Causes of unemployment and the effectiveness of demand policies

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The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others.

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Abstract

The rise in unemployment suffered by many advanced economies since 2007, particularly in Europe, has revived long standing debates about what policies are better equipped to fight unemployment. In one side of the debate, we find those who believe that structural reforms, particularly in the labour market, are the only way to achieve long lasting reductions of unemployment. In the other side of the controversy, we find those who argue that macroeconomic stimuli ought to be used to tackle unemployment. European policy makers have predominantly favoured the first view and accordingly they have agreed upon the “Europe 2020 agenda” (European Commission, 2010a) and most recently the “Fiscal Compact” (European Commission, 2012).

The theoretical underpinning of these policies is the NAIRU model proposed by Layard and Nickell (1986). According to this approach the NAIRU is exclusively determined by structural features of the labour and goods market, which cannot be modified by demand policies. Further, the NAIRU is also thought to acts as an anchor for economic activity. Consequently, the only policy that can achieve long lasting reductions of unemployment is one that tackles the features of the labour and goods market that determine the NAIRU.

This characterization of the NAIRU is far from uncontroversial, and many economists argue that there are long run links between aggregate demand and unemployment, which can channel the effects of demand policies onto the NAIRU. A well-known example is the hysteresis hypothesis proposed by Blanchard and Summers (1986), although Sawyer (1982), Rowthorn (1995, 1999) and Hein (2006) also propose other channels. Furthermore, some of these authors also question the anchor properties of the NAIRU.

Thus far, empirical research has not been able to settle this controversy. The aim of this thesis is to provide a *new* empirical assessment of the determinants of the NAIRU and its anchor properties. For that purpose, we analyse data from eight EU economies, namely the United Kingdom, the Netherlands, Germany, France, Italy, Spain, Denmark and Finland. The data cover the period from 1980 to 2007. We employ time series techniques, more specifically the Cointegrated Vector Autoregressive (CVAR) approach. This is applied to a theoretical model that encompasses the conflicting views of the NAIRU that we aim to assess.

The key novelty of our research is the use of this encompassing model. This is the first time that such an approach has been employed in the literature. The second novelty of our work is that our sample extends the analysis to the 2000s, a period which has rarely been studied before.

The findings presented in this thesis are in contrast to the dominant NAIRU view proposed by Layard and Nickell. First, we find that in all the countries in our sample, the NAIRU is determined by at least one of the following variables: Productivity, long term unemployment, capital stock or long term real interest rates. Second, we find that in all the countries in our sample, the NAIRU is either a weak anchor for economic activity or has no anchor properties at all.

Keywords: NAIRU, European unemployment, labour market institutions, structural reforms, hysteresis, capital stock, productivity, real interest rates, CVAR.

JEL codes: C32, E22, E24, E44, E60, J38, J58, J64, J68, P50, O52

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Glossary

ADF-GLS	Augmented Dickey-Fuller, Generalized Least Square
AIC	Akaike Information Criterion
ALMP	Active Labour Market Policies
APW	Average Production Worker
ARDL	Autoregressive distributed lag
ASR	Arestis, Sawyer and Rowthorn
AW	Average Wages
BS	Blanchard and Summers
CBC	Collective bargaining coverage
CE	Compensation of employees
CMPI	Commodity imports price index in USD dollars
CPI	Consumer Price Index
CRT	Chain Reaction Theory
CVAR	Cointegrated Vector Autoregressive
ECB	European Central Bank
ECM	Error Correction Model
EMU	European Monetary Union
EPL	Employment Protection Legislation
EU	European Union
FF	Functional form
GIR	Generalized Impulse Response
GIRF	Generalized Impulse Response Function
HCPI	Harmonized Consumer Price Index
HET	Heteroscedasticity
HUR	Harmonized Unemployment Rate
IMF	International Monetary Fund
IR	Impulse response
LMR	Labour Market Regulation
LNJ	Layard Nickell and Jackman
LR	Likelihood Ratio
KPSS	Kwiatkowski, Phillips, Schmidt and Shin
ML	Maximum Likelihood
NAIRU	Non-Accelerating Inflation Rate of Unemployment
NID	Normally and Independently Distributed
NORM	Normality of the residuals
OLS	Ordinary Least Square
OECD	Organization for Economic Cooperation and Development
PMR	Product Market Regulation
RBE	Real Balance Effect”
RH	Rowthorn and Hein
TE	Total employment

TLU	Total number of long term unemployed workers
TU	Total number of unemployed workers
SBC	Schwarz Bayesian Criterion
SC	Serial correlation
SGP	Stability and Growth Pact
SUR	Seemingly Unrelated Regression
SVAR	Structural Vector Autoregressive
VAR	Vector Autoregressive
VECM	Vector Error Correction Model

Chapter 1 Introduction

1.1 Purpose

The current economic crisis and the rise in unemployment that it has caused have reignited long standing debates about what policies are better equipped to fight unemployment. The debate is particularly acute in Europe where once more unemployment has surged. The approach favoured by European policy makers claims that only reforms of the labour market, which makes it more flexible, can achieve long lasting reductions of unemployment. This claim is challenged by those who argue that lower unemployment can be achieved by means of expansive macroeconomic policies.

The crux of the matter is the capacity of demand policies to affect the long run unemployment equilibrium of the economy, commonly referred to as the NAIRU or Non-Accelerating Inflation Rate of Unemployment. According to the dominant view among policy makers, the NAIRU is neutral to demand factors and consequently macroeconomic stimulus are not effective in fighting unemployment. By contrast, advocates of demand policies, argue that the NAIRU is determined by variables that are sensitive to economic activity, which can filter the impact of macroeconomic policies to the NAIRU.

This controversy has lingered in political and academic circles for the last 30 years, and thus far, empirical research has been unable to settle the debate. On the one hand, advocates of reforms claim that their approach is vindicated by empirical evidence. On the other hand, those who favour demand policies challenge the validity of these results. The persistence of these controversies signals the need for further research, the aim of this thesis is to present a *new* empirical assessment of existing NAIRU theories to contribute to these debates.

1.2 Background

During the last three decades, economic policy in advanced economies has been dominated by the version of the NAIRU proposed by Layard and Nickell (1986), later reprinted in Layard et al. (1991, Chapter 8). As it is customary in the literature, hereafter we refer to this approach with the acronym LNJ.

According to LNJ the NAIRU has two key characteristics. First, it is exclusively determined by the structural features of the labour and goods market, which cannot be modified by demand policies. In practice, the labour market has received greater attention than the product market. Second, the NAIRU acts as an anchor for economic activity because the Central Bank sets interest rates following a Taylor Rule. It follows from these propositions that demand policies can only reduce unemployment temporally, and that the only way to achieve long lasting reductions of unemployment is to reform the structures of the labour and goods market that determine the NAIRU.

The design of the European Monetary Union (EMU) and OECD's "Jobs Strategy" (OECD, 1994, 1996,p.6) are examples of the influence of LNJ's approach. In the single currency area, policy makers have renounced to use fiscal and monetary policies to stimulate the economy, with the argument that these policies can only deliver temporary gains (Duisenberg, 1999, Issing, 2000, ECB, 2004,p.41). Furthermore, the European Union has devised an agenda of reforms in the labour and goods market to foster employment growth and "reduce structural unemployment", the so called "The Lisbon Strategy", see European Commission (2000, 2005, 2007). This agenda, has recently been re-launched as the "Europe 2020 agenda" (European Commission, 2010a).

Another example of the influence of LNJ's approach in the Euro Area, is the so-called the "Fiscal Compact" (European Commission, 2012), which attempts to coordinate macroeconomic and structural policies. This is in fact the main battle horse of European authorities to tackle the current crisis. OECD's "Jobs Strategy" (OECD, 1994, 1996,p.6), and their current "Going for growth" strategy (OECD, 2006a,p.20, 2010b, p.21, 2012, Chapter 1) also recommend to make the labour and goods market more flexible, along the lines of LNJ's model.

LNJ's characterisation of the NAIRU, has taken such a centre stage among policy makers that it is sometimes forgotten that this is just one particular view of this concept, i.e. the Non-Accelerating Inflation Rate of Unemployment concept, and that there are other NAIRU models that challenge LNJ's propositions and policy recommendations.

In the survey that we present in Chapter 2, we find that LNJ's model is challenged in two fronts. First, it is questioned that the NAIRU is exclusively determined by variables that are exogenous to aggregate demand. Blanchard and Summers (1986) claims that the NAIRU can be affected by unemployment history, which in turn is determined by past demand levels, hence, creating a link between the NAIRU and demand. Similarly, Sawyer (1982) and Rowthorn (1995) argue that productivity and capital stock determine the NAIRU, since these variables are sensitive to the evolution of economic activity, productivity and capital stock provide another two links between aggregate demand and the NAIRU.

Further, Rowthorn (1999, p.422) and Hein (2006) claim that the NAIRU might also be affected by real long term interest rates, which these authors argue, can be affected by the Central Bank's policy, hence delivering a fourth link between the NAIRU and demand factors. Sometimes these alternative NAIRU models are summarized under the label of hysteresis theories (Blanchard and Summers, 1986, p.27, Bean, 1994,p.603). However, we believe this can be misleading, and here we use the term hysteresis only and exclusively to refer to the hypothesis proposed by Blanchard and Summer. The second line of attack against LNJ's model is based on the claim that there are mechanisms that prevent the NAIRU from acting as an anchor, namely hysteresis, "frictional growth" (Henry et al., 2000) and income distribution (Hein and Stockhammer, 2008).

The policy implications that follow from these models are in stark contrast to those from LNJ's model. First, reforming the labour and goods market might bear no fruits because the NAIRU is unlikely to act as an anchor. Second, insofar, past unemployment, productivity and capital stock are sensitive to the level of economic activity they provide three channels for demand policies to affect the NAIRU. Furthermore, in the case of real long term interest rates, insofar Central Banks can change their reference rate to modify the cost of borrowing, monetary authorities can also affect the NAIRU.

These critiques have led to vivid controversies during the last three decades, and the surge in unemployment experienced by advanced economies since 2007, has done nothing but to intensify these debates. Two illustrative examples of current debates can be found in Schäuble (2011) and Arestis and Sawyer (2012).

Thus far, the empirical literature has not been able to settle these controversies, particularly, with regard to the determinants of the NAIRU. On the one hand, advocates of the NAIRU *a la* LNJ argue that empirics vindicate their claims based on the following pieces of evidence. First, panel data studies that find cross-country differences in unemployment associated with differences in labour market institutions. Second, results from dynamic panel data studies that find the evolution of unemployment associated with exogenous wage-push factors. See OECD (2006c, Chapter 3) for a survey of this panel data literature. Third, time series studies that find long run links between unemployment and structural features of the labour market, in some cases also of the goods market. Further, these time series studies find no evidence of the influence of demand factors, such as productivity and capital stock, on the NAIRU. Layard and Nickell (1986) and Nickell (1998) are some well-known examples.

On the other hand, critics of LNJ's approach find this evidence unconvincing for several reasons. Some question the reliability of panel data studies used to vindicate LNJ's claims due to data quality and methodology issues (Blanchard and Wolfers, 2000, Baker et al., 2007). But the most damaging critique is that these panel data and time series studies might suffer of omitted variable biases. These misspecification claims are based on the evidence provided by panel data studies, which find that interactions of aggregate demand variables with labour market institutions, and indeed demand variables such as capital stock, productivity, and real interest rates have a significant influence on the NAIRU, see for instance Blanchard and Wolfers (2000) or Storm and Naastepad (2009). Misspecification claims are further reinforced by a new wave of time series studies, which also find significant links between the NAIRU and variables such as productivity, capital stock, real interest rates and different measures of hysteresis (Arestis et al., 2007, Schreiber, 2012).

The persistence of these theoretical and empirical controversies, signals that our understanding of the NAIRU characteristics, in particular what variables determine it, is still unsatisfactory. This situation calls for further research. The aim of this thesis is to make a contribution that helps clarifying these debates. For that purpose we propose a *new* empirical assessment of the existing NAIRU theories, that is, LNJ's model and the models proposed by its critics.

The two specific research questions we aim to answer are the following. First, is the NAIRU exclusively determined by factors exogenous to aggregate demand, as suggested by LNJ? Second, is the NAIRU an anchor for economic activity, as also pointed out by LNJ? To answer these questions we propose to use data from eight EU economies, namely the United Kingdom, the Netherlands, Germany, France, Italy, Spain, Denmark and Finland. The data cover the period between 1980 and 2007. Further, we propose to analyse these data using time series techniques and a theoretical model that encompasses the competing NAIRU theories.

1.3 Originality

The main novelty of our work resides in the use of the encompassing NAIRU model that we present in Chapter 4. As we show in that chapter, existing literature rarely tests LNJ's model against competing theories, and in the rare cases in which this is done, only one or two of the alternative theories are considered.

Secondly, the existing literature rarely considers data for the 2000s. By incorporating data from 1980 to 2007 in our sample, our research makes an original contribution to extending the current literature. This is illustrated in Chapter 4. The study also considers a wide range of European countries enabling comparisons between them to be made.

Thus, the empirical evidence presented in this thesis, in Chapter 7 to Chapter 10, extends the existing literature in two ways. First and most importantly, it considers a wider theoretical model than those used in previous studies. Secondly, it covers a period that has rarely been considered in the extant literature.

1.4 Structure

This thesis has eleven chapters and two appendixes. Chapter 2 and Chapter 3 provide a comprehensive review of the relevant literature. More specifically, Chapter 2 presents a survey of different NAIRU theories, which includes LNJ's approach to the NAIRU along with the models proposed by its critics. Chapter 3 reviews the extant empirical literature, this chapter is divided in two sections depending on the methodology used in the articles reported, namely panel data and time series.

Chapter 4 plays a pivotal role in this thesis, for it uses the reviews presented in chapters 2 and 3 to formulate the research programme that occupies the rest of the thesis. Section 4.3 deserves special mention because it presents the theoretical model that underlies our empirical work. As shown in Table 4.1, this model encompasses the different NAIRU models presented in Chapter 2, and hence constitutes an excellent framework to test their competing claims about the NAIRU.

Chapter 5 and Chapter 6 set the ground for our empirical work by providing the necessary information regarding methods and data. Chapter 5 presents the Cointegrated Vector Autoregressive (CVAR) approach used in our econometrical work. This approach can be divided into five stages which are discussed in turn. Table 5.1 and equation 5.10 are key elements to understand the relationship between our theoretical model and our empirical work, because they are the empirical counterparts of Table 4.1.

Chapter 6 presents the key features of the data used in this thesis, namely its time and geographical scope, sources and definitions. Figure 6.1 to Figure 6.16 present a first look at the data. These figures are also used to discuss some of our econometric results in subsequent chapters. Table 6.2 provides a summary of definitions and sources of the variables employed in the analysis.

Chapter 7 to Chapter 10 present the findings of our empirical work and constitute the core of this thesis. Results are presented by pairs, the grouping responds to geo-economic considerations. Chapter 7 presents our results for the UK and the Netherlands, which are generally seen as the European success stories in fighting unemployment. Chapter 8 presents our results for the two main economies of the Euro Area, Germany and France. Chapter 9 presents our results for the two largest Euro Area economies of Southern Europe, Italy and Spain. Finally, Chapter 10 presents our results for two Scandinavian economies, Denmark and Finland.

Chapter 7 to Chapter 10 follow the same structure since we apply the five stages of the CVAR approach to each country's data set. Each chapter closes with a summary of the key findings, and with a discussion of the contribution of our results to each country's time series literature.

Chapter 11 closes this thesis with a summary of our findings, a discussion of their contribution to the existing empirical literature and their implications for economic theory and policy.

Two appendices accompany this thesis. Appendix I presents summary tables of the time series literature for each pair of countries. These are constructed by extracting the relevant literature from the survey presented in Chapter 3. We used these tables to inform our discussion of findings in Chapters 7 to Chapter 10. Appendix II is a statistical annex and presents the results from the ADF-GLS and KPSS tests for each country's data set.

Chapter 2 The NAIRU, a review of different theories

2.1 Introduction

The aim of this chapter is to present a review of different NAIRU models. We start by presenting LNJ's approach to the NAIRU. This seems a natural starting point given its dominance in the policy sphere. Following, we survey models that challenge this characterization of the NAIRU grouped in two blocks. First, we review models that contradict LNJ's propositions about the NAIRU's determinants. Second, we survey models that call into question LNJ's claim that the NAIRU acts as an anchor for economic activity.

The rest of the chapter is structured as follows: Section 2.2 reviews the version of the NAIRU proposed by LNJ. Section 2.3 surveys the models that challenge LNJ's characterization of the NAIRU determinants. Section 2.4 collects the caveats about the NAIRU acting as an anchor. Section 2.5 closes the chapter summarising the key points of the theoretical controversies presented in this chapter and their policy implications.

2.2 Layard, Nickell and Jackman's approach to the NAIRU

We start by presenting LNJ's approach to the NAIRU. Our exposition is based on the widely referenced version of this model presented in Layard, et al. (1991, Chapter 8), although an earlier version can also be found in Layard and Nickell (1986). The following set of equations illustrates the main points of this model:

2.1 $$p - w = \beta_0 + \beta_1(y_d^e - \bar{y}) - \beta_2(p - p^e) - \beta_3(k - l)$$

2.2 $$w - p = \gamma_0 - \gamma_1 u - \gamma_2(w - w^e) + \gamma_3(k - l) + z_w \qquad \text{where } \gamma_3 = \beta_3$$

2.3 $$\Delta p = \Delta p_{t-1} + v$$

2.4 $$p - w = \beta_0 + \beta_1(y_d^e - \bar{y}) - \beta_2\Delta^2 p - \beta_3(k - l)$$

2.5 $$w - p = \gamma_0 - \gamma_1 u - \gamma_2\Delta^2 p + z_w + \gamma_3(k - l)$$

2.6 $$y_d - \bar{y} = -\alpha u + \varepsilon$$

2.7 $$y_d = \sigma_1 x + \sigma_2(m - p)$$

2.8 $$u^* = \frac{(\beta_0 + \gamma_0) + z_w}{\beta_1 + \gamma_1}$$

2.9 $$(w - p)^* = \frac{[\beta_1 \alpha \gamma_0 - b_0 \gamma_1]}{\gamma_1 + \beta_1 \alpha} + \frac{\beta_1 \alpha z_w}{\gamma_1 + \beta_1 \alpha} + \beta_3(k - l)$$

2.10 $$\Delta^2 p = -\frac{\beta_1 + \gamma_1}{\beta_2 + \gamma_2}(u - u^*)$$

Where $p - w$ represents prices mark up over labour costs, $(y_d^e - \bar{y})$ stands for the level of expected demand, $(w - w^e)$ is the unexpected wage, $(p - p^e)$ stands for price surprises, $(k - l)$ is productivity proxied here by the capital-labour ratio, $w - p$ stands for the real wage, z_w denotes the effect of wage-push factors "such as union and benefit effects" (Layard et al., 1991, p. 368). u stands for actual unemployment, x captures exogenous demand factors, such as fiscal policy shocks, $(m-p)$ stands for real quantity of money or real money balances, Δp is the inflation rate, $\Delta^2 p$ stands for the change in inflation and v is a white noise process. β_0 and γ_0 denote workers are firms' exogenous mark-up and capture their bargaining power in the goods and labour market respectively. All the variables are expressed in logarithms.

In this model, both firms and workers are assumed to operate in a context of imperfect competition, meaning that they have certain bargaining power to set the price of output, in the case of firms, and the price of labour they supply, in the case of workers: Firms' price behaviour is denoted by equation 2.1, where by firms set prices as a mark-up over labour cost $(p-w)$, depending on the level of expected demand $(y_d^e - \bar{y})$, price surprises $(p-p^e)$, and productivity $(k-l)$. This equation is sometimes referred to as the "Feasible" real wage.

Workers behaviour is denoted by equation 2.2, where by wages are set as a mark-up over prices $(w-p)$, depending on unemployment u, on wage surprises $(w-w^e)$, productivity $(k-l)$ and wage-push factors z_w. This is sometimes referred to as "Target" real wage. Layard et al. (1991,p.364) note that this wage setting equation is consistent with different approaches to wage setting such as wage bargaining or efficiency wage models.

A key feature of this model is that it assumes that the coefficient of productivity, in the price mark-up and in the real wage equation, are identical i.e. $\beta_3 = \gamma_3$. This implies that workers are able to fully absorb productivity gains and that capital and labour are perfect substitutes, with capital-to-labour elasticity of substitution been equal to unity[1]. This is embedded in the Cobb-Douglas production function used (Layard et al., 1991, pp.101-107).

As per equation 2.3, inflation (Δp) is assumed to follow a unit root process, which means that expectations are formed in some adaptive fashion. $\Delta p = \Delta p_{t-1} + v$ can be rewritten as $p - p_{t-1} = \Delta p_{t-1} + v$, then taking expectations we obtain $p^e = p_{t-1} + \Delta p_{t-1}$. Multiplying this expression by minus one and adding the price level (p) in both sides of the equality to obtain an expression in terms of price surprise $(p-p^e)$, it is found that changes in inflation $(\Delta^2 p)$ can be used to proxy unexpected inflation or price surprises, i.e. $p - p^e = \Delta p - \Delta p_{t-1} = \Delta^2 p$.

Once, the process of expectation formation is incorporated into price and wages behaviour denoted by equations 2.1 and 2.2, these equations can be rewritten as equations 2.4 and 2.5.

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[1] The authors acknowledged, that less than unity elasticity of substitution, i.e. non-perfect substitution, or different production function will allow for capital stock effects on the NAIRU, however, it is discarded because they argue that productivity being trended would give unemployment a trend which is not observed in the data, and that other production function, such as fixed-coefficients, would only serve to account for extreme, and unlikely, scenarios (Layard et al., 1991, p.369).

The model is completed with equations 2.6 and 2.7 that model the aggregate side of the economy: The first one is a specification of *Okun's Law* and provides a relationship between output $(y_d - \bar{y})$ and unemployment (u). The latter is an aggregate demand (y_d) expression determined by exogenous nominal factors denoted by x, such as proxy fiscal policy, and real factors, captured here by real money balances $(m - p)$.

The model contemplates two horizons: In the long run expectations are fulfilled and there are no surprises, i.e. $p - p^e = \Delta^2 p = 0$ and $y_d = y_d^e$. Then, substituting 2.6 into 2.4, and equating the resulting 2.4 with 2.5 to solve for unemployment and real wages, we obtain the model's long run unemployment and real wages equilibriums, denoted by equations 2.8 and 2.9.

According to equation 2.8 unemployment's equilibrium is determined by wage-push factors z_w, and the exogenous mark-up over labour costs and prices, i.e. β_0 and γ_0. All of which are independent or exogenous to aggregate demand. While productivity can only affect real wages' equilibrium, this follows from the equality of coefficients for $(k - l)$ in equations 2.4 and 2.5. And fiscal and monetary policies have no influence on the long run unemployment equilibrium. Thus, the long run unemployment equilibrium described by equation 2.8 is exclusively determined by factors that are exogenous to demand policies.

In the short-run, expectations might not be fulfilled, i.e. $p - p^e = \Delta^2 p \neq 0$, and in this case actual unemployment can deviate from its long run equilibrium, i.e. $u \neq u^*$, generating the negative relationship between inflation and unemployment, denoted by 2.10 and sometimes referred to as inflation augmented Phillips curve. As per equation 2.10, when unemployment falls below the u^*, i.e. $u^* > u_t$, inflation raises, and vice versa. Thus, u^* in equation 2.8 can be regarded as a "Non-Accelerating Inflation Rate of Unemployment" or NAIRU. Figure 2.1 represents equations 2.4 and 2.5 graphically, and illustrates the relationship between inflation and unemployment embedded in this model.

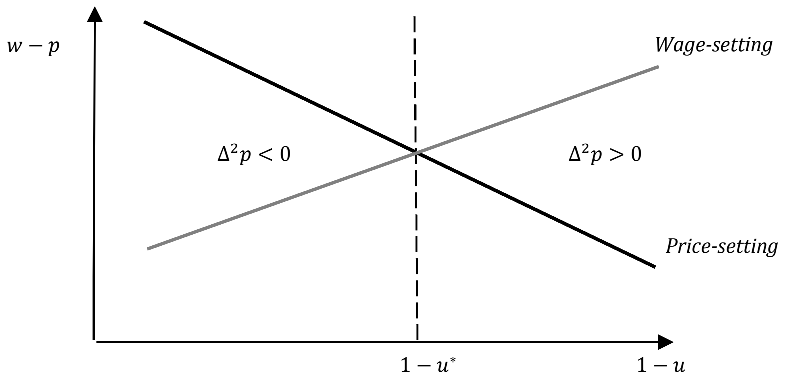

Figure 2.1 The NAIRU in Layard Nickell and Jackman's model

This diagram is based on "Figure 1" in Layard, et al. (1991,p.380). The *Price-setting* curve is the graphical counterpart of equation 2.4, and the *Wage-setting* curve represents equation 2.5. In the long run, when there are no surprises because firms' and workers' income claims are consistent the economy operates at u^*. Graphically, that is when the price and the wage setting curves intersect. To the right of u^* inflation rises and to its left it falls, as noted by equation 2.10.

The inflation dynamics depicted by equation 2.10 together with equations 2.6 and 2.7 justify LNJ's claims that the NAIRU acts an anchor: If unemployment falls below the NAIRU, as per Figure 2.1 is $u^* > u$, the economy will suffer unexpected or raising inflation $\Delta^2 p > 0$. This reduces real money balances and demand in equation 2.7, which in turn feeds into higher unemployment via 2.6. This process will continue as long as unexpected inflation persists, i.e. as long as $u^* > u$, and consequently ensures that unemployment deviations from the NAIRU are automatically corrected and makes the NAIRU an anchor for economic activity. This mechanism is usually referred to as "Real Balance Effect" (RBE) (Layard et al., 1991,p.384).

The RBE mechanism is no longer invoked, and nowadays, advocates of LNJ's approach argue that the NAIRU acts as an anchor, because Central Banks sets interest rates according to a Taylor Rule (Nickell et al., 2005). As per such a rule, when unemployment falls below the NAIRU and the economy suffers raising inflation, the Central Bank will increase interest rates in order to reduce aggregate spending and inflation. Mathematically, this implies substituting 2.7 by a formulation of the Taylor rule of the kind presented in Carlin and Soskice (2006, p.152).

Policy implications from LNJ's approach to the NAIRU are straight forward: First, because the productivity and demand policies do not affect the NAIRU, and because the NAIRU acts as an anchor, trying to stimulate productivity or economic activity using demand policies can only render short-lived unemployment reductions. Second, given that the NAIRU, is determined by structural features of the labour and goods market, in order to reduce the NAIRU these structures need to be reformed. The upshot of these reforms is that because the NAIRU serves as an anchor, reforms will have a knock-on effect over unemployment that will follow the NAIRU down.

2.3 Four nexus between aggregate demand and the NAIRU

LNJ's characterization of the NAIRU is challenged by some economists, who claim that there are long run links between aggregate demand and unemployment which would channel the effects of demand policies onto the NAIRU. The three models presented in this section provide theoretical justification for four of these channels.

2.3.1 The labour market hysteresis hypothesis:

We start with the hysteresis hypothesis proposed by Blanchard and Summers (1986), see also Ball (1999, 2009). These authors argue that after a negative demand shock, some of the workers who become unemployed can become irrelevant for the wage bargaining processes, precluding them from exerting any downward pressure over wages and inflation. Consequently, they claim, higher levels of unemployment will then be possible without exerting downward pressure on inflation. In other words, demand shocks modify the NAIRU as long as they make some workers irrelevant for the wage bargaining process.

Layard et al. (1991, p.368,p.382) present[2] a version of their NAIRU model that incorporates the hysteresis hypothesis. In the interest of comparability between the two models we will rely on their exposition, here summarised by the following equations:

2.11 $$w - p = \gamma_0 - \gamma_1 u - \gamma_{11}\Delta u - \gamma_2 \Delta^2 p + z_w + \gamma_3(k - l)$$

2.12 $$u^* = \frac{(\beta_0+\gamma_0)+z_w}{\beta_1+\gamma_1+\gamma_{11}} + \frac{\gamma_{11}}{\beta_1+\gamma_1+\gamma_{11}} u_{t-1}$$

Where Δu stands for the change in unemployment or workers fired in the last period, u_{t-1} is the past unemployment rate, the coefficient γ_{11} reflects the influence on wages of recently fired workers, and γ_1 reflects the influence on wages exerted by the whole pool of unemployed workers. The rest of variables and coefficients have the same meaning as above.

Equation 2.11 is a new “Target” real wages equation, and its main difference with that proposed by LNJ, is that the former extends equation 2.5 to consider the possibility that the whole pool of unemployed workers might have a different influence on real wages claims than recently fired workers. Under the hysteresis hypothesis we would expect that $\gamma_{11} > \gamma_1$, reflecting that those who have lost their jobs recently can exert greater downward pressure over wages than the overall pool of unemployed workers[3].

Equating the new “Target” real wage denoted by 2.11 and LNJ’s “Feasible” real wage denoted by equation 2.4, we can obtain the NAIRU expression of an economy subject to hysteresis effects, here denoted by 2.12. According to 2.12, the NAIRU is now determined by the same exogenous factors as in LNJ’s model, namely wage-push factors z_w and the exogenous mark-up over labour costs and prices b_0 and γ_0. However, after considering hysteresis it is also determined by the degree of hysteresis denoted by γ_{11}, and crucially by past

[2] See also Nickell (1998)

[3] The reverse argument is generally used in empirical work: It is usually argued that the greater the share of long term unemployed workers over total unemployment, i.e. the lower the share of new unemployed, the lower the pressure over real wages exerted by the overall unemployment rate.

unemployment levels or unemployment history. Because past unemployment is determined by past demand levels, in the presence of hysteresis effects, the NAIRU becomes endogenous to aggregate demand[4].

Before turning to the policy implications that follow from hysteresis, it is necessary to make mention to the mechanisms that can facilitate it. This is a wide an open area of research, but there is some consensus around the following factors: Blanchard and Summers (1986) note that scenarios of strong unionisation might create and insider-outsiders divide that can propitiate hysteresis. It has also been suggested that long lasting and generous unemployment benefits, can reduce workers search intensity and prevent unemployed workers from exerting downward pressure on wages. Similarly, it has been argued that minimum wage legislation and collective bargain generally reflects prime age workers preferences, and can prevent younger workers and other groups from making their wage preferences –supposedly more moderated- from influence wage setting. On the other hand, it has also been argued that long term unemployment can generate hysteresis, because workers who suffer long unemployment spells might loss valuable skills learnt in the work place, or become disaffected and stop searching for jobs. Further, it has been suggested that long-term unemployment records might raise questions about the skills of workers, who might become stigmatized. For a survey on different hysteresis mechanisms see Bean (1994, p.603-609).

Thus, under the hysteresis hypothesis policy makers have a policy choice to reduce the NAIRU (Blanchard and Summers, 1986, Ball, 1999): On the one hand, given that some of the mechanisms that generate hysteresis are associated with the structure of the labour market such as unions, wage bargaining legislation or unemployment benefits, policy makers can introduce reforms *a la* LNJ. Or alternatively, they can use hysteresis in the reverse by engineering a number of positive shocks that "...'enfranchise' as many workers as possible" (Blanchard and Summers, 1986,p.72).

Advocates of LNJ's view, acknowledge the importance of un-enfranchised workers for wage bargaining and the challenge it poses for their claims. However, they argue that hysteresis only invalidates LNJ's, in the unlikely and extreme case of full hysteresis, i.e. only if recently fired workers exert pressure over wages $\gamma_1 = 0$. In that scenario, Nickell (1998, P.805/6) notes; "...we can say that high unemployment today is the result of a set of bad shocks in the 1970s..." and in a rather sarcastic note adds "or indeed the 1870s".

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[4] Another interesting implication of 2.10 is that any proportion of past unemployment can become the new level of unemployment where inflation remains stable, and therefore the NAIRU can take any value. It follows from this that the Phillips curve can be seen as a horizontal rather than a vertical as in LNJ's model.

2.3.2 The role of productivity and capital stock

Sawyer (1982) and Rowthorn (1995) argue that productivity and capital stock affect the NAIRU. In the first case, they argue, it is because productivity gains are not fully reflected into workers' wages[5]. In the second case, because capital stock limits firm's ability to set their price mark-up. Hence, they argue an increase in productivity and/or capital stock would permit lower unemployment without inflation tensions, i.e. reduce the NAIRU. Furthermore, they argue, insofar productivity and capital stock are sensitive to the level of economic activity, they provide two channels for demand policies to affect the NAIRU.

In our exposition of this approach to the NAIRU we draw from Sawyer (1982) and Rowthorn (1995) but also from more recent formulations such as Sawyer (2002) and Arestis and Sawyer (2005). The following set of equations illustrates the main points of this approach:

2.13 $$w = \gamma_0 + p^e - \gamma_1 u + \gamma_4 B + \gamma_3 (y - l)$$

2.14 $$p - w = \beta_0 + \beta_1 \Phi - \beta_3 (y - l)$$

2.15 $$p - w = \beta_0 - \beta_4 u - \beta_5 k - \beta_3 (y - l)$$

2.16 $$\Delta k = a_0 + a_1 \Pi + a_2 \Phi$$

2.17 $$\Delta (y - l) = b_0 + b_1 \Delta \Phi$$

2.18 $$u^* = \frac{\beta_0 + \gamma_0 + \gamma_4 B}{\beta_4 + \gamma_1} + \frac{(\gamma_3 - \beta_3)}{\beta_4 + \gamma_1}(y - l) - \frac{\beta_5}{\beta_4 + \gamma_1} k$$

Where w is the nominal wage, B stands for unemployment benefits, $(y - l)$ is the labour productivity, Φ stands for capacity utilization, k is the capital stock, Δk investment, and Π stands for firms' profitability. The rest of variables and coefficients have the same meaning as above.

Equation 2.13 denotes workers' wages claims or the "Target" real wage. Workers are assumed to bargain nominal wages (w), depending on price expectations (p^e), which are assumed to follow a unit root as LNJ, the level of unemployment (u), alternative sources of income such as unemployment benefits (B), and labour productivity ($y - l$). This is consistent with different approaches to wage setting such as wage bargaining or efficiency wages models.

Firms are assumed to operate under imperfect competition allowing them to set prices as a mark-up over labour cost ($p - w$), denoted here by equation

[5] It has also been suggested that productivity can affect the NAIRU if wages are sluggish to adjust to changes in productivity growth. The argument is the following: If productivity suddenly slows down, wage claims might take some time to acknowledge it and moderate accordingly, hence this situation is likely to rise the NAIRU. On the contrary, if productivity suddenly accelerates, it might take a while before workers fully acknowledge it and include the new productivity into their claims, hence allowing for a fall in the NAIRU. See Stiglitz (1997) or Ball and Mankiw (2002)

2.14. This mark-up depends on the level of capacity utilization[6] (Φ) and productivity $(y - l)$.

Two assumptions made in these equations are crucial to understand the differences between this model and LNJ's approach. First, the coefficients for productivity in equations 2.13 and 2.15, i.e. γ_3 and β_3, are not assumed to be equal, in contrast to what is assumed in equations 2.5 and 2.4. This means that workers are not necessarily able to fully absorb productivity gains, and amounts to drop the assumption that the economy operates under a Cobb-Douglas production function is dropped. The rationale to drop this assumption is that it seems "empirically doubtful" (Rowthorn, 1999, p.413, Sawyer, 2002,p.87).

Second, capacity utilization is assumed to fall not only when unemployment grows, but also when new capital stock is installed[7]. Hence, substituting capacity utilization Φ in equation 2.14 by unemployment and capital stock we can rewrite firms' price mark-up as a negative function of unemployment, capital stock and productivity as denoted by 2.15. The negative relationship between firms' mark-up and capital stock, captures the fact that more capital stock means more excess or idle capacity, which limits firms' ability to set their price mark-up, the same way unemployment limits workers ability to claim higher wages[8] (Rowthorn, 1995, p.29).

The model is completed with equations 2.16 and 2.17, which models investment and productivity. The former, describes investment (Δk) as a positive function of profitability (Π) and capacity utilization (Φ) (Rowthorn, 1999, p.422, Sawyer, 2002, p.89, Arestis and Sawyer, 2005, p. 965). The latter, models productivity growth $\Delta(y - l)$ as a positive function of output growth, here proxied by changes in capacity utilization ($\Delta\Phi$), reflecting the so called "Kaldor-Verdoon effects" (Storm and Naastepad, 2007, p.536, 2009, p. 314).

In this framework, inflation is treated as the result of conflict over income between workers and firms, hence at the level of unemployment where their claims are consistent, inflation remains constant, and therefore a Non-Accelerating Inflation Rate of Unemployment can be found. Graphically, as in LNJ, that is when workers wage claims curve and firms' mark-up schedule intersects. Mathematically, the NAIRU can be found by assuming that price expectations in 2.13 are fulfilled, i.e. $p = p^e$, and then equating 2.13 with 2.15 to solve for unemployment which yields equation 2.18.

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[6] Φ can be seen as an equivalent of $(y_d - \bar{y})$ in LNJ's model, see equation 2.1.

[7] This might be clearer if we write $\Phi = (y_d - \bar{y})$, unemployment lowers y_d, whereas new capital stock increases $\bar{y}$ in both cases increasing the gap.

[8] In the context of an open economy, it also noted that more capital stock would lead to better trade performance, which in turn would lead to higher real exchange rate reducing cost of imports.

According to 2.18, the NAIRU is determined by a number of factors, which are exogenous to aggregate demand as in LNJ's model; such as unemployment benefits B, and the exogenous mark-up over labour costs and prices, i.e. β_0 and γ_0. However, it is also determined by the gap between workers and firms claims over productivity gains, which reduces the NAIRU as long as workers are not able to fully reflect productivity gains in their wage claims, i.e. as long as $\gamma_3 < \beta_3$. Furthermore, the NAIRU is also determined by the size of capital stock, which also reduces it, reflecting the impact of new productive capacity to limit firms' ability to mark-up labour costs.

The influence of productivity and capital stock over the NAIRU are crucial because as per equations 2.16 and 2.17 capital stock and productivity are functions of the level of capacity utilization, that is, they are sensitive to the evolution of economic activity, and in turn make the NAIRU endogenous to it. It must be emphasized that these results follow from dropping LNJ's assumptions regarding workers ability to absorb productivity gains, and from rewriting capacity utilization as a function of unemployment and capital stock.

In this model, structural reforms of the type proposed by LNJ that tackle the exogenous factors that determine the NAIRU (B, β_0, γ_0) can reduce the NAIRU (Arestis and Sawyer, 2005, p.967). However, Sawyer (2002, p.79) points this might be unnecessary because for any level of those exogenous factors, the NAIRU can be "lifted" to full employment as long as sufficient capital stock is provided. In Figure 2.1, this means that for a given set of exogenous factors, the price-setting curve can always be shifted to the right, to intersect the wage-setting curve at the level of full employment. To build such stock, Sawyer (2002, p.88) and Arestis and Sawyer (2005, p.967) recommend the use of expansive policies, which ensure high levels of aggregate demand, and consequently high capacity utilization and profitability to encourage investment. Bean (1989) disagrees with this policy recommendation, and instead advocates for labour market reforms –in line with LNJ's suggestions- to increase firms profitability. We discuss this issue further on Chapter 11.

These possibilities are acknowledges in Layard et al. (1991, p.369) but it is the trended nature of productivity and capital stock that make these authors discard them. They argue that the lack of a similar trend in unemployment series makes impossible a relationship with trended variables such as productivity and capital stock. The same argument can also be found in Blanchard and Summers (1986, p.21 and 26), Krugman (1994, p.32) or Blanchard and Katz (1997, p.56). Rowthorn (1999, p.414) respond that unemployment is the difference between the labour force and employment, which are trended. Hence, Rowthorn argues, whenever the trend of capital stock differs from that of the labour force, there will be changes in unemployment, regardless of the latter not being trended. A similar argument is proposed by the Chain Reaction Theory, see for instance Karanassou et al. (2008a, p.983), who argues that all growth determinants, trended or not, spill over into the labour market and consequently have an influence on unemployment.

Further, Blanchard and Summers (1986, p.27) critiques the capital-NAIRU relationship based on the pre-WWII US experience. They argue that "The argument that reduced capital accumulation has an important effect on the level of unemployment is difficult to support with historical examples". Somehow paradoxically, Blanchard (2002, p.4) admits that rising cost of capital can deter investment, reducing future capital stock and potential output, which would translate into lower labour demand and a higher NAIRU. Bean (1989, p.34/35) re-examines the US WWII experience and argues that conclusions are subject to the measure of capital stock used. Further, Bean notes in the same article, that even if there was not a link between capital stock and unemployment in the US prior to WWII, it does not preclude such as link from existing in a different historical moment or in a different economy.

2.3.3 Cost of borrowing and firm's price mark-up

Finally, Rowthorn (1999, p.422) and Hein (2006) argue that cost of long term borrowing, in particular its real value, increases firms mark-up rising the threshold of unemployment at which firm's and workers' income claims are compatible, i.e. the NAIRU. Furthermore, they argue, insofar the central bank can modify their reference rate to affect the real long term rates monetary authorities can modify the NAIRU.

Our exposition of this version of the NAIRU is based on Hein's (2006) model, the rationale for this choice is that it makes comparison with LNJ's model easier. The following set of equations summarized this model:

2.19 $$w_b^r = \theta + \varepsilon z$$

2.20 $$e = z = 1 - u$$

2.21 $$p = (1+m)\frac{w}{y}$$

2.22 $$w_p^r = \frac{w}{p} = \frac{y}{1+m}$$

2.23 $$i = (1+m_i)i_{CB}$$

2.24 $$\Pi = \Pi^n + R = \Pi^n + iB$$

2.25 $$m = m(i) \qquad \text{where } \frac{\partial m}{\partial i} \geq 0$$

2.26 $$\Delta w_t = \Delta p_{t-1} + \Delta y_t + \varepsilon(z_t - z^*)$$

2.27 $$\Delta p_t = \Delta(1+m)_t + \Delta w_t - \Delta y_t$$

2.28 $$z^* = e^* = \frac{\frac{y}{1+m} - \theta}{\varepsilon} \qquad \text{where } \frac{\partial z^*}{\partial m} < 0$$

Where w_b^r represents workers' real wage target, θ is the exogenous component of wage demands, z stands for the level of capacity utilization, e stands for employment, u for unemployment, p represents prices set by firms, m is the mark-up of firms prices over unit labour costs, w is the nominal wages, y stands for labour productivity, i stands for the real long term interest rates, m_i stands for creditors mark-up over the reference interest rate set by the central bank, in turn denoted by i_{CB}, Π stands for the level of profits, Π^n is the level of retained earnings, R profits payable to creditors, B is the stock of long term credits granted to firms.

Equation 2.19 describes workers' wage claims. They bargain over nominal wages considering a real wage target denoted by w_b^r, and their claims increase with the level of capacity utilization z. For convenience employment and capacity utilization are considered to be equivalents, i.e. $z = e$, whereas employment is considered to change in one-to-one basis with unemployment (u), hence $e = 1 - u$ and $z = 1 - u$ (Hein, 2006, p.312). Equation 2.21 describes how firms' set prices as a mark-up over unit labour costs w/y, rearranging in terms of real wages, we obtain the real wage consistent with firms' mark-up, denoted by 2.22.

Firms fund their investment with profits and long term credits from households and/or financial institutions. As per equation 2.23 creditors set the long term interest rates at which they lend to firms (i) as a mark-up (m_i) over the Central's Bank reference rate (i_{CB}) (Hein, 2006, p.309). This equation plays a key role in this model, because it introduces monetary policy.

Equation 2.24 shows the use of profits (Π), a part remains within the firm and constitute retained earnings (Π^n), whereas another part goes to pay creditors (R), depending on interest rates (i) and stock of long term credit granted to firms (B). It can readily be seen from this equation that a rise in the cost of borrowing reduces available funds to invest, hence if firms wish to ensure their accumulation pace need to increase their mark-ups. This is denoted by equation 2.25 that describes firms' mark-up as positive function of real long term interest rates i.

Equations 2.26 and 2.27 describe wages (Δw_t) and prices inflation (Δw_t). The former, is determined by past inflation, reflecting that nominal wages are agreed before prices are set, productivity growth, and a parameter measuring how wages react when capacity increases or fall beyond z^*. Price inflation is determined by the change in the mark-up, wages inflation, and productivity growth.

Firms are assumed to set up prices after bargaining wages with workers, hence, the economy's real wage will be the level of real wages targeted by workers that is consistent with firms mark-up. Hence, equating 2.22 and 2.19 we can find the level of capacity utilization and employment, at which workers and firms' claims are compatible, denoted here by equation 2.28. e^* is the employment counter-part of the NAIRU, because as per equation 2.26 and 2.27 when employment grows beyond z^* or e^*, wage and price inflation accelerates, and vice versa. Only when the economy is operating at the z^* inflation does not accelerate, i.e. $\Delta p_t - \Delta p_{t-1} = 0$, indicating that productivity changes are properly anticipated by workers and firms, and the latter do not change their mark-up, i.e. $\Delta(1-m)_t = 0$.

According to 2.28, the NAIRU is determined by a number of factors, which are exogenous to aggregate demand as in LNJ's model; such as is the wage-push factors θ. However, it is also determined by long term costs of borrowing embedded in firms' mark-up m, which as denoted by 2.23 are determined as mark-up over central banks interest rate. The fact that long term costs of borrowing are determined as mark-up over central banks interest rate is crucial, because it means that the central bank can then use their reference rate to reduce the NAIRU.

In this model, structural reforms *a la* LNJ, tackling the exogenous factors that determine the NAIRU, can reduce the NAIRU. However, in the light of these results, Hein (2006, p. 323) concludes that central banks should aim at delivering low interest rates to reduce the NAIRU. Fitoussi and Phelps (1988, p. 27,57), Hian Teck and Phelps (1992), and Gianella et al. (2008) acknowledge that long term real interest rates can affect the NAIRU via firm's mark-up, but they do not see the link between these rates and monetary policy, in other words, they argue that equation 2.23 does not hold. Instead they argue, long term real interest rates are the result of commodity and stock markets evolution, along with governments fiscal position (Hian Teck and Phelps, 1992, p. 896, Gianella et al., 2008, p. 21). Although this position is controversial by its own merits, Blanchard (2002,p.2) argues: "There may be other interpretations, arguing that the evolution of real interest rates was the result of shifts in investment or saving, and had nothing to do with monetary policy. I have not seen a plausible account along those lines".

2.4 Caveats about the NAIRU's anchor properties

LNJ's characterization of the NAIRU is challenged on a second front. Some economists argue that there are reasons to doubt the anchor properties of the NAIRU and the mechanisms that are supposed to ensure such properties. In this section we review three mechanisms that can preclude the NAIRU from acting as an anchor, and other critiques to the mechanisms, which according to LNJ, ensure that the NAIRU act as an anchor.

2.4.1 Labour market hysteresis

The first mechanism that can preclude the NAIRU from acting as an anchor is hysteresis. As noted by 2.12, in the presence of hysteresis effects, past unemployment determines current values of the NAIRU. That means that when a shock occurs, unemployment does not necessarily return to the ex-ante NAIRU because the new level of unemployment might turn into the new NAIRU. Of course this depends on the degree of hysteresis, or differences in the pressure over wages that different groups of workers can exert, formally $\gamma_{11} - \gamma_1$. In the presence of full hysteresis, i.e. only workers fired recently exert pressure over wages $\gamma_1 = 0$. In this case, the NAIRU does not serve as an anchor for economic activity anymore, instead it changes every period depending on the level of past unemployment u_{t-1}. The smaller the difference between γ_{11} and γ_1, the less the influence of past unemployment over the NAIRU, and the stronger the attraction power of the NAIRU.

Advocates of LNJ's view, acknowledge the importance of dis-enfranchised workers for wage bargaining and the challenge it poses for their approach to the NAIRU (Nickell, 1998, p.806). However, they argue that only in the case of full hysteresis the NAIRU would cease to be an anchor for the economy, and this scenario, they claim, seems a highly unlikely case (Nickell, 1997). Instead, Layard et al. (1991, p.382) argue that hysteresis might delay the inflation or deflation tensions caused by deviations from the NAIRU to appear, giving the false impression after a shock that actual unemployment is closer to the NAIRU than it is in fact. Although eventually, they claim, tensions will appear pushing the economy towards the NAIRU. In other words, they suggest that due to hysteresis there might be some sort of short-run NAIRU, where inflation will be constant for some time after the shock, although eventually, the difference between the level of unemployment and the NAIRU will erupt triggering the inflation dynamics which will push the short-run NAIRU towards its long run counterpart.

2.4.2 The Chain Reaction Theory and "frictional growth"

Henry et al. (2000) and Karanassou et al. (2008b) argue that the NAIRU does not serve as an anchor for unemployment due to "frictional growth". This is a phenomenon that arises from the chain reaction, or interaction between lagged adjustment processes generated by shocks in the labour market system and growth factors. Thus, this approach is generally referred to as the Chain Reaction Theory (CRT).

These lagged adjustments are related to the interplay between labour costs and employment, wages and prices gradual adjustments, long-term unemployment and the labour force (Karanassou et al., 2008b, p. 376). The following equations are generally used to formalize this approach:

2.29 $l_t = \alpha_2 l_{t-1} + \beta_2 z_t$

2.30 $n_t = \alpha_1 n_{t-1} + \beta_1 k_t - \gamma w_t$

2.31 $w_t = \beta_3 x_{\mathrm{t}} - \delta u_{\mathrm{t}}$

2.32 $u_{\mathrm{t}} = l_t - n_t$

2.33 $u^{LR} = \zeta\left[\left(\frac{\beta_2}{1-\alpha_2} z^{LR} - \frac{\beta_1}{1-\alpha_1} k^{LR} + \frac{\beta_3}{1-\alpha_1} x^{LR}\right) + \frac{(\alpha_1-\alpha_2)\lambda}{(1-\alpha_1)(1-\alpha_2)}\right]$

Where l_t stands for the labour force in period t, z_t is the working age population, n_t represents the demand for labour, k_t is the capital stock, w_t is the real wage, x_{t} stands for exogenous wage-push factors, and u_{t} is the unemployment rate. The super-index ^{LR} denotes the long run level of all variables. All variables are in logs, except u.

Equation 2.29 stands for the labour supply (l_t) of the economy which depends on the size of working age population (z_t). Equation 2.30 denotes the labour demand (n_t) of the economy that depends on capital stock (k_t), and real wages (w_t). Equation 2.31 denotes real wages as a function of wage-push factors (x_{t}) and unemployment performance (u_{t}) of the economy. Equation 2.32 computes the unemployment rate (u_{t}) as the difference between the labour force (l_t) and demand for labour (n_t).

This system of equations depicts a labour market in which shocks to any of the exogenous variables z_t, k_t and x_{t} spills-over to the whole system. For instance, an increase in the working age will affect the labour force, but through 2.32 it also affects unemployment, and in turn as long as $\delta \neq 0$ also the real wage in 2.31. Similarly and increase in the capital stock increases labour demand, and thanks to 2.32 it reduces unemployment, which in turn affects real wages. Further, an increase in wage-push factors affects real wages, and in turns as long $\gamma \neq 0$ the labour demand in 2.30, which in turn affects unemployment.

