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ABSTRACT

Labour Market Flexibility and Regional Unemployment Rate Dynamics: Spain 1980-1995*

This paper aims to shed light in the dynamics of Spanish regional unemployment rates and determine the driving forces of their disparities. The Spanish economy has one of the highest unemployment rates in the EU and is characterised by severe regional disparities. We apply the chain reaction theory of unemployment according to which the evolution of unemployment is driven by the interplay of lagged adjustment processes and the spillover effects within the labour market system. Our model includes nationwide as well as region-specific variables, and takes into account the limited labour and firm mobility in Spain. We show that the degree of labour market flexibility differs between high and low unemployment regions, and find that investment has a major influence on the unemployment trajectory. In addition, we find that in bad times high unemployment regions are hit more severely than low unemployment regions, while in good times high unemployment regions do not benefit as much as low unemployment regions.

JEL Classification: R23, J64

Keywords: regional disparities, unemployment, spillover effects, labour market, lagged adjustment processes

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1 Introduction

While the major unemployment differentials between EU countries have attracted a lot of interest over the years, the issue of substantial disparities in regional unemployment rates has only been addressed more recently (see, for example, Marston, 1985, Blanchard and Katz, 1992, Decressin and Fatás, 1995, Jimeno and Bentolila, 1998, Baddeley, Martin and Tyler, 1998 and Overman and Puga, 2002).

This paper aims to shed light in the dynamics of Spanish regional unemployment rates and determine the driving forces of their disparities. The Spanish economy has one of the highest unemployment rates in the EU and is characterised by severe regional disparities (see Bande *et al.*, 2005, 2006).

Elhorst (2003) argues that the issue of regional unemployment deserves special attention for the following two main reasons. First, the magnitudes of regional disparities are at least as large as the magnitudes of unemployment differentials among countries (OECD, 2001). For instance, in 2005, the Southern Spanish region of Extremadura had an unemployment rate of 16%; in contrast, the richer Northern Spanish region of Navarra experienced a modest unemployment rate of 5%. Such big differentials have not been witnessed by the EMU countries.

Second, regional unemployment differentials may be inefficient as they may reduce GDP and put upward pressure on inflation. In addition, there is wide agreement that the same nationwide unemployment rate may have different social repercussions depending on the distribution of regional unemployment rates.¹

The standard macro models explain unemployment differentials on the basis of the differences in the institutions of the labour market like the wage bargaining mechanism, the degree of social protection, the tax system, etc. However, although there are differences in the labour market institutions of different countries, there are no such differences between the different regions of a European country.²

This led to the development of models that interpret unemployment disparities as the result of scant inter-regional labour mobility or of regional differences in the labour market - such as the sectorial composition of employment and the regional characteristics of the unemployed workers. These explanations, although valid and relevant, only offer an incomplete account of regional unemployment rates. The evolution of regional disparities cannot be explained by labour mobility and idiosyncratic elements alone.

According to Marston (1985), the existence of regional disparities in unemployment

¹For example, consider the extreme case where a country has two regions of similar sizes. The social impact of, say, a 10% national unemployment rate is not the same when both regions experience a 10% unemployment rate, and when the unemployment rate in one region is 19% whilst in the other is 1%.

²The legal systems of European countries ensure that regional differences in labour market institutions are minimal.

may reflect an equilibrium outcome. Each region tends to its own natural rate of unemployment which is determined by demand side variables (such as the sectoral composition of the regional demand), supply-side factors (such as differences in workers' qualification levels), and institutional variables (e.g., unemployment benefits and employment protection schemes). Since all of these determinants show little variation through time, regional disparities can be viewed as an equilibrium outcome.

Alternatively, regional unemployment disparities may reflect disequilibrium in the regional labour markets. All regions would converge to the same competitive equilibrium but, due to sluggish adjustment mechanisms in the regional labour markets, adverse shocks have persistent after-effects. Being initially at equilibrium, a one-off shock generates differences in the regional unemployment rates. Regional unemployment rates respond by moving slowly towards equilibrium but, before their adjustment process is completed, they are hit by new shocks. As a result, full adjustment is never achieved and disparities in the regional unemployment rates are even greater, resulting in a polarization effect.

Blanchard and Katz (1992) show that in the US regional unemployment disparities are not persistent due to high labour and firm mobility. Workers move from high to low unemployment regions in search for better labour market prospects, while firms move to high unemployment regions to benefit from lower labour costs.³ The Blanchard and Katz model focuses exclusively on idiosyncratic shocks in a perfect labour mobility framework.

On the other hand, Decressin and Fatás (1995) show that the adjustment of European regional unemployment rates to shocks is driven by participation rather than by migration. Jimeno and Bentolila (1998) find that Spanish migration does not play any significant role in regional labour market adjustment, and the lack of wage flexibility reinforces the persistence of disparities in regional unemployment rates.

Overman and Puga (2002) show that a polarisation (clustering) process of European regional unemployment rates has taken place since 1986 as a result of changes in relative labour demand which have been similar across geographical neighbours. Idiosyncratic characteristics, national or regional, can only partly explain this neighbour effect which is strong both within and across national borders.

Bande *et al.* (2005) find that Spain is a differential country within the EU as regards regional unemployment disparities and their relationship with the business cycle. They conclude that this result is related to changes in the degree of wage bargain centralization/coordination, which introduces wage imitation effects in the sectoral bargainings, imposing high unit labour costs in the less dynamic industries of the less dynamic regions, allowing thus for less employment creation during booms and more employment destruction during recessions.

In this paper we explain the evolution of Spanish regional unemployment rates by

³This is because the large fraction of unemployed workers puts downward pressure on wages.

applying the Chain Reaction Theory (CRT) of unemployment.⁴ Following the CRT approach, we use a dynamic multi-equation labour market system to model regional disparities. Our model consists of three equations: labour demand, wage setting and labour supply. Arguments in favour of such a multi-equation model, as opposed to a single equation one, can be found in the survey by Elhorst (2003) and in Karanassou, Sala, and Snower (2003).

An advantage of a multi-equation labour market model over a single unemployment rate equation, is that growing nonstationary variables (e.g. capital stock) can be included alongside the usual stationary ones (e.g. tax rates) to determine the unemployment rate. In addition, our model includes nationwide as well as region-specific variables. This will allow us to distinguish between idiosyncratic and nationwide labour market shocks.

The CRT postulates that the evolution of unemployment is driven by the interplay of lagged adjustment processes and the spillover effects of the shocks within the labour market system.⁵ The implication is that unemployment can be viewed as the outcome of prolonged adjustments to changes in both stationary and growing variables. Since different regions may be exposed to different types of shocks and experience different adjustment processes, our approach incorporates elements of both the equilibrium and disequilibrium interpretations of regional disparities given above.

Our labour market model also takes into account the limited labour and firm mobility in Spain, and generally in Europe.⁶ Workers do not move as a result of scant wage differentials (due, for example, to centralised wage bargaining), substantial housing price differentials, and family ties. Firms do not move as they tend to agglomerate in certain regions in order to enjoy the agglomeration externalities (see Puga, 1999).

Specifically, we show that disparities in regional unemployment rates depend on

- The *regional spillover effects*, i.e. on how shocks feed through the labour market system. Different feedback mechanisms generate different unemployment responses even when regions face shocks of the same type and size (e.g. an oil price increase).
- The degree of *regional labour market flexibility*. Labour market flexibility is a function of the interplay of lagged adjustment processes and spillover effects. Unemployment trajectories diverge because some regions adjust faster than others.⁷

⁴The CRT was developed by Karanassou and Snower (1996). See also Karanassou (1998), Karanassou and Snower (1998, 2000), and Henry, Karanassou and Snower (2000).

⁵Spillover effects arise when shocks to a specific equation feed through the labour market system.

⁶This reinforces the equilibrium interpretation of regional disparities.

⁷The fact that all regions within a country are subject to the same labour market institutions does not imply that all regions will have identical lagged adjustment processes. For example, employment adjustment is not only related to firing costs - these are common to all regions as they are determined by the legal system - but also to hiring and training costs, which may be region-specific.

Our analysis seeks to answer the following questions. How does the degree of labour market flexibility differ between regions that face the same type and size of shocks? How have the various region-specific and nationwide explanatory variables contributed to regional unemployment? How has unemployment responded to actual shocks, i.e. the changes in the explanatory variables?

The rest of the paper is organised as follows. Section 2 presents an analytic model that illustrates the interactive dynamics approach of the Chain Reaction Theory of unemployment. Section 3 outlines the structure of the labour market model for the Spanish regional unemployment rates. Section 4 discusses data and estimation results. Section 5 evaluates the persistence of unemployment to wage-setting, labour demand and supply shocks. Section 6 measures the contributions of the exogenous variables to the evolution of regional unemployment. Section 7 evaluates the responses of unemployment to the actual shocks that occurred during the sample period. Finally, Section 8 concludes.

