start of the economic recovery in 2014. We hypothesize that the reforms of the labour market implemented by two consecutive governments (2010 and 2012) could be linked with such behaviour. We also find a strong spatial heterogeneity of the parameter, which is negative and significant in a subset in the northeast of the country. On the opposite side, we find south-western provinces, particularly the less dynamic region of Extremadura and other western Andalusian provinces. When we estimate together spatial and time varying parameters, we find a time-varying response that is more intense in those provinces with already high elasticity values.

At this stage, we come back to Martin and Sunley (2015) debate about the pros and cons of wage flexibility as part of the underlying mechanisms of resilience. Our findings show that when combining wage flexibility and the measures of resilience, we do not observe any linear association with resistance over the declining period, characterised by low levels of wage flexibility. On the contrary, we find that those regions with high wage flexibility are the ones with higher resilience recoverability indices. Our results support the short run dimension of the Martin and Sunley (2015) arguments for restoring pre-shock conditions, while the long-run effect, lower wages driving to a permanently reduced rate of growth, is an aspect to investigate in future works.

Our results suggest that the labour market reforms of 2010 and 2012 could have important effects on wage flexibility, which are observed nationally and at the local level. Nevertheless, while the effects are heterogeneous over local labour markets, the expected spatial variability is not always in favour of the less affluent territories. As suggested by López Mourelo and Malo (2015), labour market reforms should also be defined in local terms, or at least to account for the characteristics of local labour markets, usually strongly differentiated in structural terms.

We understand that our work can be improved a several areas. First, we assume that we could have worked with a more sophisticated empirical model, for instance assuming lagged wages as an explanatory variable or including spatial dependence in the analysis, as other papers in the literature have done. In any case, as our focus is the analysis of spatio-temporal heterogeneity, we believe that our results are not invalidated for alternative specifications. We also agree that we do not perform a causal evaluation of the labour market reforms, which is not our main aim. Similarly, further

research can inspect the mechanisms behind the observed association, such as the role of wage flexibility on job creation, less firing, or even firm mortality. Finally, we understand that the inspection of the causes of the observed heterogeneity in the labour market flexibility and its connection with resilience can be of substantial interest for further research.

## **Additional information**

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