These equations are then used to compute the NAIRU, denoted by the expression in the round bracket in equation 2.33. Finally, assuming that in the long run the growth rate of the labour force is equal to that of the labour demand, i.e. $\Delta l_t = \Delta n_t = \lambda$, the unemployment rate that the economy will experience in the long run is denoted by 2.33. It follows from this equation, that in the long run, unemployment is equal to the NAIRU plus a component determined by the lagged coefficients of the system (α_1, α_2) and the growth rate of the labour force and demand λ or "frictional growth" (Karanassou et al., 2008b, p. 380). Hence, in the long run unemployment differs from the NAIRU systematically due to the interplay of lagged effects and growth variables, i.e. frictional growth.

This mechanism differs from that of the hysteresis in that the NAIRU does not change as a result of shocks, it is instead the dynamic nature of the labour market what pushes unemployment away from the NAIRU. Henry et al. (2000,

p. 181) argue that in LNJ's approach the persistence of shocks is under-estimated, whereas the impact on exogenous components is over-rated in the hysteresis view. To this respect, they argue, the frictional growth approach presents a middle ground between LNJ's and the hysteresis approach.

2.4.3 Aggregate demand and income distribution

The third mechanism that can preclude the NAIRU from acting as an anchor is income distribution and its effect on the level of aggregate demand. Stockhammer (2004b) argues that changes in unemployment, such as deviations from the NAIRU, have knock on effects over distribution of income. Whether unemployment gravitates towards the NAIRU or not, Stockhammer argues, depends on how changes in distribution affect the overall level of aggregate demand. The following equations summarize these claims:

2.34 $$\Delta(1-\Pi_t) = \delta_1(u_t - u^*) \quad \delta_1 < 0$$

2.35 $$u_t = \delta_2(1-\Pi_{t-1})$$

Where $(1-\Pi_t)$ stands for the wage share over GDP in period t, u_t is the unemployment rate, and u^* represents the NAIRU. Equation 2.34 denotes a negative relationship between the changes in the wage share $\Delta(1-\Pi_t)$ and deviations from the NAIRU $(u_t - u^*)$, i.e. when unemployment fall below the NAIRU the wage share rises. Equation 2.35 captures the impact of distribution over economic activity, here measured by unemployment (u_t) for convenience. The sign of δ_2 is undetermined, and it illustrates the "profit" versus "wage-led" dichotomy proposed by Bhaduri and Marglin (1990). When $\delta_2 > 0$, a rise in the wage share leads to a rise in unemployment, or a contraction of aggregate demand, which is said to operate under a "profit-led regime". When $\delta_2 < 0$, a rise in the wage share reduces unemployment, or has an expansive effect over aggregate demand, which is said to operate under a "wage-led regime".

Stockhammer (2004b) show that when the economy operates under a "profit-led regime", the NAIRU act as an anchor, whereas it repels unemployment under a "wage-led regime": When unemployment falls below the NAIRU $(u_t - u^*) < 0$, as per equation 2.34 the wage share grows, if $\delta_2 > 0$, i.e. if the economy operates under a "profit-led regime", the rise in the wage share increases unemployment pushing it back towards the NAIRU, which arises as an anchor. Similar findings are also found in Rowthorn (1999, p.423). On the other hand, if $\delta_2 < 0$, i.e. if the economy operates under a "wage-led regime", the rise in the wage share reduces unemployment further below the NAIRU, which is now a repellent.

2.4.4 The "Real Balance Effect", interest rates and monetary policy rules

Finally, it has been argued that the mechanisms, which according to LNJ ensure that the NAIRU act as an anchor, do not operate. In the original formulation of LNJ's model, the anchor properties of the NAIRU depend on the "Real Balance

Effects", see equation 2.7. As per this mechanism, when the economy deviates from the NAIRU, inflation (de-)accelerates altering the real value of money balances in the economy in a way that pushes the economy back towards the NAIRU. This mechanism relies in modelling aggregate demand as a function of the quantity of the money, denoted by m in equation 2.7, which is exogenously determined by the central bank, in the fashion of the IS-LM model. However, this mechanism is at odds with the behaviour of modern Central Banks, at least in advanced economies, where monetary authorities set interest rates rather the quantity of money in the economy (Romer, 2000, Fontana, 2005). In fact, nowadays, advocates of LNJ's approach argue that anchor properties are delivered by the Central Bank in setting interest rates according to a Taylor Rule.

However, this claim has been subjected to a number of criticisms: Hein (2006), see also Hein and Stockhammer (2008), argues that the Central Bank can only ensure the NAIRU acts as an anchor under certain distributional conditions. Extending Stockhammer's (2004b) framework to introduce interest rates, they find that the NAIRU can only act as an anchor under a very specific set of conditions, however, these conditions constitute such a "special constellation" that it they are judged to be very unlikely[9] (Hein and Stockhammer, 2008, p.17).

Furthermore, Sawyer (2002, p.77) and Arestis and Sawyer (2005, p.965) argue that when Central Banks stabilize unemployment over the NAIRU –following a Taylor Rule- what corrects deviations from the NAIRU is a policy mechanism rather than an automatic market adjustment. This leads them to conclude that without such policy intervention the NAIRU is a "weak or (zero)" anchor for unemployment (Sawyer, 2002, p.77).

2.5 Summary of the theoretical review

This chapter has reviewed different views of the NAIRU. The model proposed by Layard, et al. (1991, Chapter 8) plays a central role in this literature, and it can be summarized with the following two propositions: The NAIRU is exclusively determined by structural features of the labour and goods market, which cannot be altered by demand policies. Further, the NAIRU serves as an anchor because the Central Bank sets interest rates following a Taylor Rule.

The policy implications that follow from this approach are straight forward. First, demand policies can only render short-lived or temporary unemployment reductions and consequently ought to be avoided. Second, the only way to achieve long lasting reductions of unemployment is to reform the structures of the labour and goods market that determine the NAIRU.

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[9] The derivation of these conditions requires an extension of the model presented in section 2.3.3 that would take us far afield, hence, on the interest of brevity we avoid it here, but refer the interested reader to the original paper.

However, our survey shows that this model is subject to a range of critiques that call into question its policy recommendations. We find that LNJ's model is challenged in two fronts:

First, it is questioned that the NAIRU is exclusively determined by exogenous factors. Blanchard and Summers (1986) claim that the NAIRU can be affected by unemployment history, which in turn is determined by past demand levels, hence, creating a link between the NAIRU and demand. Similarly, Sawyer (1982) and Rowthorn (1995) argue that productivity and capital stock determine the NAIRU, since these variables are sensitive to the evolution of economic activity, productivity and capital stock provide another two links between aggregate demand and the NAIRU. Further, Rowthorn (1999, p.422) and Hein (2006) claim that the NAIRU might also be affected by real long term interest rates, which these authors argue, can be affected by the Central Bank's policy, hence delivering a fourth link between the NAIRU and demand factors.

The second line of attack against LNJ's model is based on the claim that there are mechanisms that prevent the NAIRU from acting as an anchor, namely hysteresis, "frictional growth" (Henry et al., 2000) and income distribution (Hein and Stockhammer, 2008).

The policy implications that follow from these models are in striking contrast to those from LNJ's model. First, reforming the labour and goods market might bear no fruits because the NAIRU is unlikely to act as an anchor. Second, insofar past unemployment, productivity and capital stock are sensitive to the level of economic activity they provide three channels for demand policies to affect the NAIRU. Furthermore, in the case of real long term interest rates, insofar Central Banks can modify their reference rate to affect the cost of long term borrowing, monetary authorities can also modify the NAIRU.

These critiques have led to vivid controversies with exchanges of counter and counter-counter arguments, also reported in our survey, between the advocates of LNJ's approach and its critics, which last now three decades. Thus, it seems fair to conclude our review of theoretical NAIRU models, by stating that despite the endorsement of policy makers LNJ's propositions and its policy recommendations are far from uncontroversial.

Chapter 3 The NAIRU in the empirical literature

3.1 Introduction

Empirical efforts to clarify what are the determinants of the NAIRU, and whether it acts as an anchor for economic activity, have generated a large literature. The aim of this chapter is to review this literature, we structure our survey in two blocks according to the econometric techniques employed, namely panel data and time series.

It might seem surprising that a thesis that only provides time series evidence also reviews the panel data literature. However, given the importance of panel data studies in this field, our survey would seem incomplete without a section dedicated to this branch of literature. Our time series review, presents the literature's findings grouped by theory rather than per country, the interested reader can find these results grouped by country in the tables reported in Appendix I.

The rest of the chapter proceeds as follows: In section 3.2 we report evidence from panel data studies. We start with those that provide support to LNJ's claims, and then we review the critiques that have been brandished against them. Section 3.3 reviews time series evidence, starting with studies that provide support to LNJ's claims, and then studies that call into question these findings. Section 3.4 closes the chapter summarising the empirical controversies reviewed here.

3.2 Panel data studies

3.2.1 The case for a NAIRU *a la* LNJ in the panel data literature

We start by reviewing those panel data studies that yield support to the type of NAIRU proposed by LNJ. The evidence provided in Layard et al. (1991, Chapter 9) is one of the pioneering studies on this field. These authors employ a panel of 19 OECD countries from 1956 to 1988 and find that high unemployment is associated with unemployment benefits duration and unionized labour markets[10].

Scarpetta (1996) use a panel of seventeen OECD countries between 1983 and 1993, to regress unemployment on a number of structural variables and some macroeconomic variables, the latter are used to control for business cycle fluctuations. This author's findings suggest that unemployment benefits, union density and Employment Protection Legislation (EPL) are positively associated with high structural unemployment whereas coordination between workers and employers reduce it[11]. These results lead this author to conclude that

[10] For further details see Layard et al. (1991, p.428-430).

[11] This discussion refers to table 1 in Scarpetta (1996, p.58).

differences in unemployment across countries are due to differences in labour market institutions.

In another influential paper, Nickell (1997) employs a panel of twenty OECD countries from 1983 to 1994 divided into two cross-sections (1983-1988 and 1989-1994). The purpose of this manipulation is to remove cyclical fluctuations from the dataset and use the six years average of unemployment as a proxy of the NAIRU. This proxy is then regressed on a number of structural variables and the rate of change in inflation, the latter to control cyclical noise that might persist in the sample despite the data transformation. It is found that replacement rates, union density, union coverage, and total tax rate significantly increase the NAIRU, while Active Labour Market Policies (ALMP) and coordination reduce it[12].

A year later, Nickell (1998) extends his own analysis to include a variable for "owner's occupation rate", which measures the rate of owners living in their own homes and that aims to capture labour mobility. This new variable is found to be significant, and the rest of results are very similar[13]. In both cases, Nickell concludes that cross country differences in unemployment can be attributed to differences in labour market institutions.

Yet, another well-known example that concludes that different institutional settings can lead to differences in unemployment performance is Elmeskov et al. (1998). These authors use a panel of 19 OECD countries between 1983 and 1995 and use macroeconomic variables to control for business cycle fluctuations. It is found that unemployment benefits, EPL and the tax-wedge are positively associated with high unemployment while ALMP and coordination seem to reduce it[14].

In finding evidence that differences in unemployment performance are associated with differences in institutional settings, these studies are generally thought to yield support to LNJ's propositions. The short-coming of this evidence is that it only explains cross country differences, but it tells us little about how unemployment evolves over time (Nickell, 1998,p.814). This has led some to argue that a different explanation might be needed for that purpose, not necessarily along the lines of LNJ's model (Blanchard and Wolfers, 2000), we discuss this possibility in section 3.2.4.

The advocates of LNJ's approach have reacted to this critique by using dynamic panels, which allow them to explain not only differences in structural unemployment but also its evolution. We continue our review of panel data

[12] This discussion refers to regression 1 in Nickell (1997, p. 64).
[13] This draws from regression 1 in Nickell (1998,p.813).
[14] This discussion refers to Table 2 in Elmeskov et al. (1998,p.216).

studies, which provide supportive evidence of the NAIRU *a la* LNJ, reporting the evidence from dynamics panels.

An early example of dynamic panel can be found in IMF (2003). This article employs a dynamic panel data of 20 OECD countries between 1960 and 1998, to regress unemployment against institutional variables, macroeconomic variables that control for cyclical fluctuations and the lag of the unemployment rate to generate a dynamic panel. It is found that EPL, union density and tax-wedge increase unemployment while bargaining coordination, and interactions of union density with employment protection legislation and tax-wedge reduce it[15]. These results suggest, not only that differences in unemployment are associated with differences in institutions, but also that the evolution of unemployment is influenced by these exogenous factors.

Similarly, Nickell et al. (2005) employ a dynamic panel data of 20 OECD countries between 1961 and 1995, to regress unemployment against institutional variables, control macroeconomic variables and the lag of the unemployment rate. Results suggest that unemployment benefits replacement rate, benefits duration, the interaction of the last two, union density and labour taxation, increase unemployment, while coordination and its interaction with some of the other institutions reduce it. These findings are reinforced by the results of the Maddala and Wu Cointegration test reported in page 14 of this article, which confirms that institutions can explain long run unemployment development. Authors conclude that evidence supports claim that not only the NAIRU is determined by structural factors, but also its evolution.

Gianella et al. (2008) regress the change in OECD's NAIRU estimates, which they update in the same paper using a Kalman filter, on several wage and price push factors, finding that Product Market Regulation (PMR), tax-wedge, user cost of capital, union density and replacement rates have a significant positive influence on changes in the NAIRU. A second specification is also estimated for its level, with similar results, with the exception of the PMR that becomes insignificant[16].

Bassanini and Duval (2009) use a panel of 20 OECD countries between 1982 and 2003 and macroeconomic variables to control for business cycle fluctuations. They find that replacement rates (gross and net), tax-wedge, and PMR are associated with high unemployment, while corporatism reduces it[17]. Further, they find that interactions of institutions with an overall measure of institutions, is also significant in explaining unemployment differences. These suggest that unemployment differences are notoriously associated to

[15] This draws from "variant (3)" in IMF (2003,p.147).
[16] This discussion refers to column 3 (authors preferred specification) and column 4 of Gianella et al. (2008,p.24).
[17] This discussion refers to Table 1 in Bassanini and Duval (2009,p.43).

institutions heterogeneity but also that reforming institutions have complementary effects. Furthermore, they find a correlation of 96% between actual change in unemployment and that predicted by their model with interactions, which lead them to conclude that a model with such interactions can also explain unemployment's evolution.

The panel data studies reviewed in this section are so widely cited to vindicate LNJ's approach to the NAIRU, and to justify its policy recommendations, see for instance OECD (2006c, Chapter 3), that they have become the cornerstone of the empirical case for the NAIRU *a la* LNJ.

3.2.2 Data quality and panel methods caveats

This evidence has, however, left some researchers unconvinced. In this section, we review their concerns regarding data quality and methodology. Blanchard and Wolfers (2000) and Baker et al. (2007) question the reliability of studies published in the 1990s due to data quality issues. They note that time series for most of the so called labour market institutions did not exist, or were poorly recorded until the mid-1990s, and consequently researchers had to create indicators for them. This, they claim, raises questions about the degree of interaction between data and the researcher who creates indicators to evaluate a phenomenon *ex-facto*. This is more worrying, they emphasise, when we consider that some of these researchers, such as Layard and Nickell, were at the same time the proponents of some of the theoretical models under test (Blanchard and Wolfers, 2000, c22, Baker et al., 2007,p.10).

Following the publication of OECD's Job Strategy (1994) substantial efforts have been devoted to improve data quality and to produce more reliable measures of labour market institutions. However, this has reinforced caveats about data quality used during the 1990s. The reason been that the strength of evidence supporting LNJ's approach seems to have weaken as quality of data has improved (Baker et al., 2007,p.13).

Furthermore, Baker et al. (2007) also argue that in spite of efforts to improve data quality, there remain idiosyncratic measurement issues that raise questions not only about the validity of results but also about the validity of panel data techniques. A particularly worrisome case is the unemployment rate used as dependant variable in many studies. These authors argue that despite the adoption, in the early 1990s, of ILO definition for unemployment by most OECD countries, comparability of unemployment rates is still "elusive". First, because this definition is still subject to local social norms about what constitutes "active job search" and "being employed", which these authors claim might be different across countries. Second, because OECD's databases, the usual source of data in these studies, only provides standardised unemployment rates since 1980, and only for nine member states. The rest of series are completed by linking standardised series (based on surveyed unemployment) with registered unemployment series. These, Baker et al. claim pose questions to whether unemployment rates from 19 or 20 OECD countries can be pooled alongside in a panel without causing measurement problems.

Another methodological critique to the use of panel data is that in some articles, the coefficients for the explanatory variables are significantly different across countries country to country, i.e. the assumption of homogenous coefficients across the panel does not hold. Let's cite some examples: Stockhammer (2004a) in a study for France, Germany, Italy, UK and the USA, find no evidence of poolability of the coefficient for the replacement rate (in a regression on unemployment), neither for the coefficient of changes in union density (in a regression on employment growth).

Similarly, Arestis et al. (2007) with a sample of nine EMU member states, find no evidence of parameter stability across countries using Chow *F*-test and VEC residual heteroscedasticity tests. Further, Gianella et al. (2008) reject the null of equality of coefficients across countries using a Wald test for a panel of 19 OECD countries. As a result, they also provide country specific estimations, which reveal that coefficients' magnitude, significance and lag structure for each explanatory variable are substantially different from country to country, this time series evidence is discussed in section 3.3.

It must also be noted that in other panel data studies evidence suggests that there are no significant cross-country difference, see for instance Nickell et al. (2005,p. 14) and Bassanini and Duval (2009,p.44).

3.2.3 Robustness concerns

Another common caveat regarding the panel data studies presented in section 3.2.1 is that their findings do not seem to be robust to changes in the sample size, model specification, or across studies.

Blanchard and Wolfers (2000) use a panel of twenty OECD countries from 1960 to 1995, which they divide into eight cross-sections. In their initial estimations, with unobservable shocks to time invariant institutions, seven out of eight institutional variables have the expected sign and appear to be significant, in line with previous literature. However, once shocks are specified and alternative measures of institutions are introduced results for institutions change drastically. Using alternative employment protection measures, only five institutional variables remain significant, while using alternative unemployment benefits measures, only the coordination index remains significant[18].

Baker et al. (2005) replicates Nickell's (1997) study using different specifications. They find that considering five, rather than six, year's average

[18] This discussion refers to Table 6 in Blanchard and Wolfers (2000, p.31).

and dropping the observations for 1983 and 1984 from the dataset, only one variable is significant, in clear contrast to the original paper where seven out of eight variables are found significant. Furthermore, these authors enlarge the sample size to cover the period from 1960 to 1999, and add interactions between institutions, such as Replacement rate and duration of benefits, union density and coordination, and tax-wedge and coordination. In this case the seven variables, which are found significant in the original paper, become insignificant or change their sign. These are only their most notorious findings, for further details see Baker et al. (2005, p.53).

Lack of robustness is also illustrated by differences between studies, Baker et al. (2007,p.24) compare 10 panel data studies that examine the relationship between unemployment and up to eight labour market institutions. Only four of these variables are used in all 10 panel data studies; namely EPL, unemployment benefits, union density coordination and taxation. All of them are insignificant or wrongly signed in four or more papers. The only variable that is found to be significant and with the expected sign in all the studies is unemployment benefits duration, but this variable is only considered in three papers. This lack of robustness is more puzzling if we note that most of these studies tend to have similar geographical scope, generally a panel of 20 OECD countries, and use very similar data sources, generally OECD databases.

The advocates of LNJ's approach acknowledge these critiques, for instance Bassanini and Duval (2009,p.40) note that "There is no or limited consensus on the quantitative impact of institutions on unemployment, which has led some to question the case for structural reforms". Yet, they attribute these robustness problems to data limitations and the difficulties in measuring key variables, rather than to weaknesses of the empirical case for LNJ's approach (Nickell, 1998,p.815, Heckman, 2007). Similarly, OECD's (2006c, p.59-107) survey of the literature, acknowledges that evidence might be unclear with regard the influence of some labour market variables, such as union density, bargain coverage, minimum wages or EPL. But, the OECD's survey concludes, "overall" panel data evidence is supportive of a positive link between unemployment and the following variables: replacement rates, labour taxation and PMR[19]. This evidence, the authors of the survey claim, vindicates LNJ's approach.

3.2.4 Misspecification claims and the aggregate demand-NAIRU link in the panel data literature

Ball (1999,p. 213) and Blanchard and Wolfers (2000,c1/2) find a rather different culprit for robustness problems. These authors argue that robustness problems are not the result of data limitations, but instead of omitting relevant variables, in particular aggregate demand or macroeconomic variables that interact with the design of labour market institutions.

[19] And a negative link between ALMP and coordination with unemployment.

These authors note that institutions, which explain unemployment's cross-country differences, already existed in the 1960s when unemployment was low and similar across countries. Furthermore, they claim that these institutions have not changed substantially since then. This leads them to argue that these institutions cannot explain the evolution of unemployment by themselves. On the other hand, they note that shocks occurred in the 1970s and 1980s can explain the rise in unemployment, but not its cross-country differences because similar shocks hit most advanced economies during this period. Consequently, they conclude, to explain unemployment differences across countries and overtime, some form of interaction between shocks and labour market institutions is needed. We referred to this possibility in Chapter 2 as the labour market hysteresis hypothesis.

Ball (1999) use a panel data of 20 OECD countries during the 1980s to evaluate this hypothesis. Ball regress a ratio of changes in the NAIRU over changes in unemployment on unemployment benefits duration and a measure of monetary easing. This ratio is significantly increased by the duration of unemployment benefits and reduced by monetary easing. These findings, suggest that the proportion of a shock which filters into the NAIRU, measured here by the ratio used as dependent variable, interacts with labour market institution, benefits duration in particular, although monetary policy can be used as counter-weight.

Blanchard and Wolfers (2000), as discussed in the previous section, use a panel of 20 OECD countries from 1960 to 1995 divided into eight cross-sections. Initial estimations, with unobservable shocks to time invariant institutions, are in line with panel data literature that yields support to LNJ's claims. However, once shocks are specified[20] and alternative measures of institutions are introduced, results for institutions collapse, illustrating the robustness problems highlighted in the previous section[21]. On the other, it shows that shocks, and particularly some of their interactions with institutions, seem to provide a good account of cross-country differences and also of the evolution of unemployment overtime. These findings suggest that labour market institutions cannot explain changes in unemployment by themselves. Instead, these results suggest that it is the interaction between labour market institutions and shocks that explains both, cross-country differences and unemployment's evolution.

As we have discussed above, this criticism has propitiated the use of dynamic panel data, which has successfully found a link between unemployment dynamics and labour market institutions. Comparison between these two branches of the literature remains elusive because, these dynamic panels do

[20] As productivity growth, real interest rates, and labour demand shocks.
[21] This discussion refers to Table 6 in Blanchard and Wolfers (2000, p.31).

not consider interactions between shocks and institutions. An exception can be found in Nickell et al. (2005, p.21) where time dummies interacted with institutions are added to their model baseline, which we have already reported above. These authors find that none these interacted variables are significant and they conclude "make no contribution to the overall rise in unemployment".

However, it must be noted that Blanchard and Wolfers' preferred specification is based on interactions of institutions with productivity growth, real interest rates, and labour demand shocks, rather than unobservable shocks or time dummies interacted with institutions. Hence, Nickell's et al. attempt is still insufficient to counter this critique.

Storm and Naastepad (2009,p.313) go one step further, and argue that potential omitted variable(s) are not some form of interaction between macroeconomic shocks and labour market institutions, but rather demand variables such as capital stock, productivity, and real interest rates. They ground their claim in the evidence provided by the following panel data studies:

Rowthorn (1995) and Alexiou and Pitelis (2003) provide evidence of a link between unemployment and capital stock. The former finds that for a panel of 10 OECD countries, between 1960 and 1992, one percent increase in capital stock in manufacturing and services increases overall employment by 0.52%. The later, using a panel data for 12 European countries for the period between 1961 and 1998, find that increases in the capital stock of one percent reduce unemployment by 0.5%.

Rowthorn (1999) provides further evidence of the link between capital stock and the NAIRU by assessing the proposition that capital and labour are perfect substitutes, or that elasticity of substitution between capital and labour is equal to unity. First, the author surveys 33 empirical studies with evidence for the elasticity of substitution between capital stock and labour, or that provide information from which it could be computed. The median of these estimated elasticities is 0.58, and only seven out of 33 are above 0.8.

Second, using the results from the elasticity of labour demand to real wages for 19 OECD countries from three well known previous papers (Newell and Simons, 1985, Bean et al., 1986, Layard et al., 1991, appendix to Chapter 9) calculates the capital to labour elasticity of substitution[22]. Only nine out of 52 elasticities are greater than 0.5, and only five are greater than 0.8. These results

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[22] The following formula is used: $\sigma = \frac{\epsilon(s-\frac{1}{\eta})}{(1-\frac{1}{\eta})} \leq \epsilon s$ where σ is the capital to labour ratio, ϵ is the elasticity of labour demand to real wages, s is the profit share over output, and η is the price elasticity of demand facing the individual firm, (Rowthorn, 1999, p.415)

suggest that capital and labour are far from substitutes and that increases in capital stock and productivity would result in lower unemployment.

Similarly, Storm and Naastepad (2007) and Storm and Naastepad (2009) assess the impact on real wages growth of productivity gains, for a panel of twenty OECD countries, and find that labour to capital elasticity of substitution is between 0.56 and 0.70, and significantly different from unity.

Storm and Naastepad (2007) assess the impact of productivity on the NAIRU. They use a panel data for 20 OECD countries covering the period 1984-1997, and estimate the structural equations of a NAIRU model described by a productivity regime, an aggregate demand function, and a real wage growth equation. They find that expansive aggregate demand policies and protective employment legislation (EPL) increase productivity. Further, their real wage equation suggests that this productivity gains are not fully absorbed by workers, and consequently productivity gains reduce the NAIRU. These findings lead Storm and Naastepad to argue that the NAIRU can be reduced either enhancing productivity with more protective EPL, or alternatively stimulating demand. Solving the estimated equations for unemployment to obtain a NAIRU reduced form expression, they find that 1% increase in exports, investment growth or EPL will reduce the NAIRU by 1.21%, 2.56%, and 1.51% respectively, while 1% increase in real interest increase it by 0.13%.

In a later paper Storm and Naastepad (2009), extend the sample period to 2004, and consider a new variable, to measure Labour Market Regulation (LMR). This variable is created by the authors applying factor analysis to seven indicators of the labour market. Their findings are very similar to those of their previous study, first, expansive aggregate demand policies and more protective EPL and LMR increase productivity. Second, their real wage equation suggests that this productivity gains are not fully absorbed by workers, and as a result, productivity gains reduce the NAIRU. Hence, these results confirm their earlier findings that enhancing productivity with more protective EPL and LMR, or alternatively stimulating demand, can reduce the NAIRU. The specific NAIRU estimates imply that 1% increase in exports, government deficits, EPL or LMR reduces the NAIRU by 0.77%, 0.15%, 0.92% and 0.92% respectively, while 1% increase in real interest increase the NAIRU by 0.25%.

Stockhammer and Klar (2008), later reprinted in Stockhammer and Klar (2011), provide further evidence of the influence of capital accumulation and real interest rates. These authors employ two datasets, the first is the OECD data set employed by Bassanini and Duval (2006), which contains data for 20 countries over the 1970-2003 period. The second, is Baker's et al. (2005) data set covering the period 1960 and 1999. They take five years averages of all variables to remove cyclical fluctuations from the dataset and to use the five years average of unemployment as a proxy for the NAIRU. Their findings suggest that union density, collective bargaining coverage (CBC), EPL, and crucially, also real interest rates and capital accumulation have significant impact on unemployment[23].

Stockhammer and Sturn (2008), later reprinted in Stockhammer and Sturn (2012), provide further evidence of the NAIRU's link with interest rates. The authors, re-assess the evidence that labour market institutions and shocks interact by extending Ball's (1999) empirical exercise with data up to the 2000s and considering nine labour market institutions, rather than just unemployment benefits duration. As in Ball's study, the proportion of changes in unemployment that filters into the NAIRU is significantly reduced by monetary easing, but interestingly, no institution seems to have a significant impact. Hence, these results suggest that there is no interaction between institutions and monetary easing, but rather a direct impact of monetary policy on the NAIRU.

Evidence from the panel data studies surveyed in this section suggests that interactions of aggregate demand with labour market institutions and demand factors *per se*, variables such as capital stock, productivity, and real interest rates have a significant influence on the NAIRU. Thus, these findings vindicate Storm and Naastepad (2009,p.313) claim that panel data studies reported in section 3.2.1 are misspecified.

3.3 Time series studies

3.3.1 The case for a NAIRU *a la* LNJ, in the times series literature

We turn now to the time series literature, and we start by reviewing those time series studies that yield support to LNJ's approach to the NAIRU.

Layard and Nickell (1986) pioneering paper on British unemployment, proposes an estimation strategy that has been widely employed in the literature: They estimate the structural equations of a NAIRU model, which in their case includes a labour demand, a real wages equation, a price mark-up and a trade balance equation[24]. And then solve the estimated equations for unemployment to obtain a NAIRU expression. Their results suggest that the NAIRU is exclusively determined by structural factors. First, they find that the labour demand is neutral to capital stock and productivity in the long run, i.e. neither productivity nor capital stock affect the NAIRU. Further, solving the system of estimated equations for unemployment, it is found that replacements

[23] It is noted that CBC and EPL have unexpected signs. This discussion refers to specification number 3 and 6 in pages 14 and 16 respectively, which are the authors preferred specification for each dataset.

[24] As we will see below, sometimes the labour demand and external balance are not considered. In other occasions labour demand and price mark-up equations are considered as equivalent. For further details, see Bean (1994)

rates, labour taxation, unions' power, and mismatch all increase the NAIRU, while an income policy dummy for 1976 and 1977 reduces it.

Dolado et al. (1986) applies the same strategy to the Spanish case. Their estimates for the labour demand suggest that there is long run neutrality of employment to capital stock, but not to productivity, although this has a perverse influence on the NAIRU. Further, solving the system of estimated equations for unemployment, they find that taxation, replacement rates, firing costs, unions' power and mismatch have a positive and significant effect over the NAIRU.

Layard et al. (1991, p.441) updates their 1986's work, and again find that the NAIRU is determined by exogenous factors, such as replacements rates, labour taxation, unions' power, and mismatch all increase the NAIRU. In a later study, Nickell and Bell (1995) proposes a second estimation strategy that has also proven very popular. These authors estimate a reduced form of the NAIRU model for the UK, in this case described as a function of exogenous variables. Two specifications are estimated, the first is obtained using Johansen's identification procedure of cointegrated vectors, and it suggests that there is a long run relationship between unemployment and the following variables; the tax-wedge, replacement rates, union power, skills and terms of trade.

The second set of estimates is obtained by extracting the long run solution from a dynamic model containing the same variables. In this case, evidence suggests that unemployment has a significant and positive long run relationship with replacement rates, skills and terms of trade but not with the tax-wedge, union's power and industrial dispute.

Nickell (1998, p.814) extends the paper co-authored with Bell by considering real short-term interest rates in the analysis. It is found that unemployment has a significant long run relationship with skills, terms of trade, the tax-wedge, union's power and interest rates, but there is no evidence of such a relationship with replacement rates and industrial dispute. Further, it is worth mentioning that the influence of interest rates is downplayed because, according to this author, interest rates seem to have a small contribution to the long run developments.

Estrada et al. (2000) estimates a price mark up and a real wage equation for the Spanish economy and find significant evidence of a positive link between the NAIRU and the following variables; direct taxation, replacement rates and union bargaining power. The estimates of each of these variables suggest that the NAIRU is most sensitive to changes in taxation[25].

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[25] This discussion refers to the authors' preferred specification, i.e. estimates for the private sector specification. Their results for the whole economy are very similar.

Gianella et al. (2008,p.27-28) provide country specific estimates of their NAIRU regressions using SUR methods for nineteen OECD countries. Their findings suggests that there is significant evidence of links between changes in unemployment and exogenous variables, such as the tax-wedge, replacement rates, and PMR, which are found to be significant in 14 out of the 19 cases, and Union density, which is found to be significant in 11 economies. However, authors acknowledge that coefficients' magnitude, their significance and the lag structure for each explanatory variable are substantially different from country to country: For instance, for Germany union density and PMR are not significant at all, the same happens for Denmark when it comes to the tax-wedge and benefits, or for the union density in France, the Netherlands, or the UK. For Portugal only one of the lags for union density is significant. Interestingly, real long-term interest rates is the variable that is found significant in most cases, in seventeen of the nineteen regressions (all except Portugal and Japan), although this is interpreted as a signal of the importance of exogenous cost of borrowing rather than the outcome of monetary policy.

The importance of the findings reported in this section, resides in the fact that structures of the labour and goods market, proxied by labour market institutions and product market regulations, can explain long run unemployment developments, or changes in the NAIRU over time. Consequently, these results vindicate LNJ's approach to the NAIRU. Layard et al. (1991, p.443) and Nickell (1998, p.814) argue that these findings, along with panel data studies that explain unemployment differences across countries, as a result of differences in institutions, present a complete case in favour of LNJ's claims. Furthermore, they use this evidence to respond to Blanchard's and Ball's criticism, reported above, that labour market institutions cannot explain the rise in the NAIRU in the 1980s, because these exogenous factors already existed in the 1960s when unemployment was low and similar across countries.

3.3.2 The aggregate demand-NAIRU link in the time series literature

However, claims that time series are supportive of a NAIRU *a la* LNJ, discussed in the previous section, are challenged by a growing literature that finds evidence of significant links between the NAIRU and demand factors. These variables include different measures of labour market hysteresis, capital stock, productivity and real interest rates. In this section we survey this evidence grouped in four subsections depending on the demand-NAIRU link they examine.

3.3.2.1 Labour market hysteresis

We start by reviewing times series papers that study the potential link between the NAIRU and hysteresis. Finding a variable that measures this phenomenon is troublesome and different alternatives have been applied. A popular approach is to use long term unemployment as a proxy for hysteresis, these are some examples of this strategy:

Arestis and Biefang-Frisancho Mariscal (1998, 2000) find long term unemployment cointegrated with unemployment in the UK and interpret this finding as hysteresis affecting the NAIRU. The latter article also provides evidence for Germany, although in this case unemployment and long term unemployment do not seem to be cointegrated. Arestis et al. (2007) follow the same strategy to proxy hysteresis in nine EMU countries. They only find unemployment and long term unemployment cointegrated in Belgium and Austria, in the rest of cases (Germany, France, Italy, Finland, Ireland, Spain and the Netherlands) there is no supportive evidence of such long run relationship.

Logeay and Tober (2006) also use long term unemployment to measure hysteresis, although in this paper a Kalman-filter is used rather than cointegration. Contrary to some of the results provided by Arestis and his co-authors, results from this article suggest that long term unemployment affects the NAIRU in Germany. More precisely it would explain 37% of the NAIRU's change between 1974 and 2002.

Lagged (un-)employment is another popular proxy for hysteresis. Some recent examples of this can be found in Stockhammer (2004a), who finds persistence of unemployment in Germany, France, Italy, the UK and USA. Karanassou et al. (2008a) who find significant persistence of employment in Sweden, Finland and Denmark. Karanassou and Sala (2008) who find persistence of employment in Spain. And Logeay and Tober (2006) who find that past unemployment explains 31% of the NAIRU's change in the EMU during the period 1974-2002.

Others authors have employed structural VAR (SVAR) models and impulse response (IR) functions to examine the hysteresis hypothesis. The usefulness of these techniques resides in the fact that, they allows the research to simulate different shocks and examine how lasting are their effects over unemployment. If the economy suffers of hysteresis the effects of these shocks should be long lasting. Dolado and Jimeno (1997) applies these techniques to the Spanish case finding that rises in demand reduces unemployment permanently, whereas wages, prices, productivity and labour supply shocks increase unemployment, also permanently. This evidence leads them to conclude that persistence of unemployment in Spain is due to hysteresis effects.

We are cautious of this interpretation, because no evidence is provided showing that permanent effects are due to the interaction between shocks and labour market institutions. In fact, somehow contradictorily, the results from simulating a labour supply shock shows that more labour participation leads to greater unemployment, the contrary that one would expect if the economy was subject to hysteresis effects.

Hansen and Warne (2001) also use IR functions to study the impact of labour supply shocks to unemployment in Denmark. These authors find that greater labour participation leads to permanent lower unemployment, which suggest that some form of hysteresis might operate in the Danish labour market.

Another popular approach to test the hysteresis hypothesis is to apply unit root and stationarity tests to unemployment series. The rationale is that under hysteresis unemployment would exhibit a unit root or behave like a random walk. Whereas, unemployment would be stationary or mean reverting if there was a NAIRU *a la* LNJ. Romero-Avila and Usabiaga (2008) and Fosten and Ghoshray (2011) present some recent reviews of this literature. The overall conclusion is that results are mixed and sensitive to the inclusion of structural breaks and sample period studied.

However, we are wary of this approach because these tests only provide information about unemployment's behaviour, but they tell us nothing about the factors that propitiate such behaviour. On the one hand, this is means that we cannot differentiate between different demand-NAIRU nexus. On the other, as noted by Logeay and Tober (2006), these can be misleading, because if the sample under study contains changes in the exogenous factors that are supposed to determine the NAIRU, unemployment is likely to have a unit root, which might be erroneously interpreted as a sign of hysteresis.

3.3.2.2 Capital stock

The possible link between capital stock and the NAIRU has received a great deal of attention. Two estimation strategies seem to predominate in this branch of the literature, the first strategy, was pioneered by Arestis and Biefang-Frisancho Mariscal (1998). These authors use cointegration analysis to estimate the reduced form equations of a NAIRU model, that is, the unemployment and real wages long run equilibria. Their findings suggest that unemployment has a long run negative relationship with capital stock, i.e. they appear to be cointegrated, which lead these authors to conclude that capital stock affects the NAIRU, more precisely reduces it. Furthermore, they also find evidence of long term unemployment and capital stock been cointegrated, which reinforces the role of capital stock in determining labour market outcomes.

Arestis and Biefang-Frisancho Mariscal (2000) update their previous study of the UK and extends the analysis to the German economy. The results for the UK confirm the negative influence of capital stock over the NAIRU, a link that also appears to be significant in the case of Germany. Arestis et al. (2007) apply the same methodology to nine EMU Member States (Austria, Belgium Germany, Finland, France, Ireland, Italy, the Netherlands and Spain). In all cases, evidence is supportive of a long run negative relationship between unemployment and capital stock, although its magnitude differs across countries. Similar conclusions arise from Palacio et al. (2006) study using data for the USA, where it is found that capacity utilization and capital stock (to output ratio) are negatively cointegrated with the NAIRU.

The second popular approach to assess the capital stock-NAIRU link, uses autoregressive distributed lag (ARDL) techniques to model the dynamics between the labour market and capital stock, from which the researcher can then calculate the long run elasticity of employment to capital stock. Miaouli (2001) use this strategy to study the cases of France, Greece, Italy, Portugal and Spain with data for the period between 1970 and 1995. The author estimates two equations; a labour demand with capital stock among the independent variables, and capital stock function. In all four countries, Miaouli finds a positive and significant long run relationship between employment and capital stock, with elasticities ranging from 0.48 in the case of Italy to 1.70 in the case of France.

Similarly, Karanassou et al. (2008a) uses an ARDL 3SLS to study the capital stock-employment link in Denmark, Finland and Sweden. They estimate three equations, first, a labour demand as a function of capital stock among other independent variables, second, a wage equation, and third a labour supply. They find the long run elasticity of employment with respect to capital stock to be equal to 0.6% in Denmark, 0.8% in Finland and 0.7% in Sweden.

The importance of capital stock for employment in these countries is further highlighted by identifying changes in the investment regime using a Kernel density function. The means of these regimes are then used to carry counterfactual simulations: They find that investment slowdown explains 15-30% of Danish unemployment between 1970 and 2005, 50% of the rise in unemployment in Sweden between 1991 and 1997. And in the Finnish case, they find that had investment kept its pace in the late 1990s, unemployment would have been five points lower.

Karanassou and Sala (2008) applies the same approach for Spain, with annual data for the period 1972-2005. Results for the labour demand show a positive and significant long run relationship between capital stock and employment. Further, the Kernel density function exercise finds that Spain suffered a permanent shock in investment during the mid-1970s. According to authors calculations had this shock been reverted, unemployment would have been about seven points lower from 1978 onwards. The importance of capital stock is further illustrated by simulating counterfactual shocks to social security benefits, indirect taxation, financial wealth, foreign demand and capital accumulation. From this simulation, capital stock is the variable with a greater impact on unemployment.

Other estimation strategies can be found in the following articles: Ballabriga et al. (1993) estimate the level of employment consistent with the installed productive capacity and labour demand in Spain for the period between 1968 and 1988. These estimates are then compared, against the size of the labour force and actual employment to examine whether unemployment is the result of demand or productive capacity constraints. They find that between 1966 and 1975, and from 1985 to the end of the sample, capital stock was a constraint for employment. Stockhammer (2004a) uses a Seemingly Unrelated Regression (SUR) approach, to estimate unemployment and employment growth as a function of labour market institutions and accumulation in Germany, France, Italy, UK and the USA. In all cases, evidence suggests that capital accumulation reduces unemployment and accelerates employment growth, but it is in the UK case that the impact seems to be the greatest.

Finally, we acknowledge that earlier evidence for France and the Netherlands can also be found in Malinvaud (1986) and Driehuis (1986) respectively, although these findings should be taken with caution because time series techniques were underdeveloped in the 1980s these results might not be as reliable as the rest of the evidence discussed in this section.

3.3.2.3 Productivity

Several approaches have been proposed to examine the link between productivity and the NAIRU. A popular strategy is to follow the approach proposed by Layard and Nickell (1986) and estimate the structural equations of a NAIRU model, we have discussed this strategy in section 3.3.1. Using this approach Layard and Nickell (1986) find no evidence of a productivity-NAIRU link. However, the contrary is found in a number of articles that we review in the following.

Modigliani et al. (1986) and Dolado et al. (1986) find a perverse (positive) long run effect of technical change over unemployment, in Italy and Spain respectively. Results for Spain have raised some controversy, because in a latter study Ballabriga et al. (1993) find that the effect of productivity over real wages is smaller than that over prices mark-up suggesting that the impact of productivity over the NAIRU is negative.

Similarly, L'Horty and Rault (2003) estimate a price mark-up and real wage equation for France, and then solve for unemployment, finding that productivity reduces the NAIRU significantly. Hatton (2007) estimates a wage inflation equation and a labour demand equation in terms of unemployment[26] for the UK, and then solves to obtain a NAIRU expression. To illustrate the

[26] This is equivalent to use a price mark-up equation as showed in Bean (1994)

importance of productivity, the NAIRU is calculated under different productivity growth regimes, which show that higher productivity growth, generate lower NAIRU values. For instance, it is shown that had productivity grown at the average rate of the Golden Age during 1974-99, the NAIRU would have been halved. This is in contrast to earlier findings for the UK reported above.

Nymoen and Rødseth (2003) estimate wage equations for Denmark, Finland, Norway and Sweden under the assumption that in the long run labour demand is horizontal and then solve for unemployment. They find significant evidence of the influence of productivity over the NAIRU in Finland, Sweden and Norway, but not in Denmark.

The counterpart of this strategy, i.e. estimating a reduced form equation, is less used to study the productivity-NAIRU link. Nevertheless, a recent example can be found in Schreiber (2012). This author identifies an unemployment cointegrated vector for Germany, France and Italy, and finds unemployment and productivity are cointegrated in all the cases except for Italy.

Another popular strategy is to use impulse response (IR) functions to simulate productivity shocks and observe their impact on unemployment. Dolado and Jimeno (1997) applies these techniques to the Spanish economy finding that rises in productivity increase unemployment permanently. As discussed above, these authors take this evidence as sign of shocks and institutions interacting rather than productivity having an impact on the NAIRU itself.

Also using IR functions for Germany, Carstensen and Hansen (2000) finds that a technological shocks causes permanents increases in employment, hence, suggesting that productivity has a negative impact on the NAIRU. Using a SVAR to estimate a macroeconomic model of the Danish labour market, Hansen and Warne (2001) find that productivity has no long run impact on unemployment, suggesting that Danish NAIRU is unaffected by productivity.

Yet, another common strategy to examine whether productivity affects the NAIRU consists on estimating the long run elasticity of real wages to productivity. The underlying reasoning is that if productivity gains are fully absorbed by real wages, then there is no room to reduce unemployment without triggering inflation that is to reduce the NAIRU, which becomes neutral to productivity.

Arestis and Biefang-Frisancho Mariscal (1998) uses cointegration analysis to estimate the unemployment and the real wages long term equilibriums in the UK. In the case of the real wage vector, they find evidence of real wages having a long run one-to-one relationship with productivity. Schreiber (2012) also finds that real wages and productivity are cointegrated on one-to-one basis in the Netherlands, but finds no support for such relationship in the cases of

Germany, France, and Italy. Similarly, Hansen and Warne (2001) find the long run elasticity of real wages with respect to productivity close to unity in Denmark.

Findings from Karanassou et al. (2008a, p.990) contradicts evidence for the Danish case. These authors take an ADRL approach by which they estimate the long-run elasticity of real wages to productivity to be equal to 0.46 in Denmark, 1.10 in Finland and 0.82 in Sweden. Following with the ARDL approach, Karanassou and Sala (2008) find that the Spanish long run elasticity of real wages to productivity (proxied by capital deepening) is equal to 0.52. Raurich et al. (2009, p.12) and Sala (2009,p.787) also study the Spanish case using ARDL, and find the elasticity of real wages to productivity to be slightly higher, 0.65 and 0.8, but still below unity.

3.3.2.4 Real interest rates

Finally, we report studies that examine the link between the NAIRU and real interest rates. A very well-known example is Ball (1999), this study assesses the impact on unemployment of central banks' reaction to the 1980s and 1990s shocks in ten OECD countries.

In a first stage, a narrative approach is taken to assess the evolution of unemployment. Four countries UK, Ireland, Portugal and the Netherlands achieved unemployment reductions and thereafter are regarded as the success stories. On the other hand, France, Canada, Italy, Spain, Denmark and Belgium suffered persistent higher unemployment levels, and thereafter are regarded as the failure stories. In a second stage, the reaction of central banks to the inflation-unemployment evolution is analysed, evaluating their real short term interest rates policy[27]. In the success cases, it is found that monetary authorities did not intervene to tackle inflation, while in the failure cases interest rates were raised or kept high to tackle inflation, despite already experiencing high levels of unemployment.

Finally, the evolution of inflation is examined. In the success stories inflation stabilised at a lower unemployment levels, suggesting that the NAIRU had been reduced, while in the failure cases it stabilised at higher unemployment levels, suggesting that the NAIRU had increased. Ball concludes that these results provide strong support for the hysteresis hypothesis, because they suggest that monetary policy have effects over the NAIRU. However, no evidence of how interest rates policy affects workers engagement with the labour market is presented, and we will rather take the evidence provided in this article as evidence of a link between interest rates and the NAIRU.

The twin peaks in unemployment and real long term interest rates that Finland experienced during the early 1990s, has given rise to a literature that

[27] The interest rate measure in this paper is a rate to 360 days.

investigate if these two phenomena could be associated. Kiander and Pehkonen (1999) estimate the structural and the reduced form equations of NAIRU model, and find that rises in real long term interest rates increase the Finnish NAIRU significantly. In fact, these authors conclude that "we think that Finnish unemployment –its rapid rise and fall- cannot be understood properly if interest rates shocks are omitted" (p.107).

Honkapohja and Koskela (1999), who also estimates the structural equations of a NAIRU conclude similarly, rises in real long term interest rates increase the Finnish NAIRU. Although these authors introduce a novelty that is worth mentioning, in this paper the effect of interest rates is decomposed in two. On the one hand the impact of the real cost of borrowing over price behaviour, and the influence of indebtedness over price mark-ups and real wages claims. The former takes the expected positive sign, and indeed dominates the overall effect over the NAIRU, but interestingly, indebtedness has a negative influence on the NAIRU thanks to its influence on real wages claims. These authors attribute this sign to the impact of indebtedness on the opportunity cost of being unemployed.

The findings reported in this section, i.e. that interest rates might have an impact on the NAIRU are not controversial *per se*, as we note in section 3.3.1 some advocates of the LNJ's approach, report similar findings, for instance Nickell (1998, p.814) and Gianella et al. (2008). The controversy is around the interpretation of these findings and their policy implications.

Nickell (1998, p.814) argues that given the coefficient estimate found and the magnitude of the change of real short-term interest rates during the sample period in the UK, the impact of real interest rates over the NAIRU is negligible. This might be the case in the UK, but for instance might not apply to the Finnish case. Gianella et al. (2008,p.21) take a different stance, they argue that finding a link between the NAIRU and long term real interest rates does not imply that central banks can modify the NAIRU. Their rationale is that long term interest rates are a proxy for cost of capital, which is the result of investment-savings balance driven by price of commodities such as oil, the evolution of stock markets, Governments fiscal position, external balance and country risk premium. Hence, they conclude it is not a monetary policy variable but an exogenous price-push factor. As discussed in section 2.3.3 this statement is controversial by its own merits.

3.3.3 Misspecification claims in the time series

The findings reported in the previous section, suggests that there are nexus between aggregate demand and the NAIRU of the kind described by the models presented in section 2.3. This evidence challenges the case for a NAIRU *a la* LNJ in the time series literature for two reasons: First, because it cast doubts on the robustness of early findings about neutrality of productivity and capital stock, for instance in Layard and Nickell (1986) and Dolado et al. (1986). Second, because this evidence suggests that some of the time series most commonly cited to vindicate LNJ's claims, for instance Layard et al. (1991,p.441) or Nickell and Bell (1995) or Estrada et al. (2000), are misspecified, because they omit these links.

In the light of evidence reviewed in the previous section, ignoring these nexus could lead to misspecification biases as already pointed out by Stockhammer (2004a,p.20) and Arestis et al. (2007, p.144). It should be noted that this claim is reinforced by the fact that most of the studies surveyed in the previous section not only consider the role of demand factors in their econometrical models, but also control for the impact of institutions on the NAIRU.

It is worth noting, that the importance of these findings goes beyond the time series literature. In challenging the view that time series are supportive of LNJ's approach, the evidence reviewed in the previous section, also question claims that panel data and time series provide a complete case for a NAIRU *a la* LNJ, as for instance argued by Layard et al. (1991, p.443) and Nickell (1998, p.814). Furthermore, given that evidence reviewed in our last section finds a significant link between the NAIRU and demand factors, it reinforces misspecification claims already made in the panel data literature, see section 3.2.4.

The advocates of the LNJ view have responded to these critiques with the following counter-arguments:

Nickell and Bell (1995, p.58) remark that demand variables can explain unemployment developments in the long run because the economy's production function links demand and unemployment and warns about "mistakenly" interpreting this long run relationship as evidence against the LNJ's approach. Similarly, Nickell (1998, p.805) argues that unemployment is always determined by aggregate demand, and consequently finding a long-run relationship between unemployment and aggregate demand factors "tells us *nothing* about which model of unemployment is the most relevant" (emphasis in the original).