2 The Chain Reaction Theory (CRT)

An important dimension of the unemployment problem is that employment, wage setting, and labour force participation decisions are characterised by significant lags, and these lags interact with one another. The main salient feature of the chain reaction theory (CRT) is the use of dynamic multi-equation systems to model the structure of the labour market, and analyse the evolution through time of the unemployment rate. The predictions of the CRT lie in stark contrast to the unemployment rate predictions of the structuralist theory⁸ which estimates single-equation dynamic models.⁹

In the context of autoregressive multi-equation models, movements of unemployment can be viewed as "chain reactions" of responses to labour market shocks. The network of interacting lagged adjustment processes is the propagation mechanism for these chain reactions and are well documented in the literature.¹⁰ For example, firms' current employment decisions commonly depend on their past employment on account of costs of hiring, training, and firing; current wage decisions depend on past wages due to staggered wage setting; labour force participation decisions depend on the past labour force on account of costs of entering and exiting from the labour force.¹¹ By identifying the various lagged adjustment processes, the CRT can explore their interactions and quantify the potential

⁸Phelps (1994) gives a complete description of the structuralist theory.

⁹See Karanassou, Sala, and Snower (2006) for a detailed comparison of the chain reaction and structuralist theories.

¹⁰See, for example, Layard and Bean (1989), Lindbeck and Snower (1987), Nickell (1978), and Taylor (1980).

¹¹Of course, the employment, wage, and labour force adjustment processes may arise for reasons other than the ones given above.

complementarities or substitutabilities among them.

To illustrate the workings of the CRT consider the following simple system of labour demand, wage setting, and labour supply equations:¹²

$$n_t = \alpha_1 n_{t-1} - \gamma w_t + \varepsilon_t^n, \quad (1)$$

$$w_t = \alpha_2 w_{t-1} - \delta u_t + \varepsilon_t^w, \quad (2)$$

$$l_t = \varepsilon_t^l, \quad (3)$$

where n_t is employment, w_t is real wage, and l_t is labour force, the autoregressive parameters are $|\alpha_1, \alpha_2| < 1$, γ and δ are positive constants, and the error terms ε^n , ε^w , and ε^l are strict white noise processes independent of one another. All variables are in logs. The unemployment rate (not in logs) is¹³

$$u_t = l_t - n_t. \quad (4)$$

Let us rewrite the labour demand and real wage equations (1)-(2) as

$$(1 - \alpha_1 L) n_t = -\gamma w_t + \varepsilon_t^n, \quad (5)$$

$$(1 - \alpha_2 L) w_t = -\delta u_t + \varepsilon_t^w, \quad (6)$$

where L is the lag operator. Substitution of (6) into (5) gives

$$(1 - \alpha_1 L) (1 - \alpha_2 L) n_t = \gamma \delta u_t + (1 - \alpha_2 L) \varepsilon_t^n - \gamma \varepsilon_t^w. \quad (7)$$

Next, rewrite the labour supply (3) as

$$(1 - \alpha_1 L) (1 - \alpha_2 L) l_t = (1 - \alpha_1 L) (1 - \alpha_2 L) \varepsilon_t^l. \quad (8)$$

Finally, subtract from (8) the labour demand eq. (7) to get the *reduced form* unemployment rate equation:¹⁴

$$[\gamma \delta + (1 - \alpha_1 L) (1 - \alpha_2 L)] u_t = -(1 - \alpha_2 L) \varepsilon_t^n + \gamma \varepsilon_t^w + (1 - \alpha_1 L) (1 - \alpha_2 L) \varepsilon_t^l. \quad (9)$$

¹²For ease of exposition, and without loss of generality, this illustration ignores constants and explanatory variables. In Section 4 we estimate an extended version of this labour market model by including constants, several explanatory variables and the second lags of the dependent variables.

¹³Since labour force and employment are in logs, we can approximate the unemployment rate by their difference.

¹⁴The term "reduced form" means that the parameters of the equation are not estimated directly - they are simply some nonlinear function of the parameters of the underlying labour market system.

Note that the above equation is dynamically stable since (i) products of polynomials in L which satisfy the stability conditions are stable, and (ii) linear combinations of dynamically stable polynomials in L are also stable.

Alternatively, the reduced form unemployment rate equation (9) can be written as

$$u_t = \phi_1 u_{t-1} - \phi_2 u_{t-2} - \beta_1 \varepsilon_t^n + \beta_2 \varepsilon_t^w + \beta_1 \varepsilon_t^l + \theta_1 \varepsilon_{t-1}^n - \phi_1 \varepsilon_{t-1}^l + \phi_2 \varepsilon_{t-2}^l \quad (10)$$

where $\phi_1 = \frac{\alpha_1 + \alpha_2}{1 + \gamma\delta}$, $\phi_2 = \frac{\alpha_1 \alpha_2}{1 + \gamma\delta}$, $\beta_1 = \frac{1}{1 + \gamma\delta}$, $\beta_2 = \frac{\gamma}{1 + \gamma\delta}$, and $\theta_1 = \frac{\alpha_2}{1 + \gamma\delta}$.

The above reparameterisation of the reduced form unemployment rate equation helps to explain the characteristic features of the chain reaction theory. First, the autoregressive parameters ϕ_1 and ϕ_2 embody the interactions of the employment and wage setting adjustment processes (α_1 and α_2 , respectively).

Second, the coefficients β_1 and β_2 are the short-run elasticities and are a function of the feedback mechanisms that give rise to the spillover effects. When γ and δ are non zero, all labour market shocks generate spillover effects. If $\delta = 0$, i.e. unemployment does not influence wages, then labour demand and supply shocks do not spillover to wages. If $\gamma = 0$, i.e. labour demand is completely inelastic with respect to wages, then shocks to wage-setting do not spillover to unemployment. In this case the influence of the shocks (ε_t^n , ε_t^w , and ε_t^l) on unemployment can be measured through individual analysis of their respective equations. In other words, the main feedback mechanism in this toy model is provided by the wage elasticity of labour demand.

Third, the emergence of "moving average" terms (lags of the shocks) in the reduced form unemployment rate equation emphasizes the interplay of the lagged adjustment processes and the spillover effects.

In a dynamic labour market model shocks are not absorbed instantly - their effects are felt through time. The concept of unemployment persistence captures the after effects of the labour market shocks. The impulse response function of unemployment describes the responses of unemployment through time to a specific shock (impulse). For a temporary shock occurring at period t , we define unemployment persistence (σ) as the sum of its responses for all periods $t + j$ in the aftermath of the shock ($j \geq 1$):¹⁵

$$\sigma \equiv \sum_{j=1}^{\infty} R_{t+j}, \quad (11)$$

where the series R_{t+j} , $j \geq 0$ is the impulse response function (IRF) of unemployment.¹⁶ If

¹⁵See Karanassou and Snower (1996, 1998) for definitions of temporal as well as quantitative measures of persistence and their application. See also Pivetta and Reis (2004) for a discussion of various persistence measures.

¹⁶In other words, R_{t+j} , $j \geq 0$, denotes the coefficients of the infinite moving average representation of unemployment with respect to the shock.

the unemployment model (i) is static, then the shock is absorbed instantly and so $\sigma = 0$, (ii) is dynamically stable, then the effects of the shock gradually die out and persistence is a finite quantity, and (iii) displays hysteresis, then the temporary shock has a permanent effect and thus $\sigma = \infty$.

For illustrative purposes, we derive the measure of unemployment persistence in the special case of no spillover effects from wages to labour demand ($\gamma = 0$). Consider a one-off unit labour demand shock at period t , i.e. $\varepsilon_t^n = 1$, $\varepsilon_{t+j}^n = 0$ for $j \geq 1$. The infinite moving average representation (IMA) of employment is

$$n_t = \varepsilon_t^n + \alpha_1 \varepsilon_{t-1}^n + \alpha_1^2 \varepsilon_{t-2}^n + \alpha_1^3 \varepsilon_{t-3}^n + \dots$$

Since unemployment is defined as the difference between labour supply and demand in eq. (4), and there are no spillover effects, the response of unemployment t periods after the occurrence of the shock is

$$R_{t+j} = -\alpha_1^j, \quad j \geq 0. \quad (12)$$

Thus the immediate impact of this shock on unemployment is -1 and persistence equals $-\alpha_1 / (1 - \alpha_1)$.

It is important to note that if we interpret the shock at period t as the change in a specific explanatory variable, say x , over that period then (i) the immediate response (R_t) is simply the short-run elasticity of the unemployment rate with respect to x and (ii) the sum of the immediate response (R_t) and persistence (σ) gives the long-run elasticity of the unemployment rate with respect to x . Thus, the long-run elasticity of the variable is given by

$$\underbrace{R_t}_{\text{short-run elasticity}} + \underbrace{\sigma}_{\text{persistence}} = \underbrace{\sum_{j=0}^{\infty} R_{t+j}}_{\text{long-run elasticity}}. \quad (13)$$

In other words, the long-run elasticity can be decomposed into the short-run elasticity and our measure of persistence (11).