Further, Nickell et al. (2005, p.22) argues that inferring, from findings of a relationship between demand factors and unemployment, that empirical evidence contradicts the view that unemployment is determined by "labour market institutions…is wholly incorrect". We respond to these counter-arguments in Chapter 4.

3.3.4 Anchor properties of the NAIRU in the times series literature

Empirical evidence with regard to the NAIRU's anchor properties is less contentious than that studying its determinants, and even advocates of the LNJ's approach, such as central bankers, accept that deviations from the NAIRU are long lasting or slow to correct. Several approaches have been proposed to examine the behaviour of unemployment around the NAIRU:

A popular strategy among policy makers consists of estimating the output gap (GDP's counterpart of the gap between unemployment and the NAIRU) and examining its persistence. OECD (2006c, p.54/55) use OECD's Interlink model to simulate a 1% reduction of the potential output and assess its impact on the output gap of the Euro Area. Three scenarios are considered, first *nominal* interest rates are held constant, finding that the output gap needs seven years close. In the second scenario, *real* interest rates are kept constant, and although the adjustment happens in a faster fashion, it still requires five years for output to align with its potential level. In the third scenario, *real* interest rates are reduced by 1%, the adjustment speeds up but the output gap still requires more than two years to be closed. Similar results are obtained for the US in Basistha and Nelson (2007), where a Kalman filter is used to estimate the output gap. In this article the output gap is found to be large and persistent with an autoregressive component close to unity.

Duval and Vogel (2008) estimate the output gap for a panel of twenty OECD countries as a function of a synthetic labour market indicator, household mortgage debt and lagged changes of the output gap. Actual national values are then introduced in the equation and using impulse response functions, the shock of a 1% fall in GDP is simulated. The fastest economies to close the output gap are Switzerland and the UK, although they still require slightly more than two years and a half. They are followed by New Zealand, Canada, Australia, Denmark, Japan and Germany, all requiring between three and four years to close the output gap. Between four and five years are required in Norway, Sweden, Ireland, Spain, Portugal, Finland, Belgium and Austria. The economies with a slowest adjustment seem to be France and Italy, who need more than five years to absorb the shock. These results are also reported in OECD (2010b, p.33/34).

Another popular approach to test the anchor properties of the NAIRU is the Error Correction Model (ECM). This usually complements cointegration analysis aiming at identifying the NAIRU determinants, and its usefulness resides in that having identified an unemployment cointegrated vector, the error term from this relationship can be used as proxy for deviations from the NAIRU or an unemployment error correction mechanism. Then, regressing changes of unemployment on this error term the researcher can evaluate the influence of the deviations from NAIRU over unemployment dynamics.

Arestis and Biefang-Frisancho Mariscal (1998) find that in the UK, the coefficient of the ECM from their unemployment cointegrated vector is not greater than -0.024, meaning that only a very modest 2.4% of the deviation is corrected in each period[28]. These authors conclude that the UK's NAIRU is a very weak anchor for unemployment. In a later study, Arestis and Biefang-Frisancho Mariscal (2000) confirm the results for the UK, and find analogous evidence for Germany. The ECM coefficient for Germany is significant and negative, but they also imply that a modest less than 1.5% of the deviation is corrected in each period.

Similar results are obtained for nine EMU countries (Germany, France, Italy, Spain, the Netherlands, Belgium Finland, Austria and Ireland) in Arestis et al. (2007). Spain is the country with a larger significant coefficient for the ECM term, and yet the estimate for the ECM in this country implies that only 11.9% of the gap between the NAIRU and unemployment is closed each period.

Schreiber (2012) does not provide estimates of the ECM, instead it provides the correlation coefficient of two versions of the unemployment gap[29] on unemployment dynamics for Germany, France, Italy and the Netherlands. The highest of the correlation coefficient for each country are -0.434, -0.599, -0.463 and -0.216 respectively. This implies that there is a negative relationship between changes in unemployment and the unemployment gap, as suggested by anchor claims. However, the coefficients of determination implied by these correlation coefficients suggest that the unemployment gap can only explain 36% of the change in unemployment, in the best of the cases, which is also indicative of a rather weak influence on unemployment dynamics.

Autoregressive distributed lag (ARDL) estimations also allow us to assess the influence of the long run parameters over the short run dynamics of the model using an ECM term. Miaouli (2001) employ this methodology to study the dynamics of manufacturing employment in France, Italy, Spain Portugal and Greece. In all cases except France, it is found that there is some degree of attraction towards the long run employment equilibrium, in the cases of Italy and Spain it seems particularly intense, with coefficients of -1.445 and -1.112 respectively, and more moderate in the cases of Portugal and Greece, with coefficients of -0.294 and -0.366 respectively.

Layard and Nickell (1986) employ a regression with differences and levels, which can be regarded as an equivalent to a modern ARDL model, and find that a shock to UK's labour demand would have a half-life of five years.

Another valuable piece of evidence to examine the anchor properties of the NAIRU can be obtained from simulating (un-)employment shocks using IR functions, and then observing whether unemployment returns to its baseline or

[28] They differentiate between positive and negative shocks: For one lag negative shock it was equal to -0.02, meaning 2% of the deviation is corrected in the following period. For one lag positive shock it was equal to -0.01. For three lags without differentiating negative from positive shocks it was equal to -0.024.

[29] This is the difference between actual unemployment and authors' estimates of the NAIRU.

drifts away from it. Henry et al. (2000) present the response of UK's unemployment to a labour demand shock. These authors find that the jobless rate returns to its baseline but it requires between 14 to 20 years to do so, which suggests that the NAIRU has very modest anchor power in the UK. Similar results are obtained for Germany in Carstensen and Hansen (2000), these authors report the IR of employment after a labour demand shock, and they find that employment requires more than 13 years to return to its pre-shock level, suggesting that the NAIRU has very modest anchor power in Germany.

Yet another strategy to evaluating the NAIRU's anchor properties is to estimate the NAIRU and then compare its evolution against that of actual unemployment. This approach is followed in Henry et al. (2000) and Karanassou et al. (2008b), where the Chain Reaction Theory (CRT) model is used to separate the structural part of unemployment and its cyclical component for the UK and Denmark respectively. In both cases, their estimates of the NAIRU seem to be compressed within a small range of values, whereas unemployment varies widely and shows no sign of reverting to the NAIRU values. They interpret these findings as a sign of the NAIRU's lack of attraction power.

Logeay and Tober (2006) use the Kalman filter to estimate the gap between unemployment and the NAIRU. According to their estimates, this gap has a cycle length of over eight years in the German case, and ten years in the case of the Euro Area, in both cases, portraying a very slow adjustment.

3.4 Summary of empirical controversies

This chapter has reviewed the empirical literature devoted to the study of the determinants of the NAIRU and its anchor properties. The case for a NAIRU *a la* LNJ seems supported by the following pieces of evidence. First, panel data studies that find cross-country differences in unemployment associated with differences in labour market institutions. Second, results from dynamic panel data studies that find the evolution of unemployment associated with exogenous wage-push factors. See OECD (2006c, Chapter 3). Third, time series studies that find long run links between unemployment and structural features of the labour market, in some cases also of the goods market. Further, these time series studies find no evidence of the influence of demand factors, such as productivity and capital stock, on the NAIRU (Layard and Nickell, 1986, Nickell, 1998).

However, some researchers find this evidence unconvincing for the following reasons. First, some question the reliability of these panel data studies due to data quality issues, particularly those published in the 1990s because of the interaction between the researcher and data (Blanchard and Wolfers, 2000). Second, some question the suitability of panel data techniques to examine these issues, because they claim that comparability of some key variables remain "elusive" (Baker et al., 2007). Further, some note that the constancy of coefficients across countries, implied by panel data methods, does not hold (Arestis et al., 2007).

Third, it is also pointed out that results from panel data studies that vindicate LNJ's claims are not robust to changes in the sample and the specification (Baker et al., 2007). Fourth, some attribute these robustness problems to the omission of relevant variables. This claim is based on the evidence provided by panel data studies, which find that interactions of aggregate demand factors with labour market institutions, and indeed demand factors such as capital stock, productivity, and real interest rates, have a significant influence on the NAIRU (Blanchard and Wolfers, 2000, Storm and Naastepad, 2009). This is in fact, the most damaging critique to panel data studies used to vindicate LNJ's approach.

Fifth, there is a new wave of time series studies that find significant links between the NAIRU and variables such as productivity, capital stock, real interest rates and different measures of hysteresis. These findings have multiple repercussions for the empirical case for the NAIRU *a la* LNJ. On the one hand, these findings question the robustness of time series studies that find the NAIRU neutral to productivity and capital stock and that are used to vindicate LNJ's claims, such as Layard and Nickell (1986) and Nickell (1998). On the other hand, this evidence suggests that time series studies cited to vindicate LNJ's claims are misspecified, because they omit the possible link between the NAIRU and demand factors in their analysis. Hence, in the time series literature we also find claims that empirical studies used to vindicate LNJ's approach are misspecified.

Our survey has also reported the counterarguments to these critiques. Advocates of LNJ's view, claim that robustness problems in panel data studies highlight nothing else but data limitations and the difficulties to measure some of the exogenous factors that determine the NAIRU (Heckman, 2007). Further, they also argue that despite "no or limited consensus" on the quantitative impact of labour market institutions on the NAIRU, "overall" evidence is supportive of such links (OECD, 2006c, Chapter 3). Counterarguments to time series critiques are generally based on the interpretation of empirical findings. Advocates of LNJ's approach argue that unemployment is always determined by aggregate demand, and that therefore finding a long run relationship between demand factors and unemployment tells us "*nothing*" about the determinants of the NAIRU (Nickell, 1998, p.805).

Empirical evidence with regard to the anchor properties of the NAIRU seems to be less contentious, because all evidence suggests that the NAIRU is at best a weak anchor.

Thus, it seems apparent that despite considerable empirical efforts, economists still remain divided over the characteristics of the NAIRU, particularly with regard to what variables determine it.

Chapter 4 Research programme

4.1 Introduction

This chapter draws from the theoretical and empirical controversies reviewed in Chapter 2 and Chapter 3, to design the research programme that is implemented in the rest of this thesis. The chapter is organized as follows: Section 4.2 formulates the research questions we aim to answer and explains our motivations. Section 4.3 presents the theoretical model used to answer these research questions. Section 4.4 illustrates the novelty of our research programme. Section 4.5 closes the chapter with a summary.

4.2 Motivations and objectives

Our review of the theoretical literature in Chapter 2 concludes that despite the endorsement of policy makers, LNJ's propositions are far from uncontroversial. Furthermore, in the light of our empirical survey in Chapter 3, it seems apparent that despite considerable efforts, there is still no consensus over the characteristics of the NAIRU, particularly with regard to what variables determine it.

These debates have lingered in the literature for the last three decades, but the current surge in unemployment has revived them, particularly in Europe where the rise in unemployment has been more pronounced than in other advanced economies. In one side of the debate we have European policy makers, who believe that more "flexible labour markets" is the only way to achieve long lasting reductions of unemployment (Schäuble, 2011). Accordingly, they have decided to deepen the process of labour market de-regulation that started in the 1980s in line with LNJ's recommendations, by renewing the "Lisbon's Strategy" of structural reforms, now called "Europe 2020 agenda" (European Commission, 2010a). Most recently, European authorities have agreed on the "Fiscal Compact" (European Commission, 2012), which coordinates macroeconomic and structural policies, also in line with LNJ's propositions. This position is also endorsed by the ECB (2008b, a, p.66, 2010, p.64) and the OECD (2010b, 2012).

In the other side of the debate we find economists who claim that stimuli macroeconomic policies have long term effects on unemployment, see for instance Skidelsky (2010), Munchau (2011) or Arestis and Sawyer (2012). They question that the combination of structural reforms and fiscal consolidation policies, agreed upon in the "Fiscal Compact", can deliver lower unemployment. In fact, they argue, these policies will have perverse long term effects on employment and growth.

The persistence of these controversies, signals that our understanding of the NAIRU's characteristics, in particular what variables determine it, is still unsatisfactory. This situation calls for further research. The aim of this thesis is to make a contribution that helps clarify these debates. For that purpose we propose a *new* empirical assessment of the NAIRU theories reviewed in Chapter 2. The two specific research questions we aim to answer are the following:

i. Is the NAIRU exclusively determined by exogenous factors, as suggested by LNJ? Or on the contrary, is the NAIRU determined by variables such as productivity, capital stock, real long term interest rates or hysteresis, as suggested by critics of LNJ's approach?
ii. Does the NAIRU serve as an anchor or gravitation centre for economic activity, as suggested by LNJ?

To answer these questions we propose the following: First, to use data from eight EU economies, namely the United Kingdom, the Netherlands, Germany, France, Italy, Spain, Denmark and Finland. Data cover the period between 1980 and 2007, this sample period is given by data availability, see Chapter 6 for further details about the data. Second, we propose to analyse this data using time series techniques in order to formulate country specific recommendations. We discuss the rationale and the details of this methodological choice in Chapter 5. Third, we propose to employ a theoretical model that encompasses the NAIRU theories reviewed in Chapter 2. The particulars of this model are discussed below.

The novelty of this research programme resides in the use of this encompassing model and the use of a sample period with data including the period from 2000 to 2007. We illustrate the originality of our work in Section 4.4 but before we do it, it is necessary to present our model.

4.3 An encompassing NAIRU model

The theoretical model we propose to use draws from our review in Chapter 2 and from Stockhammer (2008), who presents a similar survey. The following equations summarize the model:

4.1 $p - w = \varphi_0 - \varphi_1 u - \varphi_2 k - \varphi_3(y - l) + \varphi_4(w - w^e) + \varphi_5(i - \Delta p)$

4.2 $w - p = \omega_0 - \omega_1 u + \omega_{11} lu + \omega_2(y - l) + \omega_3(p - p^e) + z_w$

4.3 $z_w = \omega_4 grr + \omega_5 t^w + \omega_6 mil$

4.4 $u^* = \beta_{10} + \beta_{12}(y - l) + \beta_{14} lu + \beta_{15} grr + \beta_{16} t^w + \beta_{17} mil + \beta_{18} k + \beta_{19}(i - \Delta p)$

$$\beta_{10} = \frac{\omega_0+\varphi_0}{\omega_1+\varphi_1}, \beta_{12} = \frac{\omega_2-\varphi_3}{\omega_1+\varphi_1}, \beta_{14} = \frac{\omega_{11}}{\omega_1+\varphi_1}, \ \beta_{15} = \frac{\omega_4}{\omega_1+\varphi_1}$$

$$\beta_{16} = \frac{\omega_5}{\omega_1+\varphi_1}, \beta_{17} = \frac{\omega_6}{\omega_1+\varphi_1}, \ \beta_{18} = -\frac{\varphi_2}{\omega_1+\varphi_1}, \ \beta_{19} = \frac{\varphi_5}{\omega_1+\varphi_1}$$

4.5 $(w - p)^* = \beta_{20} + \beta_{22}(y - l) + \beta_{24} lu + \beta_{25} grr + \beta_{26} t^w + \beta_{27} mil + \beta_{28} k + \beta_{29}(i - \Delta p)$

$$\beta_{20} = \left(\varphi_1 \frac{\omega_0+\varphi_0}{\omega_1+\varphi_1} - \varphi_0\right), \beta_{22} = \left(\varphi_1 \frac{\omega_2-\varphi_3}{\omega_1+\varphi_1} + \varphi_3\right), \beta_{24} = \left(\varphi_1 \frac{\omega_{11}}{\omega_1+\varphi_1}\right),$$

$$\beta_{25} = \varphi_1 \frac{\omega_4}{\omega_1+\varphi_1}, \beta_{26} = \varphi_1 \frac{\omega_5}{\omega_1+\varphi_1}, \beta_{27} = \varphi_1 \frac{\omega_6}{\omega_1+\varphi_1}$$

$$\beta_{28} = \left(\varphi_2 - \varphi_1 \frac{\varphi_2}{\omega_1+\varphi_1}\right), \ \beta_{29} = \left(\varphi_1 \frac{\varphi_5}{\omega_1+\varphi_1} - \varphi_5\right)$$

4.6 $\Delta u = \gamma(u - u^*)$

Where $p - w$ stands for firms' price mark-up over labour costs, u is the unemployment rate, k is the capital stock, $(y - l)$ stands for productivity, $(w - w^e)$ denotes wage surprises, $(i - \Delta p)$ is the long term real interest rate, $w - p$ stands for real wages, lu is the long term unemployment rate, $(p - p^e)$ represents price surprises, z_w encapsulates wage-push factors, grr is a measure of unemployment benefits, t^w is the tax wedge and mil captures unions' power. The asterisk in u^* and $(w - p)^*$ denote the long run unemployment equilibrium or NAIRU and the real wages equilibrium respectively. Δu is the change in actual unemployment, and $(u - u^*)$ stands for deviations of unemployment from the NAIRU. All the variables are expressed in logarithms, the coefficients φ_{i} and ω_{i} are all positive, and the sign of γ is unknown.

Equation 4.1 formulates the price setting behaviour of firms as a mark-up over labour cost $p - w$. This is consistent with the models reviewed in Chapter 2, where it was assumed that firms operate in a context of imperfect competition, which allows them to behave as price setters. In our model, firms' mark-up is a function of unemployment u, capital stock k, productivity $(y - l)$, wage surprises or unexpected rises in labour costs $(w - w^e)$ and real long term interest rates $(i - \Delta p)$.

Further, also following the models reviewed in Chapter 2, imperfect competition is not limited to the goods market, and workers are also assumed to have some bargaining power that allows them to influence real wages. In our model, workers' wage setting behaviour is denoted by equation 4.2, where real wages claims $w - p$, are a function of unemployment u, long term unemployment lu, productivity $(y - l)$, price surprises $(p - p^e)$ and a vector of wage-push factors z_w.

Equations 4.1 and 4.2 include the determinants of firms' mark-up and real wage claims considered in all the models reviewed in Chapter 2, i.e. unemployment u, capital stock k, productivity $(y-l)$, wage surprises $(w-w^e)$, real long term interest rates $(i-\Delta p)$, long term unemployment lu, productivity $(y-l)$, price surprises $(p-p^e)$ and a vector of wage-push factors z_w. These variables capture the same phenomenon over price mark-up and real wages as in Chapter 2. The only difference is that in our model we use long term unemployment lu, rather than change in unemployment Δu to account for hysteresis, see equation 2.11.

The rationale is of statistical nature, Δu is a stationary variable, which means that it cannot be used in cointegration analysis, because cointegration can only identify long run relationships between variables that are integrated of order one $I(1)$. This problem does not arise with lu which is $I(1)$, for all the countries sin the sample, the results for the stationary and unit root test are provided in Appendix II, and hence we proceed with lu as our proxy for hysteresis. It should be noted that this can be done without loss of meaning, as long as $\omega_{11} \neq \omega_1$, that is, as long as long term unemployed workers exert a different influence on real wage claims than the rest of unemployed workers. Further, as noted in Chapter 3, using lu is a popular strategy to model hysteresis in empirical work, particularly when using cointegration analysis.

As per equation 4.3, the vector of wage-push factors contains three components. A measure of unemployment benefits grr, the difference between the take home and actual pay, the so called tax-wedge t^w, and a measure of union's power mil. The rationale for considering these wage-push factors is three fold. First, the theoretical link between these variables and the NAIRU, is well documented, Nickell et al. (2005, p.3) and Sala (2009,p.780) refer to these variables as the "usual suspects".

The second reason is that these three variables summarize some of the key features of the labour market that "Europe2020 agenda" and OECD's "Going for growth" strategy recommend to reform: European Commission (2010b) recommend to ensure the efficiency of benefits and labour taxation to "make work pay", seeking the right balance between rights and responsibilities of unemployed workers and favour less constraining labour contracts. Similarly, OECD (2010b, p.21, 2012, Chapter 1) recommend to adopt measures that make wage and labour costs more flexible. Hence, we can evaluate the adequacy of these reforms with the estimates for grr, t^w and mil.

Third, another reason to consider unemployment benefits and labour taxation, is that previous empirical evidence seems to be supportive of the link between these variables and the NAIRU, see for instance the survey in OECD (2006c, p.59-107). Hence, they seem to be good representatives of LNJ's empirical case.

Equation 4.4 and 4.5, denote the NAIRU and the long run real wages equilibriums of our model. To derive them, we follow the same procedure as in the models surveyed in Chapter 2. First, we assume that in the long run expectations are fulfilled, i.e. $p = p^e$ and $w = w^e$, then equating 4.1 and 4.2 to solve for unemployment, and substituting z_w by equation 4.3 to specify the composition of the wage-push term, we obtain the NAIRU u^*, denoted by equation 4.4. Finally, substituting the unemployment term of equation 4.2 by the expression from equation 4.4, and solving for real wages we obtain the long run real wages equilibrium $(w - p)^*$ denoted by equation 4.5. It should be noted that according to equations 4.4 and 4.5, both the NAIRU and the long run real wages equilibrium, are a functions of productivity, long term unemployment, the wage-push factors, capital stock and real long term interest rates. We discuss the implications of this in Table 4.1.

Equation 4.6 closes the model describing changes in the rate of unemployment Δu, as a function of deviations from the NAIRU $(u - u^*)$. This equation captures the influence of the NAIRU over demand fluctuations, here proxied by changes in unemployment, and we use it to evaluate the anchor properties of the NAIRU. For instance, if $\gamma \approx -1$, deviations from the NAIRU $(u \neq u^*)$ cause a change in unemployment that corrects such deviations, and the NAIRU can then be considered as an anchor for economic activity. Stockhammer (2008) refers to this equation as “demand closure”.

The model described by equations 4.1 to 4.6 encompasses the NAIRU model reviewed in Chapter 2, because each of them can be obtained from these equations under a different set of restrictions. In other words, the competing NAIRU theories surveyed in Chapter 2 are nested or special cases of our model. Table 4.1 summarizes the restrictions that each nested model needs, but before we discuss the content of this table it seems adequate to explain its structure.

The first two columns show the restrictions that are required for our model to reduce to Layard et al. (1991, Chapter 8) model, here denoted by LNJ. The next two columns show the restrictions that are needed to extract a NAIRU model of the characteristics proposed by Blanchard and Summers (1986), here denoted by *BS*. The following two columns detail the restrictions that are necessary to obtain Rowthorn (1995) and Arestis and Sawyer (2005) model, here denoted by *ASR*. The last two columns show the restrictions required for our model to reduce to a NAIRU model of the characteristics proposed by Rowthorn (1999, p.422) and Hein (2006), here denoted by *RH*. Further, it should also be noted that rows *i)* to *iii)* show the restrictions that refer to the structural equations of the model i.e. equations 4.1 and 4.2. Rows *iv)-vii)* show the counterpart of these restrictions for the reduced form equations, i.e. equations 4.4 and 4.5. And row *viii)* shows the restriction that refers to the equation that links the NAIRU with unemployment fluctuations, i.e. equation 4.6.

	LNJ restrictions over		*BS* restrictions over		*ASR* restrictions over		*RH* restrictions over	
	Equation 4.1	**Equation 4.2**	**Equation 4.1**	**Equation 4.2**	**Equation 4.1**	**Equation 4.2**	**Equation 4.1**	**Equation 4.2**
i)	$\varphi_3 = \omega_2$	$\omega_{11} = 0$	$\varphi_3 = \omega_2$	$\omega_{11} \neq 0$	$\varphi_3 \neq \omega_2$	$\omega_{11} = 0$	$\varphi_3 = \omega_2$	$\omega_{11} = 0$
ii)	$\varphi_2 = 0$		$\varphi_2 = 0$		$\varphi_2 > 0$		$\varphi_2 = 0$	
iii)	$\varphi_5 = 0$		$\varphi_5 = 0$		$\varphi_5 = 0$		$\varphi_5 > 0$	
	Equation 4.4	**Equation 4.5**	**Equation 4.4**	**Equation 4.5**	**Equation 4.4**	**Equation 4.5**	**Equation 4.4**	**Equation 4.5**
iv)	$\beta_{12} = \frac{\omega_2 - \varphi_3}{\omega_1 + \varphi_1} = 0$	$\beta_{22} = \left(\varphi_1 \frac{\omega_2 - \varphi_3}{\omega_1 + \varphi_1} + \varphi_3\right) \approx 1$	$\beta_{12} = 0$	$\beta_{22} \approx 1$	$\beta_{12} \neq 0$	$\beta_{22} \approx 1$	$\beta_{12} = 0$	$\beta_{22} \approx 1$
v)	$\beta_{14} = \frac{\omega_{11}}{\omega_1 + \varphi_1} = 0$	$\beta_{24} = \left(\varphi_1 \frac{\omega_{11}}{\omega_1 + \varphi_1}\right) = 0$	$\beta_{14} \neq 0$	$\beta_{24} \neq 0$	$\beta_{14} = 0$	$\beta_{24} = 0$	$\beta_{14} = 0$	$\beta_{24} = 0$
vi)	$\beta_{18} = -\frac{\varphi_2}{\omega_1 + \varphi_1} = 0$	$\beta_{28} = \left(\varphi_2 - \varphi_1 \frac{\varphi_2}{\omega_1 + \varphi_1}\right) = 0$	$\beta_{18} = 0$	$\beta_{28} = 0$	$\beta_{18} < 0$	$\beta_{28} \neq 0$	$\beta_{18} = 0$	$\beta_{28} = 0$
vii)	$\beta_{19} = \frac{\varphi_5}{\omega_1 + \varphi_1} = 0$	$\beta_{29} = \left(\varphi_1 \frac{\varphi_5}{\omega_1 + \varphi_1} - \varphi_5\right) = 0$	$\beta_{19} = 0$	$\beta_{29} = 0$	$\beta_{19} = 0$	$\beta_{29} = 0$	$\beta_{19} > 0$	$\beta_{29} \neq 0$
	Equation 4.6		**Equation 4.6**		**Equation 4.6**		**Equation 4.6**	
viii)	$\gamma \approx -1$		$\gamma > -1$		$\gamma > -1$		$\gamma > -1$	

Table 4.1 Nested models, theoretical restrictions

Note: *LNJ*= Layard et al. (1991, Chapter 8), *BS*= Blanchard and Summers (1986), *ASR*= Rowthorn (1995) and Arestis and Sawyer (2005), *RH*=Rowthorn (1999, p.422) and Hein (2006)

Let's now discuss each set of restrictions. Our model reduces to LNJ's model if the following restrictions are imposed. In equations 4.1 and 4.2, $\varphi_3 = \omega_2$ to ensure that productivity has identical impact on firms price mark-up than over real wages claims. Further, $\varphi_2 = \varphi_5 = 0$ to make firm's mark-up independent from capital stock and real long term interest rates. And $\omega_{11} = 0$ to ensure that all unemployed workers exert the same pressure over real wages claims.

The counterparts of these restrictions in the reduced form equation of the model are as follows. In equation 4.5, $\beta_{12} = 0, \beta_{14} = 0, \beta_{18} = 0, \beta_{19} = 0$, which respectively imply that neither productivity, nor long term unemployment, nor capital stock, nor long term real interest rates have an impact on the NAIRU. In equation 4.6, $\beta_{22} \approx 1, \beta_{24} = 0, \beta_{28} = 0, \beta_{29} = 0$, which respectively imply that productivity has a one-to-one long run relationship with real wages[30], that neither long term unemployment, nor capital stock, nor long term real interest rates have an effect over long run real wages equilibrium. The restriction that closes LNJ's set is $\gamma \approx -1$, see row *viii)*. This implies that deviation from the NAIRU cause a corrective movement on actual unemployment, and as a result the NAIRU can be considered as an anchor for economic activity.

To extract BS's model from equations 4.1 to 4.6, it is necessary to relax some of LNJ's restrictions. In equations 4.2 the restriction $\omega_{11} = 0$ must be dropped to consider that long term unemployed workers might exert different pressure over real wages claims than that exerted by the rest of workers, see rows *i)*. This is equivalent to drop the restrictions $\beta_{14} = 0$ and $\beta_{24} = 0$ in equations 4.5 and 4.6, which reflects that long term unemployment has an impact on the NAIRU and the real wage equilibrium, see rows *iv)-vii)*. Finally, $\gamma \approx -1$ also needs to be dropped to reflect that the NAIRU has limited or no anchor power, see row *viii)*.

ASR's model can be obtained by relaxing some of the restrictions adopted in LNJ's case: In equations 4.1 and 4.2, the restrictions $\varphi_3 = \omega_2$ and $\varphi_2 = 0$ need to be dropped. This implies, respectively, that the impact of productivity over firms price mark-up is different to that over real wage claims and that the price mark-up is a function of capital stock. This is equivalent to drop the restrictions $\beta_{12} = 0, \beta_{18} = 0$, and $\beta_{24} = 0, \beta_{28} = 0$ over equations 4.5 and 4.6, which allows productivity and capital stock to have an impact on the NAIRU and the real wage equilibrium. Finally, $\gamma \approx -1$ is also dropped reflecting that the NAIRU is supposed to have limited or no anchor power in ASR's model.

Finally, to extract *RH*'s model, it is necessary to impose the same restrictions as in LNJ's case with the following exceptions: In equations 4.1, the restriction

[30] Productivity affects long run real wages equilibrium, even when it does not affect the NAIRU, i.e. even when $\varphi_3 = \omega_2$, as long as $\varphi_3 \neq 0$ as can be observed from $\beta_{22} = \left(\varphi_1 \frac{\omega_2 - \varphi_3}{\omega_1 + \varphi_1} + \varphi_3\right)$. We adopt the standard assumption for φ_3 that productivity would allow firms to reduce prices on one-to-one basis, i.e. $\varphi_3 \approx -1$, and hence $\beta_{22} = 1$.

$\varphi_5 = 0$ must be dropped to consider that the price mark-up is a function of long term real interest rates. This is equivalent to drop the restrictions $\beta_{19} = 0$ and $\beta_{29} = 0$ in equations 4.5 and 4.6, which allow long term real interest rates to have an impact on the NAIRU and the real wage equilibrium. According to Rowthorn (1999, p.422) and Hein (2006) the NAIRU might have anchor properties under certain condition, we denote this with $\gamma > -1$.

After showing how our model encompasses the NAIRU models reviewed in chapter 2, it is time to show how it can help to answer our research questions. Having a model that encompasses several competing NAIRU theories, which we can treat as nested or special cases of our model, allows us to test the validity of these theories by testing the set of restrictions that they require. In other words, testing the restrictions that each nested model needs, we can test the validity of such model. This possibility is already suggested in Stockhammer (2008,p.507).

Two strategies are possible to test these sets of restrictions. One possibility involves estimating equations 4.1 and 4.2, the structural equations of the model, test the restrictions that each model requires over ω_i and φ_i, and then equate our estimated equations to work-out the β_{1i} and β_{2i}. The second possibility consists of estimating equations 4.4 and 4.5, the reduced form equations of the model, and then test the restrictions over β_{1i} and β_{2i} that each model requires.

As reported in Chapter 3, there are numerous examples of both strategies in the literature. Here we favour the second approach, because having the data to estimate the reduced form equations, it seems unnecessary to estimate them indirectly via the structural equations. Further, estimating the reduced form equations we avoid the identification problem that arises when dealing with two equations with the same dependent variable such as equations 4.1 and 4.2 (Manning, 1993, p.99,105, Bean, 1994, p.583).

4.4 Originality

After presenting our theoretical model it is time to illustrate the originality of our work. We claim in section 4.2 that the novelty of this thesis resides in the use of our encompassing theoretical model and in the use of a sample period that includes data for the period from 2000 to 2007.

To illustrate this claim we present Table 4.2 to Table 4.5. These tables draw from our survey in Chapter 3 and summarize existing time series evidence for the eight countries in our sample. Table 4.2 for the UK and the Netherlands, Table 4.3 for Germany and France, Table 4.4 for Italy and Spain, and Table 4.5 for Finland and Denmark. Columns *i)* to *iii)* of these tables, show if these studies include the three wage-push factors that we consider in our theoretical model, i.e. grr unemployment benefits, t^w labour taxation and mil union's power. A black dot denotes that the variable in question is considered. Column *iv)* reports any $Other$ exogenous factor that might be considered in the paper in question.

Further, columns *v)* to *viii)* of these tables show if these studies include any of the four endogenous variables to aggregate demand that we consider in our model, i.e. $y-l$ productivity, lu long term unemployment, k capital stock and $i-\Delta p$ real long term interest rates. A black dot denotes that the variable in question is considered. Column *ix)* denotes whether the paper in question provides evidence regarding the anchor properties of the NAIRU. Finally, column *x)* shows the sample period covered by each article.

	i)	*ii)*	*iii)*	*iv)*	*v)*	*vi)*	*vii)*	*viii)*	*ix)*	*x)*
UK	**Exogenous factors**				**Endogenous factors**				**Anchor**	**Sample**
	grr	t^w	mil	**Other**	$y-l$	lu	k	$i-\Delta p$		
Layard and Nickell (1986)	●	●	●	*mm+ipd*	●		●		●	1954-1983
Layard et al. (1991,p.441)	●	●	●	*mm*						1954-1985
Nickell and Bell (1995)	●	●	●	*mm*						1963q1-1992q4
Nickell (1998)	●	●	●	*mm*				●		1964q4-1992q4
Arestis and Biefang-Frisancho Mariscal (1998)	●	●	●			●	●		●	1966q1-1994q4
Ball (1999)								●		1985-1997
Arestis and Biefang-Frisancho Mariscal (2000)		●				●	●		●	1966q1-1995q4
Henry et al. (2000)									●	1964-1997
Stockhammer (2004a)	●	●	●			●	●			1962-1993
Hatton (2007)					●					1871-1999
Gianella et al. (2008)	●	●	●	*PMR*				●		1976-2003
Duval and Vogel (2008)									●	1982-2003
Netherlands	**Exogenous factors**				**Endogenous factors**				**Anchor**	**Sample**
	grr	t^w	mil	**Other**	$y-l$	lu	k	$i-\Delta p$		
Driehuis (1986)							●			1960-1983
Ball (1999)								●		1985-1997
Arestis et al. (2007)	●	●	●			●	●		●	1983q4-2002q4
Duval and Vogel (2008)									●	1982-2003
Gianella et al. (2008)	●	●	●	*PMR*				●		1976-2003
Schreiber (2012)									●	1977q1-2008q2

Table 4.2 Variables and periods used to study the NAIRU, the UK and the Netherlands

Note: *mm* denotes a variable capturing skills miss-match, *ipd* denotes an income policy dummy for 1976 and 1977, *PMR* stands for OECD's measure of Product Market Regulation. Sample periods are annual unless they include a *q* and the corresponding quarters they cover.

Let's start with Table 4.2. We observe that most of the articles that study the cases of the UK and the Netherlands, such as Layard et al. (1991,p.441) or Nickell and Bell (1995), only consider "exogenous factors" in their analysis, i.e. we only find black dots under the heading of grr, t^w and mil. Other articles test the hypothesis that one "endogenous factor", sometimes two, affects the NAIRU, for instance in the UK's case Layard and Nickell (1986) test the hypothesis that productivity and capital stock can affect the NAIRU. Similarly, Schreiber (2012) in the Netherlands' case, test the impact of productivity over the NAIRU.

However, none of the studies reported in Table 4.2 consider the four variables that we account for in our model, none of them has a row of black dots under $y - l$, lu, k and $i - \Delta p$. In other words, these studies do not control for the theories that link these variables with the NAIRU. Hence, using our encompassing model to study the cases of the UK and the Netherlands constitutes a contribution to the existing literature of these countries.

It is worth noting that the rationale for using an encompassing model goes beyond the pure gap in the literature. As Blanchard (2002, p.3-5) points out, it is reasonable to believe that some of the variables that can make the NAIRU endogenous to aggregate demand might interact among themselves, for example real interest rates might affect capital stock or long term unemployment. Consequently, to separate the individual effect that each of these factors has on the NAIRU we need to consider a model that accounts for them. Otherwise, results could overrate or underestimate the actual effect of a particular variable. Further, Bean (1994,p.616) point out that it also important to use "models ... (that) encompass the findings from other researchers" in order to ensure comparability across studies.

Furthermore, as shown in column *x)* of Table 4.2, extant literature considering the 2000s is very limited, only Schreiber (2012) used a sample period that includes data up to 2008, and only for the Netherlands. Hence, using a sample period with data for the 2000s constitutes another contribution to the existing literature of these countries, particularly the UK.

Examining Table 4.3 to Table 4.5 we find similar patterns in the articles that study the cases of Germany, France, Italy, Spain, Denmark and Finland. On the one hand, articles consider "exogenous factors" along with one or two "endogenous factor" in their analysis, see for instance Arestis and Biefang-Frisancho Mariscal (2000) in Table 4.3, or Stockhammer (2004a) in Table 4.4 or Nymoen and Rødseth (2003) in Table 4.5. On the other, data for the 2000s is rarely used, only Schreiber (2012) uses data that includes this period, but only for Germany, France and Italy. Thus, using our encompassing model and our sample constitutes a contribution to the existing literature of these countries, namely Germany, France, Italy, Spain, Denmark and Finland.

	i)	*ii)*	*iii)*	*iv)*	*v)*	*vi)*	*vii)*	*viii)*	*ix)*	*x)*
Germany	**Exogenous factors**				**Endogenous factors**				**Anchor**	**Sample**
	$\boldsymbol{grr}$	$\boldsymbol{t^w}$	$\boldsymbol{mil}$	**Other**	$\boldsymbol{y-l}$	$\boldsymbol{lu}$	$\boldsymbol{k}$	$\boldsymbol{i-\Delta p}$		
Ball (1999)								●		1985-1997
Arestis and Biefang-Frisancho Mariscal (2000)		●				●	●		●	1966q1-1990q4
Carstensen and Hansen (2000)				w^{IR}	●				●	1964q1-1994q4
Stockhammer (2004a)	●	●	●			●	●			1962-1993
Logeay and Tober (2006)						●			●	1973q1-2002q4
Arestis et al. (2007)	●	●	●			●	●		●	1991q4-2002q4
Duval and Vogel (2008)									●	1982-2003
Gianella et al. (2008)	●	●	●	*PMR*				●		1976-2003
Schreiber (2012)		●			●				●	1977q1-2008q2
France	**Exogenous factors**				**Endogenous factors**				**Anchor**	**Sample**
	$\boldsymbol{grr}$	$\boldsymbol{t^w}$	$\boldsymbol{mil}$	**Other**	$\boldsymbol{y-l}$	$\boldsymbol{lu}$	$\boldsymbol{k}$	$\boldsymbol{i-\Delta p}$		
Malinvaud (1986)							●			1963-1984
Ball (1999)								●		1985-1997
Miaouli (2001)							●		●	1970-1996
L'Horty and Rault (2003)		●		*mm+ qr*	●					1970q1-1996q4
Stockhammer (2004a)	●	●	●			●	●			1962-1993
Arestis et al. (2007)	●	●	●			●	●		●	1979q4-2002q4
Duval and Vogel (2008)									●	1982-2003
Gianella et al. (2008)	●	●	●	*PMR*				●		1976-2003
Schreiber (2012)		●			●				●	1977q1-2008q2

Table 4.3 Variables and periods used to study the NAIRU, Germany and France

Note: *mm* denotes a variable capturing skills' miss-match, *PMR* stands for OECD's measure of Product Market Regulation. *Qr* stands for the quit ratio, w^{IR} denotes simulations of wage shocks using impulse response functions. Sample periods are annual unless they include a *q* and the corresponding quarters they cover.

There are other reasons that justify the geographical scope of our research. First, the evolution of unemployment in these countries since the 1980s has given rise to what is generally referred to as the "European Unemployment" problem (Bean, 1994), which seems to have erupted once more since 2008. Second, the evolution of unemployment in these countries is despair and hence provides an interesting sample of "winners" and "losers", to paraphrase Elmeskov et al. (1998) and Ball (1999), which should help us understand what makes an economy successful in fighting unemployment. Third, it has an interesting mix of Euro Area and non-Euro Area member states, which can yield interesting policy implications for the single currency area.

	i)	*ii)*	*iii)*	*iv)*	*v)*	*vi)*	*vii)*	*viii)*	*ix)*	*x)*
Italy	**Exogenous factors**				**Endogenous factors**				**Anchor**	**Sample**
	grr	t^w	mil	**Other**	$y-l$	lu	k	$i-\Delta p$		
Modigliani et al. (1986)					●					1961-1983
Ball (1999)								●		1985-1997
Miaouli (2001)							●		●	1975-1995
Stockhammer (2004a)	●	●	●			●	●			1962-1993
Arestis et al. (2007)	●	●	●			●	●		●	1983q4-2002q4
Duval and Vogel (2008)									●	1982-2003
Gianella et al. (2008)	●	●	●	*PMR*				●		1976-2003
Schreiber (2012)		●			●				●	1977q1-2008q2
Spain	**Exogenous factors**				**Endogenous factors**				**Anchor**	**Sample**
	grr	t^w	mil	**Other**	$y-l$	lu	k	$i-\Delta p$		
Dolado et al. (1986)	●	●	●	*mm+ fc*	●		●			1964-1983
Ballabriga et al. (1993)					●		●			1964-1988
Dolado and Jimeno (1997)				$w\&p^{IR}$	●	●				1971q1-1994q1
Ball (1999)								●		1985-1997
Estrada et al. (2000)	●	●	●							1980q1-1999q3
Miaouli (2001)							●		●	1973-1995
Arestis et al. (2007)	●	●	●			●	●		●	1979q4-2002q4
Duval and Vogel (2008)									●	1982-2003
Karanassou and Sala (2008)	●	●					●			1972-2005
Gianella et al. (2008)	●	●	●	*PMR*				●		1976-2003

Table 4.4 Variables and periods used to study the NAIRU, Italy and Spain

Note: *mm* denotes a variable capturing skills' miss-match, *PMR* stands for OECD's measure of Product Market Regulation. *Fc* stands for firing costs, $w\&p^{IR}$ denotes simulations of wage and prices shock using impulse response functions. Sample periods are annual unless they include a q and the corresponding quarters they cover.

	i)	*ii)*	*iii)*	*iv)*	*v)*	*vi)*	*vii)*	*viii)*	*ix)*	*x)*
Denmark	**Exogenous factors**				**Endogenous factors**				**Anchor**	**Sample**
	grr	t^w	mil	**Other**	$y-l$	lu	k	$i-\Delta p$		
Ball (1999)								●		1985-1997
Hansen and Warne (2001)					●	●				1901-1992
Nymoen and Rødseth (2003)	●				●					1968-1994
Duval and Vogel (2008)									●	1982-2003
Gianella et al. (2008)	●	●	●	*PMR*				●		1976-2003
Karanassou et al. (2008a)							●			1973-2005
Karanassou et al. (2008b)									●	1973-2005
Finland	**Exogenous factors**				**Endogenous factors**				**Anchor**	**Sample**
	grr	t^w	mil	**Other**	$y-l$	lu	k	$i-\Delta p$		
Kiander and Pehkonen (1999)	●	●	●					●		1961q1-1994q4
Honkapohja and Koskela (1999)	●	●			●	●		●		1970-1994
Nymoen and Rødseth (2003)	●				●					1963-1994
Arestis et al. (2007)	●	●	●			●	●		●	1980q4-2002q4
Duval and Vogel (2008)									●	1982-2003
Gianella et al. (2008)	●	●	●	*PMR*				●		1976-2003
Karanassou et al. (2008a)							●			1976-2005

Table 4.5 Variables and periods used to study the NAIRU, Denmark and Finland

Note: *PMR* stands for OECD's measure of Product Market Regulation. Sample periods are annual unless they include a q and the corresponding quarters they cover.

Using a theoretical model, in which demand factors can potentially affect the NAIRU, as our encompassing model, opens us to Nickell's critique that unemployment is always determined by aggregate demand, and consequently finding a long-run relationship between unemployment and aggregate demand factors "tells us *nothing* about which model of unemployment is the most relevant" (Nickell, 1998, p.805), see section 3.3.3 for further details.

We find this argument unconvincing for the several reasons. First, if the researcher aims to test the validity of a range of models empirically, it does not seem appropriate to interpret the results of these tests on the basis of one of the very same models that are being tested. In other words, if we want to test the validity of LNJ's model against that of its critics, it does not seem adequate to interpret the results of our empirical tests based on LNJ's theoretical assumptions. It would be equivalent to assume that LNJ's propositions hold before testing them.

Further, from an econometric perspective Nickell's claim is also hard to justify. This is because in practical terms, it amounts to argue that cointegration between unemployment and unions' power proves that unions affect the NAIRU, but cointegration between productivity and unemployment, "tells us nothing" about the NAIRU. Finally, Nickell's critique seems to be at odds with the accepted methodologies to test embedded or nested models, such as the "general to specific" approach.

4.5 Summary

In this chapter we have formulated the research programme that we develop in the rest of this thesis. We propose a *new* empirical assessment of the NAIRU theories reviewed in Chapter 2. More precisely, we aim to answer the following two questions: First, is the NAIRU exclusively determined by factors exogenous to aggregate demand, as suggested by LNJ? Second, is the NAIRU an anchor for economic activity, as also pointed out by LNJ?

To answer these questions we propose the use of data from eight EU economies, namely the United Kingdom, the Netherlands, Germany, France, Italy, Spain, Denmark and Finland. The data cover the period between 1980 and 2007. Further, we propose to analyse these data using time series techniques and a theoretical model that encompasses the NAIRU theories reviewed in Chapter 2.

The novelty of this programme rests on two pillars. Its most important contribution is the use of the encompassing model denoted by Equations 4.1-4.6. Table 4.1 presents the set of restrictions that each nested model requires to arise from our encompassing model, and constitutes the list of hypothesis to test in coming chapters. The second contribution is the use of data including the period from 2000 to 2007.

Chapter 5 Methodology

5.1 Introduction

In our empirical work, we adopt a time series approach, in particular the "Structural long run modeling" or Cointegrated Vector Autoregressive (CVAR) approach, advanced by Pesaran and Shin (2002). The aim of this chapter is to explain the rational for this choice and to present a technical description of this time series methodology.

The chapter is organized as follows: Section 5.2 explains why we favour time series techniques. Section 5.3 presents a brief overview of specific time series techniques we use, the CVAR model. Section 5.4 discusses how data properties affect our choice of model specification. Section 5.5 presents the cointegration tests used. Section 5.6 discusses the estimation and identification methods used to identify long run relationships. Section 5.7 presents the methods employed to analysis the short-run modeling of our variables. Section 5.8 discusses the use of impulse response functions to complement our analysis. Section 5.9 summarizes the chapter.

5.2 Methodology choices

Before we discuss the particulars of technique employed in our empirical work, it is necessary to explain why we have favoured time series techniques. The first reasons follows from Tables 4.2 to Table 4.5, as discussed above, there is a gap in the time series literature summarized in these tables that is worth bridging.

Second, results from time series studies can be sued to make country specific policy recommendations. The need for individual remedies, is highlighted in the literature for instance in the case of the "Spanish disease" (Dolado and Jimeno, 1997, p.1304). This is not always possible in a panel data, e.g. in the widely cited Bassanini and Duval (2009), conclusions refer to the "average OECD country", p.53.

Third, panel data techniques imposes homogeneity of coefficients across the countries, and as reported in section 3.2.2, this is controversial, and has already led some authors to dismiss panel data studies in favour of time series, for instance Arestis et al. (2007) or Gianella et al. (2008).

Fourth, panel data are subject to the potential error measurement associated with definitions of unemployment. As reported in section 3.2.2, despite OECD's and ILO's efforts to produce standardized unemployment measures, there are reasons to believe they are still subject to local social norms about what constitutes "active job search" and "being employed" (Baker et al., 2007). This problem might also exist in time series studies for large economies, but it is certainly less likely to appear than in a panel of countries.

Finally, time series techniques, in particular cointegration analysis together with Error Correction Mechanisms (ECM), can replicate the division of "temporal horizons" considered in economic theory. By "temporal horizons" we mean that this methodology allows to study what variables determine the long run unemployment equilibrium or NAIRU, but also the influence of this equilibrium on the short run dynamics of unemployment, i.e. it also allows us to study the anchor properties of the NAIRU. The CVAR approach that we propose to use has further virtues that we detail below.

5.3 Long run structural modeling, the CVAR approach

In the analysis of time series it is necessary to start by establishing the properties of the series under consideration, in particular, whether they are stationary, also referred to as integrated of order zero $I(0)$, or whether they have a unit root or integrated of order one $I(1)$. This is far from trivial, because regressing a variable with a unit root on another $I(1)$ variable, can yield spurious results unless these variables are cointegrated. To test the stationary properties of our data we use the ADF-GLS (Elliott et al., 1996) and KPSS tests (Kwiatkowski et al., 1992). In our case, evidence from these tests suggests that all variables are $I(1)$, tests results are reported in Appendix II, and consequently it is necessary to proceed with cointegration analysis.

Here, we follow the Cointegrated Vector Autoregressive (CVAR) approach proposed by Pesaran and Shin (2002). This approach consists of five steps, namely modeling, testing for cointegration, identifying long run relationships, estimating the VECM and Impulse Response functions, simulation of shocks using IR functions.

The main characteristic of this approach is that it imposes theoretically motivated restrictions on the long run relationships existing among a vector of variables, while it leaves their short-run dynamics depicted by an unrestricted VAR system. This makes it very attractive for us because as noted in Table 4.1, the bulk of the hypotheses we aim to test refer to the long run unemployment and real wages equilibria. In fact, the approach presented in Pesaran and Shin (2002), or some earlier versions of this paper, is already used in several studies that examine the determinants of the NAIRU and its anchor properties, such as Arestis and Biefang-Frisancho Mariscal (1998), Arestis and Biefang-Frisancho Mariscal (2000), Palacio et al. (2006) or Arestis et al. (2007).

In the following, our exposition of this methodology draws from Pesaran and Shin (2002) and from its textbook presentation in Pesaran and Pesaran (2003, pp132-139,429-447) and Garrat et al. (2006, Chapter 6).

5.4 Model specification

The starting point of the CVAR approach is the VAR representation of a vector z_t containing k variables that are $I(1)$, described by the following equation:

5.1 $\Delta z_t = C + \Phi_1 \Delta z_{t-1} + \cdots + \Phi_{p-1} \Delta z_{t-p+1} + \Pi z_{t-1} + \lambda x_t + \varepsilon_t$

Where Δz_t is a vector containing the first difference of the k variables contained in z_t. C is a matrix of deterministic components, its composition is not trivial and appropriate discussion of this term is provided below. The matrix Π denotes the influence on Δz_t of the level or long run relationships existing among variables contained in z_t. These long run relationships, are also referred to as cointegrated vectors, we use these two terms indistinctively in the rest of this thesis. X_t is a vector containing h exogenous *I(0)* variables. ε_t is a vector of error terms, Normally and Independently Distributed (NID) satisfying the classical conditions, i.e. $\varepsilon_t \sim NID\ (0, \Sigma)$. The subindex p denotes the lag order of the VAR system, chosen using the standard selection criteria, i.e. AIC and SBC.

Matrix Π is the key element of our analysis, three scenarios are possible depending on its rank denoted by r, but only one is of relevance for us. In the first scenario, the rank of matrix Π is zero $r = 0$. Recall that the rank of Π tells us the number of linear combinations among the variables included in z_t, that are stationary, i.e. the number of cointegrated vectors that exist among these variables. Hence, finding $r = 0$ means that there are no cointegrated vectors among the k variables contained in z_t. In this case 5.1 reduces to a VAR*(p-1)* model for Δz_t.

In the second scenario, the rank of matrix Π is $r = k$, in this case Π is said to be full rank. This means that there are k linear combinations among the k variables contained in z_t that are stationary, which suggest that each variable is stationary rather than $I(1)$. In this case, 5.1 can be re-written as a VAR*(p)* model for z_t. In the third case, and this is the relevant case for us, the rank of matrix Π, is $r < k$, in this case Π is said to be rank deficient. This means that there are r linear combinations that are stationary among the k variables contained in z_t, or r cointegrated vectors. This is the interesting case for us because then Π can be decomposed as follows: $\Pi = \gamma\beta'$ where γ is a (Kxr) matrix and β' is a (rxk) matrix. Hence, Πz_{t-1} can be rewritten as follows $\Pi z_{t-1} = \gamma\beta' z_{t-1}$, where $\beta' z_{t-1}$ denote the long run relations or cointegrated vectors that exist among z_t variables and γ denote the impact on each of these long run relations over short-run dynamics of z_t, i.e. Δz_t.

Finding the rank of Π is key for our analysis, but before presenting the tests that can help us to find out about the rank of Π, we need to discuss the composition of C and customize this general notation for the purpose of our research. Depending on what combination of intercepts and time trends C contains, and whether these intercepts and time trends belong to the short-run dynamics of z_t or to its long run relationships we can differentiate five cases, summarized by the following equations:

5.2 $$\Delta z_t = \Phi_1 \Delta z_{t-1} + \cdots + \Phi_{p-1} \Delta z_{t-p+1} + \Pi z_{t-1} + \lambda x_t + \varepsilon_t$$

5.3 $$\Delta z_t = \Phi_1 \Delta z_{t-1} + \cdots + \Phi_{p-1} \Delta z_{t-p+1} + \Pi_* z^*_{t-1} + \lambda x_t + \varepsilon_t$$

Where $\Pi_* = [\Pi, c_0] = \Pi[\mathrm{I_k}, -\mu]$

$$z^*_{t-1} = \begin{bmatrix} z_{t-1} \\ 1 \end{bmatrix}$$

5.4 $$\Delta z_t = c_0 + \Phi_1 \Delta z_{t-1} + \cdots + \Phi_{p-1} \Delta z_{t-p+1} + \Pi z_{t-1} + \lambda x_t + \varepsilon_t$$

5.5 $$\Delta z_t = c_0 + \Phi_1 \Delta z_{t-1} + \cdots + \Phi_{p-1} \Delta z_{t-p+1} + \Pi_* z^*_{t-1} + \lambda x_t + \varepsilon_t$$

Where $\Pi_* = [\Pi, c_1] = \Pi[\mathrm{I_k}, -\delta]$

$$z^*_{t-1} = \begin{bmatrix} z_{t-1} \\ T \end{bmatrix}$$

5.6 $$\Delta z_t = c_0 + c_1 t + \Phi_1 \Delta z_{t-1} + \cdots + \Phi_{p-1} \Delta z_{t-p+1} + \Pi z_{t-1} + \lambda x_t + \varepsilon_t$$

In Case *I*, denoted by 5.2, $C = 0$, C does neither contain intercepts nor deterministic trends. Case *II*, denoted by 5.3, $C = c_0$ and $c_0 = -\Pi\mu$ where μ is a $(kx1)$ vector of unknown coefficients. In this case C only contains interceptas that belongs (or are restricted) to the long run relationships rather than the short-run dynamics. Case *III*, denoted by 5.4, $C = c_0$ and $c_0 \neq -\Pi\mu$. In this case, C only contains an intercept that belongs to the short-run dynamics. Case *IV*, denoted by 5.5, $C = c_0 + c_1 T$, $c_0 \neq -\Pi\mu$ and $c_1 = -\Pi\delta$ where δ is a $(kx1)$ vector of unknown coefficients. In this case, C contains both intercepts and time trends, the time trends belongs (or are restricted) to the long run relationships, while the intercepts remain unrestricted and belongs to the short-run dynamics. Case *V*, denoted by 5.6, $C = c_0 + c_1 T$, $c_0 \neq -\Pi\mu$ and $c_1 \neq -\Pi\delta$. In this case, C contains intercepts and time trends both belonging to the short-run dynamics.

The appropriate choice among these specifications depends upon the characteristics of variables contained in z_t. Pesaran et al. (2000)[31] show that when matrix Π is rank deficient, using unrestricted versions such as case III and V, i.e. 5.4 and 5.6, generate quadratic trends in z_t, in a number that depends upon how many cointegrated vectors exist among these variables. Hence, to avoid this problem they recommend to adopt Case II, i.e. equation 5.3, when variables in z_t do not contain deterministic trend, and to adopt Case IV, i.e. equation 5.5, when variables in z_t have a deterministic trend.

In order to better illustrate the usefulness of this techniques for our research purpose, let's customize the above notation according to variables of relevance

[31] See also Pesaran and Pesaran (2003, p.135,p.432)

for our theoretical model. In our case, z_t contains nine variables which form a $(9x1)$ vector as follows[32]:

$$z_t = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ mil_t \\ k_t \\ i_t - \Delta p_t \end{pmatrix}$$

Some of these variables seem to have a time trend, see Appendix II, hence, in order to avoid the problem of quadratic trends highlighted above, in our empirical work we adopt Case's IV specification, i.e. equation 5.5, where z_{t-1}^* contains all the variables from z_t plus a time trend T:

$$z_{t-1}^* = \begin{bmatrix} z_{t-1} \\ T \end{bmatrix}, \qquad z_t^* = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ mil_t \\ k_t \\ i_t - \Delta p_t \\ T \end{pmatrix}$$

Further, considering the composition of z_t and z_t^*, and assuming that $\Pi_*$is rank deficient[33], i.e. $\Pi_* = [\Pi, c_1] = [\gamma\beta', c_1]$, we can now rewrite equation 5.5 using the notation from our theoretical model as follows:

$$5.7 \qquad \begin{pmatrix} \Delta(w_t - p_t) \\ \Delta(y_t - l_t) \\ \Delta u_t \\ \Delta lu_t \\ \Delta grr_t \\ \Delta t_t^w \\ \Delta mil_t \\ \Delta k_t \\ \Delta(i_t - \Delta p_t) \end{pmatrix} = c_0 + \Phi_1 \Delta z_{t-1} + \cdots + \Phi_{p-1} \Delta z_{t-p+1} + \gamma\beta' \begin{pmatrix} w_{t-1} - p_{t-1} \\ y_{t-1} - l_{t-1} \\ u_{t-1} \\ lu_{t-1} \\ grr_{t-1} \\ t_{t-1}^w \\ mil_{t-1} \\ k_{t-1} \\ i_{t-1} - \Delta p_{t-1} \\ T \end{pmatrix} + \lambda x_t + \varepsilon_t$$

Where c_0 is $(9x1)$ vector of intercepts, according to our encompassing model there are two long run relationships among the variables contained in z_t, denoted by equation 4.4 and 4.5, hence *a priori* we expect β' to be a $(2x10)$ matrix of coefficients, where each row denotes the coefficients that each variable takes in each of these two long run relations. Further, accordingly we expect γ to be a $(9x2)$ matrix, of coefficients capturing the impact of each of these two long run relations over the short-run dynamics of each variable in Δz_t, hence $\gamma\beta' z_{t-1}^*$ can also be written as follows:

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[32] Due to data limitation discussed in Chapter 6, In the case of Germany z_t is a $(8x1)$ vector described as follows $z_t = \left(w_t - p_t, y_t - l_t, u_t, lu_t, grr_t, t_t^w, k_t, i_t - \Delta p_t\right)'$. Consequently, for this country, we expect β' to be a $(2x8)$ matrix and γ a $(8x2)$ matrix.

[33] Recall that otherwise, there are no long run relationships among our variables.

$$\gamma\beta' z_{t-1}^{*} = \begin{pmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \\ \gamma_{31} & \gamma_{32} \\ \gamma_{41} & \gamma_{42} \\ \gamma_{51} & \gamma_{52} \\ \gamma_{61} & \gamma_{62} \\ \gamma_{71} & \gamma_{72} \\ \gamma_{81} & \gamma_{82} \\ \gamma_{91} & \gamma_{92} \end{pmatrix} \begin{pmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} & \beta_{16} & \beta_{17} & \beta_{18} & \beta_{19} & \beta_{110} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} & \beta_{26} & \beta_{27} & \beta_{28} & \beta_{29} & \beta_{210} \end{pmatrix} \begin{pmatrix} w_{t-1} - p_{t-1} \\ y_{t-1} - l_{t-1} \\ u_{t-1} \\ lu_{t-1} \\ grr_{t-1} \\ t^{w}{}_{t-1} \\ mil_{t-1} \\ k_{t-1} \\ i_{t-1} - \Delta p_{t-1} \\ T \end{pmatrix}$$

Finally, x_t is a column vector with $q + j$ rows composed of exogenous stationary variables, such as those capturing the effect of external shocks Δp_{t-q}^{vm}, and stationary dummy variables D_j, which accommodate serial correlation and/or outliners problems. We decompose x_t as follows:

$$\mathrm{x}_t = \begin{pmatrix} \Delta p_{t-1}^{vm} \\ \vdots \\ \Delta p_{t-q}^{vm} \\ D_1 \\ \vdots \\ D_j \end{pmatrix}$$

Where Δp_{t-q}^{vm} denotes the last lag of a variable that captures the evolution of real imported raw materials inflation, and D_j is the j^{th} dummy variable considered. The specific lag structure of Δp_{t-q}^{vm} and the necessary number of dummies is an empirical issue and is left undefined at this stage. Accordingly, λ is a matrix of $(9x[q + j])$ capturing the effect of each of the variables in x_t over Δz_t. Finally ε_t is a $(9x1)$ matrix of error terms.

5.5 Cointegration test

We turn now to the discussion of statistical tests that can help us determine the rank of matrix Π, that is, to find how many cointegrated vectors exist among our variables. For this purpose, we use the well-known Johansen's approach and employ the Maximum eigenvalue test λ_{max} and the Trace test λ_{trace}. Both test are sequential, they start with the null hypothesis of $r = 0$, if rejected then a new null hypothesis of $r \leq 1$ is tested, and again if rejected a new null hypothesis of $r \leq 2$ is tested. This process continues until we fail to reject the corresponding null hypothesis. Formally, under the null that rank of matrix Π is equal to r_0, H_0: $r \leq r_0$:

$$\lambda_{max}(r_0) = -nlog\left(1 - \hat{\lambda}_{r_0+1}\right)$$

$$\lambda_{trace}(r_0) = -n \sum_{i=r_0+1}^{k} log\left(1 - \hat{\lambda}_i\right)$$

Where n is the number of observation, $\hat{\lambda}_{r_0+1}$ and $\hat{\lambda}_i$ are the eigenvalues of higher order for which $\left(1 - \hat{\lambda}_{r_0+1}\right)$ and $\left(1 - \hat{\lambda}_i\right)$ are zero. For a further technical details see Pesaran and Pesaran (2003, p329) and Garrat et al. (2006,p.122). Critical values for these tests depend upon the specification chosen for C, hence in our case we consider the critical values corresponding to Case IV.

Finally, two caveats need to be taken into consideration when interpreting the results from the Maximum Eigenvalue and Trace tests: First, the results from these tests tend to be contradictory (Pesaran and Pesaran, 2003,p.293). Second, inference needs to be carried with care, because their critical values are computed using asymptotic theory, and they might lead to erroneous conclusions in finite samples (Garrat et al., 2006,p. 140). On this regard, Cheung and Lai (1993) find that in finite samples, the size of the test, i.e. the probability of rejecting the null hypothesis when it is correct, increases with the number of variables considered and the lag order of the system. Further, in the same paper it is also shown that size of the tests increase when some of the original assumptions are breached. In particular, when the residuals from equations used to compute the test, in our case equation 5.7, are not normally distributed and when the data generating process is a moving average rather than an autoregressive process. This size biases, could lead to the conclusion that there are more cointegrated vectors than actually exist.

In our analysis, we encounter these problems when using the Maximum Eigenvalue and Trace tests in Chapter 7 to Chapter 10. To overcome these short-comings, we follow the advice of Pesaran and Pesaran (2003,p.293) and Garrat et al. (2006, p.198) who suggest that when using finite samples, the researcher needs to interpret the results from the tests together with economic theory, that is, make an overall judgment weighting the tests' results against their biases in finites samples and the predictions from economic theory.

5.6 Identifying the long run relationships

The Maximum eigenvalue and the Trace tests provide information regarding the number of cointegrated vectors among the variables contained in z_t. But they do not provide any information with regard to the composition of those cointegrated vectors, i.e. what variables are contained in each of them. Formally, this can be shown by noting that different γ and β, can generate the same matrix Π, in other words, the eigenvalue and trace test tell us the space in which matrix β and γ span, its dimensions, but not their composition. In order to obtain unique values for matrix β and γ we need to impose some form of normalization over β.

Following Pesaran and Shin (2002), we draw the identifying restrictions from our theoretical model and use the Likelihood Ratio (LR) test they provide to assess the validity of these restrictions. This type of identification process is in contrast to those proposed by Johansen (1988), Phillips (1991), Johansen (1991), in which identifying schedules are based on their statistical properties. Our approach has the advantage that it delivers estimates of the long run relationships that are economically meaningful. Furthermore, Pesaran and Shin (2002) theoretically driven approach provides an excellent framework to test the restrictions over the NAIRU and the long run real wages equilibrium that the models embedded in our encompassing model require. Hence, we can treat each set of restrictions as a separate identifying schedule and then test their significance using the Likelihood Ratio (LR) test.

Let's now explain how we device these identifying schedules. We need r^2 restrictions to just identify r long run relationships. According to our encompassing model there are two cointegrated vectors among the variables contained in z_t, the first denote by equation 4.4 illustrates a long run relationships between unemployment and a set of variables, which we can interpret as the NAIRU given the long run nature of the relationship they share with. The second denotes by equation 4.5 illustrates a long run relationships between real wages and a set of variables, which we can interpret as the real wages long run equilibrium.

Hence, given our *a priori* of $r = 2$ we need four just-identifying restrictions: We identify equation 4.4 in the first cointegrated vector and equation 4.5 in the second cointegrated vector by impose two normalization restrictions $\beta_{13} = 1$ and $\beta_{21} = 1$, and two exclusion restrictions $\beta_{23} = 0$ and $\beta_{11} = 0$. These restrictions ensure that in the first vector we identify the variables that are cointegrated with unemployment, and in the second, the variables which are cointegrated with real wages. This just-identified β matrix is denoted by β_{JI} in the second column of Table 5.1. The matrix β_{JI} can be thought as the version of the matrix β that describes our encompassing model.

Then we introduce in turn, the sets of restrictions that each of the theoretical model embedded in our encompassing model require. For that purpose we draw from the restrictions from rows *iv)* to *vii)* of Table 4.1: First, the restrictions suggested by LNJ, denoted by β_{LNJ} in Table 5.1, on the one hand, $\beta_{12} = \beta_{14} = \beta_{18} = \beta_{19} = 0$ implying that productivity, long term unemployment, capital stock and real long term interest rates have no impact on unemployment's cointegrated vector.

On the other hand, $\beta_{24} = \beta_{28} = \beta_{29} = 0$ imply that neither long term unemployment, nor capital stock nor real interest rates have an effect over the real wage equilibrium. Further, indicating long run unit-proportionality between real wages and productivity, we impose $\beta_{22} = -1$. Finally, in this model there is no suggestion that neither the NAIRU nor the real wages equilibrium have a time trend, therefore we add restrictions $\beta_{110} = 0$ and $\beta_{210} = 0$. This is generally referred to the cotrending hypothesis, because in the event it held, it means that variables in the cointegrated vector share a non-deterministic trend or co-trend together as in opposite to trending along a time trend. Recall that these trends are included because some variables seem to have a time trend and it followed from modeling rather than from theoretical considerations.

z_t^*	β_{JI}		β_{LNJ}		β_{BS}		β_{ASR}		β_{RH}	
$w_t - p_t$	0	1	0	1	0	1	0	1	0	1
$y_t - l_t$	β_{12}	β_{22}	0	-1	0	-1	β_{12}	-1	0	-1
u_t	1	0	1	0	1	0	1	0	1	0
lu_t	β_{14}	β_{24}	0	0	β_{14}	β_{24}	0	0	0	0
grr_t	β_{15}	β_{25}	β_{15}	β_{25}	β_{15}	β_{25}	β_{15}	β_{25}	β_{15}	β_{25}
t_t^w	β_{16}	β_{26}	β_{16}	β_{26}	β_{16}	β_{26}	β_{16}	β_{26}	β_{16}	β_{26}
mil_t	β_{17}	β_{27}	β_{17}	β_{27}	β_{17}	β_{27}	β_{17}	β_{27}	β_{17}	β_{27}
k_t	β_{18}	β_{28}	0	0	0	0	β_{18}	β_{28}	0	0
$i_t - \Delta p_t$	β_{19}	β_{29}	0	0	0	0	0	0	β_{19}	β_{29}
T	β_{110}	β_{210}	0	0	0	0	0	0	0	0

Table 5.1. Theoretically motivated identifying restrictions for the matrix $\boldsymbol{\beta}$

Second, the restrictions inspired by the labour market hysteresis approach (Blanchard and Summers, 1986), which corresponds to β_{BS} in Table 5.1. The meaning of the restrictions would be as above. Third, we introduce the restrictions required by the claims about productivity and capital stock made by Rowthorn (1995) and Arestis and Sawyer (2005), which corresponds to β_{ASR} in Table 5.1. The meaning of the restrictions would be as above. Finally, we introduce the restrictions inspired by the claims about real long term interest rates (Rowthorn, 1999, p.422, Hein, 2006), which corresponds β_{RH} in Table 5.1. The meaning of the restrictions would be as above. Further, β_{BS}, β_{ASR} and β_{RH} also include the cotrending hypothesis, as none of these model suggests that neither the NAIRU nor the real wages equilibrium have a time trend. Finally, it should be noted that the coefficients for grr_t, t_t^w and mil_t are left unrestricted in β_{BS}, β_{ASR} and β_{RH} because these models do not deny that exogenous factors can affect the NAIRU.

The validity of each set of restrictions can then be tested using the following Likelihood Ratio (LR) test:

$$LR(\beta' = \beta'_q) = 2\left(ll_{r^2} - ll_q\right) \sim X^2_{LR}(q - r^2)$$

Where $\beta' = \beta'_q$ denotes the null hypothesis that matrix β' is equal to a restricted version of it with q over-identifying restrictions. ll_{r^2} is the maximum value of the log-likelihood function obtained under r^2 just identified restrictions. ll_q is the maximum value of the log-likelihood function obtained under q over-identifying restrictions (Pesaran and Shin, 2002). See also Pesaran and Pesaran (2003, p.443) or Garrat et al. (2006, p.128).

This approach has a number of practical difficulties that need to be addressed. First, estimated coefficients are obtained using a Maximum Likelihood (ML) function. It is well documented that this methodology is extremely sensitive, and it is not always possible to obtain converging results (Pesaran and Pesaran, 2003). Garrat, et al. (2006, p. 199) advices to introduce over identified restrictions with a meaningful sequence, to make the most of the information contained in the data. In our analysis, we encounter this problem in several occasions, and following their advice we experiment introducing the same set of restrictions following different sequences.

5.7 The Short run dynamics: VECM

Having identified the matrix β' of long run coefficients from $\Pi_* = [\gamma\beta', c_1]$, we turn now to the estimation of γ. Let's start by denoting ξ_{t-1} as the lagged error term from our cointegrated vectors or long run errors, hence:

5.8
$$\xi_{t-1} = \begin{pmatrix} \xi_{1,t-1} \\ \xi_{2,t-1} \end{pmatrix} = \begin{pmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} & \beta_{16} & \beta_{17} & \beta_{18} & \beta_{19} & \beta_{110} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} & \beta_{26} & \beta_{27} & \beta_{28} & \beta_{29} & \beta_{210} \end{pmatrix} \begin{pmatrix} w_{t-1} - p_{t-1} \\ y_{t-1} - l_{t-1} \\ u_{t-1} \\ lu_{t-1} \\ grr_{t-1} \\ t^{w}{}_{t-1} \\ mil_{t-1} \\ k_{t-1} \\ i_{t-1} - \Delta p_{t-1} \\ T \end{pmatrix}$$

In the first row, $\xi_{1,t-1}$ accounts for errors from the first cointegrated vector, whereas, in the second row $\xi_{2,t-1}$, denotes the errors from the second long run relationship. By plugging equation 5.8 into 5.7, and expanding the matrix γ we obtain what is generally referred to as the Vector Error Correction Model (VECM) formulation of our empirical specification, here denoted by the following equation:

5.9
$$\begin{pmatrix} \Delta(w_t - p_t) \\ \Delta(y_t - l_t) \\ \Delta u_t \\ \Delta lu_t \\ \Delta grr_t \\ \Delta t_t^w \\ \Delta mil_t \\ \Delta k_t \\ \Delta(i_t - \Delta p_t) \end{pmatrix} = c_0 + \Phi_1 \Delta z_{t-1} + \cdots + \Phi_{p-1} \Delta z_{t-p+1} + \begin{pmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \\ \gamma_{31} & \gamma_{32} \\ \gamma_{41} & \gamma_{42} \\ \gamma_{51} & \gamma_{52} \\ \gamma_{61} & \gamma_{62} \\ \gamma_{71} & \gamma_{72} \\ \gamma_{81} & \gamma_{82} \\ \gamma_{91} & \gamma_{92} \end{pmatrix} \begin{pmatrix} \xi_{1,t-1} \\ \xi_{2,t-1} \end{pmatrix} + \lambda x_t + \varepsilon_t$$

The Interest in this formulation resides in the fact that equation 5.9 describes the vector Δz_t as a function of a vector of long run errors ξ_{t-1} sometimes referred to as Error Correction Mechanism (ECM) terms, hence the name VECM for this formulation. The rest of terms have the same meaning as in 5.7. In our case, considering that $\xi_{1,t-1}$ accounts for the error term from the first cointegrated vector, in which we aim to identify the variables that share a long run relationship with unemployment, i.e. the NAIRU. We can interpret these errors as deviations from the NAIRU. Hence, the first column of coefficients in γ tells us about the impact of these deviations over the variables in Δz_t. Similarly, $\xi_{2,t-1}$ can be interpreted as deviations of real wages from their long run equilibrium. Therefore, the second column of coefficients of γ, tells us about the impact of these deviations over the variables in Δz_t.

The matrix of coefficients γ can easily be estimated by estimating equation 5.9 using the standard Ordinary Least Square (OLS) procedure, because all these components in this equation are stationary: Since z_t is a vector of $I(1)$

variables, the vector of its first difference Δz_t can only contain $I(0)$ variables, similarly with lags of Δz_t. The components of ξ_{t-1} are also $I(0)$ because they describe the errors of two cointegrated vectors, which by definition are stationary. Finally, x_t is a vector of $I(0)$ variables by construction. Thus, equation 5.9 can be estimated by OLS without risk of estimating a spurious regression.

The matrix formulation from equation 5.9 summarizes nine equations, one for each of the nine variables included in Δz_t, we are particularly interested in Δu_t, here reproduced for the sake of clarity:

5.10 $$\Delta u_t = c_{30} + \Phi_1 \Delta z_{t-1} + \cdots + \Phi_{p-1} \Delta z_{t-p+1} + \gamma_{31} \xi_{1,t-1} + \gamma_{32} \xi_{2,t-1} + \lambda x_t + \varepsilon_t$$

Equation 5.10 describes unemployment dynamics as a function of an intercept c_{30}, lagged values of the first differences of variables contained in Δz_t, the vector x_t of lagged imported raw materials inflation and dummy variables. And crucially the long run errors from the unemployment cointegrated vector $\xi_{1,t-1}$ and the real wages cointegrated vector $\xi_{2,t-1}$, which can be interpreted as deviations from the NAIRU and the real wages long run equilibrium. Hence, equation 5.10 can be used to assess the impact of deviations from the NAIRU over unemployment dynamics Δu_t, in particular to assess if these deviations generate corrective movements over Δu_t, meaning that the NAIRU serve as an anchor for actual unemployment.

It can readily be argued that 5.10 is the empirical counterpart of equation 4.6. Where γ_{31} tell us the effect of deviations from the NAIRU over Δu_t: If $\gamma_{31} < 0$ deviations from the NAIRU in $t-1$ provoke changes of actual unemployment in t in the opposite direction. For instance, when unemployment grows above the long run in $t-1$ it provokes a reduction of actual unemployment in t which corrects the deviation, and vice versa. Hence, the sign of γ_{31} tells us whether unemployment gravitates around the NAIRU or not. The intensity of the anchor can be evaluated by the size of the coefficient, for instance, if $\gamma_{31} = -1$, it means that 100% of the unemployment deviation from the NAIRU occurred in $t-1$, is corrected for in the following period. In this case, the NAIRU is a very strong anchor. Hence, testing $\gamma_{31} = -1$ in equation 5.10 is the empirical counterpart of the restrictions in row *viii)* of Table 4.1.

5.8 Impulse response analysis

We complete our analysis estimating and plotting the Generalized Impulse Response (GIR) functions of the variables contained in the vector z_t. GIR functions allow us simulating the response of z_t to a shock equivalent to one standard deviation of the error term in one of the equations in 5.9, this is sometimes referred to as unit shock. Hence, plots of the GIR function present the researcher with a diagrammatical illustration of the effects of a shock. For technical details of GIR in a CVAR systems like the one considered here see Pesaran and Pesaran (2003, p.427) or Garrat et al. (2006, p.142).

In our case, we simulate an unemployment shock equivalent to one standard deviation of the error term in equation 5.10, denoted by $\sigma_{\hat{\varepsilon}_3}$. The purpose is to gather further evidence of the anchor properties of the NAIRU to complement the VECM results. If we observe that unemployment returns quickly to its pre-shock level, we can infer that the NAIRU acts as a strong anchor for unemployment. On the contrary, if unemployment drifts away from its baseline, we can infer that the NAIRU has no anchor power at all, or that this is very limited.

5.9 Summary

This chapter provides a technical description of the CVAR approach employed in this thesis and illustrates its usefulness to answer our research questions. The main characteristic of this approach is that it imposes theoretically motivated restrictions, on the long run relationships existing among a vector of variables, while it leaves their short-run dynamics unrestricted. This makes it very attractive for us, because the bulk of the hypotheses we aim to test refer to the NAIRU and the long run real wages equilibria, which are long run relationships by definition.

Table 5.1 summarizes the restrictions that we aim to impose on the long run relationships, this draws from the restrictions to the reduced form equations of Table 4.1, which summarize the restrictions that each model embedded into our encompassing model requires. Hence, by testing the restrictions in Table 5.1 we can assess the validity of the claims made by each of these nested models with regard to the NAIRU determinants.

Further, the VECM formulation of the CVAR, in particular its equation for Δu_t denoted by equation 5.10, allows us to test the impact of deviations from the NAIRU on unemployment dynamics to assess the anchor properties of the NAIRU. This can be regarded as the empirical counterpart of equation 4.6, and hence can be used to test the hypothesis over the anchor properties of the NAIRU from Table 4.1.

Chapter 6 Data

6.1 Introduction

The purpose of this chapter is to present the key features of the data used in this thesis. We start with a general overview of the data that discusses its geographic and time scope. Then we turn to the specifics of the variables employed in our analysis and provide details of their sources and definitions. This includes a discussion of interpolation methods used. Finally, we inspect visually the relevant variables and discuss the key features of their evolution in our sample period.

The chapter is structured as follows: Section 6.2 gives a birds-eye view of our data. Section 6.3 provides details of the variables' definitions and sources. Section 6.4 discusses issues regarding the interpolation methods employed. Section 6.5 presents figures for all the variables. Section 6.6 closes the chapter with a summary of its content.

6.2 Data overview

Our data comprises eight country data sets, one for each of the eight EU member states studied here: The UK, the Netherlands, Germany, France, Italy, Spain, Denmark and Finland. Data are quarterly and cover the period from 1980 to 2007 with some country variations that we discuss below. Table 6.1 provides a snap shoot of each of these eight country data sets:

	UK	**Netherlands**	**Germany**	**France**	**Italy**	**Spain**	**Denmark**	**Finland**
Variables	*w-p*	*w-p*	*w-p*	*w-p*	*w-p*	*w-p*	*w-p*	*w-p*
	y-l	*y-l*	*y-l*	*y-l*	*y-l*	*y-l*	*y-l*	*y-l*
	u	*u*	*u*	*u*	*u*	*u*	*u*	*u*
	lu	*lu*	*lu*	*lu*	*lu*	*lu*	*lu*	*lu*
	grr	*grr*	*grr*	*grr*	*grr*	*grr*	*grr*	*grr*
	t^w	t^w	t^w	t^w	t^w	t^w	t^w	t^w
	mil	*mil*		*mil*	*mil*	*mil*	*mil*	*mil*
	k	k	k	k	k	k	k	k
	$i-\Delta p$	$i-\Delta p$	$i-\Delta p$	$i-\Delta p$	$i-\Delta p$	$i-\Delta p$	$i-\Delta p$	$i-\Delta p$
	p^{vm}	p^{vm}	p^{vm}	p^{vm}	p^{vm}	p^{vm}	p^{vm}	p^{vm}
Dummy	$D05q4$					$D87q4$		$D97q123$
Sample's Start point:	1984q1	1987q1	1992q4	1980q1	1983q4	1980q1	1990q1	1988q1
End point:	2007q4	2007q4	2007q4	2004q4	2007q4	2007q4	2007q4	2007q4
Number of observations:	96	84	61	100	97	112	72	80

Table 6.1. Time and geographical span of each country's data set

Each country data set contains the following variables (in logs): real wages $w-p$, labour productivity $y-l$, unemployment u, long term unemployment lu, a measure of unemployment benefits grr, the tax wedge t^w, a measure of unions' power mil, capital stock k, long term real interest rates $i-\Delta p$ and a measure of real cost of imported raw materials p^{vm}. The datasets of the UK, Spain and Finland also include a dummy variable denoted by $D05q4$, $D87q4$

and $D97q123$ respectively, which control for one-off exceptional events. A detail description of all variables is provided in the next section.

The span of the data set varies from country to country: Spain, France, Italy and the UK have the longest data spans with above or around a hundred observations. The Netherlands and Finland also have reasonably large datasets with eighty or above observations. Denmark and Germany have the smallest data sets, with only seventy-two and sixty-one observations respectively.

The start point is determined in all cases by data availability. It is worth mentioning that in the case of Germany this is strictly determined by the availability of consistent data for reunified Germany[34]. The last observation corresponds to the fourth quarter of 2007 for the countries except for France, whose data set ends in 2004. This is due to a break in the tax-wedge series for the French economy, which we cannot correct for, further details on this issue are provided in section 6.3.6. The end point of our data sets coincides with the beginning of the ongoing economic crisis in the turn from 2007 to 2008.

Most of the data come from OECD's sources and Eurostat's statistical office, although we also use data from the IMF statistical offices.

6.3 Variable definitions and sources

6.3.1 Real wages

Real wages $w - p$: Difference between logarithm of nominal average wage w and the logarithm of Consumer Price Index (CPI) denoted by p. Logarithm of nominal average wage (w) is computed by taking the logarithm of the ratio between the "compensation of employees" (CE) component of GDP over total employment (TE).

CE is a nominal, seasonally adjusted variable measured in millions of National currency units, which is defined as: "Total remuneration, in cash or in kind, payable by an employer to an employee in return for work done by the latter during the accounting period. Compensation of employees is broken down into: a) wages and salaries: wages and salaries in cash; wages and salaries in kind; b) employers' social contributions: employers' actual social contributions; employers' imputed social contributions" (Eurostat, 2010). CE is downloaded from Eurostat statistical postal (Eurostat, 2010), [d1] in the publishers code system.

TE is a labour force survey measure of employment which includes armed forces (conscripts as well as professional military), with some exception: Figures for Germany and Denmark are based on the National Accounts. In the

[34] We contemplated the possibility of linking this data set with pre-reunification data. However, the time cost of data search was greater than the gains, which seemed marginal in a study which already considered another seven countries.

French case, INSEE provides quarterly series on civilian employment, which are added to armed forces figures by OECD (2009). *TE* data are downloaded from OECD's Economic Outlook no.86 (OECD, 2009).

p is the log of the Consumer Price Index (base=2005), for all items and the whole economy, published by OECD in their statistical portal (OECD, 2010d). It is worth noting that CPI index is based on the national definition as oppose to the Harmonized Consumer Price Index (HCPI) produced by Eurostat, which is only available for a shorter sample period.

Further, it should be noted that this measure of real wages is created following the definition of "*real compensation*" published in OECD's Economic Outlook, which is calculated by taking the "ratio of all wages and salaries paid to wage earners plus all non-wage labour costs paid by employers (e.g. to unemployment insurance, social security, pensions) to the number of employees" OECD (2009, table 11). The rationale to follow this definition is that it is used in similar studies, for instance Arestis et al. (2007) and Karanassou et al. (2008a).

6.3.2 Productivity

Productivity $(y - l)$: (logarithm) of the ratio of real GDP over total employment $log\left[\left(\frac{GDP}{CPI}\right)/TE\right]$. Where GDP is the nominal, seasonally adjusted Gross Domestic Product measure in millions of National currency units published by Eurostat (2010), [b1gm] in the publishers code system. Real GDP is calculated by deflating this nominal measure of GDP using the CPI measure described above. Finally, *TE* is the total employment measure also described above.

6.3.3 Unemployment

Unemployment rate u: (logarithm) of unemployment rates based on Labour Force Surveys according to Eurostat's procedures to derive the Harmonized Unemployment Rates (HURs). Data downloaded from OECD's (2009) Economic Outlook no.86. [UNR] as per OECD's code system. This measure of unemployment is widely used in the literature, see for instance Nickell et al. (2005), Arestis et al. (2007) or Bassanini and Duval (2009).

The rationale to use the logarithm of the unemployment rate, rather than the rate itself, follows from the fact that using rates –in preliminary estimations- we encountered multiple non-converging problems when estimating the long run coefficients. This is typical of Maximum Likelihood estimations, see section 5.5. In our case, using logs of all variables, including logarithm of the unemployment rate alleviated this problem considerably and we adopt this manipulation. This has the upshot that estimates can be interpreted as elasticities.

A measure of the NAIRU, or a proxy for structural unemployment such as six or five years average, is sometimes employed in panel data studies that address the same questions as this thesis, see for instance Nickell (1998), Blanchard and Wolfers (2000) or Stockhammer and Klar (2008). Using cointegration analysis this is unnecessary, because cointegration allows us to identify long run relationships, and a variable that has a long run relationship with unemployment must influence the NAIRU, see for instance Arestis et al. (2007) or Schreiber (2012).

6.3.4 Long-term unemployment

Long-term unemployment lu: (logarithm) of ratio of long term unemployed workers (TLU) over total number of unemployed workers (TU) multiplied by one hundred. TLU is the number of unemployed workers that have been out of work for 52 weeks (one year) or more. Data are downloaded from the Labour Force Surveys reported in OECD statistical portal (OECD, 2010d). TU is the headcount measure of OECD's [UNR] described above, i.e. it measures the number of unemployed workers in thousands. A similar procedure is followed in the literature to generate a long-term unemployment variable, see Layard et al. (1991, p.422).

Data for long-term unemployment is only available with annual frequency and linear interpolation is used to obtain quarterly observations. Further details on the interpolation method are provided in the section 6.3.11.

6.3.5 Unemployment benefits

Unemployment benefits grr: (logarithm) of OECD's "*Gross Replacement Rates*" calculated as the ratio between out-of-work benefits and in-work earnings times hundred.

Benefits are computed considering a worker of 40 years old, who has continuously worked since s/he was 20 years old, and therefore s/he is fully entitled to maximum benefits, and considering her/his family situations (single, with dependent spouse, and with spouse in work) and three duration categories (first year, second and third year, fourth and fifth year), which gives place to nine levels of unemployment benefits.

The in-work earnings measure is the Average Production Worker (APW) wages defined by OECD as workers in ISIC industry sector D, i.e. manufacturing. Two levels of earnings are considered 100% and 67% of APW. Each of the nine benefit levels are divided by the two earnings measures delivering eighteen replacement rates which are then averaged into the single measure used here. Data are downloaded from OECD (2010a). For further details in the computation procedure of these variables see Martin (1996) and OECD (1994, Chapter 8).

Data for Gross Replacement rates are only available with biannual frequency and linear interpolation is necessary to obtain quarterly data, see section 6.3.11.

6.3.6 Tax-wedge

Tax-wedge t^w: (logarithm) of OECD's "*Tax-wedge (old definition)*" linked with OECD's *Tax-wedge (new definition)*. In both cases, old and new definition, the tax-wedge is calculated as the ratio of taxation paid by workers over average labour costs.

Taxation includes the income tax, employees and employer's social security[35] minus cash transfers corresponding to a worker earning 100% of average wages, under two different family situations (single no children and married couple with one earner and two children). Labour cost includes gross earnings and employers social contribution corresponding to a worker earning 100% of average wages. The following formula summarizes these calculations:

$$t^w = log\left(\frac{income\ tax + employee's\ social\ security + employer'social\ security - cash\ transfers}{gross\ earnings + employer\ social\ security}\right)$$

Following the procedure employed by OECD in computing the grr, we average the two tax-wedges depending on family situation to obtain a summary indicator. Annual series for the Tax-wedge *(old definition)*, with annual frequency, were kindly provided by Bert (2009) from the Tax Policy and Statistics Division (Centre for Tax Policy and Administration, OECD), while the Tax-wedge *(new definition)*, also with annual frequency, are downloaded from OECD statistical portal (OECD, 2010d). Data for tax-wedge are only available with annual frequency and linear interpolation is employed to obtain quarterly data, see section 6.3.11.

There are only two differences between the Tax-wedge *(old definition)* and the Tax-wedge *(new definition)* (OECD, 2005c): First, the time span they cover, the old definition covers the period 1980 to 2004 whereas the new definition only covers the period between 2000 and 2007. Second, the earnings measure considered, *old definition* considers is the Average Production Wages (APW), which only includes manufacturing (sector D in ISIC Rev.3). Whereas, the *new definition* considers the Average Wages (AW), which includes not only manufacturing but also Mining and quarrying, Electricity, gas and water supply, Construction, Wholesale and retail trade, Hotels and restaurants, Transport, Financial intermediation and real estates, renting and business activities (i.e. sectors C to K in ISIC Rev. 3).

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[35] OECD did not collect data for employer's social contributions for France until 1994. Hence, in the interest of a greater sample size we consider the tax-wedge measure without this component for France: $t^w = log\left(\frac{income\ tax + employee's\ social\ security - cash\ transfers}{gross\ earnings}\right)$. This is also done in Arestis et al. (2007).

These two tax-wedge series are linked as follows: Data are available for both variables for the period 2000-2004, hence, we take the difference between each observation for this period, average it, and subtract this "average difference" from the Tax-wedge *(new definition)*. The series are then connected at the end point of the Tax-wedge *(old definition)* series (2004) to introduce as little noise as possible to the series. The linkage is then further smoothed by taking logs after interpolation.

6.3.7 Union's power

Unions' power *mil*: (logarithm) of strike activity, measured in number of days lost in labour dispute in the case of the UK and Spain, number of hours lost in labour dispute in the case of Italy, and number of workers involved in labour dispute for the rest of countries. This variable is not available in any form for Germany and the analysis for this country is performed without this variable as in Arestis et al. (2007). This measure is widely used in the literature, see for instance Layard et al. (1991, p.419), Arestis and Biefang-Frisancho Mariscal (1998) or Arestis et al. (2007). Data for the number of employees involved in labour dispute are only available with annual frequency and linear interpolation is used to obtain quarterly data. Further details on the interpolation method are provided in the section 6.3.11.

In the literature, there are other popular proxies for unions' power, and it is necessary explain our choice of variable. Another popular measure of union's power is Union Density (share of unionized workers), see for instance Layard et al. (1991, p.419), Nickell et al. (2005) and Bassanini and Duval (2009). However, as pointed out by Siebert (1997,p.47) or Nickell et al. (2005,p.6) in many countries wage bargaining covers non-unionized workers as well as members of trade unions. For example, French workers covered by collective agreements are close to 90%, despite Union Density been around 10%. Similarly in Spain and the Netherlands, less than 40% of workers are unionized but more than 80% are covered by collective wage agreements.

Thus, it is likely that Union Density will fail to capture workers' influence on wages, in the sense that low (high) union density does not necessarily imply low (high) workers or unions influence on wages, see also Baker et al. (2007, p.13). The share of workers covered by collective agreements might be a good alternative, but to the best of our knowledge, time series available are not long enough to conduct a study of the type we aim to perform here.

6.3.8 Capital stock

Capital stock k: (logarithm) of capital stock of the total economy, less housing services, it is measured in real terms expressed in millions of local currency. Downloaded from OECD's Economic Outlook no.86 (OECD, 2009). [*KTV*] as per publisher's code system.

This measure is also used in Karanassou et al. (2008a), but differs from the series employed in Arestis and Biefang-Frisancho Mariscal (1998), Arestis and Biefang-Frisancho Mariscal (2000) and Arestis et al. (2007). These three studies use a measure of “Business sector capital stock” produced by OECD, which is no longer published (Schreyer and Webb, 2006, Schreyer et al., 2011).

6.3.9 Real long term interest rates

Real long term interest rates ($i - \Delta p$): (logarithm) of central government bond yields on the secondary market, gross of tax, with a residual maturity of around 10 years minus the inflation rate, calculated using the Consumer Price Index (CPI) discussed above. Data are downloaded from Eurostat (2010). Central government bond yields correspond to [Maastricht’s Treaty long-term interest rate convergence criterion] as per publisher’s code system.

6.3.10 Real imported raw materials price

Real cost of imported inputs p^{vm}: (logarithm) of the ratio of Commodity imports price index (in terms of local currency) to CPI, weighted by the share of imports to GDP: $p^{vm} = v * log(P^m/CPI)$.

The Commodity imports price index in terms of local currency P^m, is calculated by multiplying the Commodity imports price index in USD dollars (CMPI) by one over the exchange rate (GBP, Euro and Danish Crown to the dollar). Where the Commodity Imported Price Index (CMPI) is the average of the Index of Non-Fuel Primary Commodities index (*NFPC*) (base 2005=100 in USD) and Average Petroleum Spot index of UK Brent, Dubai, and West Texas index (*Oilp*) (base 2005=100 in USD). CPI is as per description above. Finally, the share of imports to GDP v, is calculated by multiplying the ratio of imports to GDP by a hundred. Imports to GDP and the exchange rates weights respond are used to control for the reliance of the economy on imported raw materials and exchange rates fluctuations. Data for *NFPC* and *Oilp* are downloaded from the IMF statistical portal IMF (2010). Data for imports are downloaded from Eurostat statistical portal Eurostat (2010), and data for exchange rates are downloaded from OECD statistical portal (OECD, 2010d).

Similar measures of imported raw materials price indexes are constructed in the literature see for instance Layard and Nickell (1986, p. s157) and Nickell and Bell (1995,p. 58). Data for *NFPC* and *Oilp* indexes are only available in monthly basis. To create quarterly series we considered the last month of the quarter as our quarterly observation. This procedure is followed in the interest of consistency with linear interpolation methods used here.

6.3.11 Dummy variables

We employ three dummies in our analysis. In the UK’s data set, the variable $D05q4$ is a dummy for the last quarter of 2005, which takes the value one in this quarter and zero elsewhere. In the Spanish data set, $D87q4$ is a dummy for the last quarter of 1987, which takes the value one in this quarter and zero elsewhere. In the Finnish data set, the variable $D97q123$ is a dummy for the first three quarters of 1997 that takes the value one in these quarters and zero elsewhere.

All three dummies control for the outliers that appear in the quarters in which they take the value one. These outliers seem to be the source of serial correlation that we find in preliminary estimations. We considered several strategies to account for serial correlation, but in all cases the dummy is the best way to correct this problem without over-parameterizing our empirical specification[36]. Karanassou and Sala (2008) and Schreiber (2012, p.1322) also follow this approach.

We cannot be certain of what makes our estimations less precise in these quarters, but we speculate that these outliers might be caused by the following factors. We start with the UK. In the last quarter of 2005 the UK economy suffered the largest rise in quarterly unemployment in our sample, see the 1st difference of u in Figure II.1. According to the Bank of England (2005, p.p.9-11) the slowdown in GDP during 2005 is the result of a contraction of households' consumption, which they attribute to the growing cost of energy, higher interest rates, and the slowdown in house prices. Since our estimates do not control for the latter, we suspect that the outlier we find in the last quarter of 2005 is the result of the evolution of the housing market. Hence, $D05q4$ might be seen as a control variable for the 2005 slowdown in house prices.

Turning now to the Spanish dummy, Spain suffers substantial unemployment rises and falls in the period studied here, see Figure II.6. Our estimations seem to account for these swings reasonably well, except for the reduction of unemployment that takes place in the last quarter of 1987. We suspect that this fall might be associated with some of the changes in legislation that followed the entrance of Spain to the European Union in 1986. Karanassou and Sala (2008) also report outliers in this period and also resort to the use of dummies to control for them. Therefore, $D87q4$ might capture these changes in the Spanish legal system.

In the Finnish case, the first and third quarter of 1997 saw the two largest reductions in unemployment recorded in our sample, see Figure II.8. According to the Bank of Finland (1997, p.p.13-16) the fall of unemployment during 1997 is due to an acceleration of economic growth. More precisely, to a recovery of employment in sectors such as construction and manufacturing that had remained stagnant since the early 1990s. The Bank of Finland attributes this acceleration to "record high" consumer confidence. Since we do not include

[36] For a detailed discussion on preliminary estimations see section 7.2.1 for the UK's case, section 9.3.1 for Spain, and section 10.3.1 for Finland.

confidence indicators among our explanatory variables, we suspect that the outliers in 1997 are the result of this wave of optimism. Hence, our dummy might be seen as proxy of this rush of optimism.

6.4 Comments on interpolation methods

As we point out above, our measures of tax-wedge t^w , long-term unemployment lu and the number of employees involved in labour dispute mil (for the Netherlands, France, Denmark and Finland), are only available in annual frequency and interpolation is used to transform these series into quarterly time series. We follow a standard linear interpolation procedure:

First, we treat each annual observation as the observation of the fourth quarter of the reference year. For example, the tax-wedge observation for 1980 t^w_{1980}, is treated as the observation of the last quarter of that year $t^w_{1980} = t^w_{1980q4}$, then operating similarly with each annual value we reconstruct our series in terms of the last quarter of the year. Second, we assume year-on-year or annual changes denoted by our original data are evenly distributed in each quarter, i.e. that changes from quarter-to-quarter are identical. Hence, we divide the difference between two data points by four, following with our example $\frac{t^w_{1981q4}-t^w_{1980q4}}{4}$, to calculate the portion of the annual change that corresponds to each quarter.

Then, progressively adding the change of the year-on-year difference divided by four to our last observation point, in our example t^w_{1980q4}, we can construct our quarterly data as follows:

$$t^w_{1981q1} = t^w_{1980q4} + \frac{t^w_{1981q4} - t^w_{1980q4}}{4}$$

$$t^w_{1981q2} = t^w_{1981q1} + \frac{t^w_{1981q4} - t^w_{1980q4}}{4}$$

$$t^w_{1981q3} = t^w_{1981q2} + \frac{t^w_{1981q4} - t^w_{1980q4}}{4}$$

The series for Gross Replacement Rates grr are only available in biannual frequency and the same linear interpolation procedure is used to transform these series into quarterly time series. In this case the formulation is as follows, first:

$$grr_{1980}=grr_{1980q4}$$

$$grr_{1982}=grr_{1982q4}$$

Second,

$$grr_{1981q1} = grr_{1980q4} + \frac{grr_{1982q4} - grr_{1980q4}}{8}$$

$$grr_{1981q2} = grr_{1981q1} + \frac{grr_{1982q4} - grr_{1980q4}}{8}$$

$$\vdots$$

$$grr_{1982q3} = grr_{1982q2} + \frac{grr_{1982q4} - grr_{1980q4}}{8}$$

The lack of higher frequency series for these variables has made their linear interpolation common practice in the literature. In the time series field, see for instance Stockhammer (2004a) and Arestis et al. (2007), and in the panel data literature, see for example Nickell et al. (2005) and Stockhammer and Sturn (2008).

The advantages of interpolation are clear, it allows the researcher to expand the sample size, but there are also downsides that need to be acknowledged. The main problem associated with the use of interpolation, is that the researcher introduces an element of artificiality into the series insofar s/he attributes the same share of the year-on-year change to each quarter, which might not necessarily be the case. In other words, the researcher is introducing some degree of error measurement. While this might still be true, it is generally argued that variables such as replacement rates are fairly constant throughout time and that changes in these series happen slowly. Consequently, it is claimed that linear interpolation ought to introduce little noise into the data (Stockhammer, 2004a, p.23).

In any case, a researcher trying to compare the effect of demand factors, usually available in quarterly frequency, against that of wage-push factors, usually in annual frequency, faces a trade-off: Either not making use of the information that quarterly data provides or introducing some noise into wage-push factors series by using interpolation to increase their frequency. Considering that noise from interpolation is likely to be small for the reasons pointed out above, we believe that favoring the quarterly data side of the trade-off is a reasonable compromise. Facing this dilemma Arestis et al. (2007) and Stockhammer and Sturn (2008) also favour quarterly frequency.

In the context of the time series techniques that we employ in this thesis, there are two caveats that we must also be bear in mind. First of all, in attributing the same change into each quarter of the year, we are imposing a constant trend within each year, which might artificially increase probability of finding these variables to be $I(1)$ or even $I(2)$. In the case of the ADF-GLS test, interpolation might increase probability of not-rejecting the null hypothesis of unit root, i.e.

reduce power of this test. In the case of the KPSS test, interpolation might increase the probability of rejecting the null hypothesis of stationarity, i.e. increase size of the test.

Second, as noted by the interpolation equations above, t^w_{1981q3} is by construction highly correlated with t^w_{1981q2}, t^w_{1981q1} and t^w_{1980q4}, and similarly the four observations corresponding to each year in our sample. This means that when estimating the VECM, the unexplained component at point $1981q3$ is likely to be correlated with the residuals at points $1981q2$, $1981q1$ and $1980q4$. In other words, that interpolation increases chances of having serial correlation in our ECM equations, although we account for this problem with a sufficiently rich lag structure in the model.

6.5 A first look at the data

We turn now to the data itself, in this section, we present figures for all the variables in each of the eight country's data sets. All variables are plotted in their logarithm form except unemployment, long term unemployment, gross replacement rates, tax-wedge, real long term interest rates and the wage share. The reason to plot the rates and not the logarithm version of these variables is that the researched might be familiar with the values of these variables and hence, seems more informative to use rates.