Next, we present the structure of the labour market system that we estimate in section 4 and provide an economic rationale for our choice of framework.

3 Structure of the Regional Model

We use a structural vector autoregressive distributed lag model for the Spanish regions to analyse regional unemployment persistence and explain unemployment rate disparities:¹⁷

$$\mathbf{A}_0 \mathbf{y}_{it} = \mathbf{A}_1 \mathbf{y}_{i,t-1} + \mathbf{A}_2 \mathbf{y}_{i,t-2} + \mathbf{B}_0 \mathbf{x}_{it} + \mathbf{B}_1 \mathbf{x}_{i,t-1} + \mathbf{C}_0 \mathbf{z}_t + \mathbf{C}_1 \mathbf{z}_{t-1} + \mathbf{e}_{it}, \quad (14)$$

where \mathbf{y}_{it} is a vector of endogenous variables, \mathbf{x}_{it} is a vector of regional exogenous variables, \mathbf{z}_t is a vector of national exogenous variables, the \mathbf{A} 's, \mathbf{B} 's and \mathbf{C} 's are coefficient matrices, and \mathbf{e}_{it} is a vector of identically independently distributed error terms.

The multi-equation system (14) consists of (i) a labour demand equation, describing the equilibrium employment (n_{it}), (ii) a wage setting equation, describing real wage (w_{it}) determination, (iii) a labour supply equation, describing the equilibrium size of the labour force (l_{it}), and (iv) a definition of the unemployment rate (not in logs):¹⁸

$$u_{it} = l_{it} - n_{it}. \quad (15)$$

According to (14) the regional unemployment rate is determined by (i) local conditions measured by the regional exogenous variables \mathbf{x}_{it} (such as capital stock), and (ii) nationwide variables \mathbf{z}_t (such as oil prices) which are common to all regions. In contrast, the models in Blanchard and Katz (1992), and Decressin and Fatás (1995) emphasize regional dynamics as opposed to national dynamics, analysing exclusively the effects of regional specific shocks.

In our empirical work we split the 17 Spanish regions into two groups depending on the evolution of the regional unemployment rate relative to the national one. The regions with a higher (lower) unemployment rate than the national one are referred to as the "high (low) unemployment regions".¹⁹ Table 1 lists the regions in each of the two groups and Figure 1 plots the unemployment rates of each group.

¹⁷The dynamic system (14) is stable if, for given values of the exogenous variables, all the roots of the determinantal equation

$$|\mathbf{A}_0 - \mathbf{A}_1 L - \mathbf{A}_2 L^2| = 0$$

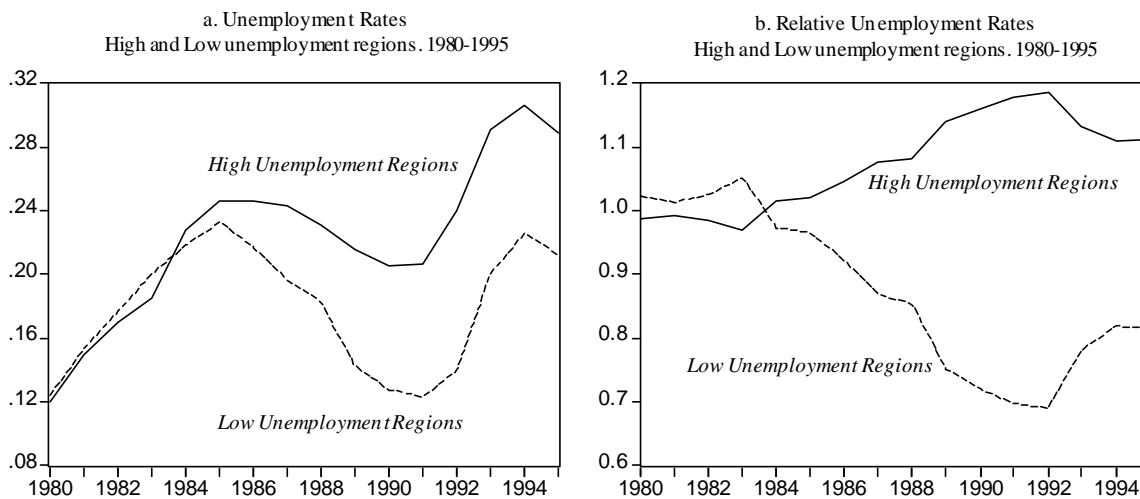
lie outside the unit circle. Note that the estimated equations in Section 4 below satisfy this condition.

¹⁸Given then the labour force and employment are in logarithms, this is an approximation.

¹⁹This grouping of the Spanish regions is supported by a distribution dynamics analysis, as suggested by Quah (1997) and Overman and Puga (2002). Results are available upon request.

Table 1: Groups of regions	
High unemployment regions	Low unemployment regions
Andalucia	Aragón
Asturias	Baleares
Canarias	Cataluña
Cantabria	Madrid
Castilla-La Mancha	Navarra
Castilla y León	La Rioja
Extremadura	
Galicia	
Murcia	
País Vasco	
Comunidad Valenciana	

Figure 1



Each panel of regions is modeled along the lines of the structural system (14). Notwithstanding, our model does not allow for any labour or firm mobility between the high and low unemployment groups of regions. This is in line with the results for Europe by Decressin and Fatás (1995) but is in contrast to the findings of Blanchard and Katz (1992) who assume perfect mobility of workers and firms between regions, and find that this assumption is valid for the behaviour of US workers and firms.

The absence of labour mobility between the two panels of regions can be justified on the following grounds. First, wage differentials may not be sufficiently large to induce

workers to move from the high unemployment regions to the low unemployment regions where wages are higher. This was exactly the case during the 1979-86 period when wage bargaining was centralised.²⁰

Second, although wage differentials have increased since 1986, the scant labour mobility can be explained on the basis of the huge differentials in average housing prices between the high and low unemployment groups of regions.

Third, the combination of rising incomes with family and government support may have made people more sensitive to the amenities in their place of residence (de la Fuente, 1999). Attanasio and Padoa-Schioppa (1991) argue that young people, who are the bulk of emigrants, are less willing to move when unemployed because of the support provided by the rising family incomes. In addition, Antolin and Bover (1997) find that those unemployed receiving unemployment benefits are less likely to migrate.

The above empirical evidence is also supported by the Eurostat database which documents very low levels of regional migration over the past decades.

Regarding firm mobility firms do not move from the low to the high unemployment regions, where wages are lower, for the following reasons.

First, the high unemployment regions in Spain are generally peripheral and have an inadequate endowment of public infrastructures (highways connecting poor regions with richer ones were finished during the last decade, for instance).²¹ This leads to higher transportation costs and thus limits the willingness of firms to move.

Second, in contrast to the Blanchard and Katz (1992) findings for the US, Spanish firms do not move to lower wage regions due to agglomeration effects.²² When firms locate close to large markets, they enjoy positive agglomeration externalities and increasing returns to scale. Hence, moving to another region would imply an overall increase in costs (the lower wage does not compensate for the loss of these externalities). In fact, firms have tended to locate mainly in the richer regions of Madrid, Ebro Axis and the Mediterranean coast.

In the following sections we attempt to identify the causes of regional unemployment in Spain by examining the interplay of labour market lags with region-specific and national shocks in each of the high and low unemployment groups of regions.

²⁰See Bande *et al.* (2005) for an intuition of the effect of centralised wage bargaining on regional unemployment.

²¹Despite the high effort by the EU to improve the infrastructure endowments of poor regions, European regional funds have not succeeded in improving the performance of the high unemployment regions relative to the rest of the country.

²²See Krugman (1998) for the arguments of the new economic geography on agglomeration effects.

4 Estimation Results

Our estimated dynamic structural model comprises a system of labour demand, wage setting and labour force equations, and covers two panels of regions. A panel for the group of the eleven high unemployment rate regions and a panel for the group of the six low unemployment rate regions (see Table 1).

A robust analysis of the evolution through time of regional unemployment disparities requires an ample number of observations. Pooled estimation enables us to use 176 and 96 observations for the high and low unemployment rate panels, respectively. The pooling of observations on a cross section of regions over several time periods can increase the efficiency of econometric estimates.²³ Within each group of regions, our estimation captures differences in economic behaviour solely through fixed effects (i.e. differing constants in the estimated equations), while the coefficients for the explanatory variables are taken to be identical across groups of regions.

The data sources are (i) Datastream, (ii) the BD-MORES dataset, elaborated by the *Dirección General de Análisis y Programación Presupuestaria* (Ministry of Economy) and the University of Valencia, and (iii) the Spanish Labour Force, elaborated by the Spanish Statistics Institute (*INE*). The sample frequency is annual and the period of analysis is 1980-1995, due to data limitations.²⁴ Table 2 gives the definitions of the variables.