6.5.1 Evolution of unemployment

We start by examining the evolution of unemployment in Figure 6.1, which shows the evolution of unemployment in the eight countries in our sample. There seem to be three different patterns:

In the UK, the Netherlands and Denmark unemployment seems to trend downwards overall. In the UK and the Netherlands unemployment peaks in the mid-1980s and although there is a new rise in the early 1990s, this is less severe than the previous hike. In Denmark unemployment peaks in the early 1990s and after that unemployment also seems to trend downwards. Furthermore, after the second half of the 1990s these three economies enjoy levels of unemployment in the range between 4% and 6% unemployment consistently.

This is in contrast to the evolution of unemployment in Germany, France and Italy where the jobless rate seems to trend upwards for most of the sample period. In France and Italy the hikes of the 1980s are followed by even higher rates in the 1990s, and in both economies unemployment is well above 8% by the end of the 1990s. It is only in the very late 1990s and early 2000s that unemployment starts to fall, in France to levels around 8%, and in Italy to levels around 6%. Similarly, Germany's unemployment peaks in the 1990s, only to be followed by yet a new maximum in the mid-2000s. Also as in France, and Italy, Germany's unemployment falls in the second half of the 2000s, but only to levels around 8%.

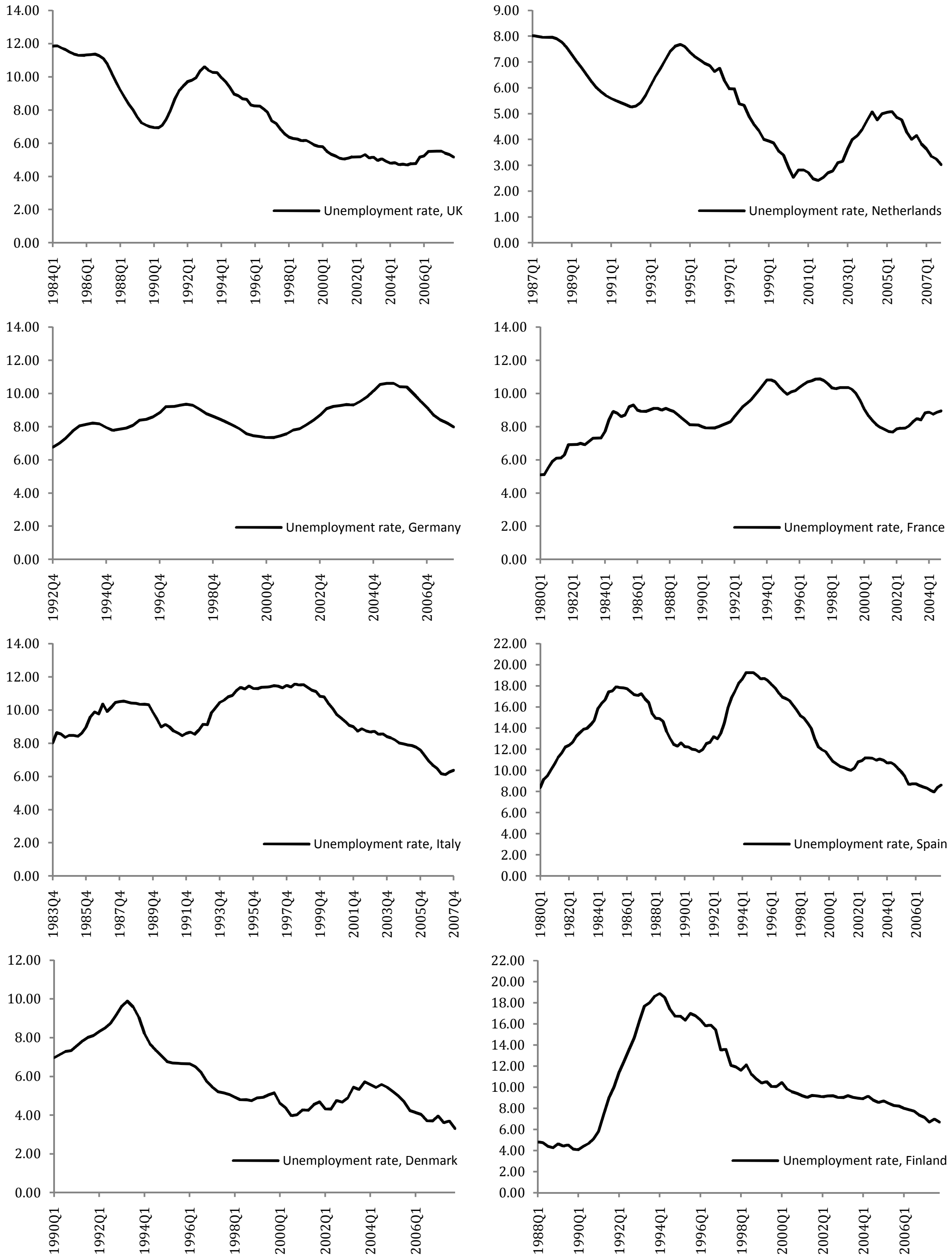
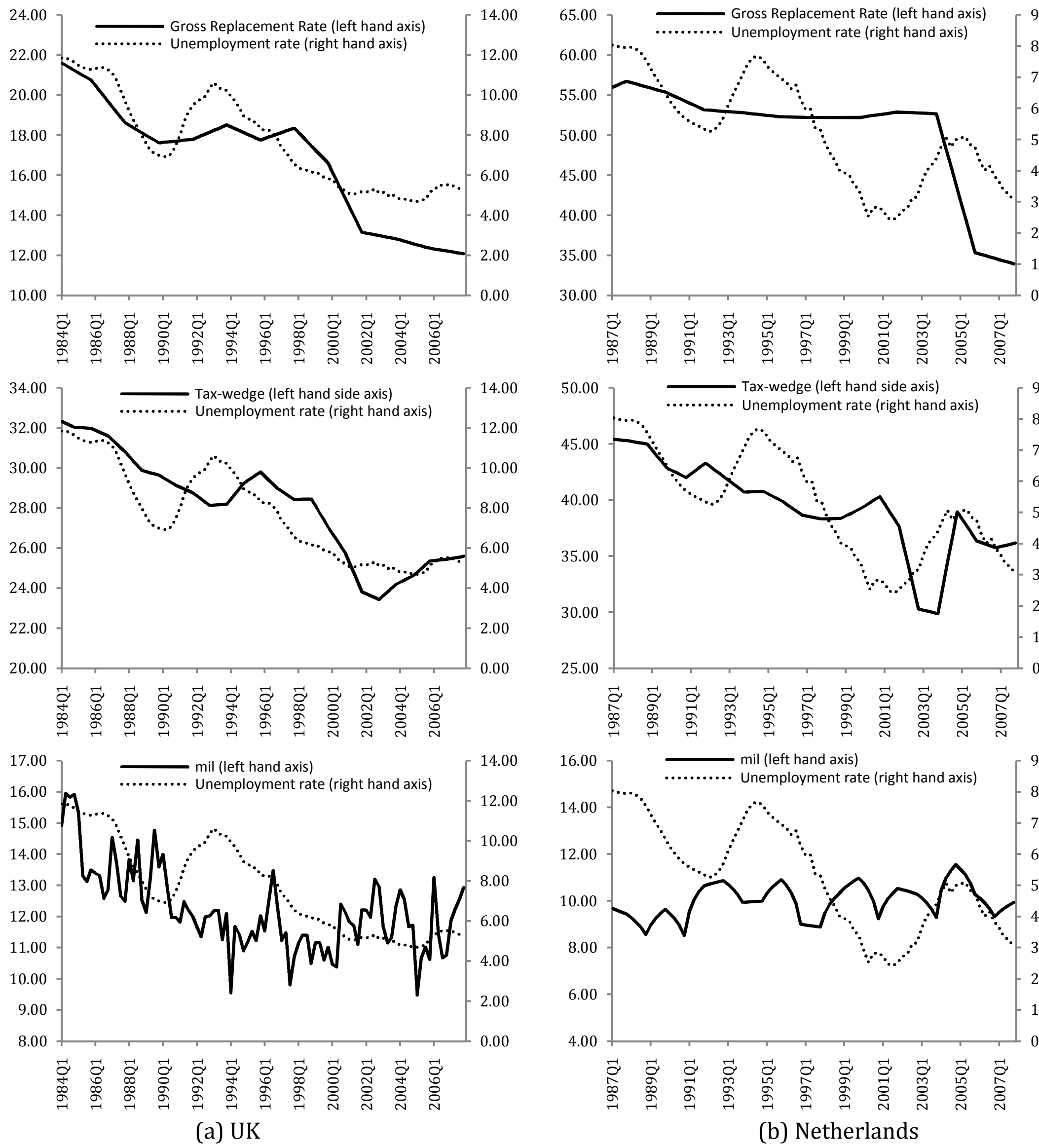


Figure 6.1. Evolution of unemployment

Spain and Finland suffer the highest levels of unemployment out of the eight countries. Spanish unemployment is never below 8%, and it hits levels close to 20% in the mid-1980s and in the mid-1990s. After this point it shows an impressive reduction although it never trespasses the 8% barrier. Finland, starts at a lower level, but it also suffers unemployment levels close to 20% in the early 1990s, which is followed by a remarkable fall, although it does not reach the 6% to 8% range until the second half of the 2000s, well above the 1980s levels. In the plots presented in the rest of this section, the evolution of unemployment is presented in the background (with a dashed line), this is convenient to complement our discussion of findings in subsequent Chapters.

6.5.2 Evolution of wage-push factors

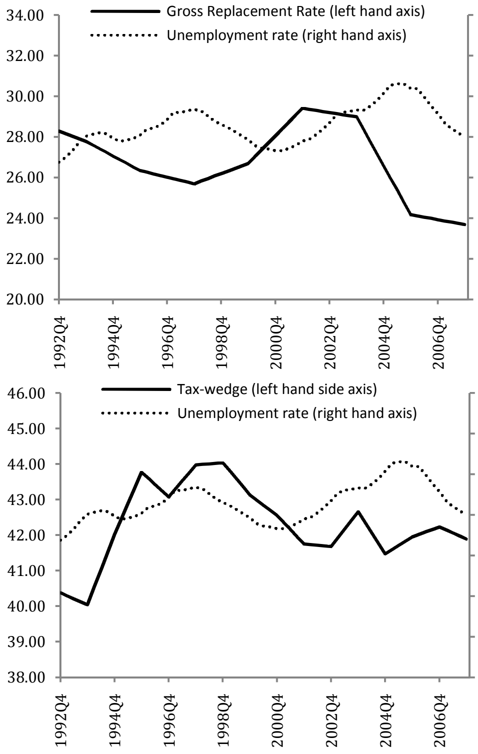
We turn no to the evolution of wage-push factors, we present the data in pairs of countries following the country grouping that we use in Chapter 7 to Chapter 10. We start with the UK and the Netherlands in Figure 6.2:



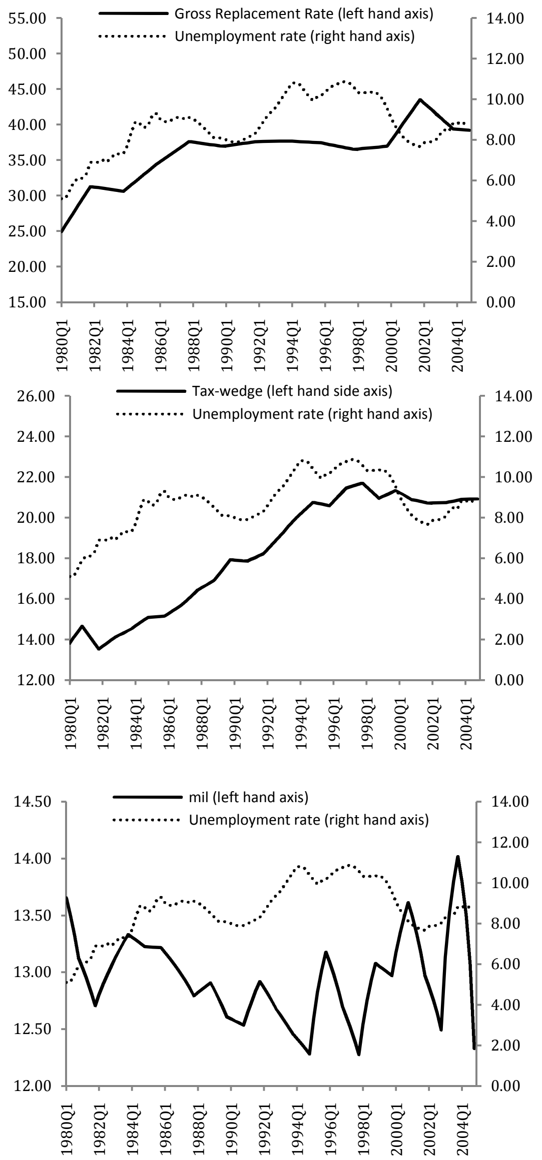
(a) UK (b) Netherlands

Figure 6.2. Wage-push factors UK and Netherlands

In the UK's case all three wage-push variables show a clear downward trend throughout the sample period, reflecting cuts in unemployment benefits, labour taxation and a slowdown in union activity. A similar picture arises from the plots for unemployment benefits and labour taxation for the Netherlands, but not from the diagram for workers' militancy, which suggests that strike action increases moderately but steadily throughout the sample period in the Netherlands.



(y) Germany

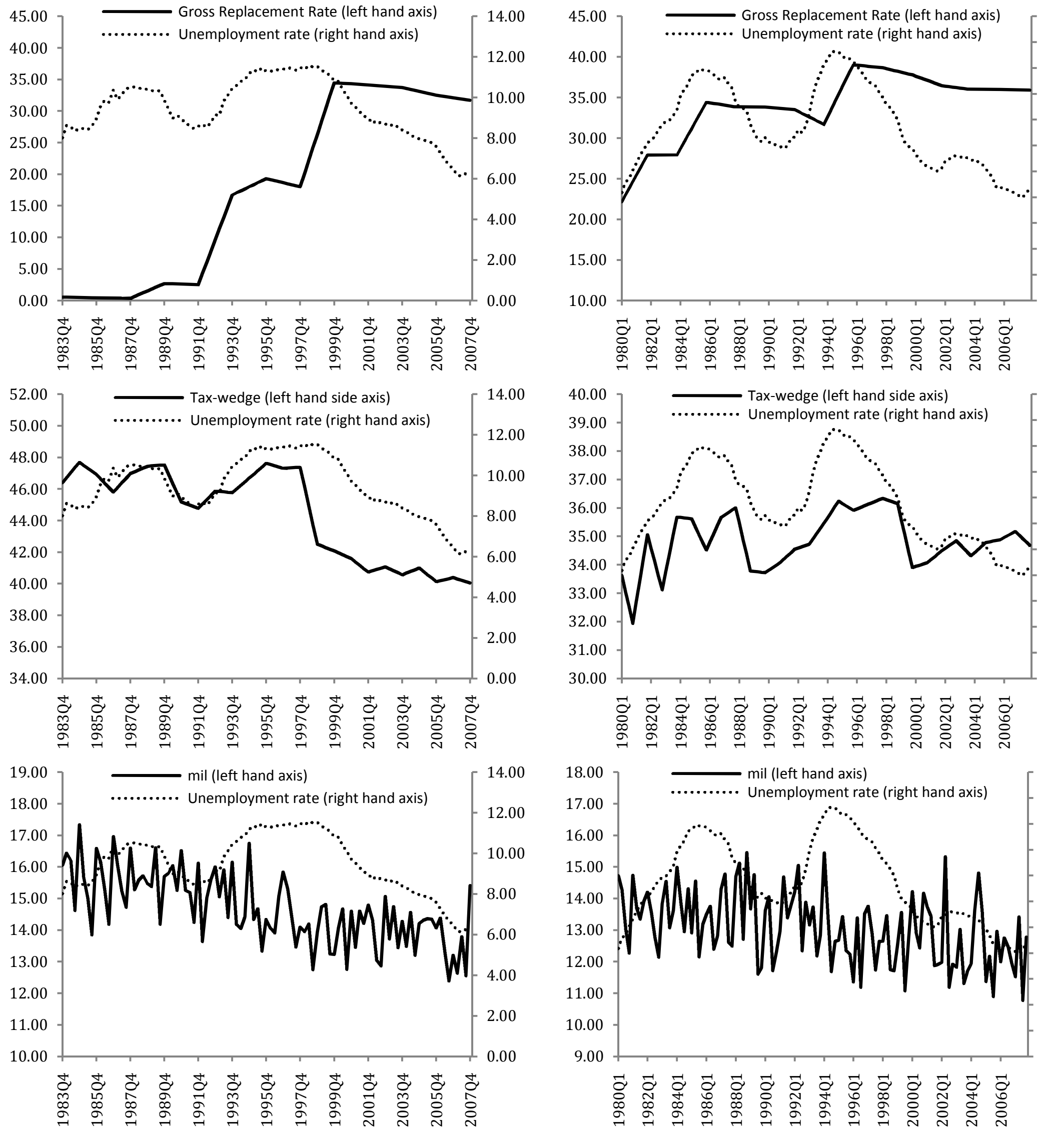


(b) France

Figure 6.3. Wage-push factors Germany and France

Figure 6.3 shows the evolution of the wage-push factors for Germany and France. In the German case, although unemployment benefits and labour taxation seem to follow opposite trends, while benefits seem to trend downwards while the tax-wedge seems to trend upwards overall, both measures fall during the late 1990s and early 2000s. In France, unemployment benefits and labour taxation show clear upward trend since 1980, although there also seems to be some attempt to curb this trend towards the end of the sample period. Workers' militancy in France seems to remain relatively constant throughout the period, although it becomes more volatile since the mid-1990s.

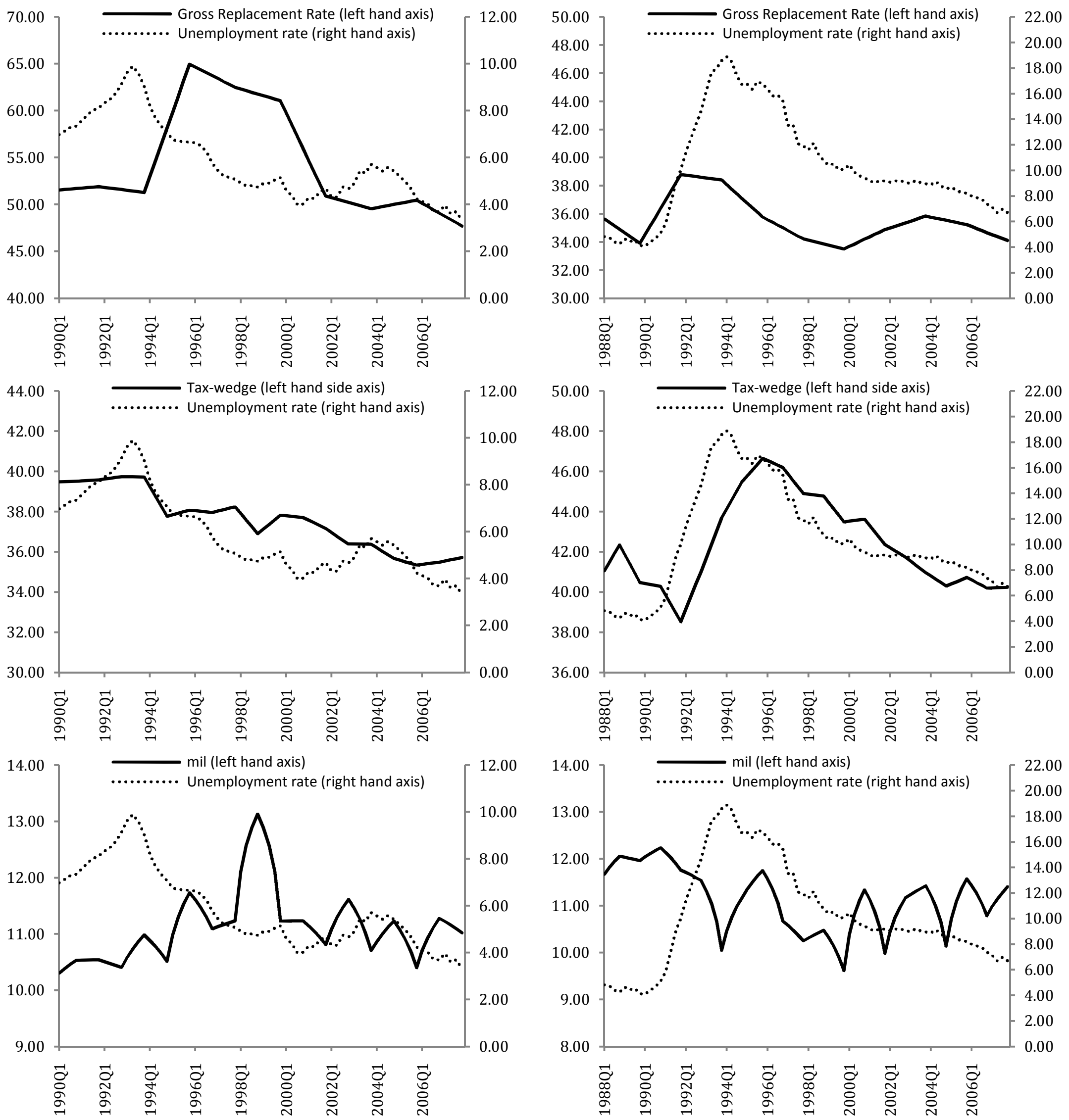
Figure 6.4 shows the evolution of the wage-push factors in Italy and Spain. In both countries, unemployment benefits exhibit a clear upward trend, whereas workers' militancy shows a steady decline. Interestingly, in both countries, we observe a reduction of benefits in the second half of the 1990s. The evolution of labour taxation is despair, while it shows a clear downward trend in Italy, exacerbated in the late 1990s, Spanish labour taxation shows a clear upward tendency, which seems to moderate beyond 1998.



(a) Italy (b) Spain

Figure 6.4. Wage-push factors Italy and Spain

Figure 6.5 shows the evolution of the wage-push factors for Denmark and Finland. In Denmark unemployment benefits and labour taxation show a downward trend, in the case of benefits, despite a substantial rise in 1996 that is reverted subsequently. On the other hand, the diagram for workers' militancy suggests that strike action increases steadily throughout the period. In the Finnish case, initial and end values for unemployment benefits and labour taxation are very similar, but they are far from constant throughout the sample period. In both cases, there is a substantial rise in the early 1990s, although most marked in the case of labour taxation. Rises in benefits generosity are soon reverted, and as from 1992 onwards there is a clear downward trend. Increases in labour taxation, are also reversed, and from 1996 onwards it shows a clear downward trend. Workers' militancy seems to remain constant throughout the period, although it is more volatile beyond 2000s.

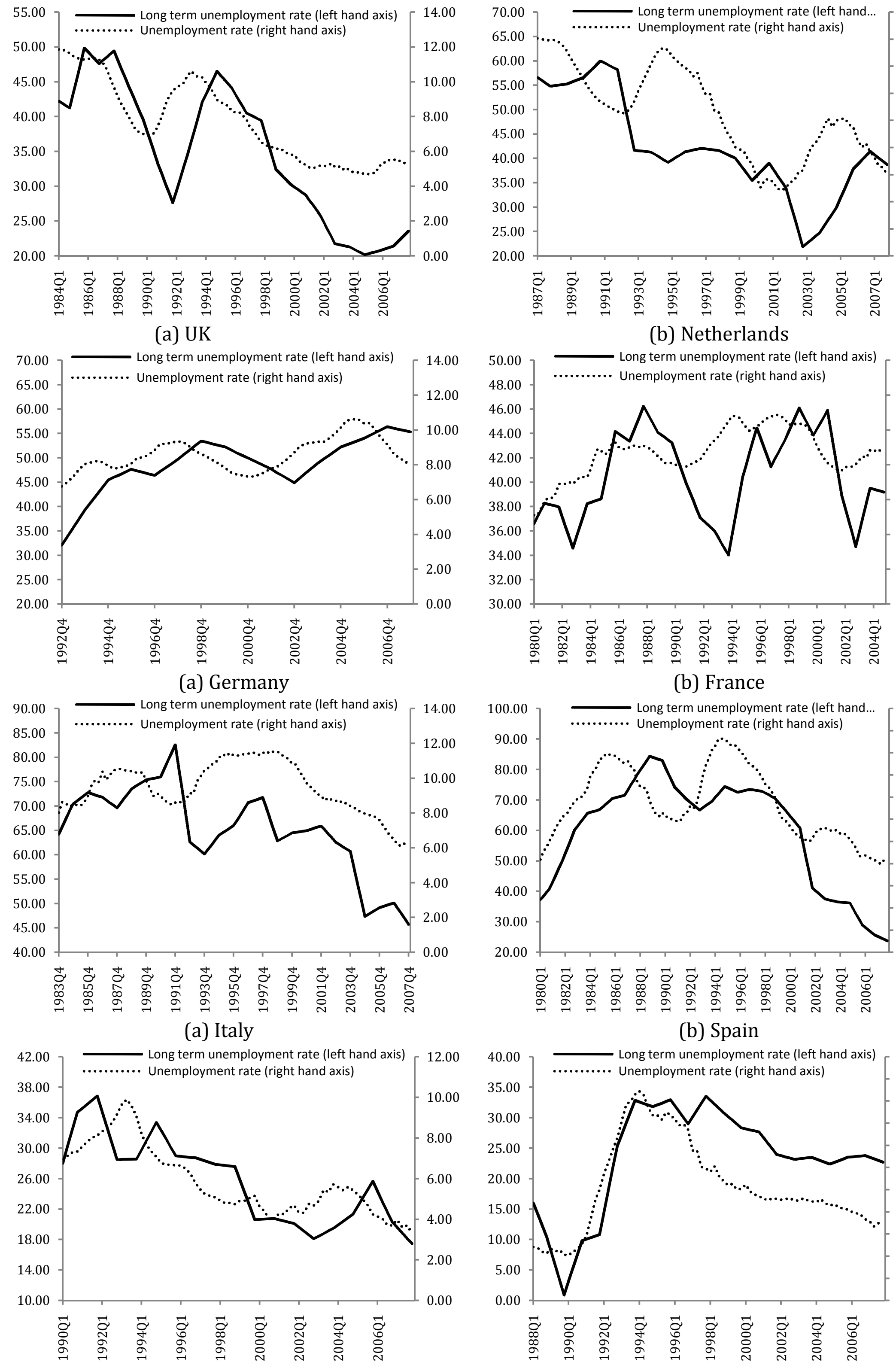


(a) Denmark (b) Finland

Figure 6.5. Wage-push factors Denmark and Finland

6.5.3 Evolution of long term unemployment

Next, in Figure 6.6 we show the evolution of the long term unemployment rates for the eight countries in our sample. We observe two differentiated patterns: In the UK, Germany, France, Denmark and Finland, long term unemployment rates mirrors the evolution of unemployment. On the other hand, in the Netherlands, Italy and Spain long term unemployment peaks in the late 1980s or early 1990s and then falls markedly.

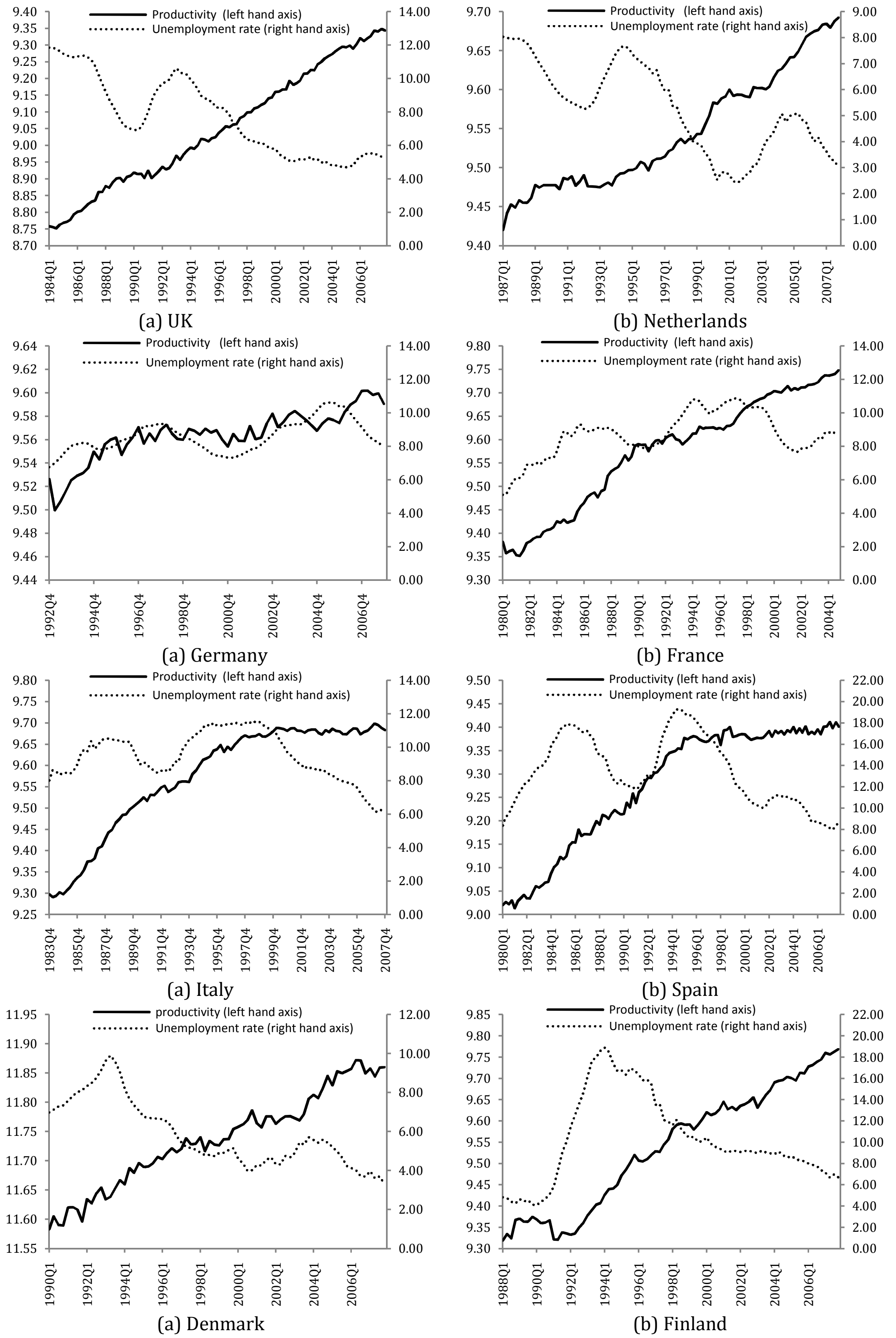


(a) UK (b) Netherlands
(a) Germany (b) France
(a) Italy (b) Spain
(a) Denmark (b) Finland

Figure 6.6. Evolution of long term unemployment rate

6.5.4 Evolution of productivity

Following, in Figure 6.7 we present the evolution of productivity for the eight countries in our sample. In all of them there is a clear upward trend, although there are some events that are worth noting.



(a) UK (b) Netherlands

(a) Germany (b) France

(a) Italy (b) Spain

(a) Denmark (b) Finland

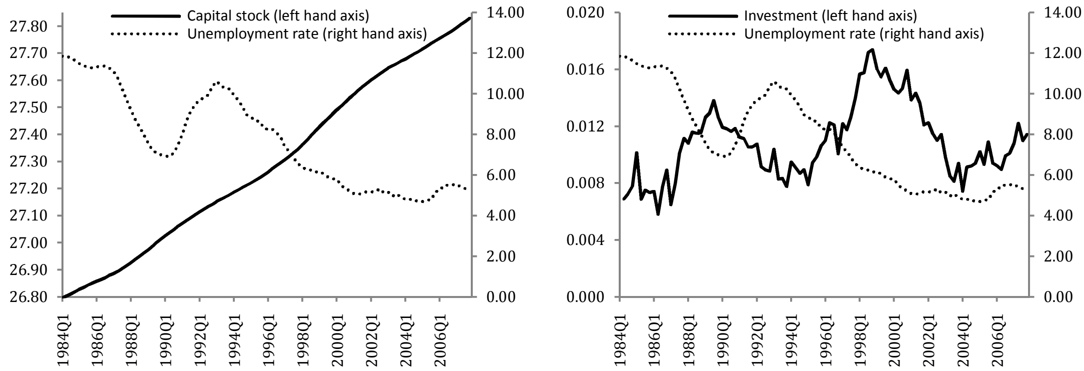
Figure 6.7. Evolution of productivity

In the UK, productivity grows steadily throughout the period, although between 1988 and 1992 it slows down considerably and nearly flattens. Dutch productivity also exhibits an upward trend overall, although between 1989 and 1993, and between 1999 and 2003 it has two plateaus where productivity barely increases. In Germany, despite an initial fall in productivity, the sample period is dominated by growth, which is particularly intense between 1993 and 1996 and after 2004. In the French case, productivity remains stagnant up to 1982, then it grows very rapidly up to 1990, where it shows some steady but very modest growth until 1996, and thereafter it resumes strong growth again.

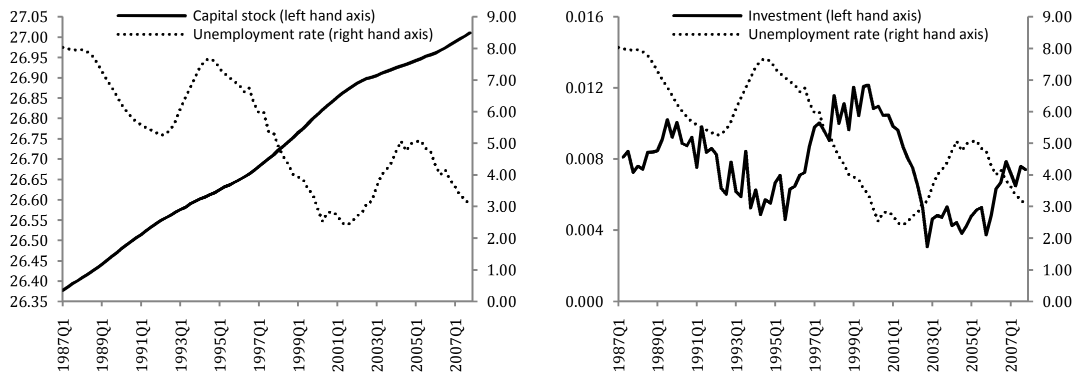
In Italy and Spain, the evolution of productivity is very similar, after a period of stagnant productivity in the early 1980s, it grows rapidly until the second half of the 1990s (after 1997 in Italy and after 1995 in Spain), and beyond this point it flattens dramatically. In the Italian case it should be noted that there is a second plateau between 1991 and 1993. In the Danish case productivity grows overall, but there are two periods, in which productivity flattens, namely between 2000 and 2004 and from 2005 to the end of the sample. In Finland, productivity stagnates in the late 1980s, it even falls in the early 1990s, and after 1992 it grows very vigorously until 1998 when growth moderates.

6.5.5 Evolution of capital stock and investment

In this section we return to our presentation in pairs of countries to show the evolution of capital stock. To better illustrate our discussion we complement the capital stock diagram with another plot for investment, calculated as the first difference of k. We start with the UK and the Netherlands in Figure 6.8:



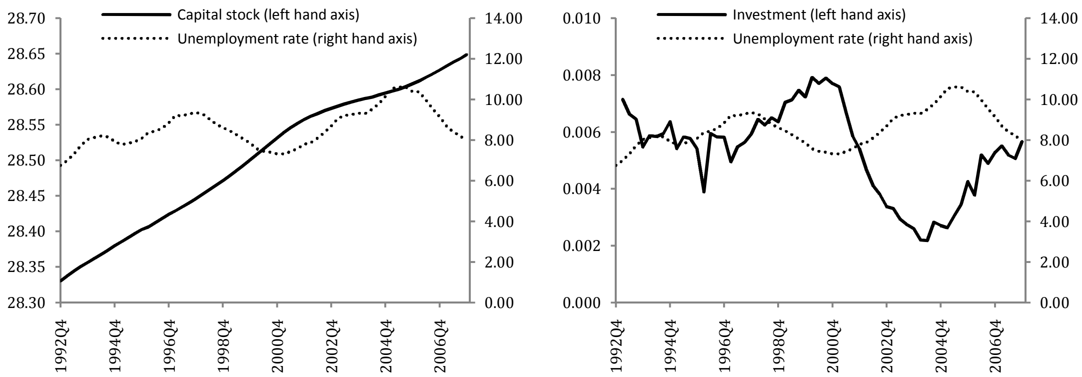
(y) United Kingdom



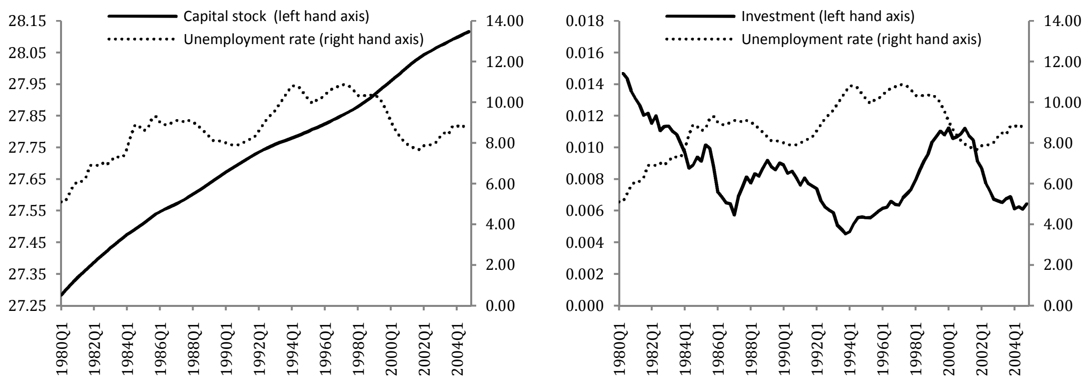
(b) Netherlands

Figure 6.8. Capital stock and investment in the UK and Netherlands

In both countries capital stock has a clear upward trend, although some events deserve our attention. In the UK, capital stock grows rapidly until 1989 and then slows down until 1994. This is followed by a prolonged period of very rapid capital stock growth during the second half of the 1990s. Beyond 1999 capital stock grows at a diminishing rate until 2004 when growth intensives again. In the Dutch case, capital stock grows moderately until 1991, beyond this year growth continues but at a diminishing rates until 1996. This is followed by a notorious surge that peaks after 1999. Although this period of fast growing capital stock is followed by an evenly impressive slowdown from 1999 to 2003. Between 2003 and 2006 capital stock grows at modest but fairly constant rates, after 2006 it seems to revitalize albeit modestly.



(y) Germany

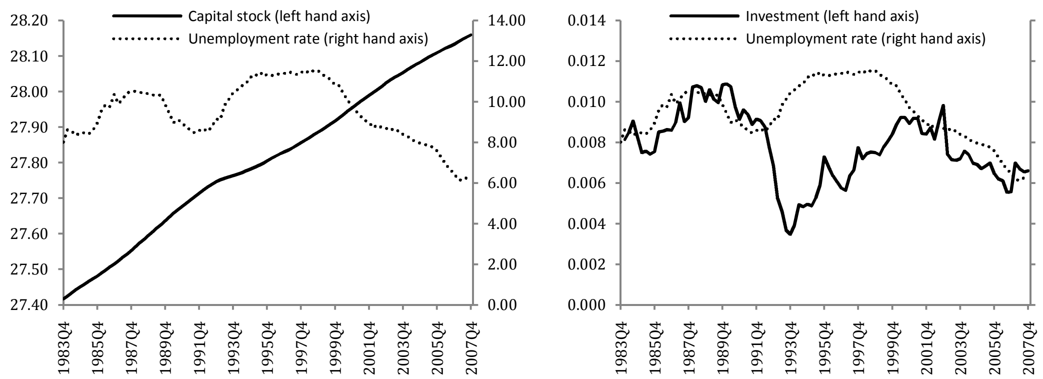


(b) France

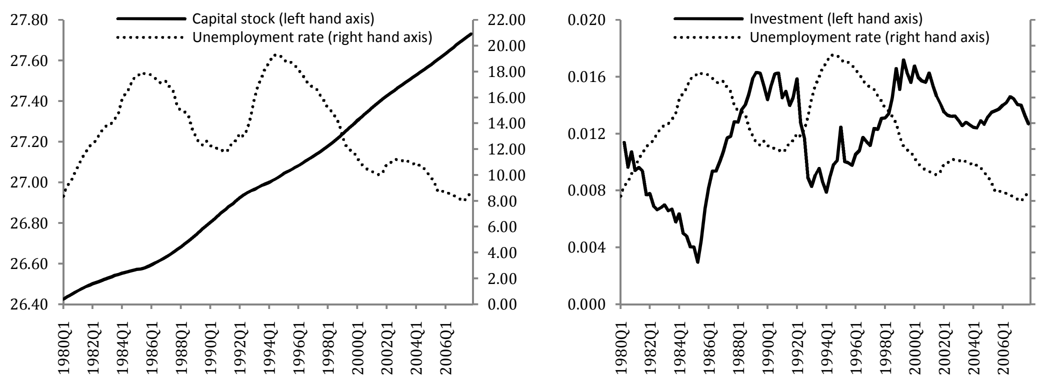
Figure 6.9. Capital stock and investment in Germany and France

Figure 6.9 shows the evolution of capital stock and investment for Germany and France. In both economies, capital stock has a clear upward trend, although there are some events that are worth mentioning: In Germany, capital stock grows at a relatively stable rate during the early 1990s, and accelerates between 1998 and 2000. After 2000 there is a notorious slowdown in capital stock growth, although beyond 2003 it recovers. In the French case, capital stock growth diminishes during the early 1980s, reaching a low in 1986, although soon revitalizes and after 1986 capital stock grows rapidly until the early 1990s. In the mid-1990s, capital stock suffers a prolonged slow down, and it is not until 1998 that we observe another surge in capital stock growth followed yet again, by another slow down beyond 2000.

Figure 6.10 shows the evolution of capital stock and investment for Italy and Spain. In both countries capital stock has a clear upward trend, although some events deserve our attention: In Italy panel I, capital stock grows moderately in the late 1980s, followed by a notorious slowdown that reaches its lowest point in 1993. Beyond 1993, capital stock grows slowly but steadily during the 1990s and early 2000s peaking after 2001, thereafter capital stock grows at a slower pace again. In the Spanish case panel (d), capital stock growth diminishes during the early 1980s, reaching its minimum before 1986. In the 1980s, this phenomenon was referred to as "investment strike" (Muñoz de Bustillo Llorente, 2005,p.221). It soon regains momentum, and after 1986 capital stock grows impressively, peaking in the late 1980s, and maintaining vigorous growth during the early 1990s. Between 1992 and 1994 capital stock slows down again, but beyond 1994 growth intensifies reaching a maximum after 1998. And although capital stock growth slows down moderately after 2000, it remains strong until the end of the sample period.



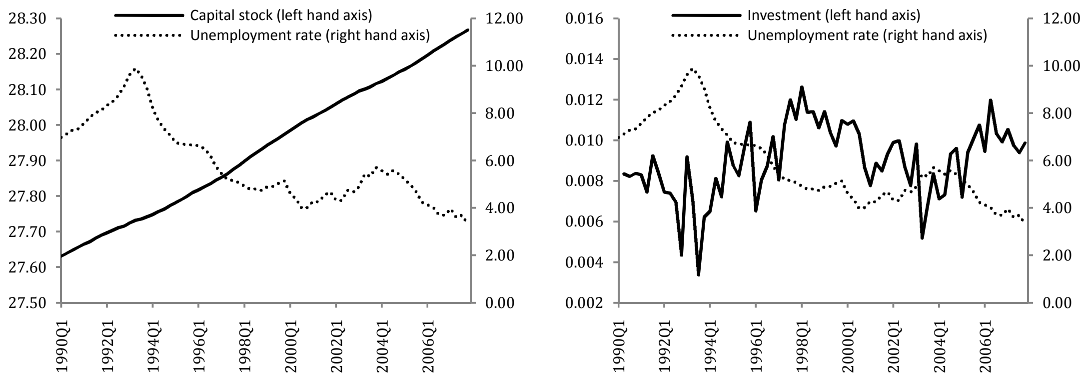
(a) Italy



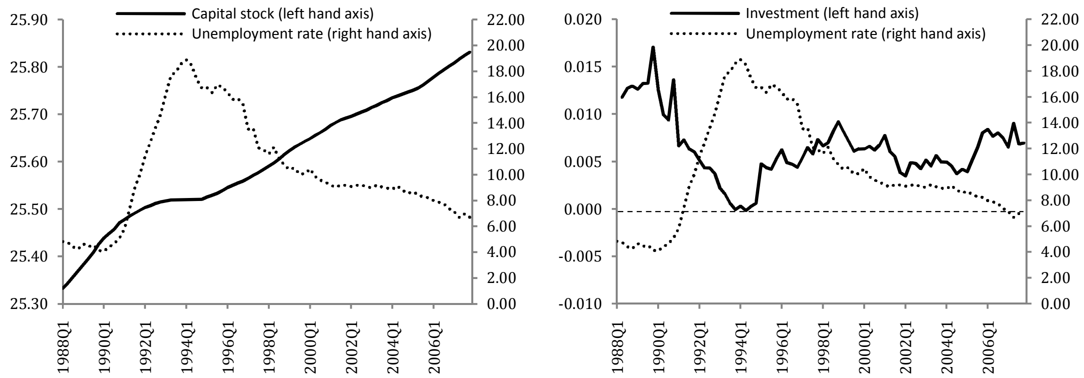
(b) Spain

Figure 6.10. Capital stock and investment in Italy and Spain

Figure 6.11 shows the evolution of capital stock and investment for Denmark and Finland. In both countries capital stock has a clear upward trend, although there are some events that are worth mentioning: In Denmark there seem to be two differentiated periods, from 1990 to 1995 capital stock growth is very volatile and more moderate than in the second period, between 1995 and 2008, which is also characterized by volatility but also strong growth, particularly between 1998 and 2000 and in 2006. The Finland's case, capital stock grows at its fastest rates before 1990. From 1990 to 1994 it grows at diminishing rates reaching zero growth around 1994, where capital stock flattens. Beyond 1994 it resumes growth at a modest but fairly stable pace, except for the period between 2002 and 2005 when it seems to slow down again.



(y) Denmark

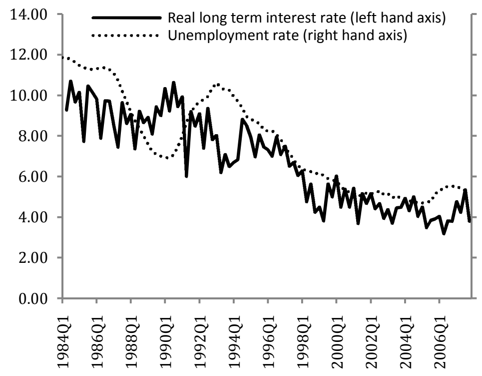


(b) Finland

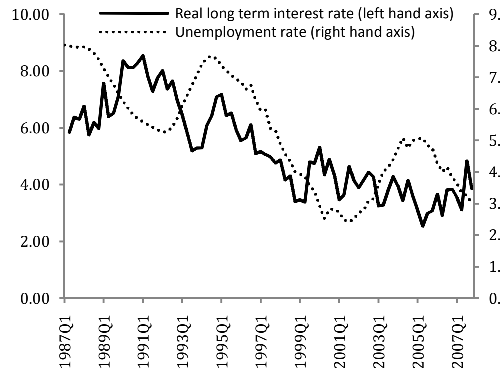
Figure 6.11. Capital stock and investment in Denmark and Finland

6.5.6 Evolution of real long term interest rates

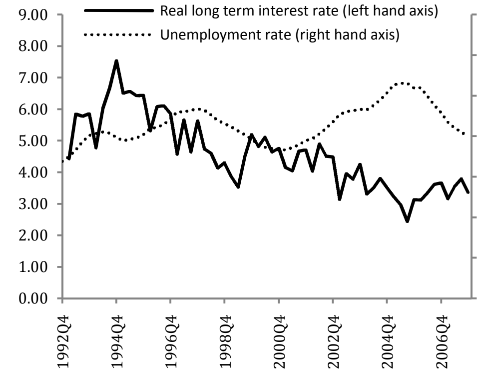
Next, in Figure 6.12 we show the evolution of the long term real interest rates for the eight countries in our sample. Although in all cases this variable clearly trends downward, there are two differentiated patterns. First, in the UK, Italy and Denmark, there is an initial period of relatively high but stable real long term interest rates, which is followed by a period of falling rates that starts in the early 1990s. Second, in the Netherlands, Germany, France, Spain and Finland there is a short-lived rise in real long term interest rates in the first years of the sample period, which is followed by a marked downward trend.



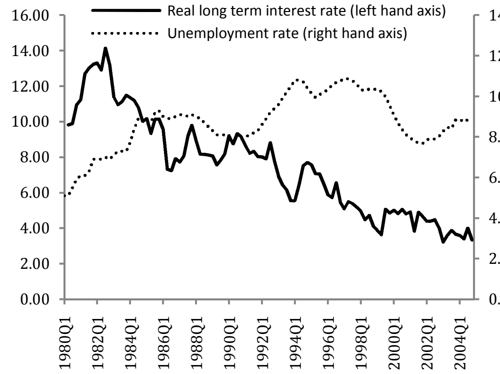
(a) UK



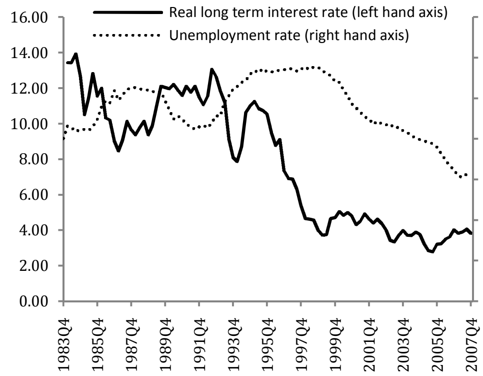
(b) Netherlands



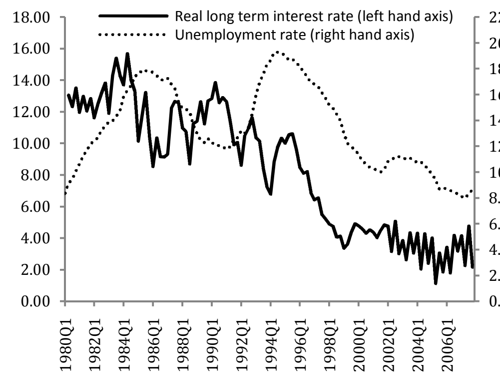
(a) Germany



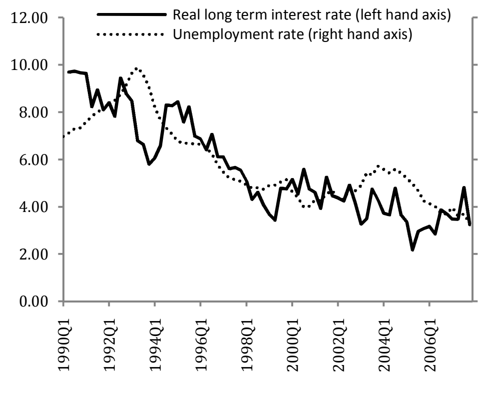
(b) France



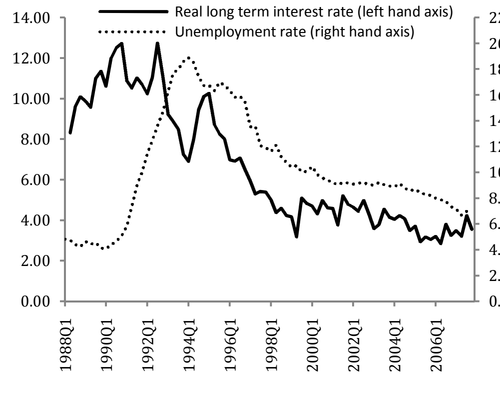
(a) Italy



(b) Spain



(a) Denmark

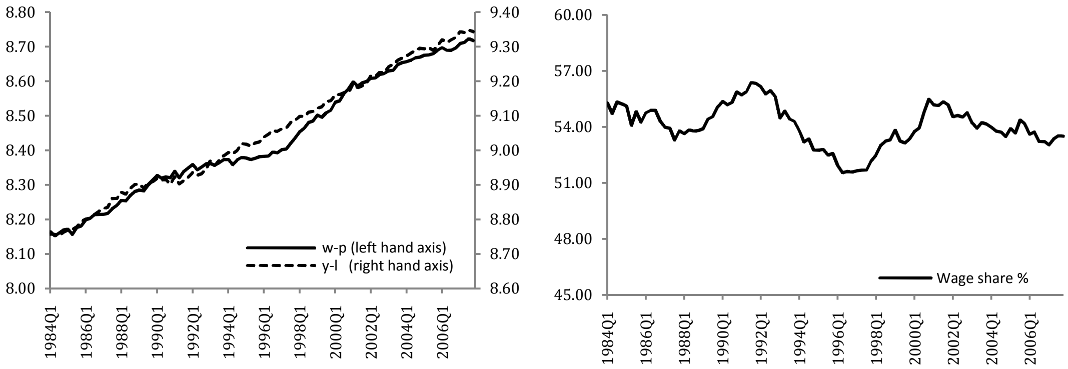


(b) Finland

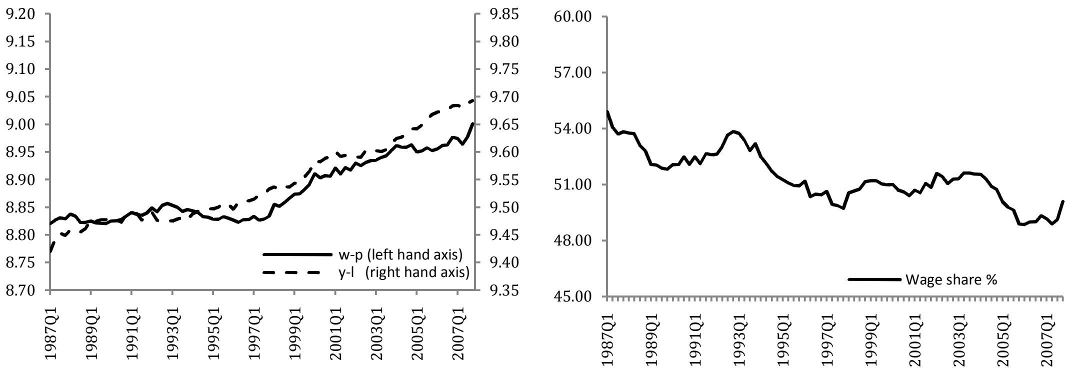
Figure 6.12 Evolution of long term real interest rates

6.5.7 Evolution of real wages, productivity and the wage share

In this section we present the evolution of real wages against that of productivity, this comparison allows us to examine the evolution of the wage share (over GDP). We start with the cases of the UK and the Netherlands in Figure 6.13: In the UK's case, real wages and productivity seem to trend upwards together, which translates in a fairly stable wage share. In the Netherlands, we can differentiate four stages: Up to 1993 real wages and productivity seem to move together and the wage share remains stable. Between 1993 and 1998 real wages fall whereas productivity continues its rise, and as a result the wage share falls during this period. After 1998 real wages and productivity regain momentum and move in parallel, leaving the wage share stable until 2004. Thereafter, real wages slow down again despite raising productivity, which reduces the wage share once more.



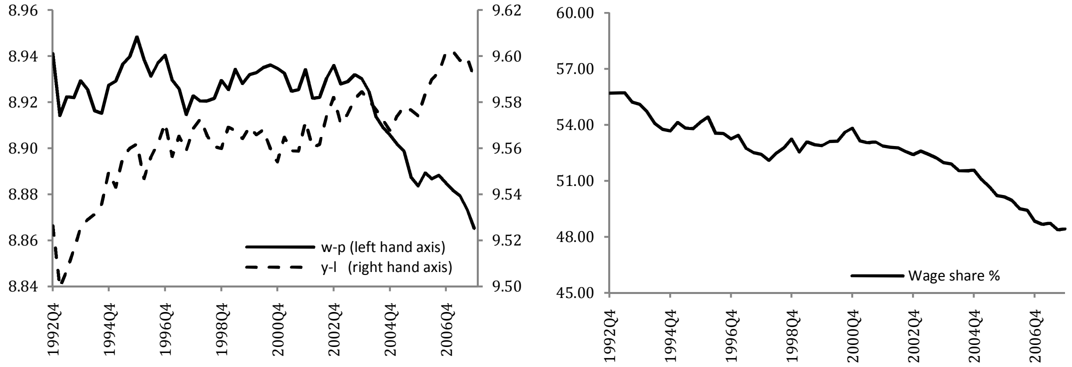
(y) United Kingdom



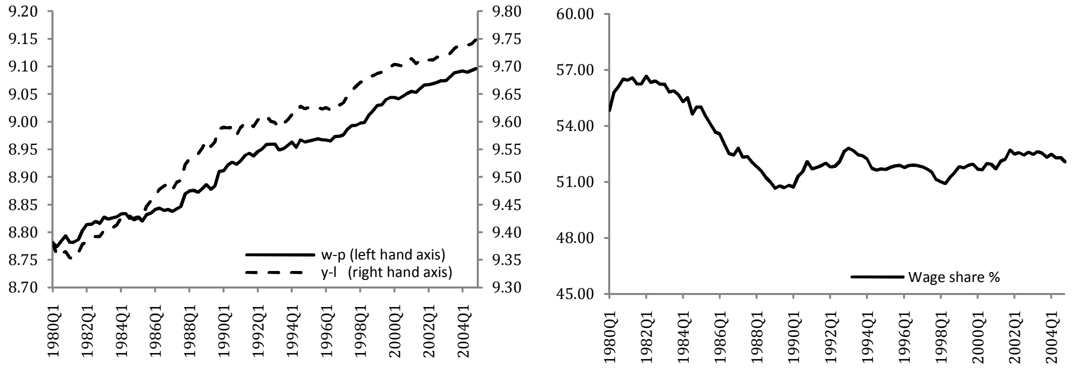
(b) Netherlands

Figure 6.13. Real wages, productivity and distribution in the UK and Netherlands

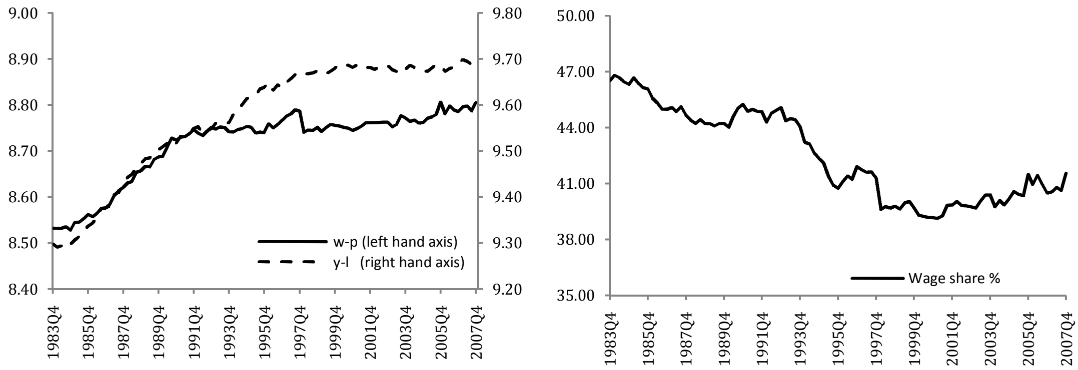
Figure 6.14 presents the cases of Germany and France, Italy and Spain. In Germany, up to 2003 real wages remain fairly constant despite considerable rises in productivity, which translates into a falling wage share. This process intensives in the latter part of the sample after 2003, as real wages fall despite productivity sustained growth. In France, we can differentiate three moments: Before 1982 real wages and productivity seem to move together and the wage share remains stable. Between 1982 and 1987 productivity grows in a context of stagnant real wages, which translates in a falling wage share. After 1987, real wages and productivity seem to trend upwards in parallel, leaving the wage share relatively stable but at a lower level than at the beginning of the sample period.



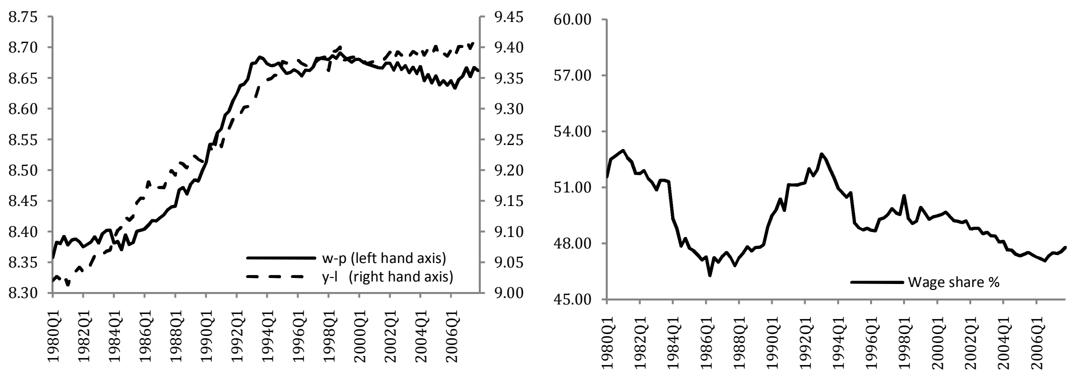
(a) Germany



(b) France



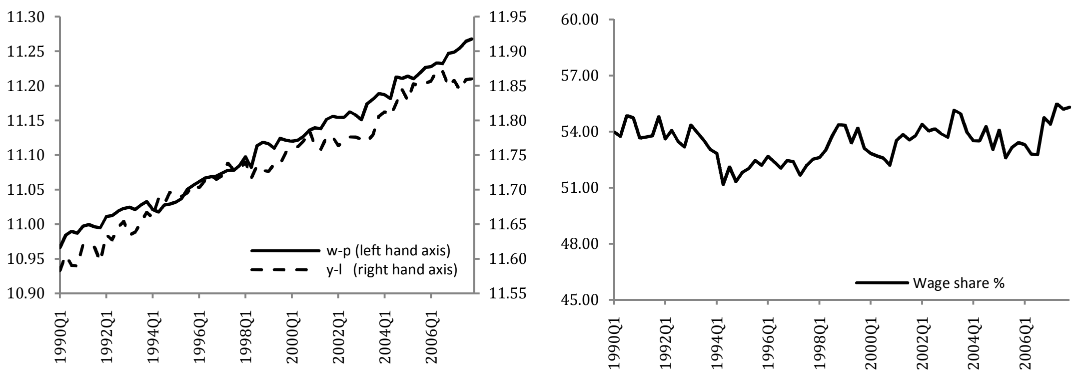
(c) Italy



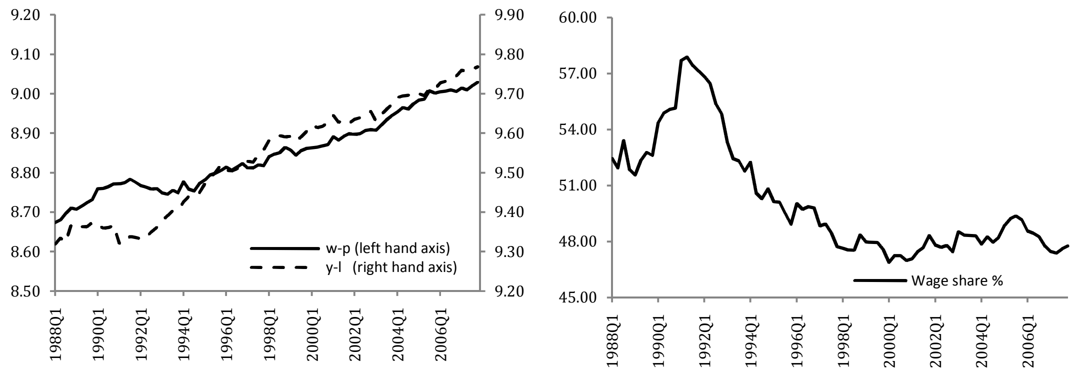
(d) Spain

Figure 6.14. Real wages, productivity and distribution in Germany, France, Italy and Spain

In the Italian case, we can differentiate three moments: Up to 1993 real wages and productivity trend upwards in a close move, although productivity grows faster, giving place to a slight reduction in the wage share. Between 1993 and 1997 real wages stagnate whereas productivity continues rising, intensifying the fall in the wage share during this period. After 1997 productivity and real wages both stagnate, leaving the wage share unchanged, although towards the end of the period real wages grow slightly. In Spain, we can differentiate two phases: Before 1993 real wages and productivity trend upwards, their trends are not well synchronized and that causes substantial swings in the wage share that seems to fluctuate around the same level. After 1992, real wages stagnate even falling in some quarters, productivity also slows downs notoriously but it hardly falls, creating a widening gap between productivity and wages, which reduces the wage share particularly after 2000.



(y) Denmark



(b) Finland

Figure 6.15. Real wages, productivity and distribution in Denmark and Finland

Figure 6.15 shows the evolution of real wages against that of productivity, and the wage share for Denmark and Finland. In the Danish case, as in the UK, real wages and productivity seem to trend in a synchronized fashion while the wage share remains stable. In Finland, we can differentiate three periods: Before 1992 real wages grow despite productivity remaining constant, even falling in some quarters, this translates in a rising wage share. Between 1992 and 1997 the opposite happens, and the wage share falls well beyond its initial level. After 1997 real wages and productivity seem to trend upwards together and the wage share remains stable.

6.5.8 Evolution of imported raw materials prices

Finally, Figure 6.16 present the evolution of our measure of real cost of imported inputs p^{vm} for all the economies in our sample.

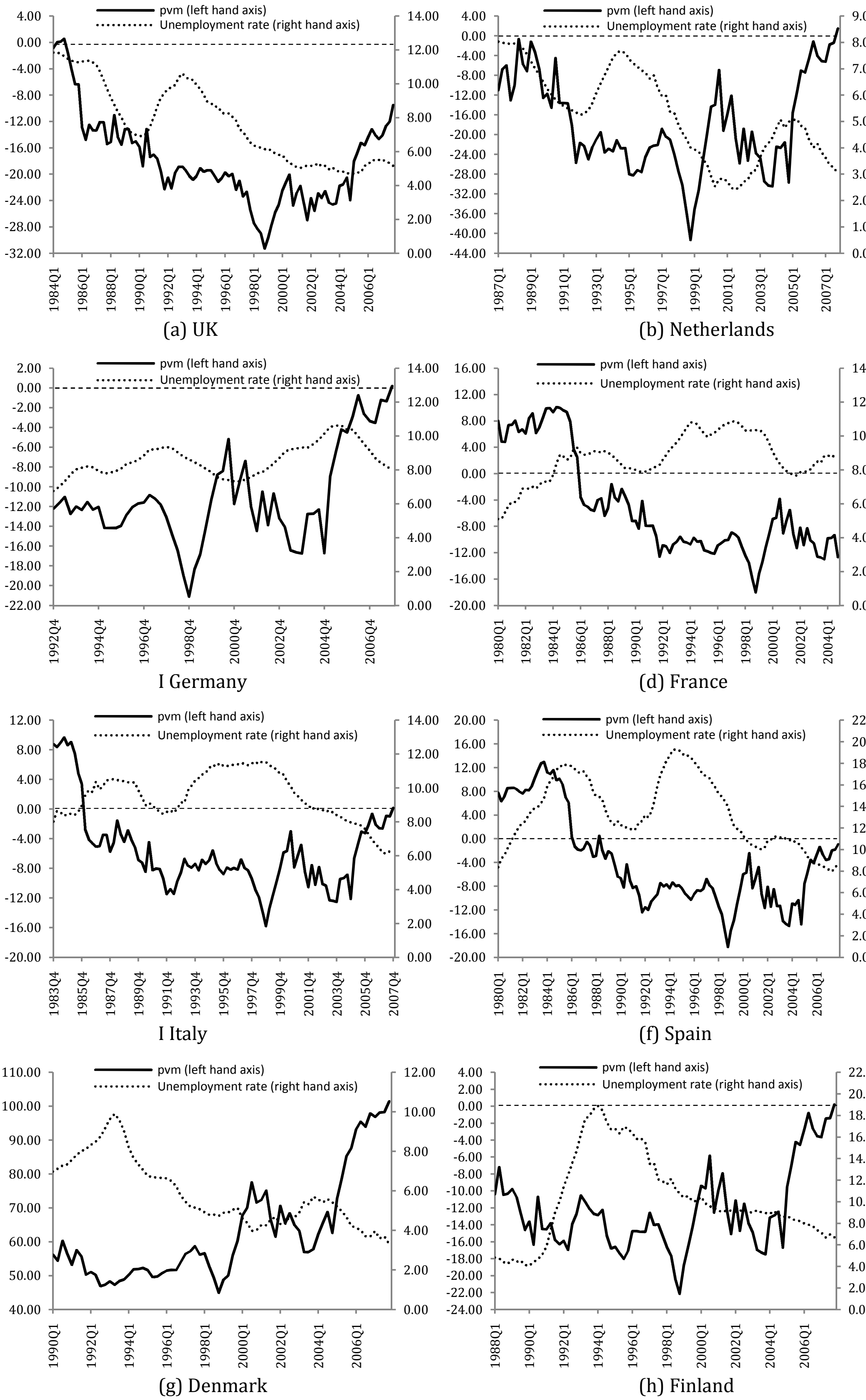


Figure 6.16. External shocks

Observing Figure 6.16 there seems to be a common pattern to all of them except for Denmark, this pattern can be characterized as follows. p^{vm} is positive until the mid 1980s reflecting that imported raw materials are growing faster than domestic prices, see UK in panel (a), France in panel (d), Italy in panel I and Spain in panel (f). Recall that for the rest of countries we do not have data for the 1980s. In the second half of the 1980s, p^{vm} turns negative and even shows a more or less marked downward trend until 1998, reflecting that external price conditions become more and more favourable for importers of raw materials. After 1998, p^{vm} surges and in some cases such as the Netherlands, Germany, Italy, Spain and Finland, it approximates zero suggesting that prices of imported raw materials are growing nearly as fast as domestic prices, while in the UK and France, p^{vm} remains well into the negatives despite the rise.

In Denmark, the overall movement of p^{vm} is similar, relatively stable for most of the 1990s, and rapidly rising after 1998. The peculiarity of the Danish case is that p^{vm} is positive for all the sample period, suggesting that Denmark is under a negative external price shock throughout our sample. This seems to be due to the weakness of the Danish Crown in front of the US Dollar used to measure the commodity indexes (*NFPC* and *Oilp*) included in p^{vm}.

6.6 Summary

In this chapter we have discussed the particulars of the data employed in our empirical analysis. The key features of our data can be summarized as follows. Data comprises eight data sets one for each of the eight economies studied here, namely the UK, the Netherlands, Germany, France, Italy, Spain, Denmark and Finland. Data are quarterly and cover the period from 1980q1 to 2007q4, with some country variations depending on data availability.

Each country's data set contains nine core variables denoted by the following vector $z_t = (w_t - p_t, y_t - l_t,\ u_t, lu_t, grr_t, t_t^w, mil_t, k_t, i_t - \Delta p_t)'$. Germany is the only exception because its data set does not contain a measure of workers' militancy mil_t. Each country's data set also includes a vector x_t of several lags of Δp_{t-q}^{vm}, which accounts for external shocks, the exact number of lags varies in each case depending on the most suitable econometric specification. This issue is explained in the following chapters. In the cases of the UK, Spain and Finland, the vector x_t also contains a dummy, denoted by $D05q4$, $D87q4$ and $D97q123$ respectively. These dummies are used to control for outliners.

OECD's statistical office is the main source of data, although we also employ data from Eurostat's statistical office, and to a lesser extend from the IMF statistical offices. Finally, in order to provide a quick reference point to definitions and sources of the variables we provide the following summary table:

Variables	Description	Source
w-p	(log) real wages computed as $w - p$	[OC]
w	(log) average nominal wages calculated: $log\ (CE/TE)$	[OC]
CE	Employees Compensation component of *GDP*, accounts for total remuneration paid to employees (wages and salaries in cash and in kind plus employers' social contributions). In nominal terms, seasonally adjusted and measured in millions of National currency units.	[5]
TE	Total employment as per labour force survey, and includes armed forces (conscripts as well as professional military), except for Germany and Denmark where figures are based on the National Accounts.	[2]
p	(log) of the Consumer Price Index (CPI) (Base=2005) for all items and the whole economy.	[1]
y-l	(log) real labour productivity calculated: $log\left[\left(\frac{GDP}{CPI}\right)/TE\right]$	[OC]
GDP	Gross Domestic Product in nominal terms, seasonally adjusted, measured in millions of National currency units.	[5]
u	(log) unemployment rate, based on Labour Force Surveys	[2]
lu †	(log) long-term unemployment rate: log[(TLU/TU)*100]	[OC]
TLU	Number of long-term unemployed workers, i.e. workers that have been out of work for 52 weeks (one year) or more, as per Labour Force Surveys.	[1]
TU	Number (in thousands) of unemployed workers, as per u description	[2]
grr †	(log) Gross Replacement Rates calculated as the ratio between out-of-work benefits (under three family situations and three durations of unemployment) and in-work earnings (100% and 67% of manufacturing wages) times hundred.	[3]
t^w †	(log) linked *Tax-wedge* calculated as the ratio of taxation paid by workers over average labour costs, for a worker earning 100% of average wages under two family situations (single no children and married couple with one earner and two children): $log\left(\frac{income\ tax+employee's\ social\ security+employer'\ social\ security-cash\ transfers}{gross\ earnings+employer\ social\ security}\right)$ France's measure does not include employer SCC.	[4],[1]
mil *	(log) of strike activity, measured in number of days lost in labour dispute (UK and Spain)	[1]
	(log) of strike activity, measured in number of hours lost in labour dispute (Italy)	[1]
	(log) of strike activity, measured in number of workers involved in labour dispute (The Netherlands, France, Denmark and Finland). Not available for Germany	[5]
k	(log) real capital stock for the total economy (excluding housing services) expressed in millions of local currency.	[2]
$i - \Delta p$	(log) of central government bond yields on the secondary market, gross of tax, with a residual maturity of around 10 years minus the inflation rate. Log$[i10y - (\Delta p * 100)]$	[OC]
i10y	Central government bond yields on the secondary market, gross of tax, with a residual maturity of around 10 years.	[5]
p^{vm}	(log) of the ratio of commodity imports price index (in terms of local currency) to CPI, weighted by the share of imports to GDP: $p^{vm} = v * log(P^m/CPI)$	[OC]
v	Share of imports to GDP (in percentage): $(M/GDP) * 100$	[OC]
M	Imported goods and services in nominal terms, seasonally adjusted, measured in millions of National currency units.	[5]
P^m	Commodity imports price index in terms of local currency: $CMPI * (1/gbpusd)$ for the UK, $CMPI * (1/eurusd)$ for Euro Area Member States and $CMPI * (1/dcusd)$ for Denmark.	[OC]
CMPI‡	Commodity Imports Price Index in terms of USD: $(NFPC + Oilp)/2$	[OC]
NFPC	Index Non-fuel Primary Commodities index (Base 2005=100 in USD)	[6]
Oilp	Average Petroleum Spot index of UK, Brent, Dubai & West Texas (Base 2005=100 in USD)	[6]
gbpusd	The US dollar/Great Britain Pound exchange rates	[1]
eurusd	The US dollar/Euro exchange rates	[1]
dcusd	The US dollar/Danish crown exchange rates	[1]
$D05q4$	UK's dummy, value=1 in the last quarter of 2005 and zero otherwise.	[OC]
$D87q4$	Spain's dummy, value=1 in the last quarter of 1987, and zero otherwise.	[OC]
$D97q123$	Finland's dummy, value=1 in the first three quarters of 1997, and zero otherwise.	[OC]
WS	Wage share of GDP: $exp^{(w-p)-(y-l)} * 100$	[OC]
T	Time trend	[OC]

Table 6.2. Data description and sources

Source legend: [OC] Own Calculation, [1] OECD.stat, [2] OECD Economic Outlook no. 86, [3] Benefits and Wages: OECD Indicators, [4] Correspondence with Centre for Tax Policy and Administration, OECD, [5] Eurostat, [6] IMF.

Note: † indicates that original annual data are transformed into quarterly data using linear interpolation. * indicates that original annual data for the Netherlands, France, Denmark and Finland is transformed into quarterly data using linear interpolation. ‡ Indicates that original monthly data are made quarterly by considering the last month of the quarter observation as the quarterly value.

Chapter 7 Determinants of the NAIRU and its anchor properties, evidence from the UK and the Netherlands

7.1 Introduction

This chapter presents the results of applying the CVAR approach presented in Chapter 5, to data for the UK and the Netherlands. To contextualize our findings, we open the chapter with a summary of the time series literature reviewed in Chapter 3 that refers to these economies. A summary table of this literature can also be found in Table I.1, in Appendix I.

UK's literature is generally thought to provide support to LNJ's claims, this is based on the early work of Layard and Nickell (1986), where it is found that the NAIRU is neither determined by capital stock nor productivity, but by exogenous wage-push factors. This evidence is yet reinforced by later studies such as Layard et al. (1991, p.144), Nickell and Bell (1995) and Nickell (1998), who also find evidence of links between unemployment and exogenous features of the labour market.

However, these findings are challenged by a growing literature that finds evidence of links between the NAIRU and demand via different channels. Hatton (2007) find a significant negative long run link between unemployment and productivity. Arestis and Biefang-Frisancho Mariscal (1998, 2000) and Stockhammer (2004a) find evidence of labour market hysteresis and of a negative link between capital stock and the NAIRU. Further, there is evidence of a link between the NAIRU and real interest rates (Nickell, 1998, Ball, 1999, Gianella et al., 2008).

When it comes to the anchor properties of the NAIRU in the UK, evidence is less contentious because all seems to suggest that the NAIRU is at best a weak anchor. Layard and Nickell (1986) and Arestis and Biefang-Frisancho Mariscal (1998, 2000) find that deviations from the NAIRU have little influence on unemployment dynamics. In the same vein, all estimates suggest that the adjustment after a shock is very protracted (Henry et al., 2000, Duval and Vogel, 2008).

The Dutch experience has received less attention but the overall picture is very similar to that from the UK. It is usually argued that the evolution of unemployment in the Netherlands provides support to LNJ's approach (Siebert, 1997, OECD, 2000b,p.223, Nickell and Van Ours, 2000), however, there is a body of empirical literature that challenges these claims. Arestis et al. (2007) find a significant negative long run link between capital stock and unemployment, which reinforces early evidence of a negative influence of accumulation over unemployment (Driehuis, 1986). Furthermore, there is evidence of a link between the NAIRU and real interest rates (Ball, 1999, Gianella et al., 2008).

Further, as in the UK's case, deviations from the NAIRU seem to have little influence on unemployment dynamics (Arestis et al., 2007, Schreiber, 2012), and the adjustment to shocks appear to be very sluggish (Duval and Vogel, 2008), all of which suggests that the NAIRU is at best a weak anchor.

The rest of the chapter presents our own findings, and it is structured as follows: Section 7.2 presents results for the UK, section 7.3 the results for the Netherlands. Each of them contains five subsections devoted to the five CVAR stages: Data properties and model specification, Cointegration tests, Identification process, VECM estimations, and GIR simulations. Finally, section 7.4 closes the chapter with a summary of key findings.

7.2 UK

7.2.1 Data properties and model specification

In order to confirm that the CVAR approach can be applied to the UK's data set, we examine the stationary properties of the data. According to the unit root and stationarity tests results, reported in Appendix II, all the variables in UK's $z_t = (w_t - p_t, y_t - l_t,\ u_t,\ lu_t,\ grr_t, t_t^w,\ mil_t,\ k_t,\ i_t - \Delta p_t)'$ are $I(1)$. These results justify the use of cointegration techniques such as the CVAR which we proceed to model now.

The starting point is the CVAR benchmark specification, equation 5.1. The composition of its deterministic component C is decided after visual inspection of the data in Figure II.1. This inspection reveals that some of the variables of z_t exhibit a time trend, which could cause the problem of quadratic trends discussed in section 5.4. In order to avoid this phenomenon, we decompose the matrix of deterministic components C into intercepts and time trends, and restrict the time trends to the long run term, as per equation 5.5.

The choice of lag order for this specification draws from the standard model selection criteria, reported in Table 7.1, and along with the composition of x_t, is the result of extensive experimentation with several specifications. After this process we adopt the following VAR (2) expression with $\mathrm{x}_t = (\Delta p_{t-1}^{vm}, \Delta p_{t-2}^{vm}, D05q4)'$ as our preferred specification[37]:

[37] We experimented with more parsimonious models (than our preferred specification), such as a VAR(2) specification with $\mathrm{x}_t = (\Delta p_{t-1}^{vm})$ and $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm})'$, Models of similar dimensions to equation 7.1, such as VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm}, \Delta p_{t-3}^{vm})'$, and $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm}, D05q406q12)'$ where $D05q406q12$ is a dummy for the last quarter of 2005 and the first half of 2006, in which our estimates seemed less accurate. And less parsimonious models, such as a VAR(3) specification following AIC's suggestions, and a VAR(2) specification with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm},\ D05q4, EMS\ )'$ where $D05q4$ is the dummy considered in equation 7.1, and EMS is a dummy for the period in which the UK was part of the European Monetary System between 1990q1 to 1992q3, for which our estimates seemed less accurate. However, these specifications are unable to accommodate serial correlation problems, in some cases despite consuming greater degrees of freedom than our preferred specification, and consequently are discarded.

7.1 $\Delta z_t = c_0 + \Phi_1 \Delta z_{t-1} + \gamma\beta' z_t^* + \lambda x_t + \varepsilon_t$ where, $z_t = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ mil_t \\ k_t \\ i_t - \Delta p_t \end{pmatrix}, z_t^* = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ mil_t \\ k_t \\ i_t - \Delta p_t \\ T \end{pmatrix}, x_t = \begin{pmatrix} \Delta p_{t-1}^{vm} \\ \Delta p_{t-2}^{vm} \\ D05q4 \end{pmatrix}$

Variables in z_t, z_t^* and x_t have the same meaning as in Chapter 6. We adopt this specification, because it appears to deliver the best balance between parsimony, a rich and informative lag structure[38] and satisfactory diagnostic test results for the UK's data set.

Lag order	AIC	SBC
5	2449.4	1886.9
4	2405.3	1944.1
3	2391.8	2031.9
2	2360.1	2101.4
1	2229.0	2071.5
0	1239.7	1183.5

Table 7.1. Lag order selection criteria, UK

Note: The test is carried out with 90 observations covering the period between 1985q3 to 2007q4. Statistics reported here are obtained from estimating an unrestricted VAR model for the variables contained in the vector z_t, with a constant and a time trend[39], two lags of Δp^{vm}, and the dummy variable $D05q4$.

7.2.2 Cointegration tests

Following, we test for cointegration among the variables of z_t, Table 7.2 presents the results of the Maximum Eigenvalue (λ_{max}) and Trace (λ_{trace}) tests:

		λ_{max}		λ_{trace}	
H_0	H_1	Statistic	95% Critical values	Statistic	95% Critical values
r=0	r=1	91.84	61.27	355.41	222.62
r≤1	r=2	61.73	55.14	263.57	182.99
r≤2	r=3	57.42	49.32	201.84	147.27
r≤3	r=4	41.50	43.61	144.43	115.85
r≤4	r=5	33.46	37.86	102.93	87.17
r≤5	r=6	26.67	31.79	69.46	63.00
r≤6	r=7	20.41	25.42	42.79	42.34
r≤7	r=8	12.04	19.22	22.38	25.77
r≤8	r=9	10.34	12.39	10.34	12.39

Table 7.2. Results from cointegration tests, UK

Note: Test statistics are obtained from applying the Maximum Eigenvalue and Trace test to z_t using a VAR(2) model with unrestricted intercepts and restricted trend coefficients, two lags of Δp^{vm}, and the dummy variable $D05q4$, with 93 observations covering the period between 1984q4 to 2007q4. Critical values are chosen according to this specification.

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[38] It should be noted that a VAR(2) specification with nine variables is the equivalent to an $ARMA(18,16)$, (Hamilton, 1994, p.349)

[39] The inclusion of the time trend responds to the fact that most of our variables are trended, (Pesaran and Pesaran, 2003, p.310).

The Maximum Eigenvalue test fails to reject the null hypothesis of having three long run relationships, while the Trace test fails to reject the null hypothesis of having seven cointegrated vectors. Hence, both tests suggest that there are more long run relationships than as per our theoretical model, which only predicts two, although they disagree about the exact number. These results are rather inconclusive, although as discussed in section 5.5, this problem is well reported in the literature.

In these circumstances, it is generally advised to weight the tests results against their potential biases and economic theory (Pesaran and Pesaran, 2003,p.293, Garrat et al.,2006,p.198). Cheung and Lai (1993) find that the Maximum Eigenvalue and Trace tests tend to overstate the number of cointegrated vectors in the following situations: When the sample size is small, when the dimension of the model is large, and when the residuals of the regressions used to calculate the test statistics do not follow a normal distribution, see section 5.5 for further details.

In our case, we have a reasonable large sample of 96 observations, but we are estimating a large VAR (2) with nine variables, and some of its residuals are not normally distributed[40]. Hence, it seems reasonable to suspect that tests results reported in Table 7.2 might be inflated. In this scenario, Pesaran and Pesaran (2003,p.293) and Garrat et al. (2006,p.198) recommend to rely on the predictions from economic theory rather than the tests' results. We follow their advice and proceed under the assumption of *r*=2.

7.2.3 Identifying the long run relationships

In order to identify which variables take part in these two long run relationships, we use the four sets of theoretically driven restrictions detailed in Table 5.1 (β_{LNJ}, β_{BS}, β_{ASR} and β_{RH}) as identifying schedules. Table 7.3 reports the results of this process.

We start by imposing the restrictions contained in β_{LNJ}. This set of restrictions is insignificant at the standard 5%, its log-likelihood ratio (LR) test is a $X^2_{(10)}$=62.016 with a p-value equal to [0.000]. Hence, evidence seems to lean against β_{LNJ}. Next, we test the validity of the restrictions contained in β_{BS}, which are also insignificant as a whole with a p-value for the LR test equal to [0.000]. Following, we introduce the set of restrictions of β_{ASR}[41], for which evidence is not very supportive either, since it is insignificant with a p-value for the LR test equal to [0.002]. Finally, the set of restrictions contained in β_{RH} is also found insignificant, with a p-value for LR test equal to [0.000].

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[40] This refers to the residuals obtained from estimating the vector of equations contained in equation 7.1. We do not report them here due to space limitations, but are available upon request.

[41] Please note that the coefficient β_{22} is left unrestricted because we fail to obtain converging results when introducing $\beta_{22} = -1$ despite introducing β_{ASR} following different sequences.

z_t^*	$\hat{\beta}_{LNJ}$		$\hat{\beta}_{BS}$		$\hat{\beta}_{ASR}$		$\hat{\beta}_{RH}$		$\hat{\beta}_{\text{Hybrid}}$	
$w_t - p_t$	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
$y_t - l_t$	0.000	-1.000	0.000	-1.000	-0.267	-1.858[NC]	0.000	-1.000	0.000	-1.335§
					None	None				(0.134)
u_t	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
lu_t	0.000	0.000	-1.200§	-0.207§	0.000	0.000	0.000	0.000	0.000	0.000
			(0.408)	(0.088)						
grr_t	-0.272	-0.091	0.307	0.012	-0.081	-0.110	-0.738	-0.109	-0.991§	0.000
	(0.579)	(0.073)	(0.469)	(0.101)	None	None	(1.128)	(0.124)	(0.450)	
t_t^w	-3.162§	0.118	-0.026	0.648§	-2.511	0.4501§	-4.096	0.069	0.000	0.373§
	(1.459)	(0.185)	(0.918)	(0.198)	None	(0.074)	(3.268)	(0.358)		(0.042)
mil_t	0.104	-0.004	0.013	-0.019§	0.099	-0.005	0.118	-0.003	-0.112§	-0.004§
	(0.063)	(0.008)	(0.029)	(0.006)	None	None	(0.104)	(0.011)	(0.052)	(0.001)
k_t	0.000	0.000	0.000	0.000	0.414	0.561	0.000	0.000	11.40§	0.307§
					None	None			(3.452)	(0.075)
$i_t - \Delta p_t$	0.000	0.000	0.000	0.000	0.000	0.000	0.502	0.022	0.646§	0.000
							(1.090)	(0.122)	(0.301)	
T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.123§	0.000
									(0.038)	
r^2	4		4		4		4		4	
ll_{r^2}	2532.7		2532.7		2532.7		2532.7		2532.7	
q	14		12		10		12		11	
ll_q	2501.7		2532.7		2522.4		2502.4		2526.0	
$X_{LR}^2(q - r^2)$	$X^2(10)$=62.016 [0.000]		$X^2(8)$=37.47 [0.000]		$X^2(6)$=20.4376 [0.002]		$X^2(8)$=60.561 [0.000]		$X^2(7)$=13.387§ [0.063]	

Table 7.3. Identification process and estimation of long run elasticities, UK

Note: These estimations were carried with 93 observations covering the period between 1984q4 to 2007q4. Asymptotic standard errors for each β coefficient are provided in brackets. § indicates significant at 5% and * indicates significant at 10%. NC indicates that the coefficient is subject to a theoretical restriction for which we failed to obtain converging results, and hence had to be left unrestricted. r^2=Number of just identified restrictions, and q= Number of total restrictions imposed, i.e. over-identifying restrictions. ll_{r^2} is the maximum value of the log-likelihood function obtained under r^2 just identified restrictions. ll_q is the maximum value of the log-likelihood function obtained under q over-identifying restrictions. $X_{LR}^2(q - r^2)$ is the chi-square statistics for the log-likelihood Ratio (LR) test. P-values for this test are provided in square brackets.

Hence, evidence does not seem to yield support to any of the four sets of restrictions drawn from each of the nested NAIRU models. Far from concluding that none of them is supported by the data, we interpret these results as a sign that the unemployment and real wages cointegrated vectors are more complex than as portrayed by these stylised theoretical models.

In fact, evidence from the trial and error process by which these sets of restrictions are introduced reveals some suggestive features of the data[42]: Introducing $\beta_{18} = 0$, $\beta_{22} = -1$ and $\beta_{110} = 0$ pushes $\hat{\beta}_{LNJ}$, $\hat{\beta}_{BS}$ and $\hat{\beta}_{RH}$ to rejection. In the case of $\hat{\beta}_{ASR}$, it is imposing $\beta_{19} = 0$ and $\beta_{110} = 0$ that pushes the set of restrictions into rejection. Further, $\beta_{12} = 0$ seems supported by the data in several cases. This evidence suggests that some form of hybrid between β_{ASR} (where $\beta_{18} \neq 0$) and β_{RH} (where $\beta_{19} \neq 0$), along with $\beta_{12} = 0$, $\beta_{22} \neq -1$ and $\beta_{110} \neq 0$ might be supported by the data.

To test this hypothesis we build a sequence of restrictions denoted by β_{Hybrid}, which contains these features, and experiment imposing further restrictions, generally exclusion restrictions to coefficients that appear to be individually insignificant, until we find a $\hat{\beta}_{Hybrid}$ supported by the data. Results of this process are reported in the last column of Table 7.3.

The set of restrictions $\hat{\beta}_{Hybrid}$ is significant at the standard 5%, the LR test is a $X^2_{(7)}$=13.387 with a p-value equal to [0.063]. Furthermore, according to the asymptotic standard errors (in brackets), all the unrestricted coefficients are individually significant at the standard levels. $\hat{\beta}_{Hybrid}$ is clearly more significant than the rest of β matrices examined in Table 7.3 and consequently we adopt it as our preferred long run specification.

To better discuss the economic implications of these results we rewrite $\hat{\beta}_{Hybrid}$ in terms of the two cointegrated vectors that it describes (asymptotic standard errors in brackets):

$$u_t = \underset{(0.450)}{0.991}grr_t + \underset{(0.052)}{0.112}mil_t - \underset{(3.452)}{11.40}k_t - \underset{(0.301)}{0.646}(i_t - \Delta p_t) + \underset{(0.038)}{0.123}T + \hat{\xi}_{1,t} \tag{7.2}$$

$$(w_t - p_t) = \underset{(0.134)}{1.335}(y_t - l_t) - \underset{(0.042)}{0.373}t_t^w + \underset{(0.001)}{0.004}mil_t - \underset{(0.075)}{0.307}k_t + \hat{\xi}_{2,t} \tag{7.3}$$

[42] It must be noted that comments regarding the importance of individual restrictions reported here, are consistent with different ordering of the restrictions. This is worth mentioning, because given that restriction are introduced on one-by-one basis, and that the LR statistic, refers to the whole set of over-identifying restrictions. It is difficult to discern whether the (in-) significance of a set of restrictions is caused by the last restriction introduced or by the combination of this one with the restrictions introduced previously. To ensure that our inference regarding individual coefficients is well grounded we experiment with different ordering of the restrictions contained in each restricted β. Thus, the comments made here are robust to different ordering of the restrictions.

Equation 7.2 describes the unemployment long run relationship, and hence can be regarded as our NAIRU equation. Since all the variables are measured in logarithms, the coefficients from this equation can be interpreted as the elasticities of the NAIRU with respect to each variable. Equation 7.3 describes the real wages long run equilibrium and its coefficients can also be interpreted as long run elasticities.

According to equation 7.2, the UK's NAIRU is determined by some features of the labour market, such as unemployment benefits and workers' militancy, as also reported in Layard and Nickell (1986), Layard et al. (1991,p.441) or Nickell and Bell (1995). Although contrary to LNJ's propositions, the NAIRU is not exclusively determined by these exogenous factors:

First, the NAIRU is also influenced by the size of capital stock, our estimates suggest that an increase in capital stock of 1% would reduce the NAIRU by 11.40%. That means that for a NAIRU equal to 10%, a rise in capital stock of 1% would reduce it to 8.860%. According to our theoretical model, this evidence suggests that capital stock limits firms' ability to mark-up wages[43]. Our finding reinforce previous evidence that capital stock reduces the NAIRU in the UK, particularly that from Arestis and Biefang-Frisancho Mariscal (1998, 2000) who also find unemployment negatively cointegrated with capital stock, see also Stockhammer (2004a). Further, this finding also reinforces doubts about the robustness of Layard and Nickell's (1986) early results, who find no evidence of a link between the NAIRU and capital stock.

Second, the NAIRU is determined by real long term interest rates, our estimate suggest that an increase in real long term interest rates of 1% would reduce the NAIRU by 0.646%. The sign of this coefficient is unexpected, because Rowthorn (1999, p.422) and Hein (2006) suggest that cost of long term borrowing rises firms' price mark-up and the NAIRU, and our findings suggest that it would reduce them[44]. This could be the result of a wealth effect, by which higher real long term interest rates rises funding available to firms rather than making it more expensive, as suggested by Bell-Kelton and Ballinger (2005).

It could also reflect the impact of the cost of borrowing on the opportunity cost of being unemployed, as pointed out by Honkapohja and Koskela (1999)[45]. These authors argue that higher cost of borrowing rises the opportunity cost of

[43] As per equation 4.4 $\beta_{18} = -\frac{\varphi_2}{\omega_1+\varphi_1}$, hence finding $\hat{\beta}_{18} < 0$ requires $\varphi_2 > 0$, as long as the denominator is positive, i.e. $\omega_1 + \varphi_1 > 0$, which implies that unemployment reduces workers ability to set real wages and firms ability to set their price mark-up, both very reasonable.

[44] As per equation 4.4, $\beta_{19} = \frac{\varphi_5}{\omega_1+\varphi_1}$, hence finding $\hat{\beta}_{19} < 0$, requires $\varphi_5 < 0$, which implies that hikes in long term interest rates would reduce firms mark-up. As long as $\omega_1 + \varphi_1 > 0$.

[45] To account for this possibility in our model we would need to expand our real wage equation 4.2 to consider the following term: $-\omega_7(i - \Delta p)$, which would deliver a new $\beta_{19} = \frac{\varphi_5-\omega_7}{\omega_1+\varphi_1}$. Hence, observing a $\hat{\beta}_{19} < 0$, would require that $\varphi_5 < \omega_7$.

being unemployed, because unemployed workers will find harder to pay their debts, than those at work. As a result, they argue, workers will moderate their real wage demands to secure their jobs and the NAIRU will fall.

In any case, this finding reinforces previous evidence that real interest rates affect the NAIRU in the UK, see Nickell (1998), Ball (1999) and Gianella et al. (2008) although in these studies the relationship found has the conventional positive sign. Considering the importance of capital stock highlighted by our results, and that these studies do not account for it, a possible explanation for this sign discrepancy is that their positive real interest rate coefficient is in fact capturing the negative influence of capital stock over the NAIRU.

Finally, we find significant evidence of the NAIRU having a time trend. It is worth noting that we do not find significant evidence of productivity having any impact on the NAIRU, as also reported in Layard and Nickell (1986), but in contrast to the findings from Hatton (2007). Further, there is no evidence of labour market hysteresis affecting the NAIRU, contrary to Arestis and Biefang-Frisancho Mariscal (1998, 2000) and Stockhammer (2004a). Having controlled for long term unemployment in our analysis, we suspect that hysteresis in these studies might be capturing the effect of some omitted variables, which here have a significant influence on the NAIRU.

Turning now to equation 7.3, the real wages equilibrium is positively affected by productivity, with an elasticity slightly greater than unity, 1.335 to be precise. This contradicts the findings from Arestis and Biefang-Frisancho Mariscal (1998) who find a long run one-to-one relationship between real wages and productivity. Workers' militancy also increases the long run real wages equilibrium, suggesting that strike action increases real wages in the long run, although the effect is modest. On the other hand, labour taxation and capital stock reduce the real wages equilibrium. This suggests that in the long run, workers are not able to compensate tax increases over their wages and that greater capital does not result in greater real wages.

7.2.4 Short-run dynamics of unemployment and the anchor properties of the NAIRU

To analyse the behaviour of unemployment around the NAIRU, we estimate the ECM equation for Δu_t using the residuals from 7.2 and 7.3 as error correction terms, see section 5.7 for further details. The resultant Δu_t, estimated with 93 observations over the period 1984q4-2007q4, is the following:

$$7.4 \quad \Delta u_t = \underset{[0.003]}{-14.52} + \underset{[0.103]}{0.028}\hat{\xi}_{1,t-1} + \underset{[0.000]}{1.026}\hat{\xi}_{2,t-1} - \underset{[0.055]}{0.746}\Delta(w_{t-1} - p_{t-1}) + \underset{[0.188]}{0.485}\Delta(y_{t-1} - l_{t-1})$$

$$+\underset{[0.962]}{0.005}\Delta u_{t-1} - \underset{[0.000]}{0.430}\Delta lu_{t-1} + \underset{[0.000]}{1.164}\Delta grr_{t-1} - \underset{[0.622]}{0.179}\Delta t^{w}_{t-1} + \underset{[0.067]}{0.004}\Delta mil_{t-1}$$

$$-\underset{[0.627]}{0.666}\Delta k_{t-1} - \underset{[0.504]}{0.011}\Delta(i_{t-1} - \Delta p_{t-1}) - \underset{[0.882]}{0.000}\Delta p^{vm}_{t-1} - \underset{[0.546]}{0.001}\Delta p^{vm}_{t-2} + \underset{[0.000]}{0.073}D05q4 + \hat{\varepsilon}_{3t}$$

Adj. R^2=0.633,

$X^2_{SC}(4)$= 8.722 [0.068], X^2_{FF} (1)= 1.135 [0.287],

$X^2_{Norm}(2)$= 0.681 [0.711], $X^2_{Het}(1)$= 0.440 [0.507]

$\hat{\xi}_{1,t} = u - 0.991grr - 0.112mil + 11.40k + 0.646(i - \Delta p) - 0.123T$

$\hat{\xi}_{2,t} = (w - p) - 1.335(y - l) + 0.373t^{w} - 0.004mil + 0.307k$

$\sigma_{\hat{\varepsilon}_3} = 0.0190$

Where Adj. R^2 denotes Adjusted R-square, X^2_{SC}, X^2_{FF}, X^2_{Norm}, X^2_{Het} are chi-square statistics for Serial correlation (SC), Functional form (FF), Normality of the residuals (NORM) and Heteroscedasticity (HET) tests respectively. $\sigma_{\hat{\varepsilon}_3}$ is the standard deviation of the error term in equation 7.4. p-values for t-tests and diagnostic tests are reported in square brackets[46].

According to equation 7.4 the coefficient for $\hat{\xi}_{1,t-1}$ is not significantly different from zero, meaning that deviations from the NAIRU have no significant influence on unemployment dynamics. In other words, there is no evidence of the NAIRU acting as an anchor. Arestis and Biefang-Frisancho Mariscal (1998, 2000) also find that deviations from the NAIRU have little influence on unemployment, as per their estimates, only a very modest 2.4% and 2.1% of the deviation is corrected each quarter. Layard and Nickell (1986) report similar findings in terms of employment.

The coefficient for $\hat{\xi}_{2,t-1}$ is significant and positive. This suggests that setting real wages above their long run equilibrium increases unemployment. According to the dichotomy proposed by Bhaduri and Marglin (1990), this estimate suggests that the UK operates under a “profit-led regime”, contrary to the findings from Bowles and Boyer (1995) and Hein and Vogel (2007), who find evidence of the UK operating under a “wage-led regime”.