Table 2: Definitions of variables

<u>Regional variables</u>	<u>National variables</u>
n_{it} : total employment	oil_t : real oil price
l_{it} : labour force	b_t : real social security benefits per person
u_{it} : unemployment rate ($= l_{it} - n_{it}$)	tax_t : indirect tax rate
w_{it} : real wage (=labour income per employee)	imp_t : real import prices
k_{it} : real capital stock	
pop_{it} : working age population	
pr_{it} : real productivity	

All variables are in logs except for the unemployment rate u_{it} , and the indirect tax rate, tax_t .

Dynamic panel data and nonstationary panel time series models have attracted a lot of attention over the past few years. As a result, the study of the asymptotics of macro panels with large N (number of units, e.g. countries or regions) and large T (length

²³The advantages of using panel data sets for economic research are numerous and well documented in the literature. See, for example, Hsiao (1986) and Baltagi (1995) for a detailed exposition of stationary panel data estimation.

²⁴The reason for restricting our analysis to the 1980-1995 period is twofold. First, the regional capital stock series are obtained from the BD-MORES dataset which currently covers the 1980-1995 period and is *expected* to be updated for the period 1980-2000. Second, in 2001 the Spanish Statistics Institute (*INE*) introduced fundamental changes in the Labour Force Survey (mainly related to the definition of labour force) in order to make the survey comparable to the Eurostat standards. The induced structural break in the labour force and unemployment rate series implies that the figures for these series are not compatible to the ones prior to 2001.

of the time series) has become the focus of panel data econometrics.²⁵ We test if it is appropriate to use stationary panel data estimation techniques by performing a series of unit root tests.

In particular, we test the order of integration of the national variables using the KPSS unit root test.²⁶ Table 3 presents these tests and shows that for all four national variables - real oil price, real social security benefits, indirect tax rate, and real import price - we cannot reject the null hypothesis of (trend) stationarity.

Table 3: Unit Root Tests

	<i>oil_t</i>	<i>b_t</i>	<i>tax_t</i>	<i>imp_t</i>	5% c.v.
KPSS _c	0.46	0.44	0.45	0.43	0.46
KPSS _{c,t}	0.10	0.10	0.14	0.09	0.15
KPSS _c uses an intercept in the test.					
KPSS _{c,t} uses an intercept and trend in the test.					

4.1 Panel Unit Roots

Since it is widely accepted that the use of pooled cross-section and time series data can generate more powerful unit root tests,²⁷ we examine the stationarity of the regional variables using panel unit root tests. We apply the simple statistic proposed by Maddala and Wu (1999) - this is an exact nonparametric test based on Fisher (1932):

$$\lambda = -2 \sum_{i=1}^N \ln p_i \sim \chi^2(2N), \quad (16)$$

where p_i is the probability value of the ADF unit root test for the i th unit (region). The Fisher test has the following attractive characteristics. First, since it combines the significance of N different independent unit root statistics, it does not restrict the au-

²⁵Banerjee (1999) and Baltagi and Kao (2000), and Smith (2000) provide an overview of the above topics and survey the developments in this technical and rapidly growing literature.

²⁶Kwiatkowski-Phillips-Schmidt-Shin (1992) proposed the following statistic to test the null hypothesis of stationarity:

$$\text{KPSS}(\kappa) = \frac{\sum_{t=1}^T S_t^2}{T^2 s^2(\kappa)},$$

where T is the sample size, $S_t = \sum_{i=1}^t \hat{\varepsilon}_i$ is the partial sum of the residuals when the series is regressed on an intercept (and possibly on a time trend), and $s^2(\kappa)$ is a consistent non-parametric estimate of the disturbance variance. In particular, $s^2(\kappa)$ is constructed as in Phillips (1987) or Phillips and Perron (1988) by using a Bartlett window adjustment based on the first κ sample autocovariances as in Newey and West (1987). KPSS report critical values (c.v.) for the case of (i) a constant in the auxilliary regression: 1% c.v.=0.74, 2.5% c.v.=0.57, 5% c.v.=0.46, 10% c.v.=0.35, and (ii) both a constant and a trend: 1% c.v.=0.22, 2.5% c.v.=0.18, 5% c.v.=0.15, 10% c.v.=0.12.

²⁷See, for example, Levin and Lin (LL) (1993), Im, Pesaran and Shin (2003), Harris and Tzavalis (1999), Maddala and Wu (1999). Note that the asymptotic properties of tests and estimators proposed for nonstationary panels depend on how N (the number of cross-section units) and T (the length of the time series) tend to infinity, see Phillips and Moon (1999).

toregressive parameter to be homogeneous across i under the alternative of stationarity. Second, the choice of the lag length and of the inclusion of a time trend in the individual ADF regressions can be determined separately for each region. Third, the sample sizes of the individual ADF tests can differ according to data availability for each cross-section. Finally, it should be noted that the Fisher statistic can be used with any type of unit root test. Maddala and Wu (1999), using Monte Carlo simulations, conclude that the Fisher test outperforms both the Levin and Lin (1993) and the Im, Pesaran and Shin (2003) tests.²⁸

Table 4 reports the Fisher statistics for all the variables used in our structural equations. The null hypothesis is that the time series has been generated by an $I(1)$ stochastic process, and the test follows a chi-square distribution with 34 degrees of freedom (the 5% critical value is 48.32). Note that all the panel unit root test statistics are greater than the critical value, so the null of a unit root can be rejected at the 5% significance level.

Table 4: Panel Unit Root Tests

$\lambda(n_{it}) = 66.19$	$\lambda(w_{it}) = 65.27$	$\lambda(pop_{it}) = 49.37$
$\lambda(l_{it}) = 52.78$	$\lambda(k_{it}) = 87.93$	$\lambda(pr_{it}) = 93.26$
Notes: $\lambda(\cdot)$ is the test proposed by Maddala and Wu (1999).		
The test follows a chi-square (34) distribution.		
The 5% critical value is approximately 48.		

Tables 3 and 4 indicate that we can proceed with stationary panel data estimation techniques.

4.2 Stationary Dynamic Panel Data Model

We estimate the lagged adjustment processes and long-run elasticities of the system of behavioural equations (14) by using a fixed-effects (FE) model:

$$\begin{aligned}
 \mathbf{A}_0 \mathbf{y}_{it} &= \mathbf{A}_1 \mathbf{y}_{i,t-1} + \mathbf{A}_2 \mathbf{y}_{i,t-2} + \mathbf{B}_0 \mathbf{x}_{it} + \mathbf{B}_1 \mathbf{x}_{i,t-1} + \mathbf{C}_0 \mathbf{z}_t + \mathbf{C}_1 \mathbf{z}_{t-1} + \mathbf{e}_{it}, \\
 \mathbf{e}_{it} &= \boldsymbol{\mu}_i + \mathbf{v}_{it}, \quad i = 1, \dots, N, \quad t = 1, \dots, T,
 \end{aligned} \tag{17}$$

²⁸Levin and Lin (LL) proposed asymptotic panel unit root tests which are based on pooled regressions. The major criticism against the LL tests is that, under the alternative of stationarity, the autoregressive coefficient is the same across all units (i.e. $H_1 : \rho_1 = \rho_2 = \dots = \rho_N = \rho < 0$).

This restrictive assumption is relaxed in the asymptotic test proposed by Im, Pesaran and Shin (IPS). Like the Fisher test, and in contrast to the LL tests, the IPS test is based on the individual ADF regressions for each of the N cross-section units. While the Fisher test uses the probability values of the individual ADF tests, the IPS uses their test statistics. Compared to the Fisher test, the disadvantage of the IPS test is that it implicitly assumes the same T for all countries and the same lag length for all the individual ADF regressions.

The above equation shows that the vector²⁹ of disturbances (\mathbf{e}_{it}) follows a one-way error component model, where $\mathbf{v}_{it} \sim iid(\mathbf{0}, \sigma_v^2)$ with $Cov(\mathbf{e}_{it}, \mathbf{e}_{jt}) = \mathbf{0}$, for $i \neq j$. The vector of scalars μ_i represents the effects that are specific to the i th region and are assumed to remain constant over time. In other words, the FE model assumes that slope coefficients and variances are identical across regions and only intercepts are allowed to vary.

The FE estimator³⁰ is the most common estimator for dynamic panels. In homogenous dynamic panels (i.e. models with constant slopes) the FE estimator is consistent as $T \rightarrow \infty$, for fixed N .³¹ Baltagi and Griffin (1997) compare the performance of a large number of homogenous and heterogeneous estimators and provide evidence in support of the FE estimator. In particular, they find that (i) individual unit estimates (both OLS and 2SLS) exhibit substantial variability, whereas pooled estimators provide more plausible estimates, and (ii) accounting for potential endogeneity is "disappointing as the 2SLS estimators performed worse than their counterparts assuming all variables are exogenous."