7.2.5 Impulse response and the effects of an unemployment shock

We complete our analysis simulating an unemployment shock of one standard deviation of the error term in equation 7.4, i.e. $\sigma_{\hat{\varepsilon}_3} = 0.0190$. This amounts to a rise in unemployment of 7.58% in annual terms[47]. Figure 7.1 shows the effect of this shock on the variables of z_t using their GIR functions:

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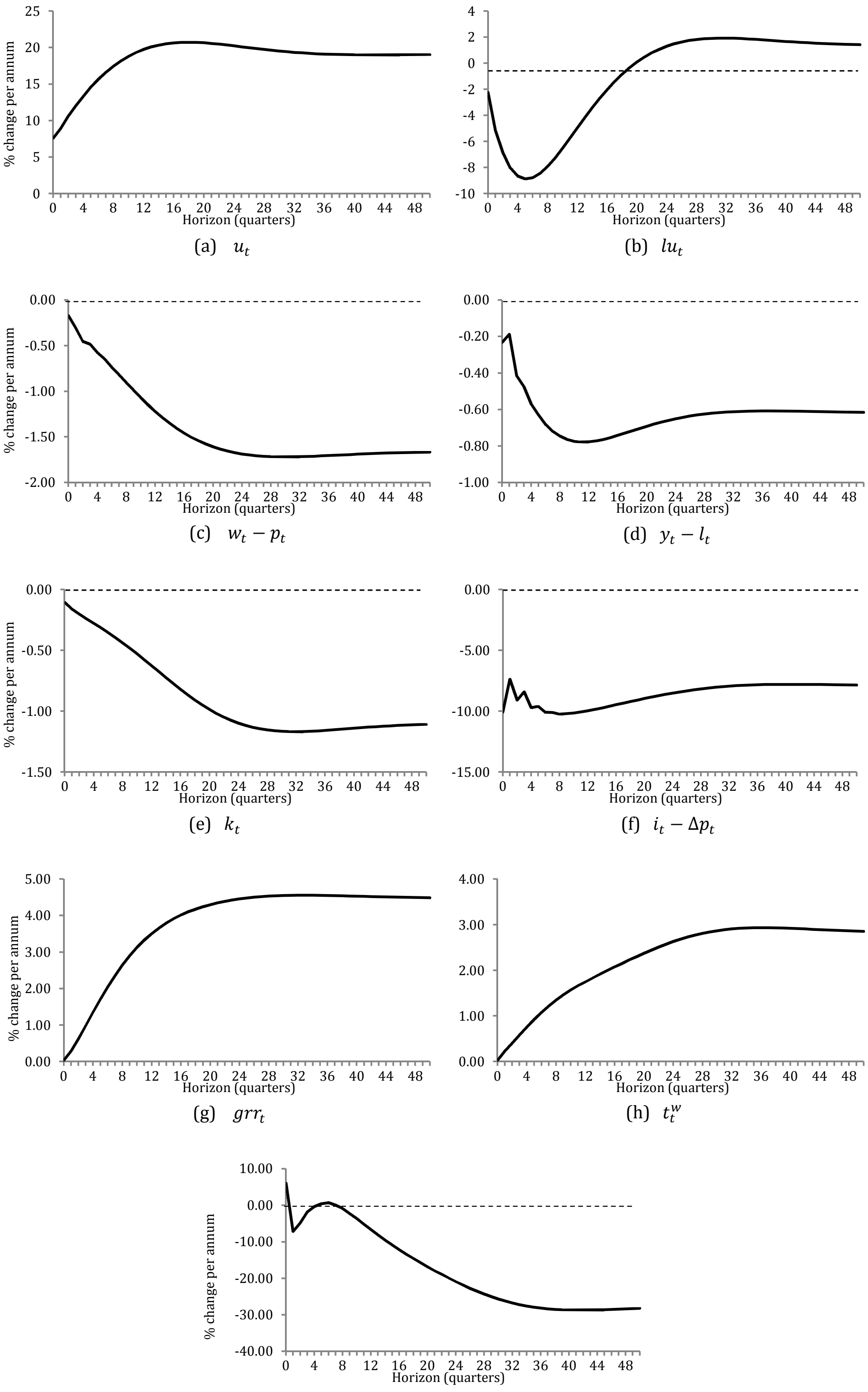
[46] All diagnostic tests are passed at the standard 5% significance level ensuring that estimated coefficients are unbiased, and that inference can be done using the t-test.

[47] Because u_t is the logarithm of the unemployment rate, Δu_t approximates its growth rate, hence, assuming a shock to Δu_t of 0.0190 is equivalent to assume a 1.9% increase in unemployment in one quarter, or 7.58% in annual terms.



(a) u_t (b) lu_t

(c) $w_t - p_t$ (d) $y_t - l_t$

(e) k_t (f) $i_t - \Delta p_t$

(g) grr_t (h) t_t^w

(i) mil_t

Figure 7.1 GIRF of a standard deviation shock to unemployment on all variables, UK

Unemployment in panel (a), shows no sign of returning to its baseline after the shock, as it would be expected if the NAIRU acted as an anchor, instead it drifts upwards until it stabilizes six years after the shock, at a level 19% greater than its pre-shock value. This behaviour suggests that the NAIRU has no anchor properties, and therefore reinforces the results from equation 7.4. Our estimate is more pessimistic than previous impulse response estimates. Henry et al. (2000) find that unemployment needs between 14 to 20 years to return to its baseline after a labour demand shock, Duval and Vogel (2008) find that the UK needs between two and three years to close the output gap. However, the overall conclusion is similar the NAIRU does not seem to be a strong anchor.

The reaction of long term unemployment to the shock, shown in panel (b), is described by a J-curve, which suggests that the effect of the shock changes over time. On impact, lu_t falls as the number of recently fired workers increases, but as time goes by, some of these workers remain unemployed, and the long term unemployment rate rises until it stabilizes above its baseline.

Real wages and productivity, panels (c) and (d), both fall as a consequence of the shock, although the fall in real wages is more pronounced than that of productivity. While $w_t - p_t$ stabilizes at a level 1.6% smaller than its pre-shock value, $y_t - l_t$ stabilizes 0.6% below its baseline. This suggests that the wage share of GDP falls as a result of the shock.

Capital stock and real long term interest rates, panel (e) and (f), fall as a consequence of the shock until they stabilize at a level 1% and 8% smaller than their baselines, respectively. This reaction to the rise in unemployment is very suggestive of the type of negative long run relationship that we find in our econometric analysis.

The last three panels refer to the wage-push factors considered in our model. Unemployment benefits and labour taxation, panels (g) and (h), increase after the shock until they stabilize above their baseline. This could either be the result of a fall in wages, or a rise in social provisions and taxes, respectively. Recall that grr_t and t_t^w are relative measures of benefits and labour taxation with respect to wages, see Chapter 6 for further details on data description. Finally, workers' militancy panel (i), fluctuates widely on impact, probably reflecting greater volatility in industrial relations after the shock, but it ends up falling sharply until it stabilizes at a level 30% below its pre-shock situation.

7.3 Netherlands

7.3.1 Data properties and model specification

We turn now to the Dutch case, data of Netherland's data set are very similar to those of the UK, for evidence from unit root and stationary tests suggest that all variables contained in the Netherlands' $z_t = (w_t - p_t,\ y_t - l_t,\ u_t,\ lu_t,\ grr_t,$

$t_t^w,\ mil_t,\ k_t,\ i_t - \Delta p_t)'$ are $I(1)$, see Appendix II, which justifies the use of the CVAR approach.

We follow the same modelling strategy as in the UK's case. The starting point is the CVAR's benchmark equation 5.1. The composition of C is decided after visual inspection of the data in Figure II.2, which reveals that some of the variables of z_t exhibit a time trend. To avoid the problem of quadratic trends this could cause we adopt equation's 5.5 specification.

The choice of lag order and the composition of x_t, are decided drawing from the model selection criteria reported in Table 7.4, and after extensive experimentation with several specifications. After this process, the following VAR (2) expression with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm})'$ is adopted as our preferred specification[48]:

7.5 $$\Delta \mathrm{z}_t = \mathrm{c}_0 + \Phi_1 \Delta \mathrm{z}_{t-1} + \gamma\beta' \mathrm{z}_t^* + \lambda \mathrm{x}_t + \varepsilon_t \qquad \text{where, } z_t = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ mil_t \\ k_t \\ i_t - \Delta p_t \end{pmatrix}, z_t^* = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ mil_t \\ k_t \\ i_t - \Delta p_t \\ T \end{pmatrix}, \mathrm{x}_t = \begin{pmatrix} \Delta p_{t-1}^{vm} \\ \Delta p_{t-2}^{vm} \end{pmatrix}$$

Variables in z_t, z_t^* and x_t have the same meaning as in Chapter 6. This specification seems to provide the best balance between parsimony, a rich and informative lag structure[49] and satisfactory diagnostic test results for the Netherlands' data set.

Lag order	AIC	SBC
5	2048.7	1529.0
4	1942.9	1518.7
3	1893.9	1565.1
2	1885.5	1652.2
1	1831.5	1693.7
0	1059.6	1017.2

Table 7.4. Lag order selection criteria, Netherlands

Note: The test is carried out with 78 observations covering the period between 1988q3 to 2007q4. Statistics reported here are obtained from estimating an unrestricted VAR model for the variables contained in the vector z_t, with a constant and a time trend, and two lags of Δp^{vm}.

[48] We experimented with more parsimonious models (than our preferred specification), such as a VAR(1) specification with $\mathrm{x}_t = (\Delta p_{t-1}^{vm})$, this lag order draw from SBC indications in Table 7.4. Or a VAR(1) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm})'$, and a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm})$. And less parsimonious models such as a VAR(2) specification with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm}, \Delta p_{t-3}^{vm})'$. More parsimonious specifications fail to pass the corresponding diagnostic tests, in particular serial correlation, whereas, less parsimonious passed the serial correlation tests, but at the expenses of consuming greater degrees of freedom than our preferred specification, and consequently are discarded.

[49] Equivalent to an $ARMA(18,16)$, (Hamilton, 1994, p.349)

7.3.2 Cointegration tests

Table 7.5 presents the results of testing for cointegration among the variables of z_t. The Maximum Eigenvalue test (λ_{max}) fails to reject the null hypothesis of having three long run relationships, while the Trace test (λ_{trace}) fails to reject the null hypothesis of having four cointegrated vectors. Hence, both tests suggest that there are more long run relationships than as per our theoretical model, although they disagree about the exact number.

		λ_{max}		λ_{trace}	
H_0	H_1	Statistic	95% Critical values	Statistic	95% Critical values
r=0	*r=1*	73.36	61.27	310.02	222.62
r≤1	*r=2*	55.59	55.14	236.66	182.99
r≤2	*r=3*	52.81	49.32	181.06	147.27
r≤3	*r=4*	42.95	43.61	128.25	115.85
r≤4	*r=5*	31.31	37.86	85.30	87.17
r≤5	*r=6*	18.99	31.86	53.99	63.00
r≤6	*r=7*	14.37	25.42	34.99	42.34
r≤7	*r=8*	11.94	19.22	20.62	25.77
r≤8	*r=9*	8.69	12.39	8.69	12.39

Table 7.5. Results from cointegration tests, Netherlands

Note: Test statistics are obtained from applying the Maximum Eigenvalue and Trace test to z_t using a VAR(2) model with unrestricted intercepts and restricted trend coefficients, and two lags of Δp^{vm}, with 81 observations covering the period between 1987q4 to 2007q4. Critical values are chosen according to this specification.

As discussed in section 5.5, in these circumstances it is necessary to weight the tests results against their potential biases and economic theory. Considering that in the Netherland's data set we only have 84 observations, that we are estimating a large VAR (2) with nine variables and that some of its residuals are not normally distributed, it seems reasonable to suspect that the test results might suffer of size biases. To overcome these problems, we follow the approach adopted in the UK's case, and proceed under the assumption of *r*=2 as suggested by economic theory.

7.3.3 Identifying the long run relations

In order to identify which variables take part in these two long run relationships, we use the four sets of restrictions from Table 5.1 (β_{LNJ}, β_{BS}, β_{ASR} and β_{RH}) as identifying schedules. Table 7.6 reports the results of this process.

We start by imposing the restrictions contained in β_{LNJ}. This set of restrictions is insignificant at the standard 5%, its log-likelihood ratio (LR) test is a $X^2(10)$=53.328 with a p-value equal to [0.000]. Hence, evidence seems to lean against β_{LNJ}. Next, we test the validity of the restrictions contained in β_{BS}, which are also insignificant as a whole with a p-value for LR test equal to [0.000]. Following, we introduce the set of restrictions of β_{ASR}, for which evidence is not very supportive either, since it is insignificant with a p-value for the LR test equal to [0.000]. Finally, the set of restrictions contained in β_{RH} is also found insignificant with a p-value for LR test equal to [0.000].

z_t^*	$\hat{\beta}_{LNJ}$		$\hat{\beta}_{BS}$		$\hat{\beta}_{ASR}$		$\hat{\beta}_{RH}$		$\hat{\beta}_{\text{Hybrid}}$	
$w_t - p_t$	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
$y_t - l_t$	0.000	-1.000	0.000	-1.000	-7.004 None	-1.000	0.000	-1.000	6.418§ (0.726)	-1.000
u_t	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
lu_t	0.000	0.000	-0.421 (0.539)	0.037 (0.055)	0.000	0.000	0.000	0.000	0.000	0.000
grr_t	-0.544 None	-0.026 (0.025)	-1.090 (0.726)	-0.014 (0.031)	3.376 None	-0.076 (0.058)	-0.668 None	-0.046 (0.030)	1.334§ (0.171)	0.000
${t^w}_t$	-2.616§ (0.839)	-0.259§ (0.037)	-1.994 (1.047)	-0.356§ (0.153)	13.95 None	-0.424§ (0.185)	-2.633§ (0.886)	-0.307§ (0.059)	2.483§ (0.420)	-0.276§ (0.038)
mil_t	-0.247 None	0.003 (0.006)	-0.039 (0.157)	0.004 (0.007)	-0.650 None	0.006 (0.009)	-0.150 (0.092)	0.003 (0.006)	0.000	0.000
k_t	0.000	0.000	0.000	0.000	11.29 none	-0.092 (0.098)	0.000	0.000	1.586§ (0.333)	0.000
$i_t - \Delta p_t$	0.000	0.000	0.000	0.000	0.000	0.000	-0.091 (0.333)	0.022 (0.018)	0.408§ (0.079)	0.000
T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
r^2	4		4		4		4		4	
ll_{r^2}	2076.2		2076.2		2076.2		2076.2		2076.2	
q	14		12		11		12		14	
ll_q	2049.5		2050.0		2059.7		2050.3		2070.2	
$X_{LR}^2(q - r^2)$	X^2(10)=53.328 [0.000]		X^2(8)=52.461 [0.000]		X^2(7)= 32.979 [0.000]		X^2(8)=51.717 [0.000]		X^2(10)=12.073§ [0.280]	

Table 7.6. Identification process and estimation of long run elasticities, Netherlands

Note: These estimations were carried with 81 observations covering the period between 1987q4 to 2007q4. Asymptotic standard errors for each β coefficient are provided in brackets. § indicates significant at 5% and * indicates significant at 10%. r^2=Number of just identified restrictions, and q= Number of total restrictions imposed, i.e. over-identifying restrictions. ll_{r^2} is the maximum value of the log-likelihood function obtained under r^2 just identified restrictions. ll_q is the maximum value of the log-likelihood function obtained under q over-identifying restrictions. $X_{LR}^2(q - r^2)$ is the chi-square statistics for the log-likelihood Ratio (LR) test. *P*-values for this test are provided in square brackets.

Hence, evidence does provide support to any of the four sets of restrictions drawn from each of the nested NAIRU models. As in the previous case, we interpret these results as a sign that the unemployment and real wages cointegrated vectors are more complex than as portrayed by theoretical models. In fact, evidence from the trial and error process by which these sets of restrictions are introduced reveals some suggestive features of the data[50]: In all cases, $\beta_{22} = -1$ seems supported by the data, whereas $\beta_{18} = 0$ pushes β_{LNJ}, β_{BS} and β_{RH} into rejection. This evidence suggests that some variant of β_{ASR} (where $\beta_{18} \neq 0$ and $\beta_{22} = -1$) might be supported by the data.

Also as in the UK's case, we test this hypothesis building a sequence of restrictions denoted by β_{Hybrid}, which contains these features, and experiment until we find a $\hat{\beta}_{Hybrid}$ supported by the data, here reported in the last column of Table 7.6. In this case, $\hat{\beta}_{Hybrid}$ is significant at the standard 5%, the LR test is a $X^2_{(10)}$=12.073, with a p-value equal to [0.280]. It must be noted that all the unrestricted coefficients are individually significant at the standard levels (see asymptotic standard errors in brackets). $\hat{\beta}_{Hybrid}$ is clearly more significant than the rest of β matrices examined in Table 7.6 and consequently we adopt it as our preferred long run specification.

The following equations show the unemployment and real wages cointegrated vectors implied by $\hat{\beta}_{Hybrid}$ (asymptotic standard errors in brackets), recall that the coefficients of these equations can be interpreted as long run elasticities because all variables are measured in logarithms.

7.6 $$u_t = \underset{(0.726)}{-6.418}(y_t - l_t) - \underset{(0.171)}{1.334}grr_t - \underset{(0.420)}{2.483}t_t^w - \underset{(0.333)}{1.586}k_t - \underset{(0.079)}{0.408}(i_t - \Delta p_t) + \hat{\xi}_{1,t}$$

7.7 $$(w_t - p_t) = (y_t - l_t) + \underset{(0.038)}{0.276}t_t^w + \hat{\xi}_{2,t}$$

As per equation 7.6, the Netherlands' NAIRU is determined by some features of the labour market, such as unemployment benefits and labour taxation, as also reported in Arestis et al. (2007) or Gianella et al. (2008). Although contrary to LNJ's propositions, the NAIRU is not exclusively determined by these exogenous factors:

First, the NAIRU is also affected by productivity, our estimates suggest that an increase in productivity of 1% would reduce the NAIRU by 6.418%. According to our theoretical model, this evidence suggests that the impact of productivity over firms mark-up is greater than its impact on real wages[51]. This seems a plausible possibility because the wage share in the Netherlands has fallen in the

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[50] As in the UK's case, it must be noted that comments regarding the importance of individual restrictions reported here, are consistent with different ordering of the restrictions.

[51] As per equation 4.4 $\beta_{12} = \frac{\omega_2 - \varphi_3}{\omega_1 + \varphi_1}$, hence finding $\hat{\beta}_{12} < 0$ requires $\varphi_3 > \omega_2$. As long as the denominator is positive, i.e. $\omega_1 + \varphi_1 > 0$.

period studied here, see Figure 6.13 (b). We do not have knowledge of previous evidence of this relationship.

Second, the NAIRU is influenced by the size of capital stock, our estimates suggest that 1% increase in capital stock would reduce the NAIRU by 1.586%. As discussed in the UK's section, this evidence suggests that capital stock limits firms' ability to mark-up wages. Our finding reinforces previous evidence that capital stock reduces the NAIRU in the Netherlands, particularly that from Arestis et al. (2007) who also find unemployment negatively cointegrated with capital stock, see also (Driehuis, 1986).

Third, the NAIRU is determined by real long term interest rates, our estimate suggest that 1% increase in real long term interest rates would reduce the NAIRU by 0.408%. The sign of this coefficient is unexpected and we speculate it could be the result of the wealth or/and the debt effect discussed in UK's section. In any case, this finding reinforces previous evidence that real interest rates affect the NAIRU in the Netherlands, see Ball (1999) and Gianella et al. (2008) although in these studies the relationship found has the conventional positive sign. Considering the importance of capital stock highlighted by our results, and that these studies do not account for it, a possible explanation for this sign discrepancy is that their positive real interest rate coefficient is in fact capturing the negative influence of capital stock over the NAIRU. Finally, it is worth noting, that we do not find evidence of labour market hysteresis determining the NAIRU, as also reported in Arestis et al. (2007).

Turning now to equation 7.7, the real wages equilibrium is positively affected by productivity on one-to-one basis, suggesting that productivity gains are fully reflected in the long run real wages equilibrium. Similar findings are reported by Schreiber (2012), who also finds unit proportionality between real wages and productivity in the Netherlands. Labour taxation also increases the long run real wages equilibrium, this suggests that in the long run workers are able to compensate tax increases over their wages.

Finally, combining the evidence of long run unit proportionality, between productivity and real wages, with the negative effect of productivity over the NAIRU suggests three possible scenarios[52]: First, one where unemployment reduces firms ability to mark-up wages ($\varphi_1 > 0$) but firms' reaction to productivity gains is above unity ($\varphi_3 > 1$). Second, a scenario where unemployment has no influence on firms' ability to mark-up wages ($\varphi_1 = 0$)

[52] As per equation 4.5 $\beta_{22} = \left(\varphi_1 \frac{\omega_2 - \varphi_3}{\omega_1 + \varphi_1} + \varphi_3\right)$, hence if $\hat{\beta}_{22} = 1$ and $\hat{\beta}_{12} = \frac{\omega_2 - \varphi_3}{\omega_1 + \varphi_1} < 0$ rewriting β_{22}as follows; $\varphi_1 \frac{\omega_2 - \varphi_3}{\omega_1 + \varphi_1} = 1 - \varphi_3$, we can see that:

If $\varphi_1 > 0$ then $\varphi_3 > 1$
If $\varphi_1 = 0$ then $\varphi_3 = 1$
If $\varphi_1 < 0$ then $\varphi_3 < 1$

and firms' reaction to productivity is equal to unity ($\varphi_3 = 1$). Third, one where unemployment increases firms' ability to mark-up wages ($\varphi_1 < 0$) but firms reaction to productivity is below unity ($\varphi_3 < 1$).

7.3.4 Short-run dynamics of unemployment and the anchor properties of the NAIRU

To analyse the behaviour of unemployment around the NAIRU, we estimate the ECM equation for Δu_t using the residuals from 7.6 and **7.7** as error correction terms. The resultant Δu_t, estimated with 81 observations over the period 1987q4- 2007q4, is the following:

7.8
$$\Delta u_t = \underset{[0.325]}{6.717} - \underset{[0.490]}{0.042}\hat{\xi}_{1,t-1} + \underset{[0.025]}{0.962}\hat{\xi}_{2,t-1} - \underset{[0.096]}{1.528}\Delta(w_{t-1} - p_{t-1}) - \underset{[0.957]}{0.056}\Delta(y_{t-1} - l_{t-1})$$
$$-\underset{[0.824]}{0.027}\Delta u_{t-1} - \underset{[0.297]}{0.201}\Delta lu_{t-1} - \underset{[0.947]}{0.033}\Delta grr_{t-1} + \underset{[0.714]}{0.140}\Delta t^{w}_{t-1} - \underset{[0.498]}{0.012}\Delta mil_{t-1}$$
$$-\underset{[0.116]}{7.290}\Delta k_{t-1} - \underset{[0.658]}{0.018}\Delta(i_{t-1} - \Delta p_{t-1}) - \underset{[0.472]}{0.001}\Delta p^{vm}_{t-1} - \underset{[0.397]}{0.001}\Delta p^{vm}_{t-2} + \hat{\varepsilon}_{3t}$$

Adj. R^2=0.447

$X^2_{SC}(4)$= 7.552 [0.109], X^2_{FF} (1)= 0.381 [0.537]

$X^2_{Norm}(2)$= 5.669 [0.059], $X^2_{Het}(1)$= 0.116 [0.734]

$$\hat{\xi}_{1,t} = u + 6.418(y - l) + 1.334grr + 2.483t^{w} + 1.586k + 0.408(i - \Delta p)$$

$$\hat{\xi}_{2,t} = (w - p) - (y - l) - 0.276t^{w}$$

$$\sigma_{\hat{\varepsilon}_3} = 0.0443$$

Where Adj. R^2, X^2_{SC}, X^2_{FF}, X^2_{Norm}, X^2_{Het} have the same meaning as above. $\sigma_{\hat{\varepsilon}_3}$is the standard deviation of the error term in equation 7.8. p-values for t-tests and diagnostic tests are reported in square brackets[53].

As per equation 7.8 the coefficient for $\hat{\xi}_{1,t-1}$ is not significantly different from zero, meaning that deviations from the NAIRU have no significant influence on unemployment dynamics, i.e. there is no evidence of the NAIRU acting as an anchor. Arestis et al. (2007) also find that deviations from the NAIRU have little influence on unemployment, as per their estimates, only a very modest 6.8% of the deviation is corrected each quarter. Our findings are also consistent with Schreiber's (2012) results, who find that deviations from the NAIRU only explain 4.6% of unemployment dynamics.

The coefficient for $\hat{\xi}_{2,t-1}$ is significant and positive. This suggests that setting real wages above their long run equilibrium increases unemployment. According to Bhaduri and Marglin's dichotomy, this estimate suggests that the Netherlands operates under a "profit-led regime", as also reported by Hein and Vogel (2007).

[53] All diagnostic tests are passed at the standard 5% significance level.

7.3.5 Impulse response and the effects of an unemployment shock

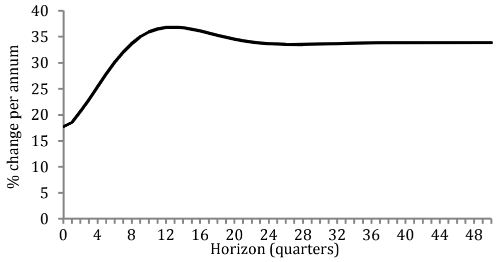
We complete our analysis simulating an unemployment shock of one standard deviation in equation 7.8, i.e. $\sigma_{\hat{\varepsilon}_3} = 0.0443$, which amounts to a rise in unemployment of 17.73% in annual terms. Figure 7.2 shows the effect of this shock using GIR functions:

Unemployment, panel (a), shows no sign of returning to its baseline after the shock, instead it drifts upwards until it stabilizes six years after the shock, at a level 33% greater than its pre-shock value. This behaviour suggests that the NAIRU has no anchor properties and reinforces our findings from equation 7.8. Our estimate is more pessimistic than previous impulse response estimates. Duval and Vogel (2008) find that the Netherlands needs between three and four years to close the output gap, but the overall conclusion is similar, the NAIRU does not seem to be a strong anchor.

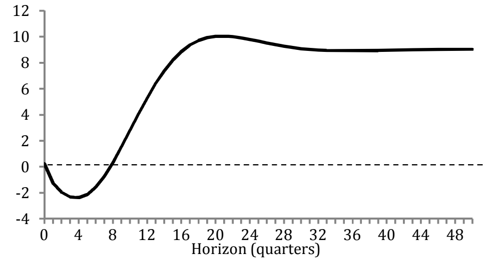
The reaction of long term unemployment, shown in panel (b), is described by a J-curve. As discussed in the UK's section, this illustrates that the effect of the shock changes over time. Real wages and productivity, panels (c) and (d), both fall as a result of the shock, although the fall in real wages is more pronounced than that of productivity. While $w_t - p_t$ stabilizes at a level 1.6% smaller than its pre-shock value, $y_t - l_t$ stabilizes 0.2% below its baseline. This suggests that the wage share falls as a result of the shock.

Capital stock and real long term interest rates, panels (e) and (f), fall as a consequence of the shock until they stabilize at a level 1.5% and 15% smaller than their baselines, respectively. This reaction to the rise in unemployment is very suggestive of the type of negative long run relationship that we find in our econometric analysis. The same comment applies to the permanent reduction of productivity which follows to the shock.

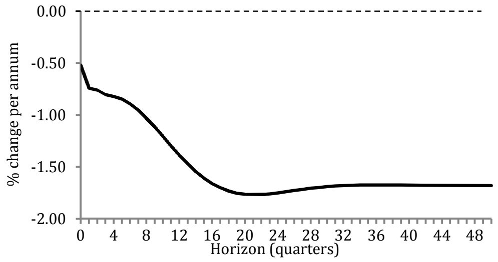
The last three panels refer to the wage-push factors of our model. Unemployment benefits and labour taxation, panels (g) and (h), fall after the shock until they stabilize below their baseline. As discussed in the UK's case, this could either be the result of a rise in wages, or a fall in social provisions and taxes, respectively. Workers' militancy panel (i), falls sharply after the shock, until it stabilizes at a level 85% below its pre-shock situation.



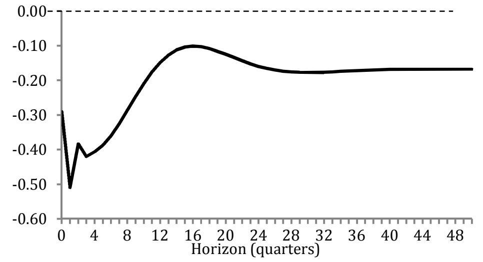
(a) u_t



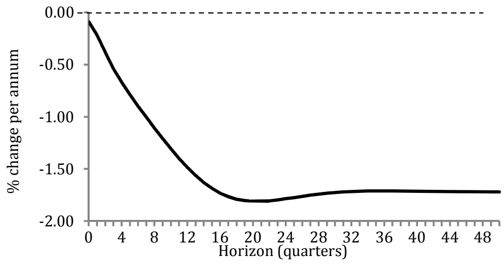
(b) lu_t



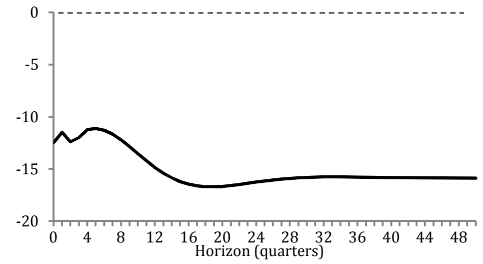
(c) $w_t - p_t$



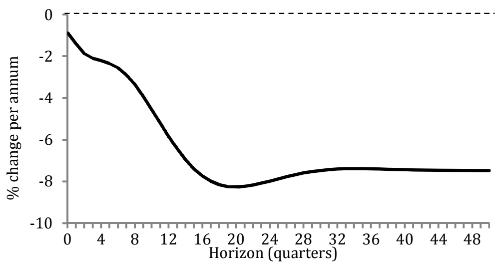
(d) $y_t - l_t$



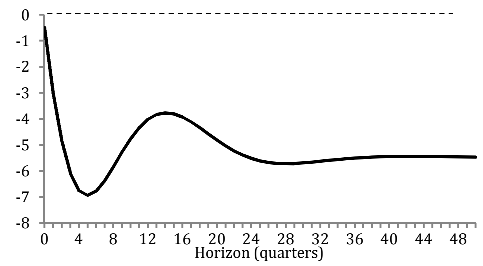
(e) k_t



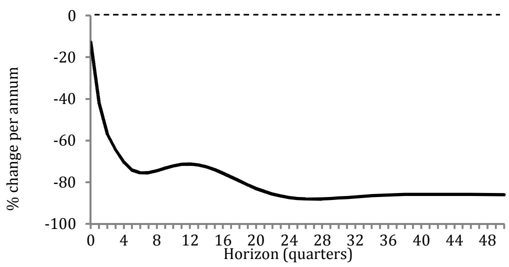
(f) $i_t - \Delta p_t$



(g) grr_t



(h) t_t^w



(i) mil_t

Figure 7.2 GIRF of a standard deviation shock to unemployment on all variables, Netherlands

7.4 Summary

In this chapter we have used the CVAR approach to study the determinants of the NAIRU and its anchor properties in the UK and the Netherlands. This methodology allows us to study the determinants of the NAIRU by testing the long run restrictions required by each of the models nested in our encompassing model (β_{LNJ}, β_{BS}, β_{ASR} and β_{RH}). Panel *i*) of Table 7.7 summarizes the results of this process. According to our estimations, none of the set of restrictions is individually significant, although evidence is very supportive of a $\hat{\beta}_{\text{Hybrid}}$ that combines different features of β_{ASR} and β_{RH} in each country.

	UK	Netherlands
i) Identification process		
$\hat{\beta}_{LNJ}$	[0.000]	[0.000]
$\hat{\beta}_{BS}$	[0.000]	[0.000]
$\hat{\beta}_{ASR}$	[0.002]	[0.000]
$\hat{\beta}_{RH}$	[0.000]	[0.000]
$\hat{\beta}_{\text{Hybrid}}$	[0.063]	[0.280]
ii) NAIRU determinants		
grr	0.991	-1.334
t^w	*NS*	-2.483
mil	0.112	*NS*
$y-l$	*NS*	-6.418
lu	*NS*	*NS*
k	-11.40	-1.586
$i-\Delta p$	-0.646	-0.408
T	0.123	*NS*
iii) NAIRU's anchor properties		
$\hat{\xi}_{1,t-1}$	*NS*	*NS*
Time required to return to baseline (GIR)	*No Return*	*No Return*

Table 7.7. Summary of findings for the UK and the Netherlands

Note: *i)* Results for the identification process are drawn from Table 7.3 in the UK's case and from Table 7.6 for the Netherlands. *ii)* Values for the NAIRU elasticities are drawn from each country's unemployment cointegrated vector, equations 7.2 and 7.6 respectively. *iii)* Coefficients of $\hat{\xi}_{1,t-1}$ are drawn from equations 7.4 and 7.8 respectively. "Time required to return to baseline" draws from Figure 7.1 and Figure 7.2 respectively. *NS* not significant and "*No return*" indicates that unemployment does not return to its baseline.

Panel *ii)* of Table 7.7 presents these $\hat{\beta}_{\text{Hybrid}}$. In the UK, the NAIRU is determined by some wage-push factors together with capital stock and long term interest rates. In the Netherlands, the NAIRU is determined by some labour market institutions along with productivity, capital stock and long term interest rates. Hence, according to our results for the UK and the Netherlands the NAIRU is *not* exclusively determined by exogenous factors contrary to what LNJ's model suggests.

Further, these results add to the body of empirical literature that questions the claim that time series evidence for the UK and the Netherlands support LNJ's propositions, as for instance suggested by Nickell and Van Our (2000). In fact, our findings raise questions about the validity of the UK's time series literature in which such claims are grounded for two reasons. First, our results cast doubts on the robustness of studies that find the NAIRU neutral to capital stock, such as Layard and Nickell (1986). Second, our finding that capital stock and real long term interest rates influence the NAIRU, suggests that some of the time series studies which are usually cited to vindicate LNJ's claims, for instance Layard et al. (1991,p.441) or Nickell and Bell (1995), are likely to be misspecified because they omit these variables. Stockhammer (2004a,p.20) and Arestis et al. (2007, p.144) have already warn of these potential biases.

The CVAR approach also allows us to examine the anchor properties of the NAIRU by estimating a VECM model and GIR functions. Our results are summarized in Panel *iii)* of Table 7.7.

According to our VECM estimations deviations from the NAIRU in the UK and the Netherlands have no significant influence on unemployment's dynamics. These findings are reinforced by the results of simulating and unemployment shock using GIR functions, which suggest that after this shock unemployment drifts away from its baseline in both countries, rather than returning to it as it would be expected if the NAIRU acted as an anchor.

Hence, our VECM and GIR results question LNJ's claim about the anchor properties of the NAIRU, although they are in tune with the existing literature, which suggest that the NAIRU in the UK and the Netherlands is at best a weak anchor for economic activity.

In sum, our findings for the UK and the Netherlands presented in this chapter challenge the validity of LNJ's propositions, the time series literature that provides support to this model and consequently policy recommendations inspired by this approach. See Chapter 11 for further discussion on policy implications.

Chapter 8 Determinants of the NAIRU and its anchor properties, evidence from Germany and France.

8.1 Introduction

This chapter presents the results of applying the CVAR approach to data for Germany and France. We start by summarizing the time series literature reviewed in Chapter 3 that refers to these economies. A summary table of this literature can also be found in Table I.2 of Appendix I.

It is commonly believed that the evolution of unemployment in Germany provides support to LNJ's claims (Saint-Paul, 2004,p.52/3, OECD, 2010c, Rinne and Zimmermann, 2011,p.21). This seems to be backed by findings that suggest that unemployment benefits and labour taxation determine the NAIRU (Gianella et al., 2008). However, these estimates for wage-push factors seem to be far from robust, see for instance Carstensen and Hansen (2000).

Furthermore, evidence of significant links between the NAIRU and demand also challenges these claims. Carstensen and Hansen (2000) and Schreiber (2012) find evidence of a negative long run link between unemployment and productivity. Further, Arestis and Biefang-Frisancho Mariscal (2000) and Arestis et al. (2007) find a significant negative link between capital stock and unemployment, these results are yet reinforced by evidence of the negative impact of accumulation over unemployment (Stockhammer, 2004a). Finally, there is evidence of a link between the NAIRU and real interest rates (Ball, 1999, Gianella et al., 2008). Evidence with regard to hysteresis effects is less clear, but Logeay and Tober (2006) find some supportive evidence the hysteresis hypothesis.

The anchor properties of the NAIRU in Germany are less contentious, because all evidence suggests that the NAIRU is at best a weak anchor. Arestis and Biefang-Frisancho Mariscal (2000), Arestis et al., (2007) and Schreiber (2012) all find that deviations from the NAIRU have little influence on unemployment dynamics. Furthermore, the adjustment after a shock seems to be very protracted (Carstensen and Hansen, 2000, Logeay and Tober, 2006, Duval and Vogel, 2008).

A similar picture arises when looking at the literature for France, there are numerous claims that French unemployment performance provides support to LNJ's claims (Saint-Paul, 2004,p.52/3, Jamet, 2006). This is based on findings that suggest that labour market institutions determine the NAIRU (L'Horty and Rault, 2003, Gianella et al., 2008), but this evidence does not seem to be robust.

Furthermore, evidence of significant links between the NAIRU and demand through different channels, challenge claims that France's evidence provides support to LNJ's claims: L'Horty and Rault (2003) and Schreiber (2012) find evidence of a negative long run link between unemployment and productivity. Miaouli (2001) find a significant positive long run link between capital stock and employment. Similarly, Arestis et al. (2007) find evidence of a significant negative long run link between capital stock and unemployment. These results are yet reinforced by evidence of the negative impact of accumulation over unemployment (Stockhammer, 2004a).

Further, there is evidence of a link between the NAIRU and real interest rates (Ball, 1999, Gianella et al., 2008). The role of hysteresis is more ambiguous, although Stockhammer (2004a) finds evidence of unemployment and employment persistence. Further as in the German case, deviations from the NAIRU seem to have little influence on unemployment dynamics (Miaouli, 2001, Arestis et al., 2007, Schreiber, 2012), and the adjustment to shocks appear to be very sluggish (Duval and Vogel, 2008), which suggests that the NAIRU is at best a weak anchor.

The rest of the chapter is structured as follows: Section 8.2 presents our result for Germany, section 8.3 our results for France. Each of them contains five subsections devoted to the five CVAR stages. And section 8.4 closes the chapter with a summary of key findings.

8.2 Germany

8.2.1 Data properties and model specification

In order to confirm that the CVAR approach can be applied to Germany's data set, we examine the stationary properties of the data. According to the unit root and stationarity tests results, reported in Appendix II, all the variables in Germany's $z_t = (w_t - p_t, y_t - l_t,\ u_t, lu_t, grr_t, t_t^w, k_t, i_t - \Delta p_t)'$ are $I(1)$. These results justify the use of cointegration techniques such as the CVAR which we proceed to model now.

The starting point is the CVAR benchmark specification, equation 5.1. The composition of its deterministic component C is decided after visual inspection of the data in Figure II.3. This inspection reveals that some of the variables of z_t exhibit a time trend, which could cause the problem of quadratic trends discussed in section 5.4. In order to avoid this phenomenon, we decompose the matrix of deterministic components C into intercepts and time trends, and restrict the time trend to the long run term, as per equation 5.5.

The choice of lag order for this specification draws from the standard model selection criteria, reported in Table 8.1, and along with the composition of x_t, is the result of extensive experimentation with several specifications. After this process we adopt the following VAR (2) expression with $x_t = (\Delta p_{t-1}^{vm})$ as our preferred specification[54]:

$$\text{8.1} \qquad \Delta z_t = c_0 + \Phi_1 \Delta z_{t-1} + \gamma\beta' z_t^* + \lambda x_t + \varepsilon_t \qquad \text{where } z_t = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ k_t \\ i_t - \Delta p_t \end{pmatrix}, z_t^* = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ k_t \\ i_t - \Delta p_t \\ T \end{pmatrix}, x_t = (\Delta p_{t-1}^{vm})$$

Variables in z_t, z_t^* and x_t have the same meaning as in Chapter 6. We adopt this specification because it appears to deliver the best balance between parsimony, a rich and informative lag structure[55] and satisfactory diagnostic test results for Germany's data set.

Lag order	AIC	SBC
5	1788.9	1443.6
4	1650.1	1369.1
3	1663.9	1447.1
2	1672.2	1519.6
1	1618.4	1530.1
0	1095.5	1071.4

Table 8.1. Lag order selection criteria, Germany

Note: The test is carried out with 55 observations covering the period between 1994q2 to 2007q4. Statistics reported here are obtained from estimating an unrestricted VAR model for the variables contained in the vector z_t, with a constant and a time trend, and one lag of Δp^{vm}.

8.2.2 Cointegration tests

Following, we test for cointegration among the variables of z_t, Table 8.2 presents the results of the Maximum Eigenvalue (λ_{max}) and the Trace (λ_{trace}) tests. The Maximum Eigenvalue test fails to reject the null hypothesis of having two long run relationships, while the Trace test fails to reject the null hypothesis of having seven cointegrated vectors. That is, λ_{max} supports the predictions from our theoretical model of two long run relationships, but the λ_{trace} suggests otherwise. Due to the problems of these tests in finite samples, see section 5.5, we resort to an overall judgment of their results along with economic theory (Pesaran and Pesaran, 2003,p.293, Garrat et al., 2006,p.198). The Maximum Eigenvalue and our theoretical model suggest that there are two long run relationships among our variables, hence, it seems reasonable to proceed under the assumption of *r*=2.

---

[54] We experimented with more parsimonious models (than our preferred specification), such as a VAR(1) with $x_t = (\Delta p_{t-1}^{vm})$, this lag order draw from SBC indications in Table 8.1. Or a VAR(1) with $x_t = (\Delta p_{t-1}^{vm}, \Delta p_{t-2}^{vm})'$. And less parsimonious models, such as a VAR(2) with $x_t = (\Delta p_{t-1}^{vm}, \Delta p_{t-2}^{vm})'$. However, these specifications are unable to accommodate serial correlation problems, in some cases despite consuming greater degrees of freedom than our preferred specification, and consequently are discarded.

[55] Equivalent to an $ARMA(16,14)$, (Hamilton, 1994, p.349)

		λ_{max}		λ_{trace}	
H_0	H_1	Statistic	95% Critical values	Statistic	95% Critical values
r=0	*r=1*	77.59	55.14	295.57	182.99
r≤1	*r=2*	60.46	49.32	217.98	147.27
r≤2	*r=3*	41.21	43.61	157.51	115.85
r≤3	*r=4*	35.10	37.86	116.30	87.17
r≤4	*r=5*	34.30	31.79	81.21	63.00
r≤5	*r=6*	20.41	25.42	46.90	42.34
r≤6	*r=7*	14.09	19.22	26.49	25.77
r≤7	*r=8*	12.40	12.39	12.00	12.39

Table 8.2. Results from cointegration tests, Germany

Note: Test statistics are obtained from applying the Maximum Eigenvalue and Trace test to z_t using a VAR(2) model with unrestricted intercepts and restricted trend coefficients, and one lag of Δp^{vm}, with 58 observations covering the period between 1993q3 to 2007q4. Critical values are chosen according to this specification.

8.2.3 Identifying the long run relations

In order to identify which variables take part in these two long run relationships, we use the four sets of theoretically driven restrictions detailed in Table 5.1 (β_{LNJ}, β_{BS}, β_{ASR} and β_{RH}) as identifying schedules. Table 8.3 reports the results of this process.

We start by imposing the restrictions contained in β_{LNJ}. This set of restrictions is insignificant at the standard 5%, its log-likelihood ratio (LR) test is a $X^2{}_{(10)}$=63.106 with a p-value equal to [0.000]. Hence, evidence seems to lean against β_{LNJ}. Next, we test the validity of the restrictions contained in β_{BS}[56], which are also insignificant as a whole with a p-value for the LR test equal to [0.000]. Following, we introduce the set of restrictions of β_{ASR}, for which evidence is not very supportive either, since it is insignificant with a p-value for the LR test equal to [0.002]. Finally, the set of restrictions contained in β_{RH} is also found insignificant, with a p-value for LR test equal to [0.000].

Hence, evidence does not seem to yield support to any of the four sets of restrictions drawn from each of the nested NAIRU models. As in previous cases, we interpret these results as a sign that the unemployment and real wages cointegrated vectors are more complex than as portrayed by theoretical models.

[56] It should be noted that the coefficient β_{29} is left unrestricted because we fail to obtain converging results when introducing $\beta_{29} = 0$, despite introducing β_{BS} following different sequences. This problem also appears when imposing β_{ASR}.

z_t^*	$\hat{\beta}_{LNJ}$		$\hat{\beta}_{BS}$		$\hat{\beta}_{ASR}$		$\hat{\beta}_{RH}$		$\hat{\beta}_{\text{Hybrid}}$	
$w_t - p_t$	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
$y_t - l_t$	0.000	-1.000	0.000	-1.000	13.34	-1.000	0.000	-1.000	8.933§	1.000
					(9.172)				(2.393)	
u_t	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
lu_t	0.000	0.000	0.937	0.195	0.000	0.000	0.000	0.000	0.000	0.247§
			(1.214)	None						(0.121)
grr_t	-0.338	0.218§	-0.535	-0.274§	1.388	-1.737§	-0.378	-0.595	0.831§	-1.458§
	(0.577)	(0.013)	(0.498)	(0.136)	(1.187)	(0.765)	(0.398)	(0.464)	(0.322)	(0.334)
${t^w}_t$	-2.989§	-0.161§	-4.456	-0.736	-5.453§	-1.001§	-1.928	-1.456§	-4.617§	-1.863§
	(1.330)	(0.038)	(2.759)	none	(1.906)	(0.505)	(1.091)	(0.610)	(0.711)	(0.392)
k_t	0.000	0.000	0.000	0.000	-1.758	7.312	0.000	0.000	-1.312§	6.903§
					(0.967)	(3.876)			(0.345)	(1.698)
$i_t - \Delta p_t$	0.000	0.000	0.000	0.000	0.000	0.000	0.155	-0.323	0.000	0.000
							(0.247)	None		
T	0.000	0.000	0.000	0.002[NC]	0.000	-0.040[NC]	0.000	0.000	0.000	-0.040§
				none		(0.022)				(0.010)
r^2	4		4		4		4		4	
ll_{r^2}	1821.3		1821.3		1821.3		1821.3		1821.3	
q	14		11		10		12		9	
ll_q	1789.8		1786.1		1810.8		1786.1		1818.7	
$X_{LR}^2(q - r^2)$	$X^2(10)$=63.106 [0.000]		$X^2(7)$=70.342 [0.000]		$X^2(6)$=21.004 [0.002]		$X^2(8)$=70.4874 [0.000]		$X^2(5)$=5.219§ [0.390]	

Table 8.3. Identification process and estimation of long run elasticities, Germany

Note: These estimations were carried with 58 observations covering the period between 1993q3 to 2007q4. Asymptotic standard errors for each β coefficient are provided in brackets. § indicates significant at 5% and * indicates significant at 10%. NC indicates that the coefficient is subject to a theoretical restriction for which we failed to obtain converging results, and hence had to be left unrestricted. r^2=Number of just identified restrictions, and q= Number of total restrictions imposed, i.e. over-identifying restrictions. ll_{r^2} is the maximum value of the log-likelihood function obtained under r^2 just identified restrictions. ll_q is the maximum value of the log-likelihood function obtained under q over-identifying restrictions. $X_{LR}^2(q - r^2)$ is the chi-square statistics for the log-likelihood Ratio (LR) test. P-values for this test are provided in square brackets.

In fact, evidence from the trial and error process by which these sets of restrictions is introduced reveals some suggestive features of the data[57]: Introducing $\beta_{17}=0$ and $\beta_{22}=-1$ pushes the set $\hat{\beta}_{LNJ}$, $\hat{\beta}_{BS}$ and $\hat{\beta}_{RH}$ into rejection (Similarly $\beta_{29}=0$ when we obtain converging results). In the case of $\hat{\beta}_{ASR}$, it is imposing $\beta_{24}=0$ and $\beta_{22}=-1$ that pushes the set of restrictions into rejection. On the other hand, $\beta_{14}=0$ and $\beta_{18}=0$ seem to be supported by the data in most cases. This evidence suggests that some form of hybrid between β_{ASR} (where $\beta_{17}\neq 0$) and β_{BS} (where $\beta_{24}\neq 0$), along with $\beta_{14}=0$, $\beta_{18}=0$, $\beta_{22}\neq -1$ and $\beta_{29}\neq 0$ might be supported by the data.

As in the UK's case, we test this hypothesis building a sequence of restrictions denoted by β_{Hybrid}, which contains these features, and experiment until we find a $\hat{\beta}_{Hybrid}$ supported by the data, here reported in the last column of Table 8.3. In this case, $\hat{\beta}_{Hybrid}$ is significant at the standard 5%, the LR test is a $X^2{}_{(5)}$=5.219 with a p-value equal to [0.390]. Furthermore, according to the asymptotic standard errors (in brackets), all the unrestricted coefficients are individually significant at the standard levels. $\hat{\beta}_{Hybrid}$ is clearly more significant than the rest of β matrices examined in Table 8.3 and consequently we adopt it as our preferred long run specification.

The following equations show the unemployment and real wages cointegrated vectors implied by $\hat{\beta}_{Hybrid}$ (asymptotic standard errors in brackets), recall that the coefficients of these equations can be interpreted as long run elasticities because all variables are measured in logarithms.

8.2
$$u_t = \underset{(2.393)}{-8.933}(y_t - l_t) - \underset{(0.322)}{0.831}grr_t + \underset{(0.711)}{4.617}t_t^w + \underset{(0.345)}{1.312}k_t + \hat{\xi}_{1,t}$$

8.3
$$(w_t - p_t) = -(y_t - l_t) - \underset{(0.121)}{0.247}lu_t + \underset{(0.334)}{1.458}grr_t + \underset{(0.392)}{1.863}t_t^w - \underset{(1.698)}{6.903}k_t + \underset{(0.010)}{0.040}T + \hat{\xi}_{2,t}$$

According to equation 8.2 Germany's NAIRU is determined by some features of the labour market, such as unemployment benefits and labour taxation, as also reported in Gianella et al. (2008). Although contrary to LNJ's propositions, the NAIRU is not exclusively determined by these exogenous factors:

First, the NAIRU is also affected by productivity, our estimates suggest that an increase in productivity of 1% would reduce the NAIRU by 8.933%. As discussed in the Netherlands' section, this evidence suggests that the impact of productivity over firms mark-up is greater than its impact on real wages. This seems a plausible possibility because the German wage share has fallen in the period studied here, see Figure 6.14 (a). This finding reinforces previous evidence that productivity reduces the NAIRU in Germany, particularly that

[57] As in the UK's case, it must be noted that comments regarding the importance of individual restrictions reported here, are consistent with different ordering of the restrictions.

from Schreiber (2012) who also find unemployment negatively cointegrated with productivity, and Carstensen and Hansen (2000) who using IR functions, show how positive technological shocks increase employment permanently.