As noted in the previous section, the empirical model consists of three estimated equations: labour demand, labour supply, wage setting, and the definition of the unemployment rate. The structure of our labour market system is in the spirit of the models presented in Karanassou and Snower (1998), and Henry, Karanassou and Snower (2000).

Tables 5 and 6 present the estimated models for the high and low unemployment groups of regions, respectively. Fixed effects estimation implies that within a specific group, differences in labour market behaviour across regions is captured solely through fixed effects: only differing constants in the estimated equations (but identical coefficients for the exogenous variables and the endogenous regressors).³² The Schwarz model selection criterion prefers this fixed-effect model over heterogeneous models containing individual region time series regressions.³³

²⁹This is a 3×1 vector representing the labour demand, wage setting, and labour supply equations in our system.

³⁰The fixed-effects estimator is also known as the least squares dummy variables (LSDV) estimator, or the within-group or the analysis of covariance estimator.

³¹Kiviet (1995) showed that the bias of the FE estimator in a dynamic model of panel data has an approximation error of $O(N^{-1}T^{-3/2})$. Therefore, the FE estimator is consistent only as $T \rightarrow \infty$, while it is biased and inconsistent when N is large and T is fixed.

³²We do not show the region-specific coefficients, which are the constants or fixed effects of the model. Results are available upon request.

³³Specifically, we select between each of the pooled equations presented in Tables 5 and 6 and the corresponding individual regressions by using the Schwarz Information Criterion (*SIC*). We compute the model selection criteria as follows:

$$\begin{aligned} SIC_{pooled} &= MLL - 0.5k_{pooled} \log(NT), \\ SIC_{individual} &= \sum_{i=1}^j MLL_i - N [0.5k_i \log(T)], \quad j = 11, 6 \end{aligned}$$

where MLL_{pooled} , MLL_i denote the maximum log likelihoods of the pooled model and the i th region

In the labour demand equation, employment depends negatively on the real wage, and positively on both the level and growth rate of the capital stock. The oil price and indirect taxes (as a ratio to GDP) have a negative impact on labour demand. The lagged employment terms capture the *employment adjustment* process. All the explanatory variables are highly significant with the exception of the tax rate that is significant at the 20% (14%) size of the test for the high (low) unemployment group of regions.

In the wage setting equation, real wage depends negatively on unemployment and import prices,³⁴ and positively on productivity and benefits. The lag of real wage captures the adjustment process due to *wage staggering*. Except for benefits in the low unemployment group of regions and unemployment in both panels, which are significant at the 15% size of the test, all other variables are statistically significant at conventional levels.

Finally, in the estimated labour supply equation, the size of the labour force depends positively on working age population and negatively on the real wage.³⁵ The statistical significance of past labour force is associated with the *labour force adjustment* process.

Table 5: High unemployment group of regions

Labour demand: n_{it}			Wage setting: w_{it}			Labour supply: l_{it}		
	coef.	p-value		coef.	p-value.		coef.	p-value
$n_{i,t-1}$	0.52 (0.05)	0.00	$w_{i,t-1}$	0.80 (0.04)	0.00	$l_{i,t-1}$	0.73 (0.05)	0.00
w_{it}	-0.32 (0.03)	0.00	u_{it}	-0.14 (0.09)	0.14	w_{it}	-0.14 (0.03)	0.00
k_{it}	0.25 (0.04)	0.00	Δu_{it}	0.63 (0.09)	0.00	$w_{i,t-1}$	0.07 (0.03)	0.07
Δk_{it}	1.22 (0.21)	0.00	pr_{it}	0.17 (0.05)	0.00	pop_{it}	0.45 (0.08)	0.00
oil_t	-0.03 (0.01)	0.00	b_t	0.34 (0.07)	0.00	Δpop_{it}	0.71 (0.22)	0.00
tax_t	-0.43 (0.33)	0.20	b_{t-1}	-0.31 (0.07)	0.00			
			imp_t	-0.08 (0.03)	0.00			
			imp_{t-1}	0.07 (0.03)	0.03			
MLL=417.85			MLL=399.48			MLL=494.00		
S.E.=0.020			S.E.=0.022			S.E.=0.013		
Standard errors in parentheses; Δ denotes the difference operator.								
MLL is the maximum log likelihood; S.E. is the standard error of the model.								

time series regression, respectively; k_{pooled} , k_i are the number of parameters estimated in the fixed effects model and the individual region time series regression, respectively; N is the number of regions and T is the time dimension of the sample size. The model that maximises SIC is preferred. (Results are available upon request.)

³⁴Real import prices proxy the competitiveness of the economy.

³⁵The negative impact of the real wage indicates that the income effect dominates.

Table 6: Low unemployment group of regions

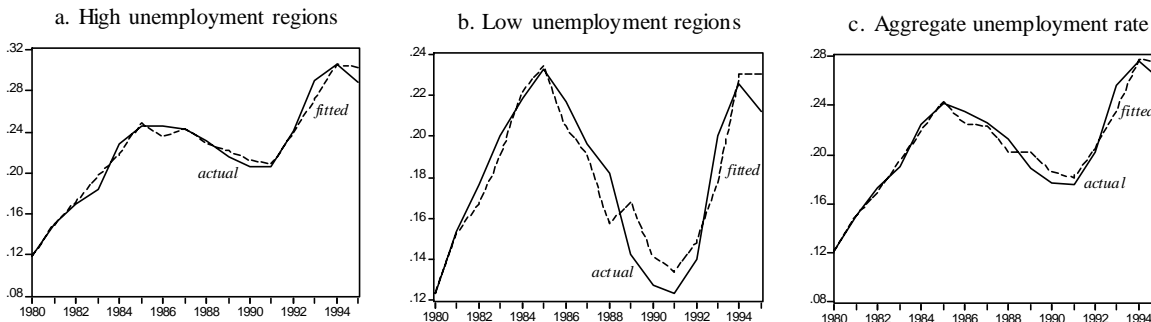
Labour demand: n_{it}			Wage setting: w_{it}			Labour supply: l_{it}		
	coef.	p-value		coef.	p-value.		coef.	p-value
$n_{i,t-1}$	0.78 (0.09)	0.00	$w_{i,t-1}$	0.64 (0.01)	0.00	$l_{i,t-1}$	0.59 (0.07)	0.00
$n_{i,t-2}$	-0.27 (0.09)	0.00	u_{it}	-0.21 (0.14)	0.14	w_{it}	-0.15 (0.05)	0.01
w_{it}	-0.20 (0.05)	0.00	Δu_{it}	0.63 (0.15)	0.00	$w_{i,t-1}$	0.13 (0.05)	0.02
k_{it}	0.17 (0.05)	0.00	pr_{it}	0.22 (0.09)	0.03	pop_{it}	0.56 (0.12)	0.00
Δk_{it}	0.69 (0.24)	0.00	b_t	0.17 (0.13)	0.21			
oil_t	-0.05 (0.01)	0.00	b_{t-1}	-0.16 (0.10)	0.15			
tax_t	-0.80 (0.52)	0.14	imp_t	-0.17 (0.04)	0.00			
			imp_{t-1}	0.12 (0.04)	0.00			
MLL=216.13			MLL=210.39			MLL=245.86		
S.E.=0.020			S.E.=0.025			S.E.=0.017		
Standard errors in parentheses; Δ denotes the difference operator.								
MLL is the maximum log likelihood; S.E. is the standard error of the model.								

It is important to note that an essential feature of the above estimations is that the unemployment rate is influenced by the size of the capital stock both in the short-run and long-run. This is another salient feature of the CRT and is in sharp contrast to the influential form of the literature that asserts that policies that shift upward the time path of capital stock have no long-run effect on the unemployment rate (see Layard *et al.*, 1991). This assertion derives from the observation that the unemployment rate is trendless in the long-run. However, Karanassou and Snower (2004) argue that there is no reason to believe that the labour market alone is responsible for ensuring that the unemployment rate is trendless in the long-run. In general, equilibrating mechanisms in the labour market and other markets are jointly responsible for this phenomenon. Thus restrictions on the relationships between the long-run growth rates (as opposed to the levels) of capital stock and other growing exogenous variables are sufficient for this purpose.

Figure 2 shows that the fitted unemployment rate generated by our system tracks the trajectory of the actual unemployment rate very accurately.

In the following sections we seek to examine the role played by the lagged adjustment processes and their interplay with the changes in the exogenous variables in the evolution of the unemployment rate.

Figure 2. Actual and fitted values



5 Persistence of Shocks

We first show that the set of lagged adjustment processes in the model and their interplay with the feedback mechanisms give rise to the propagation of shocks. In the context of the estimated models in Tables 5 and 6, we measure the impacts of the different labour market shocks on the time path of the unemployment rate for the two groups of regions.

Following the methodology outlined in section 2, we derive the reduced form unemployment rate equation for each group of regions

$$\rho(L) u_{it} = b(L) x_{it} + c(L) z_t + \theta_d(L) \varepsilon_{it}^n + \theta_w(L) \varepsilon_{it}^w + \theta_s(L) \varepsilon_{it}^l, \quad (18)$$

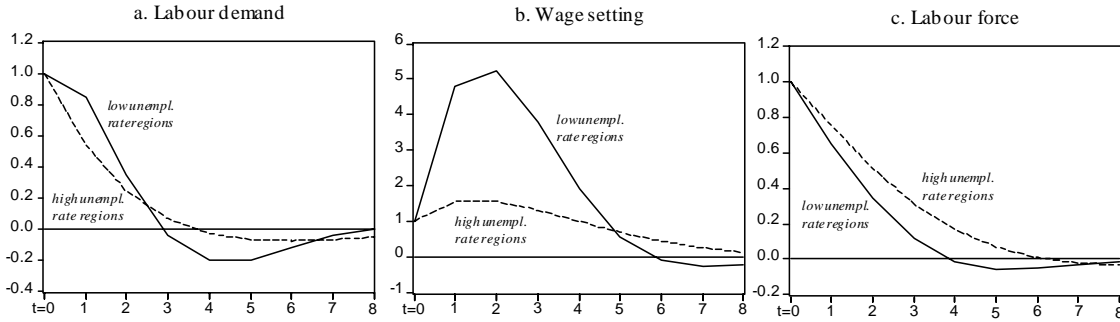
where the autoregressive polynomial $\rho(L)$ is dynamically stable,³⁶ x_{it} is a 3×1 vector of exogenous regional variables and z_t is a 4×1 vector of exogenous national variables; $b(L)$ and $c(L)$ are 1×3 and 1×4 vectors of lag polynomials, respectively; ε_{it}^n , ε_{it}^w , and ε_{it}^l are the error terms in the labour demand (employment), wage setting, and labour supply (labour force) equations, respectively, given in Tables 5-6. Note that the parameters in all of the above lag polynomials - autoregressive $\rho(\cdot)$, slope $b(\cdot)$, $c(\cdot)$, and moving average $\theta(\cdot)$ - are functions of the estimated coefficients given in Tables 5-6.

Next, we introduce a one-off unit labour demand shock at period $t = 0$, i.e. $\varepsilon_{i0}^n = 1$, $\varepsilon_{it}^n = 0$ for $t \geq 1$, in each of the regional panel models. The generated unemployment rate impulse response functions for both regional groups are plotted in Figure 3a. To get a perspective of the temporal persistence of the shocks and compare the resulting trajectories, the impulse response functions in Figure 3 have been normalised so that the immediate impact of the shock is unity. The responses through time of the unemployment

³⁶Note that $\rho_0 = 1$ so that $\rho(L) = 1 + \rho_1 L + \dots + \rho_q L^q$. Dynamic stability implies that the roots of $\rho(L) = 0$ lie outside the unit circle.

rate to a unit one-period wage setting and labour supply shocks are presented in Figure 3b and 3c, respectively.

Figure 3. Impulse response function of unemployment to a temporary shock



Responses of unemployment to a one-off unit shock occurring at period $t=0$. The responses have been normalized so that the immediate impact is unity

Figures 3a and 3c show that the unemployment effects of labour demand and supply shocks start decreasing once the shock has been initiated. In contrast, Figure 3b shows that the real wage shock continues to push up unemployment for another two years after its initial impact before it starts to gradually dissipate. This pattern is more profound in the high unemployment group of regions than in the low unemployment group.

It takes several years before the one-off shocks are completely absorbed by the labour market. In particular, 20% of the initial impact of the shock is still felt by the market after approximately two years (labour demand shock), or five years (wage shock), or three years (labour supply shock).

It is also useful to examine the propagation mechanisms from a quantitative perspective. For each shock, we calculate unemployment persistence (σ) by substituting the respective impulse response function in equation (11). In other words, unemployment persistence is the sum of all the after-effects of the shock.

The total effect (τ) of the shock on unemployment is obtained by simply adding the "current" effect, i.e. the initial unemployment response (R_0), to the "future" effect, i.e. the persistence measure: $\tau \equiv \sum_{t=0}^{\infty} R_t = R_0 + \sigma$. It is important to note the following distinction. While the size of the shock should be understood as the instantaneous direct effect that it has on the dependend variable, the initial response captures both the direct and indirect effects of the shock on unemployment. The indirect effects are due to spillovers. When there are no spillover effects in the labour market system, the initial unemployment response is equal to the size of the shock, i.e. $R_0 = 1$. We can also refer to the initial response as the short-run elasticity.

Table 7 below gives the persistence statistics for both the high and low unemployment groups of regions. Since the differences between the impulse response trajectories of the high and low unemployment groups are small for the labour demand shock, the table focuses on wage and labour supply shocks only.

Table 7: Persistence of shocks

<i>shocks</i> →	<u>Wage setting</u>	<u>Labour supply</u>
High Unemployment Regions		
short-run elasticity R_0 (initial response)	0.20	1.09
persistence σ (sum of future responses)	1.38	1.78
long-run elasticity τ (short-run elasticity+persistence)	1.58	2.87
Low Unemployment Regions		
short-run elasticity R_0 (initial response)	0.05	1.02
persistence σ (sum of future responses)	0.79	0.96
long-run elasticity τ (short-run elasticity+persistence)	0.84	1.98

Both the real wage and labour supply shocks are far more persistent in the high unemployment regions than in the low unemployment regions.

Following a labour supply shock, the overall future increase in unemployment is 1.78 percentage points for the high unemployment group - almost double the increase in the low unemployment regions. Nevertheless, the short-run elasticities are similar - in both the high and low regions unemployment increases by one percentage point.

Following a shock in wage setting, the short-run elasticity is four-times larger in the high unemployment regions than in low unemployment regions. The persistence generated in the high unemployment regions also exceeds that of the low unemployment regions. As a result, the total increase in unemployment is 1.6 percentage points - almost double the increase in the low unemployment regions.

6 Contributions of the Exogenous Variables

It is clear from Figure 1a that the evolution of the unemployment rate is characterised by two turning points: while it is increasing prior to 1985 and after 1991, it is decreasing between 1985 and 1991.³⁷ Consequently, we are interested in measuring how each of the

³⁷Specifically, in the low (high) group of regions, the unemployment rate reaches a peak value of 23% (24%) in 1985, it then gradually goes down to 12% (21%) by 1991, and then starts increasing to end up at 21% (29%) in 1995.

exogenous variables contributed to the trajectory of the unemployment rate during the booming period of the second half of the 80's, and the recession years of the early 90's.³⁸

First, we capture the unemployment effects of the changes of a given exogenous variable, say x , over the 1985-1991 period by keeping it constant at its 1985 level throughout the booming years and dynamically solving the resulting model. The simulated series represents the trajectory of the unemployment rate in the absence of any changes in x after 1985, and in the presence of all other shocks during that period.³⁹

Figures 4a-4f plot the actual and simulated series. The distance between the two series reflects the contributions of each of the exogenous variable to the unemployment rate over the 1985 -1991 period.

Investment (i.e. the growth rate of capital stock) and oil prices were the main driving forces of the downward trend in unemployment during the boom period. By 1991, the contribution of investment amounted to approximately 7 (9) percentage points, pp, decrease in the unemployment rate of the high (low) unemployment regions. The reduction of oil prices after the mid eighties also contributed to the decrease of unemployment by 7 (11) pp in the high (low) unemployment regions.

Benefits contributed by increasing unemployment 4 (1) pp in the high (low) group of regions. Taxes were responsible for an increase of no more than 1 pp in the unemployment rate of all regions, while import prices put an upward pressure on unemployment of around 2 pp. Finally, the contribution of working age population growth was negligible in the low unemployment regions and a decrease of less than 2 pp in the high unemployment regions.

Figures 5a-5f present the unemployment contributions of the exogenous variables over the recession years of the first half of the 90's.

The changes in investment over the 1991-1995 period put an upward pressure on unemployment. The unemployment contribution of investment was 9 (4) pp increase in the unemployment rate of the high (low) group of regions. It is worthwhile to note the asymmetry of the relative unemployment rate gains and losses of the two groups during the boom and recession periods. In the boom years 1985-1991, the high unemployment rate group benefited by 22% less than the low unemployment group of regions. In the recession years 1991-1995, the high unemployment regions were hit by more than twice as much as the low unemployment regions.

As expected, the unemployment contributions of oil prices were minimal after 1991

³⁸Figure A in the Appendix gives the plots of the exogenous variables.

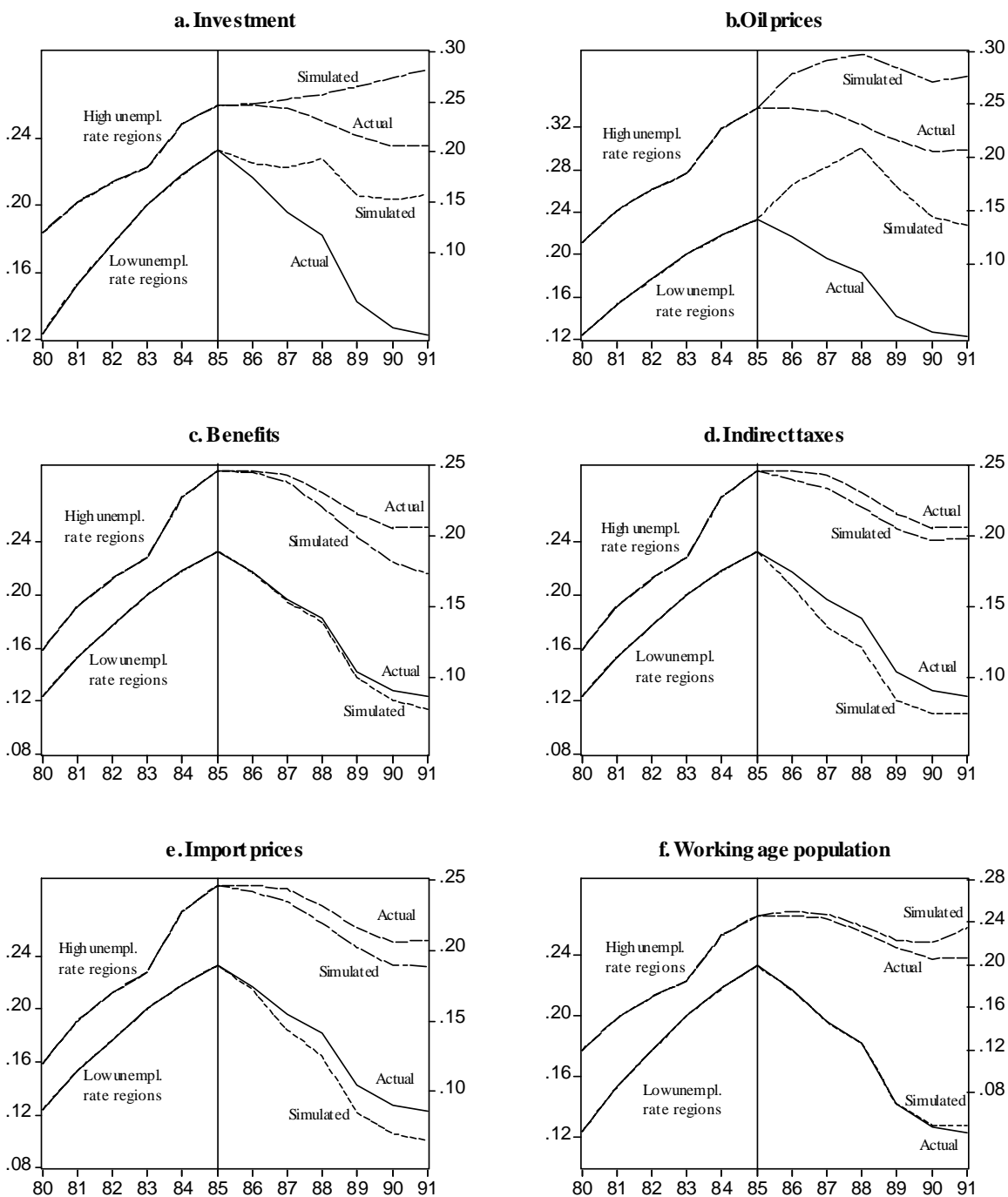
³⁹It is important to note that this is simply a dynamic accounting exercise, answering the question: how much of the movement in unemployment can be accounted for by the movements in each of the exogenous variables. It does not tell us what would happen to unemployment if the exogenous variables followed different trajectories, because in that event agents may change their behavior patterns and thus the parameters of our behavioral equations may change (in accordance with the Lucas critique).

when oil prices stabilised at relatively low levels. The effects of benefits and taxes were quite small, the impact of competitiveness was negligible, while the growth of working age population led to an unemployment rate increase of 2 pp in all regions.

The above discussion shows that capital stock (investment) and oil prices have a substantial impact on the trajectory of the unemployment rate. Although benefits, taxes, and competitiveness influence the unemployment rate, their role is less important. Had these variables remained at their 1985 levels, the resulting unemployment rate would not have been much different than the actual one in both groups of regions. On the contrary, had the capital stock remained at the (low) value of 1985 (in other words, had the economy not engaged in a strong investment process during the second half of the eighties) the unemployment rate would have been much higher, especially in the high unemployment group of regions.

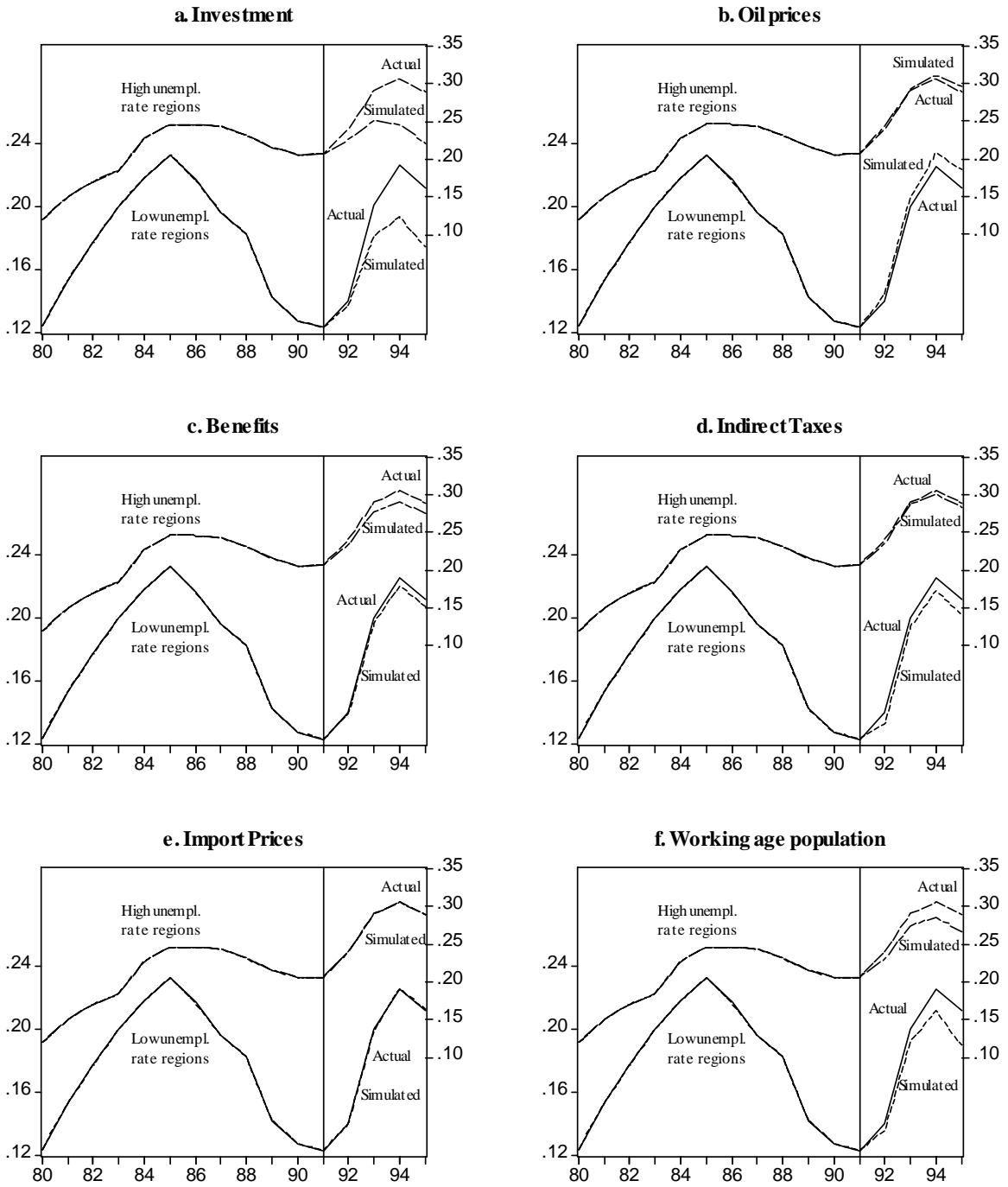
Our results are in line with the work of Henry et al (2000) for the UK. They show that over the 1964-1997 period the NRU was reasonably stable (around 4%), and the long swings in unemployment were due to prolonged after-effects of transitory but long-lasting shocks: the oil price shocks of the 70's and the slowdown of investment in the 90's. These results are clearly against a conventional wisdom which claims that changes in unemployment are mainly caused by changes in the NRU, commonly due to changes in taxes and benefits.

Figure 4
Unemployment Contributions: 1985-1991



Left scale: low unemployment regions - Right scale: high unemployment regions

Figure 5
Unemployment Contributions: 1991-1995



Left scale: low unemployment regions - Right scale: high unemployment regions

7 Total Effects of Actual Shocks

So far we measured (i) the responses of unemployment to hypothetical one-off unit labour market shocks and (ii) the contributions of the exogenous variables to the evolution of the unemployment rate during the sample period. To complete our analysis of labour market dynamics and unemployment reactions to economic shocks, we now seek to answer a rather different question. How has unemployment responded to the changes that each of the exogenous variables underwent during our sample?

For ease of exposition suppose the estimated reduced form unemployment rate equation is given by⁴⁰

$$u_{it} = \rho u_{i,t-1} + cz_t, \quad t = 0, 1, 2, \dots, T. \quad (19)$$

In this illustrative model unemployment is dynamically stable ($|\rho| < 1$) and depends on the exogenous variable z . Assuming for simplicity that unemployment is initially at its steady state, if the exogenous variable remains constant then unemployment will also remain constant. We can thus say that the changes in the exogenous variable z determine the trajectory of the unemployment rate.

At each point in time we define the shock in the exogenous variable, ϵ_t , as the difference between its value at year t and its value at the base year $t = 0$:

$$\epsilon_t \equiv z_t - z_0 = \sum_{j=1}^t \Delta z_j, \quad (20)$$

where $\Delta z_t \equiv z_t - z_{t-1}$ is the annual change of the series. In other words, the actual shock of the exogenous variable at a point in time t , ϵ_t , is given by the cumulative sum of its yearly changes. Unemployment is thus driven by a series of actual shocks ($\epsilon_1, \epsilon_2, \dots, \epsilon_T$) occurring during the sample period.

In line with the analysis in Section 2, the unemployment responses to all shocks during the sample period are given by the following triangular ($T \times T$) matrix:

$$\begin{pmatrix} c\epsilon_1 & - & - & \dots & - \\ c\rho\epsilon_1 & c\epsilon_2 & - & \dots & - \\ c\rho^2\epsilon_1 & c\rho\epsilon_2 & c\epsilon_3 & \dots & - \\ \dots & \dots & \dots & \dots & \dots \\ c\rho^{T-1}\epsilon_1 & c\rho^{T-2}\epsilon_2 & c\rho^{T-3}\epsilon_3 & \dots & c\epsilon_T \end{pmatrix}. \quad (21)$$

The number of rows refers to the time periods in the sample and the number of columns to

⁴⁰This dynamic model without spillovers provides the simplest analytical tool to explain how we compute the total effects of actual shocks. This methodology is then applied to our estimated labour market model (the results are given in Table 8 below).

the actual shocks. In particular, the j th column of the above matrix gives the responses of unemployment to the j th shock at every period in the sample. The t th row of (21) gives the responses of unemployment to every shock in the sample at time t :

$$R_{tj} = c\rho^j\epsilon_t, \quad j = 0, 1, 2, \dots, t, \quad (22)$$

where R_{tj} denotes the t period response of unemployment to the j th shock.

We can thus define the combined response of unemployment (\tilde{R}_t) to all actual shocks at time t as the sum of all the responses in the t th row:

$$\tilde{R}_t = \sum_{j=1}^t R_{tj}. \quad (23)$$

Essentially, the *combined response function* is obtained by the superimposition of the impulse response functions (IRF's) generated by the ϵ 's.

Finally, the sum of all combined responses measures the *total effect of the evolution of the exogenous variable* on the unemployment rate:

$$\sum_{t=1}^T \tilde{R}_t = \sum_{t=1}^T \sum_{j=1}^t R_{tj}. \quad (24)$$

Observe that the above total effect is just the sum of all the elements in matrix (21).

The total unemployment effect of the evolution of the exogenous variable and the contribution of the exogenous variable to the unemployment rate differ in one main respect. The former measures the impact of an exogenous variable in the absence of all other shocks, whereas the latter measures its impact in the presence of all other shocks.

Table 8 below gives the total effect of the evolution of each exogenous variable over the estimation period (1982-1995), the boom period (1985-1991), and the recession years (1992-1995). The results confirm our findings in the previous section: the variables whose evolution is most important for the unemployment rate are oil prices and investment. Although taxes, benefits, and import prices put upward pressure on the unemployment rate, their effects are much weaker.

Oil prices had the biggest role in the reduction of unemployment during the booming years - the decrease in the high unemployment regions was 7 pp, almost two thirds of that in the low unemployment regions.

During the recession years, the growth rate of capital stock (investment) was the main factor behind the rise in unemployment - the increase in the high unemployment regions was more than double of that in the low unemployment regions. This should be contrasted to the economic upturn of 1985-1991, where the 5 pp decrease in the high

unemployment rate regions was only 70% of the decrease in the low unemployment regions. Once again, this is what we observed in the previous section: while in good times the high unemployment group does not benefit as much as the low unemployment group, in bad times the high unemployment group is hit more severely than the low unemployment group.

These results are also supported by Bande *et al.* (2005) who show that in Spain, in contrast to other European countries, regional disparities in unemployment increase during economic upturns and decrease during downturns. They argue that this is due to the differences in the wage setting mechanism of three groups of regions. The existence of wage imitation effects imposes higher costs on firms in the less dynamic sectors of the economy. These costs have a greater impact on the less dynamic regions since they have a higher concentration of lagging industries.

Table 8: Total effects of actual shocks (pp)

	tax_t	b_t	oil_t	imp_t	Δk_{it}
<i>High Unemployment Regions</i>					
1985-1991	1.5	3.4	-7	1.9	-5
1992-1995	0.2	0.5	-0.3	0	5.6
<i>Low Unemployment Regions</i>					
1985-1991	2.1	0.7	-10.9	2.4	-7.2
1992-1995	1	-0.1	-1.1	-0.3	2.6

8 Conclusions

In this paper we explained the evolution of regional unemployment rate disparities by modeling the dynamics of the Spanish labour market. We applied the chain reaction theory (CRT) of unemployment and estimated a standard labour market model consisting of labour demand, wage setting, and labour supply equations for the Spanish regions. We grouped the regions into high and low unemployment groups and showed that unemployment disparities depend on regional spillover effects and the degree of regional labour market flexibility.

In our analysis we first investigated how the degree of labour market flexibility differs between regions that face the same type and size of shocks.

We then identified the driving forces of regional unemployment rate disparities during the boom period of 1985-1991 and the recession years of the first half of the 90's by measuring (i) the contributions of region-specific and nationwide explanatory variables to the evolution of unemployment, and (ii) the total effects of actual shocks, i.e. changes in

the explanatory variables that occurred in our sample, on the unemployment trajectory. These two methodologies complement one another since they differ in one main respect. The "contributions" measure reflects the unemployment impact of the changes in an exogenous variable in the presence of all other shocks, whereas the "total effects" measure captures the impact of the changes in an exogenous variable in the absence of all other shocks.

Our findings can be summarised as follows. First, it takes several years before one-off shocks are completely absorbed by the labour market. In particular, 20% of the initial impact of the shock is still felt by the market after approximately two years (labour demand shock), five years (wage shock), and three years (labour supply shock). Both the real wage and labour supply shocks are far more persistent in the high unemployment regions than in the low unemployment regions.

Second, investment was the main driving force of the downward trend in unemployment during the boom period and the rise of unemployment during the recession years. Furthermore, the increase in the high unemployment regions was more than double of that in the low unemployment regions. This should be contrasted to the economic upturn of 1985-1991, where the decrease in the high unemployment rate regions was only 70% of the decrease in the low unemployment regions. That is, in bad times the high unemployment group is hit more severely than the low unemployment group, while in good times the high unemployment group does not benefit as much as the low unemployment group.

Third, although the influence of oil prices on unemployment was substantial during the boom period, it was negligible after 1991 when oil prices stabilised at relatively low levels.

Finally, the role of benefits, taxes, and competitiveness in the evolution of the unemployment rate is less important.

The policy implications that emerge from our analysis are that different policies should be applied to the high and low unemployment groups of regions in order to reduce regional unemployment disparities. This is in line with the recommendations made by Overman and Puga (2002).

Also, the role of investment should be emphasized since we showed that this is a key variable in the explanation of regional unemployment swings. This result indicates the need for a debate on how the EU structural funds were spent in the high unemployment regions. De la Fuente (2003) provides an attempt towards this direction. In addition, there should be an evaluation of the impact on the Spanish regional labour markets of the progressive reduction in EU structural funds in the forthcoming years.

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Appendix

Figure A. Explanatory variables in the labour market model