Second, the NAIRU is influenced by the size of capital stock, although it has a perverse effect, for our estimates suggest that an increase in capital stock of 1% would increase the NAIRU by 1.312%. According to our theoretical model this evidence suggests that capital stock increases firms' ability to mark-up wages rather than reduces it, making capital and labour substitutive factors of production[58]. Alternatively, this could also reflect that capital stock increases workers real wage claims and that this effect dominates over that of capital stock in the price mark-up[59].

In any case, this findings reinforces previous evidence that capital stock affects the NAIRU in Germany, see Arestis and Biefang-Frisancho Mariscal (2000), Arestis et al. (2007) and Stockhammer (2004a), although the sign of our estimated coefficient is contrary to that obtained in these articles. This sign discrepancy could be due to our sample size or differences in the definition of capital stock used. Our measure of capital stock accounts for the "whole economy" while previous studies use a measure that only considers the "business sector", see section 6.3.8 for further details. Although considering the importance of productivity highlighted by our results, and that these studies do not account for it, we cannot discard that their capital stock coefficient is in fact capturing the influence of productivity over the NAIRU.

It is worth noting, that we do not find evidence of labour market hysteresis having any impact on the NAIRU, as also reported in Arestis and Biefang-Frisancho Mariscal (2000) and Arestis et al. (2007), but in contrast to the findings from Logeay and Tober (2006). Further, there is no evidence of real long term interest rates playing a significant role in determining the NAIRU contrary to Ball (1999) and Gianella et al. (2008). Having controlled for long term interest rates in our analysis, we suspect that the real cost of borrowing in these studies, might also be capturing the effect of some omitted variables, which here have a significant influence on the NAIRU.

Turning now to equation 8.3, the real wage equilibrium is negatively affected by productivity on one-to-one basis suggesting that productivity gains reduce rather than increase real wages in the long run. This is unsurprising considering the fall of the German wage share in the period studied here, see

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[58] As per equation 4.1 $\beta_{18} = -\frac{\varphi_2}{\omega_1+\varphi_1}$, hence finding $\hat{\beta}_{18} > 0$ requires $\varphi_2 < 0$, as long as the denominator is positive.

[59] To account for this possibility we would need to expand our real wage equation 4.2 to consider the following term: $+\omega_7 k$, which would deliver a new $\beta_{18} = \frac{\omega_7-\varphi_2}{\omega_1+\varphi_1}$. Thus observing a $\beta_{18} > 0$, could imply that $\omega_7 > \varphi_2$, that is, growing capital stock increases workers real wages claims beyond what it reduces firms mark-ups.

panel (a) in Figure 6.14. Similarly, Schreiber (2012) finds no evidence of positive unit proportionality between real wages and productivity, although this author does not test if this relationship could take a negative sign.

Long term unemployment and capital stock also reduce the long run real wages equilibrium. This suggests that long term unemployed workers, are still able to exert downward pressure over real wage claims and that greater capital stock does not result in greater wages in the long run. On the other hand, unemployment benefits, labour taxation and a time trend increase the long run real wages equilibrium, suggesting that benefits and taxation generates upward pressure over real wages in the long run.

8.2.4 Short-run dynamics of unemployment and the anchor properties of the NAIRU

To analyse the behaviour of unemployment around the NAIRU, we estimate the ECM equation for Δu_t using the residuals from 8.2 and 8.3 as error correction terms. The resultant Δu_t, estimated with 58 observations over the period between 1993q3-2007q4, is the following:

8.4
$$\Delta u_t = \underset{[0.000]}{109.0} + \underset{[0.454]}{0.027}\hat{\xi}_{1,t-1} - \underset{[0.000]}{0.541}\hat{\xi}_{2,t-1} + \underset{[0.040]}{0.797}\Delta(w_{t-1} - p_{t-1}) - \underset{[0.424]}{0.337}\Delta(y_{t-1} - l_{t-1})$$
$$+\underset{[0.000]}{0.823}\Delta u_{t-1} - \underset{[0.000]}{1.083}\Delta lu_{t-1} - \underset{[0.000]}{1.153}\Delta grr_{t-1} + \underset{[0.568]}{0.213}\Delta t^w_{t-1} + \underset{[0.003]}{14.64}\Delta k_{t-1}$$
$$-\underset{[0.914]}{0.001}\Delta(i_{t-1} - \Delta p_{t-1}) - \underset{[0.058]}{0.001}\Delta p^{vm}_{t-1} + \hat{\varepsilon}_{3t}$$

Adj. R^2=0.775

$X^2_{SC}(4)$= 1.160 [0.885], X^2_{FF} (1)= 0.006 [0.939]

$X^2_{Norm}(2)$= 0.861 [0.650], $X^2_{Het}(1)$= 7.205 [0.007]

$$\hat{\xi}_{1,t} = u + 8.933(y - l) + 0.831grr - 4.617t^w - 1.312k$$

$$\hat{\xi}_{2,t} = (w - p) + (y - l) + 0.247lu - 1.458grr - 1.863t^w + 6.903k - 0.040T$$

$$\sigma_{\hat{\varepsilon}_3} = 0.0134$$

Where Adj. R^2, X^2_{SC}, X^2_{FF}, X^2_{Norm}, X^2_{Het} have the same meaning as above. $\sigma_{\hat{\varepsilon}_3}$is the standard deviation of the error term in equation 8.4. p-values for t-tests and diagnostic tests are reported in square brackets[60].

According to equation 8.4 the coefficient for $\hat{\xi}_{1,t-1}$ is positive but very small, meaning that deviations from the NAIRU have a negligible influence on unemployment dynamics, and consequently it is unlikely to act as an anchor. Arestis and Biefang-Frisancho Mariscal (2000) also find that deviations from the NAIRU have little influence on unemployment, as per their estimates, only a

[60] All diagnostic tests are passed at the standard 5% significance level, except the heteroscedasticity tests. Hence, although our estimates are still unbiased, inference using the t-test needs to be taken with caution because heteroscedasticity reduces the power of the test. That is, the individual significance test is less likely to reject the null hypothesis of not significantly different from zero.

very modest 1.5% of the deviation is corrected each quarter. Further, Arestis et al. (2007) find that deviations from the NAIRU have no significant influence on unemployment. Our findings are also consistent with Schreiber's (2012) results, who find that deviations from the NAIRU only explain 18.8% of unemployment dynamics.

The coefficient for $\hat{\xi}_{2,t-1}$ is significant and negative. This suggests that setting real wages above their long run equilibrium reduces unemployment. According to the dichotomy proposed by Bhaduri and Marglin (1990), this estimate suggests that Germany operates under a "wage-led regime", as also reported by Hein and Vogel (2007) but in contrast to findings from Bowles and Boyer (1995).

8.2.5 Impulse response and the effects of an unemployment shock

We complete our analysis simulating an unemployment shock of one standard deviation in equation 8.4, i.e. $\sigma_{\hat{\varepsilon}_3} = 0.0134$, which amounts to a rise in unemployment of 5.36% in annual terms. Figure 8.1 shows the effect of this shock using GIR functions:

Unemployment, panel (a), shows no sign of returning to its baseline after the shock, instead it drifts upwards until it stabilizes four years after the shock, at a level 16% greater than its pre-shock value. This behaviour suggests that the NAIRU has no anchor properties and reinforces the results from equation 8.4. Our estimate is more pessimistic than previous impulse response estimates. Carstensen and Hansen (2000) find that employment needs more than 13 years to return to its baseline after a labour demand shock. Similarly, Logeay and Tober (2006) find that the unemployment-NAIRU gap has a cycle length of over eight years. Further, Duval and Vogel (2008) find that the Germany needs between three and four years to close the output gap. However, the overall conclusion is similar the NAIRU does not seem to be a strong anchor.

As a consequence of the shock, long term unemployment increases, panel (b), until it stabilizes at a level 14% above its pre-shock situation. Real wages and productivity, panels (c) and (d), follow opposite trajectories. As a consequence of the shock, the real wage falls until it stabilizes at a level 2% smaller than its pre-shock value, while productivity increase until it stabilizes 0.8% above its baseline. This suggests that the wage share falls as a result of the shock.

Capital stock and real long term interest rates, panels (e) and (f), fall as a consequence of the shock, until they stabilize at levels 2.3% and 12% smaller than their baseline, respectively.

The last two panels refer to the wage-push factors considered in our model. Unemployment benefits panel (g), and labour taxation panel (h), follow opposite patterns after the shock: Benefits fall permanently to a level 13%

below its pre-shock situation, this could either be the result of a reduction in social provisions or a rise in wages. Whereas, labour taxation, increases to a level 3.5% higher than prior to the shock, this could either be the result of a rise in labour taxes or a fall in wages. Recall that both variables are relative measures with respect to wages.

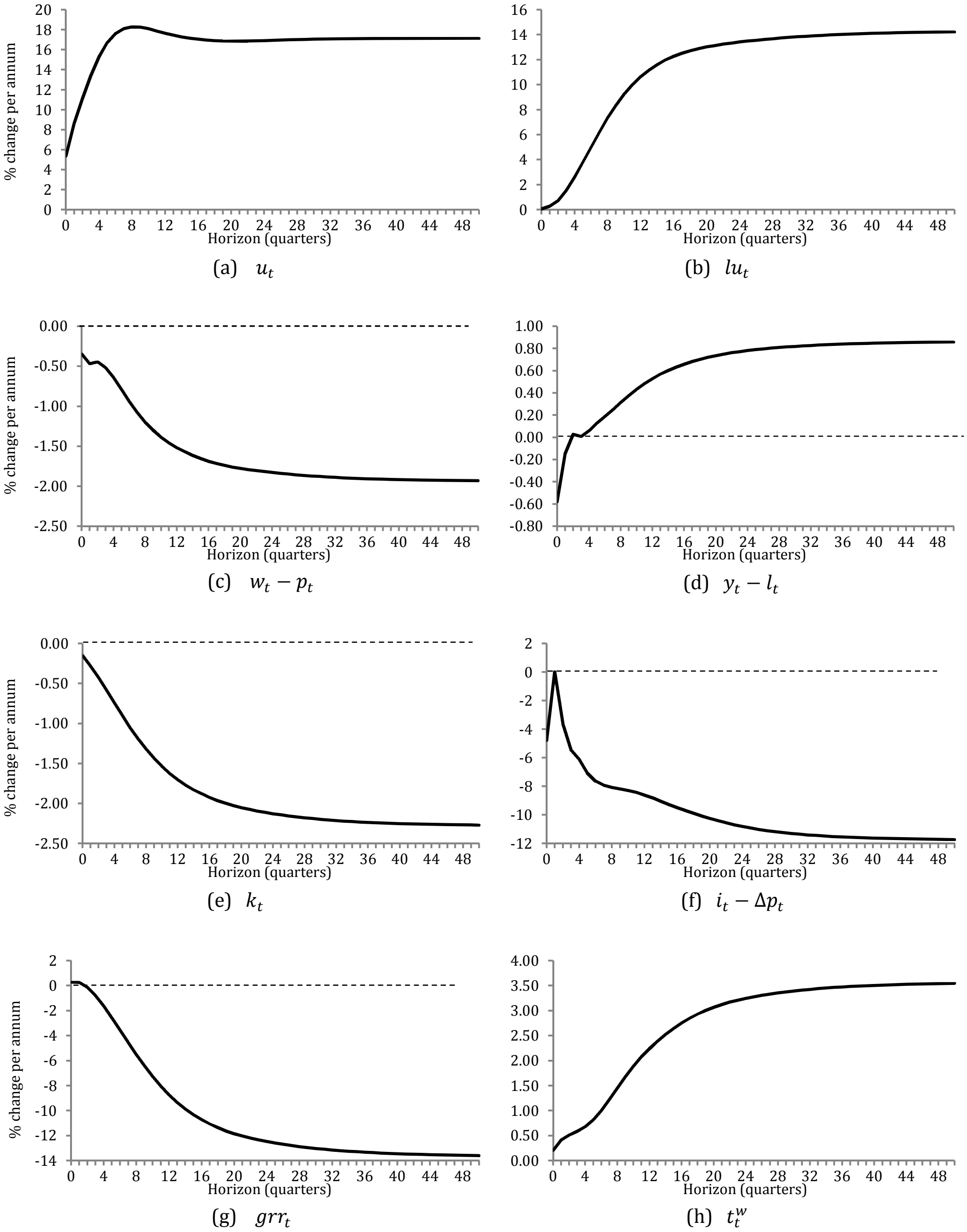

Figure 8.1 GIRF of a standard deviation shock to unemployment on all variables, Germany

8.3 France

8.3.1 Data properties and model specification

We turn now to the French case, data properties of France's data set are very similar to those of Germany, for evidence from unit root and stationary tests suggest that all variables contained in France's $z_t = (w_t - p_t, y_t - l_t,\ u_t,\ lu_t,\ grr_t, t_t^w,\ mil_t,\ k_t,\ i_t - \Delta p_t)'$ are $I(1)$, see Appendix II, which justifies the use of the CVAR approach.

We follow the same modelling strategy as in previous cases. The starting point is the CVAR's benchmark equation 5.1. The composition of C is decided after visual inspection of the data in Figure II.3, which reveals that some of the variables of z_t exhibit a time trend. To avoid the problem of quadratic trends this could cause we adopt equation's 5.5 specification.

The choice of lag order and the composition of x_t, are decided drawing from the model selection criteria reported in Table 8.4, and after extensive experimentation with several specifications. After this process, the following VAR (3) expression with $\mathrm{x}_t = (\Delta p_{t-1}^{vm})$ is adopted as our preferred specification[61]:

8.5 $$\Delta \mathrm{z}_t = \mathrm{c}_0 + \Phi_1 \Delta \mathrm{z}_{t-1} + \Phi_2 \Delta \mathrm{z}_{t-2} + \gamma\beta' \mathrm{z}_t^* + \lambda \mathrm{x}_t + \varepsilon_t$$

$$\text{Where } z_t = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ mil_t \\ k_t \\ i_t - \Delta p_t \end{pmatrix}, z_t^* = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ mil_t \\ k_t \\ i_t - \Delta p_t \\ T \end{pmatrix}, \mathrm{x}_t = (\Delta p_{t-1}^{vm})$$

Variables in z_t, z_t^* and x_t have the same meaning as in Chapter 6. This specification seems to provide the best balance between parsimony, a rich and informative lag structure[62] and satisfactory diagnostic test results for France's data set.

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[61] We experimented with more parsimonious models (than our preferred specification), such as a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm})$, this lag order draw from SBC indications in Table 8.4. Or a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm})'$, and a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm}, Mitt)'$ where $Mitt$ is a dummy for the period in which President Mitterrand tried to implement the "*110 Proposals for France*" between 1981q2-1983q1 (To be more precise May 1981 to March 1983) in which our estimates seemed less accurate creating several outliners. And less parsimonious models, such as a VAR(3) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm})'$. However, these specifications are unable to accommodate serial correlation problems, in some cases despite consuming greater degrees of freedom than our preferred specification, and consequently are discarded.

[62] Equivalent to an $ARMA(27{,}24)$, (Hamilton, 1994, p.349)

Lag order	AIC	SBC
5	2815.4	2266.1
4	2689.8	2243.4
3	2731.1	2387.8
2	2741.0	2500.6
1	2572.9	2435.6
0	1543	1508.9

Table 8.4. Lag order selection criteria, France

Note: The test is carried out with 94 observations covering the period between 1981q3 to 2004q4. Statistics reported here are obtained from estimating an unrestricted VAR model for the variables contained in the vector z_t, with a constant and a time trend, and one lag of Δp^{vm}.

8.3.2 Cointegration tests

Table 8.5 presents the results of testing for cointegration among the variables of z_t. The Maximum Eigenvalue test (λ_{max}) fails to reject the null hypothesis of having four long run relationships, while the Trace test (λ_{trace}) fails to reject the null hypothesis of having eight cointegrated vectors. Hence, both tests suggest that there are more long run relationships than our theoretical model, although they disagree about the exact number.

		λ_{max}		λ_{trace}	
H_0	H_1	Statistic	95% Critical values	Statistic	95% Critical values
r=0	*r=1*	92.91	61.27	384.96	222.62
r≤1	*r=2*	75.15	55.14	292.05	182.99
r≤2	*r=3*	62.98	49.32	216.90	147.27
r≤3	*r=4*	52.06	43.61	153.93	115.85
r≤4	*r=5*	32.51	37.86	101.87	87.17
r≤5	*r=6*	22.42	31.79	69.36	63.00
r≤6	*r=7*	20.90	25.42	46.94	42.34
r≤7	*r=8*	16.47	19.22	26.04	25.77
r≤8	*r=9*	9.57	12.39	9.57	12.39

Table 8.5. Results from cointegration tests, France

Note: Test statistics are obtained from applying the Maximum Eigenvalue and Trace test to z_t, using a VAR(3) model, with unrestricted intercepts and restricted trend coefficients, and one lag of Δp^{vm}, with 96 observations covering the period between 1981q1 to 2004q4. Critical values are chosen according to this specification.

As discussed in section 5.5, in these circumstances it is necessary to weight the tests results against their potential biases and economic theory. In this case, we have a reasonable large sample of 100 observations, but we are estimating a large VAR(3) with nine variables, and some of its residuals are not normally distributed. Hence, it seems reasonable to suspect that the test results might suffer of size biases. To overcome these problems, we follow the approach adopted in the UK's case, and proceed under the assumption of *r*=2 as suggested by economic theory.

8.3.3 Identifying the long run relations

In order to identify which variables take part in these two long run relationships, we use the four sets of restrictions from Table 5.1 (β_{LNJ}, β_{BS}, β_{ASR} and β_{RH}) as identifying schedules. Table 8.6 reports the results of this process:

z_t^*	$\hat{\beta}_{LNJ}$		$\hat{\beta}_{BS}$		$\hat{\beta}_{ASR}$		$\hat{\beta}_{RH}$		$\hat{\beta}_{\text{Hybrid}}$	
$w_t - p_t$	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
$y_t - l_t$	0.000	-1.000	0.000	-0.253§NC	-0.066	-0.338§NC	0.000	-1.000	0.000	0.000
				(0.114)	None	(0.110)				
u_t	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
lu_t	0.000	0.000	-0.653§	0.183§	0.000	0.257§NC	0.000	0.000	-2.374§	0.186§
			(0.319)	(0.036)		(0.068)			(0.670)	(0.027)
grr_t	1.656§	0.285	0.984	0.169§	1.638§	0.182§	2.001§	0.107	0.000	0.239§
	(0.416)	None	(0.529)	(0.038)	(0.685)	(0.071)	(0.533)	(0.100)		(0.047)
${t^w}_t$	-1.244§	-0.060	-1.254§	-0.066	-1.409§	-0.131§	-0.903§	-0.074	0.000	0.000
	(0.192)	(0.052)	(0.163)	(0.050)	(0.392)	(0.076)	(0.284)	(0.065)		
mil_t	-0.077	-0.063	0.060	-0.023	-0.111	-0.054	0.014	-0.033	0.761§	0.000
	(0.081)	none	(0.117)	(0.020)	None	(0.030)	(0.116)	None	(0.184)	
k_t	0.000	0.000	0.000	-0.298§NC	0.088	-0.194	0.000	0.000	-1.278§	-0.488§
				(0.090)	none	(0.100)			(0.311)	(0.017)
$i_t - \Delta p_t$	0.000	0.000	0.000	0.000	0.000	0.000	0.215	-0.011	0.000	0.000
							(0.137)	(0.031)		
T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
r^2	4		4		4		4		4	
ll_{r^2}	2947.8		2947.8		2947.8		2947.8		2947.8	
q	14		10		9		12		14	
ll_q	2916.5		2937.6		2935.6		2918.2		2938.7	
$X_{LR}^2(q - r^2)$	X^2(10)=62.611 [0.000]		X^2(6)=20.249 [0.003]		X^2(5)= 24.354 [0.000]		X^2(8)=59.241 [0.000]		X^2(10)=18.156§ [0.052]	

Table 8.6. Identification process and estimation of long run elasticities, France

Note: These estimations were carried with 96 observations covering the period between 1981q1 to 2004q4. Asymptotic standard errors for each β coefficient are provided in brackets. § indicates significant at 5% and * indicates significant at 10%. NC indicates that the coefficient is subject to a theoretical restriction for which we failed to obtain converging results, and hence had to be left unrestricted. r^2=Number of just identified restrictions, and q= Number of total restrictions imposed, i.e. over-identifying restrictions. ll_{r^2} is the maximum value of the log-likelihood function obtained under r^2 just identified restrictions. ll_q is the maximum value of the log-likelihood function obtained under q over-identifying restrictions. $X_{LR}^2(q - r^2)$ is the chi-square statistics for the log-likelihood Ratio (LR) test. P-values for this test are provided in square brackets.

We start by imposing the restrictions contained in β_{LNJ}. This set of restrictions is insignificant at the standard 5%, its log-likelihood ratio (LR) test is a $X^2{}_{(10)}$=62.611 with a p-value equal to [0.000]. Hence, evidence seems to lean against β_{LNJ}. Next, we test the validity of the restrictions contained in β_{BS}, which are also insignificant as a whole with a p-value for the LR test equal to [0.003]. Following, we introduce the set of restrictions of β_{ASR}, for which evidence is not very supportive either, since it is insignificant with a p-value for the LR test equal to [0.000]. Finally, the set of restrictions contained in β_{RH} is also found insignificant, with a p-value for LR test equal to [0.000].

It should be noted that the coefficients β_{22} and β_{28} are left unrestricted in $\hat{\beta}_{BS}$ because we fail to obtain converging results when introducing $\beta_{22} = -1$ and $\beta_{28} = 0$, despite introducing β_{BS} following different sequences. The same occurs with β_{22} and β_{24} when we impose β_{ASR}.

Hence, evidence does not provide support to any of the four sets of restrictions drawn from each of the nested NAIRU models. As in previous cases, we interpret these results as a sign that the unemployment and real wages cointegrated vectors are more complex than as portrayed by theoretical models. In fact, evidence from the trial and error process by which these sets of restrictions are introduced reveals some suggestive features of the data[63]: Introducing $\beta_{18} = 0$ pushes $\hat{\beta}_{LNJ}$, $\hat{\beta}_{BS}$ and $\hat{\beta}_{RH}$ into rejection, so does $\beta_{14} = 0$ in the cases of β_{LNJ} and β_{RH} (Similarly $\beta_{22} = -1$ when we obtain converging results). This evidence suggests that some form of hybrid between β_{BS} (where $\beta_{14} \neq 0$) and β_{ASR} (where $\beta_{18} \neq 0$) along with $\beta_{22} \neq -1$ might be supported by the data.

As in the UK's case, we test this hypothesis building a sequence of restrictions denoted by β_{Hybrid}, which contains these features, and experiment until we find a $\hat{\beta}_{Hybrid}$ supported by the data, here reported in the last column of Table 8.6. In this case, $\hat{\beta}_{Hybrid}$ is significant at the standard 5%, the LR test is a $X^2{}_{(10)}$=18.156 with a p-value equal to [0.052]. It must be noted that all the unrestricted coefficients are individually significant at the standard levels (see asymptotic standard errors in brackets). $\hat{\beta}_{Hybrid}$ is clearly more significant than the rest of β matrices examined in Table 8.6 and consequently we adopt it as our preferred long run specification.

The following equations show the unemployment and real wages cointegrated vectors implied by $\hat{\beta}_{Hybrid}$ (asymptotic standard errors in brackets), recall that the coefficients of these equations can be interpreted as long run elasticities because all variables are measured in logarithms.

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[63] As in the UK's case, it must be noted that comments regarding the importance of individual restrictions reported here, are consistent with different ordering of the restrictions.

8.6 $$u_t = +2.374lu_t - 0.761mil_t + 1.278k_t + \hat{\xi}_{1,t}$$
(0.670) (0.184) (0.311)

8.7 $$(w_t - p_t) = -0.186lu_t - 0.239grr_t + 0.488k_t + \hat{\xi}_{2,t}$$
(0.027) (0.047) (0.017)

As per equation 8.6, France's NAIRU is determined by workers' militancy as reported in Arestis et al. (2007), see also L'Horty and Rault (2003) or Gianella et al. (2008). Although contrary to LNJ's propositions, the NAIRU is not exclusively determined by exogenous factor:

First, the NAIRU is also determined by long term unemployment, our estimates suggest that an increase in the long term unemployment rate of 1% would increase the NAIRU by 2.374%. According to our theoretical model, this suggests that workers suffering jobless spells of a year or longer, cannot exert downward pressure over real wages claims causing labour market hysteresis[64]. Similarly, Stockhammer (2004a) also find evidence of hysteresis in France.

Second, the NAIRU is influenced by the size of capital stock, although it has a perverse effect, because our estimates suggest that an increase in capital stock of 1% would increase the NAIRU by 1.278%. As discussed in Germany's section, this could be the result of capital stock increasing firms' ability to mark-up wages rather than reduces it, or a sign that capital stock increases workers real wage claims more than it reduces firms' mark-up. In any case, this finding reinforces previous evidence that capital stock affects the NAIRU in France, see Miaouli (2001), Arestis et al. (2007) and Stockhammer (2004a), although the sign of our estimated coefficient is contrary to that obtained in these articles. As in the German case, this sign discrepancy could be the result of using a different measure of capital stock.

It is worth noting, that we do not find significant evidence of productivity having an impact on the NAIRU, contrary to L'Horty and Rault (2003) and Schreiber (2012). Further, there is no evidence of real long term interest rates determining the NAIRU, contrary to Ball (1999) and Gianella et al. (2008). Having controlled for productivity and long term interest rates in our analysis, we suspect that in previous studies, these variables, might be capturing the effect of some omitted variables, which here have a significant influence on the NAIRU.

Turning now to equation 8.7, the real wages equilibrium is not affected by productivity suggesting that productivity gains do not results in greater real wages in the long run, as also reported by Schreiber (2012), who finds no evidence of cointegration between real wages and productivity in France. We find that the real wage equilibrium is positively affected by capital stock, which

[64] As per equation 4.4 $\beta_{14} = \frac{\omega_{11}}{\omega_1+\varphi_1}$, hence finding $\hat{\beta}_{14} > 0$ requires $\omega_{11} > 0$. As long as the denominator is positive, i.e. $\omega_1 + \varphi_1 > 0$.

suggests that larger productive capacity results in greater real wages in the long run. This is consistent with the positive link between capital stock and the NAIRU that we find in equation 8.6.

On the other hand, unemployment benefits and long term unemployment reduce the long run real wages equilibrium. This suggests that greater benefits generosity eases pressure over real wages in the long run, and that workers who suffer long unemployment spells are still able to exert downward pressure over real wage claims. The latter seems contradictory with evidence from equation 8.6, although according to our theoretical model, this is possible as long as firms' mark-ups increase with unemployment[65].

8.3.4 Short-run dynamics of unemployment and the anchor properties of the NAIRU

To analyse the behaviour of unemployment around the NAIRU, we estimate the ECM equation for Δu_t using the residuals from 8.6 and 8.7 as error correction terms. The resultant Δu_t, estimated with 96 observations over the period 1981q1-2004q4, is the following:

$$
\begin{aligned}
8.8 \qquad \Delta u_t = & \underset{[0.011]}{-2.644} + \underset{[0.346]}{0.012\hat{\xi}_{1,t-1}} - \underset{[0.000]}{1.010\hat{\xi}_{2,t-1}} + \underset{[0.039]}{1.102\Delta(w_{t-1} - p_{t-1})} - \underset{[0.068]}{0.743\Delta(y_{t-1} - l_{t-1})} \\
& + \underset{[0.000]}{0.455\Delta u_{t-1}} - \underset{[0.011]}{0.415\Delta lu_{t-1}} + \underset{[0.160]}{0.581\Delta grr_{t-1}} + \underset{[0.260]}{0.452\Delta t^{w}_{t-1}} + \underset{[0.328]}{0.019\Delta mil_{t-1}} \\
& - \underset{[0.817]}{0.975\Delta k_{t-1}} + \underset{[0.777]}{0.006\Delta(i_{t-1} - \Delta p_{t-1})} + \underset{[0.001]}{1.714\Delta(w_{t-2} - p_{t-2})} - \underset{[0.007]}{1.019\Delta(y_{t-2} - l_{t-2})} \\
& - \underset{[0.000]}{0.486\Delta u_{t-2}} + \underset{[0.357]}{0.144\Delta lu_{t-2}} - \underset{[0.704]}{0.148\Delta grr_{t-2}} - \underset{[0.043]}{0.764\Delta t^{w}_{t-2}} - \underset{[0.859]}{0.004\Delta mil_{t-2}} \\
& - \underset{[0.492]}{2.917\Delta k_{t-2}} + \underset{[0.418]}{0.017\Delta(i_{t-2} - \Delta p_{t-2})} - \underset{[0.180]}{0.001\Delta p^{vm}_{t-1}} + \hat{\varepsilon}_{3t}
\end{aligned}
$$

Adj. R^2=0.564

$X^2_{SC}(4)$= 2.638 [0.620], X^2_{FF} (1)= 2.035 [0.154]

$X^2_{Norm}(2)$= 6.151 [0.046], $X^2_{Het}(1)$= 13.86 [0.000]

$\hat{\xi}_{1,t} = u - 2.374lu + 0.761mil - 1.278k$

$\hat{\xi}_{2,t} = (w - p) + 0.186lu + 0.239grr - 0.488k$

$\sigma_{\hat{\varepsilon}_3} = 0.0178$

Where Adj. R^2, X^2_{SC}, X^2_{FF}, X^2_{Norm}, X^2_{Het} have the same meaning as above. $\sigma_{\hat{\varepsilon}_3}$ is the standard deviation of the error term in equation 8.8. p-values for t-tests and diagnostic tests are reported in square brackets[66].

---

[65] As discussed above $\hat{\beta}_{14} > 0$ means that $\omega_{11} > 0$. Further, as per equation 4.5 $\beta_{24} = \left(\varphi_1 \frac{\omega_{11}}{\omega_1 + \varphi_1}\right)$, hence finding $\hat{\beta}_{24} = \left(\varphi_1 \frac{\omega_{11}}{\omega_1 + \varphi_1}\right) < 1$ requires $\varphi_1 < 0$.

[66] All diagnostic tests are passed at the standard 5% significance level, except the heteroscedasticity and normality tests. Hence, although our estimates are still unbiased, inference using the t-test is no longer valid because it is based on the assumption that residuals are normally distributed.

As per equation 8.8 the coefficient for $\hat{\xi}_{1,t-1}$ is positive but very small, meaning that deviations from the NAIRU have a negligible influence on unemployment dynamics, and consequently it is unlikely to act as an anchor. Miaouli (2001) and Arestis et al. (2007) also find that deviations from the NAIRU have little influence on changes in employment and unemployment respectively. Our findings are also consistent with Schreiber's (2012) results, who find that deviations from the NAIRU only explain 35.9% of unemployment dynamics.

The coefficient for $\hat{\xi}_{2,t-1}$, is significant and negative. This suggests that setting real wages above their long run equilibrium reduces unemployment. According to Bhaduri and Marglin's dichotomy, this estimate suggests that France operates under a "wage-led regime", as also reported by Hein and Vogel (2007) but in contrast to findings from Bowles and Boyer (1995).

8.3.5 Impulse response and the effects of an unemployment shock

We complete our analysis simulating an unemployment shock of one standard deviation in equation 8.8, i.e. $\sigma_{\hat{\varepsilon}_3} = 0.0178$, which amounts to a rise in unemployment of 7.13% in annual terms. Figure 8.2 shows the effect of this shock using GIR functions:

Unemployment in panel (a), shows no sign of returning to its baseline after the shock, instead it drifts upwards until it stabilizes six years after the shock, at a level 12% greater than its pre-shock value. This behaviour suggests that the NAIRU has no anchor properties and reinforces our findings from equation 8.8. Our estimate is more pessimistic than previous impulse response estimates. Duval and Vogel (2008) find that France needs more than five years to close the output gap, but the overall conclusion is similar, the NAIRU does not seem to act as a strong anchor.

The reaction of long term unemployment, shown in panel (b), is described by a J-curve. As discussed in the UK's section, this illustrates that the effect of the shock changes over time. Real wages and productivity, panels (c) and (d), both increase in an unsynchronized fashion for about eight years after the shock until they stabilize at a similar level. This suggests that the shock does not affect the wage share.

Capital stock, panel (e), falls as a consequence of the shock and stabilizes at a level 0.8% smaller than its baseline. On the other hand, the shock has no permanent effects on real long term interest rates, panel (f), although after the shock it fluctuates for about six years.

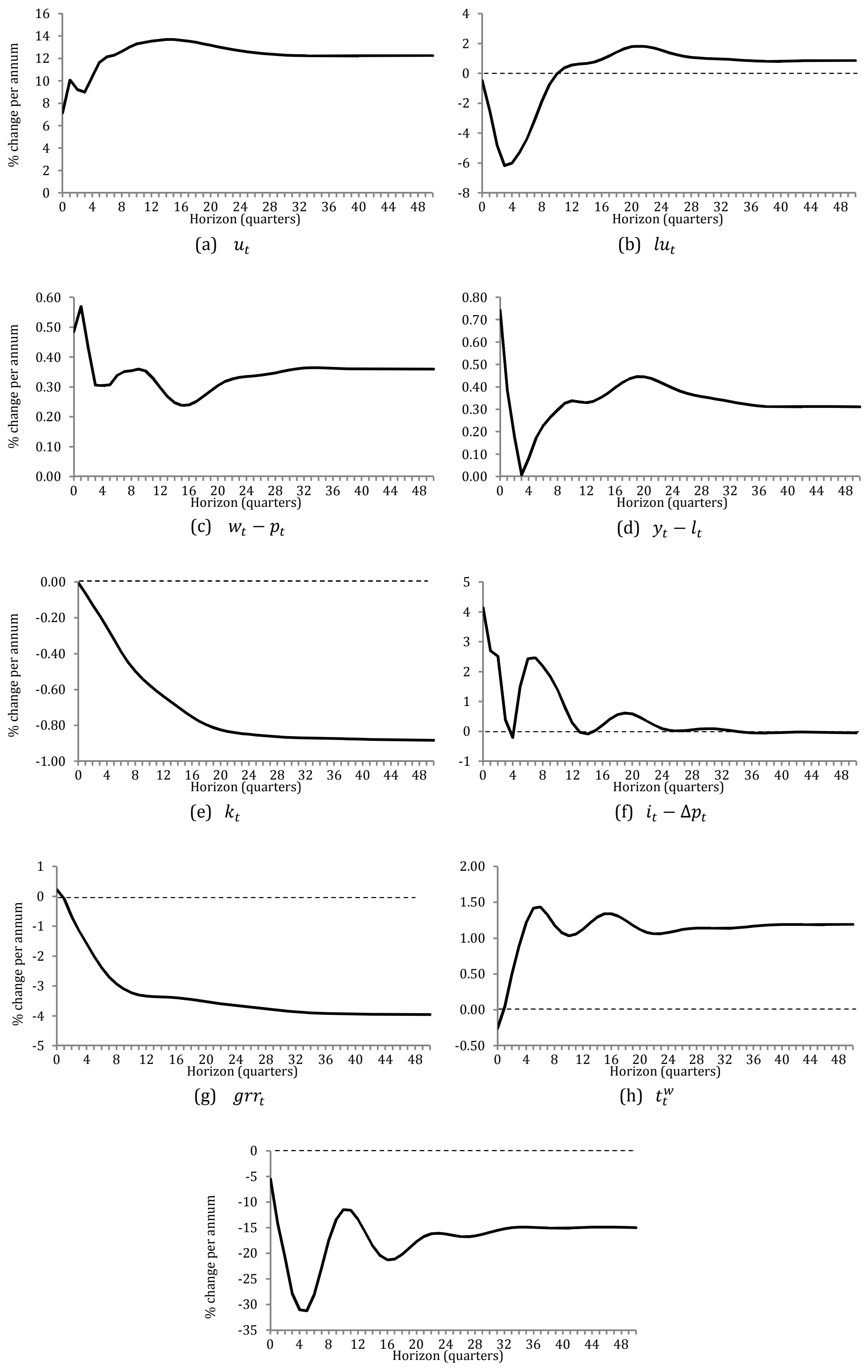

Figure 8.2 GIRF of a standard deviation shock to unemployment on all variables, France

The last three panels refer to the wage-push factors of our model. Unemployment benefits panel (g), and labour taxation panel (h), follow opposite patterns after the shock: Benefits fall permanently to a level 3.9% below its baseline, this could either be the result of a reduction in social provisions or a rise in wages. Whereas labour taxation, increases to a level

1.1% greater than its pre-shock level, this could either be the result of a rise in labour taxes or a fall in wages. Recall that both variables are relative measures with respect to wages. Workers' militancy panel (i), falls sharply on impact, and although it recovers modestly two years after the shock, it ends stabilizing at a level 14.9% below its baseline.

8.4 Summary

In this chapter we have used the CVAR approach to study the determinants of the NAIRU and its anchor properties in Germany and France. This methodology allows us to study the determinants of the NAIRU by testing the long run restrictions required by each of the models nested in our encompassing model (β_{LNJ}, β_{BS}, β_{ASR} and β_{RH}). Panel *i)* of Table 8.7 summarizes the results of this process. According to our estimations, none of the set of restrictions is individually significant, although evidence is very supportive of a $\hat{\beta}_{\text{Hybrid}}$ that combines different features of β_{ASR} and β_{BS} in each country.

	Germany	France
i) Identification process		
$\hat{\beta}_{LNJ}$	[0.000]	[0.000]
$\hat{\beta}_{BS}$	[0.000]	[0.003]
$\hat{\beta}_{ASR}$	[0.002]	[0.000]
$\hat{\beta}_{RH}$	[0.000]	[0.000]
$\hat{\beta}_{Hybrid}$	[0.390]	[0.052]
ii) NAIRU determinants		
grr	-0.831	*NS*
t^w	4.617	*NS*
mil	*n/a*	-0.761
$y-l$	-8.633	*NS*
lu	NS	2.374
k	1.312	1.278
$i-\Delta p$	*NS*	*NS*
T	*NS*	*NS*
iii) NAIRU's anchor properties		
$\hat{\xi}_{1,t-1}$	0.027	0.012
Time required to return to baseline (GIR)	*No Return*	*No Return*

Table 8.7. Summary of findings for Germany and France

Note: *i)* Results for the identification process are drawn from Table 8.3 in the Germany's case and from Table 8.6 for France. *ii)* Values for the NAIRU elasticities are drawn from each country's unemployment cointegrated vector, equations 8.2 and 8.6 respectively. *iii)* Coefficients of $\hat{\xi}_{1,t-1}$ are drawn from equations 8.4 and 8.8 respectively. "Time required to return to baseline" draws from Figure 8.1 and Figure 8.2 respectively. *NS* means not significant and "*No return*" indicates that unemployment does not return to its baseline.

Panel *ii)* of Table 8.7 presents these $\hat{\beta}_{\text{Hybrid}}$. In Germany, the NAIRU is determined by some wage-push factors together with productivity and capital stock. While, in France the NAIRU is determined by some labour market institutions along with long term unemployment and capital stock. Hence, according to our results for these countries the NAIRU is *not* exclusively determined by exogenous factors contrary to what LNJ's model suggests.

Further, these results add to the body of literature that questions the claim that time series evidence for Germany and France support LNJ's propositions, as for instance suggested by Saint-Paul (2004).

The CVAR approach also allows us to examine the anchor properties of the NAIRU by estimating a VECM and GIR functions. Our results are summarized in Panel *iii)* of Table 8.7.

According to our VECM estimations deviations from the NAIRU in Germany and France have a negligible influence on unemployment's dynamics. These findings are reinforced by the results of simulating and unemployment shock using GIR functions, which suggest that after this shock unemployment drifts away from its baseline in both countries, rather than returning to it as it would be expected if the NAIRU acted as an anchor.

Hence, our VECM and GIR results question LNJ's claim about the anchor properties of the NAIRU, although they are in tune with the existing literature, which suggest that the NAIRU in Germany and France is at best a weak anchor for economic activity.

In sum, our findings for Germany and France presented in this chapter challenge the validity of LNJ's propositions and consequently policy recommendations inspired by this approach. For instance, calls for labour market reforms that increase incentives to work in Germany (Brandt et al., 2005,p.66, Rinne and Zimmermann, 2011,p.21) and in France (Jamet, 2006, OECD, 2007a). Policy implications are discussed further in Chapter 11.

Chapter 9 Determinants of the NAIRU and its anchor properties, evidence from Italy and Spain.

9.1 Introduction

This chapter presents the results of applying the CVAR approach to data for Italy and Spain. To contextualize our findings, we open the chapter with a summary of the time series literature reviewed in Chapter 3 that refers to these economies. A summary table of this literature can also be found in Table I.3, in Appendix I.

In the Italian case, it is usually argued that unemployment records provide support to LNJ's claims (OECD, 2003, 2005b,p.26, Saint-Paul, 2004,p.52/3). These claims are supported by findings of a significant link between the NAIRU and some wage-push factors such as unemployment benefits and labour taxation, see for instance (Gianella et al., 2008).

However, this evidence is challenged by a growing literature that finds evidence of links between the NAIRU and demand, through a number of avenues. Miaouli (2001) find a significant positive long run link between capital stock and employment. Similarly, Arestis et al. (2007) find evidence of a significant negative long run link between capital stock and unemployment. These results are yet reinforced by evidence of the negative impact of accumulation over unemployment (Stockhammer, 2004a). Further, there is evidence of a link between the NAIRU and real interest rates (Ball, 1999, Gianella et al., 2008). The impact of productivity and hysteresis is ambiguous, Modigliani et al. (1986) even finds evidence a perverse effect of productivity on the NAIRU.

When it comes to the anchor properties in the Italian economy, the bulk of evidence suggests that the NAIRU is at best a weak anchor, because deviations from the NAIRU have little influence on unemployment dynamics (Arestis et al., 2007, Schreiber, 2012). Furthermore, adjustments to shocks seem to be very protracted (Duval and Vogel, 2008). Only Miaouli's (2001) estimations suggest that deviations from the labour demand have a strong correcting influence on employment.

The Spanish experience has generated an extensive literature, and it is generally believed that labour market institutions are to be blamed for the dismal performance of the Spanish labour market, dubbed as the "Spanish disease". This is based on the early work of Dolado et al. (1986), who find that the NAIRU is not determined by capital stock but labour market factors. This evidence is yet reinforced by later studies such as Estrada et al. (2000), which also find evidence of links between unemployment and exogenous factors of the labour market.

More recently, the consensus view has shifted to explain Spanish unemployment, along the lines of the hysteresis hypothesis, as a combination of adverse shocks and an over-protective labour market (Bentolila et al., 1990, Blanchard and Jimeno, 1995). Although labour markets institutions are still seen as the ultimate culprit for unemployment's evolution. This new consensus view, is supported by evidence from Dolado and Jimeno (1997), who find that shocks such as demand, wages, prices and productivity, have permanent effects over unemployment.

However, this evidence is challenged by a growing body of literature that finds demand factors *per se*, having an impact on the NAIRU. Miaouli (2001) and Karanassou and Sala (2008) find a significant long run positive link between capital stock and employment. Similarly, Arestis et al. (2007) find a significant negative long run link between capital stock and unemployment, see also Ballabriga et al. (1993). Furthermore, there is evidence of a link between the NAIRU and real interest rates (Ball, 1999, Gianella et al., 2008). The impact of productivity is ambiguous, and there is even evidence of a perverse productivity effect (Dolado et al., 1986, Dolado and Jimeno, 1997).

Further, as in the Italian case, the bulk of evidence suggests that the NAIRU is at best a weak anchor. Arestis et al. (2007) find that deviations from the NAIRU seem to have little influence on unemployment dynamics. In the same vein, adjustments after a shock appear to be very sluggish (Duval and Vogel, 2008). Only Miaouli's (2001) estimations suggest that deviations from the labour demand have a correcting influence on employment.

The rest of the chapter presents our findings and it is structured as follows: Section 9.2 presents result for Italy, section 9.3 the results for Spain. Each of them contains five subsections devoted to the five CVAR stages. Section 9.4 closes the chapter with a summary of our key findings.

9.2 Italy

9.2.1 Data properties and model specification

In order to confirm that the CVAR approach can be applied to Italy's data set, we examine the stationary properties of the data. According to the unit root and stationarity tests results, reported in Appendix II, all the variables in Italy's $z_t = (w_t - p_t, y_t - l_t,\ u_t, lu_t, grr_t, t_t^w, mil_t, k_t, i_t - \Delta p_t)'$ are $I(1)$. These results justify the use of cointegration techniques such as the CVAR which we proceed to model now.

The starting point is the CVAR benchmark specification equation 5.1. The composition of its deterministic component C is decided after visual inspection of the data in Figure II.5. This inspection reveals that some of the variables of z_t exhibit a time trend, which could cause the problem of quadratic trends discussed in section 5.4. In order to avoid this phenomenon, we decompose the matrix of deterministic components C into intercepts and time trends, and restrict the time trend to the long run term, as per equation 5.5.

The choice of lag order for this specification draws from the standard model selection criteria, reported in Table 9.1, and along with the composition of x_t, is the result of extensive experimentation with several specifications. After this process we adopt the following VAR (2) expression with $x_t = (\Delta p^{vm}_{t-1})$ as our preferred specification[67]:

9.1 $$\Delta z_t = c_0 + \Phi_1 \Delta z_{t-1} + \gamma\beta' z^*_t + \lambda x_t + \varepsilon_t \qquad \text{where, } z_t = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t^w_t \\ mil_t \\ k_t \\ i_t - \Delta p_t \end{pmatrix}, z^*_t = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t^w_t \\ mil_t \\ k_t \\ i_t - \Delta p_t \\ T \end{pmatrix}, x_t = (\Delta p^{vm}_{t-1})$$

Variables in z_t, z^*_t and x_t have the same meaning as in Chapter 6. We adopt this specification because it appears to deliver the best balance between parsimony, a rich and informative lag structure[68] and satisfactory diagnostic test results for Italy's data set.

Lag order	AIC	SBC
5	2180.3	1638.0
4	2141.8	1701.2
3	2105.2	1766.3
2	2110.8	1873.6
1	2010.8	1875.2
0	1107.4	1073.5

Table 9.1. Lag order selection criteria, Italy

Note: The test is carried out with 91 observations covering the period between 1985q2 to 2007q4. Statistics reported here are obtained from estimating an unrestricted VAR model for the variables contained in the vector z_t, with a constant and a time trend, and one lag of Δp^{vm}.

9.2.2 Cointegration tests

Following, we test for cointegration among the variables of z_t, Table 9.2 presents the results of the Maximum Eigenvalue (λ_{max}) and the Trace (λ_{trace}) tests:

[67] We experimented with more parsimonious models (than our preferred specification), such as a VAR(1) with $x_t = (\Delta p^{vm}_{t-1})$, this lag order draw from SBC indications in Table 9.1. Or a VAR(1) with $x_t = (\Delta p^{vm}_{t-1}, \Delta p^{vm}_{t-2})'$. And less parsimonious models, such as a VAR(2) with $x_t = (\Delta p^{vm}_{t-1}, \Delta p^{vm}_{t-2})'$ and a VAR(3) model. More parsimonious specifications fail to pass the corresponding diagnostic tests, in particular serial correlation, whereas, less parsimonious passed the serial correlation tests, but at the expenses of consuming greater degrees of freedom than our preferred specification, and consequently are discarded.

[68] Equivalent to an $ARMA(18,16)$, (Hamilton, 1994, p.349)

		λ_{max}		λ_{trace}	
H_0	H_1	Statistic	95% Critical values	Statistic	95% Critical values
r=0	*r=1*	84.55	61.27	310.48	222.62
r≤1	*r=2*	55.17	55.14	225.93	182.99
r≤2	*r=3*	43.65	49.32	170.76	147.27
r≤3	*r=4*	36.02	43.61	127.11	115.85
r≤4	*r=5*	28.59	37.86	91.09	87.17
r≤5	*r=6*	22.17	31.79	62.50	63.00
r≤6	*r=7*	18.37	25.42	40.33	42.34
r≤7	*r=8*	14.72	19.22	21.97	25.77
r≤8	*r=9*	7.25	12.39	7.25	12.39

Table 9.2. Results from cointegration tests, Italy

Note: Test statistics are obtained from applying the Maximum Eigenvalue and Trace test to z_t, using a VAR(2) model with unrestricted intercepts and restricted trend coefficients, and one lag of Δp^{vm}, with 94 observations covering the period between 1984q3 to 2007q4. Critical values are chosen according to this specification.

The Maximum Eigenvalue test fails to reject the null hypothesis of having two long run relationships, while the Trace test fails to reject the null hypothesis of having five cointegrated vectors. That is, λ_{max} supports the predictions from our theoretical model of two long run relationships, but the λ_{trace} suggests otherwise. Due to the problems of these tests in finite samples, see section 5.5, we resort to an overall judgment of their results along with economic theory (Pesaran and Pesaran, 2003,p.293, Garrat et al., 2006,p.198). The Maximum Eigenvalue and our theoretical model suggest that there are two long run relationships among our variables, hence, it seems reasonable to proceed under the assumption of r=2.

9.2.3 Identifying the long run relations

In order to identify which variables take part in these two long run relationships, we use the four sets of restrictions from Table 5.1 (β_{LNJ}, β_{BS}, β_{ASR} and β_{RH}) as identifying schedules. Table 9.3 reports the results of this process.

We start by imposing the restrictions contained in β_{LNJ}. This set of restrictions is significant at the standard 5%, its log-likelihood ratio (LR) test is a $X^2_{(10)}$= 18.142 with a p-value equal to [0.053]. Hence, evidence seems to provide support to β_{LNJ}. Next, we test the validity of the restrictions contained in β_{BS}, which are insignificant as a whole at the standard 5%, although they are marginally significant at 1%, with a p-value for the LR test equal to [0.041]. Following, we introduce the set of restrictions β_{ASR}[69], for which evidence is quite supportive, since it is comfortably significant with a p-value for the LR test equal to [0.469]. Finally, the set of restrictions contained in β_{RH} is found insignificant at the standard 5%, although it is marginally significant at 1%, with a p-value for the LR test equal to [0.022].

[69] It should be noted, that the coefficient β_{29}, is left unrestricted because we fail to obtain converging results when introducing $\beta_{29} = 0$, despite introducing β_{ASR} following different sequences.

z_t^*	$\hat{\beta}_{LNJ}$		$\hat{\beta}_{BS}$		$\hat{\beta}_{ASR}$		$\hat{\beta}_{RH}$		$\hat{\beta}_{\text{Hybrid}}$	
$w_t - p_t$	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
$y_t - l_t$	0.000	-1.000	0.000	-1.000	-1.941§	-1.000	0.000	-1.000	-2.044§	-1.000
					(0.352)				(0.400)	
u_t	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
lu_t	0.000	0.000	-0.038	-0.073	0.000	0.000	0.000	0.000	0.000	0.000
			(0.842)	(0.167)						
grr_t	-0.132§	0.023§	-0.128	0.028	-0.045	0.016	-0.135§	0.023§	-0.102§	0.040§
	(0.051)	(0.011)	(0.077)	(0.015)	(0.067)	(0.025)	(0.043)	(0.009)	(0.034)	(0.010)
t_t^w	-3.530§	0.332	-3.444	0.428	-1.841	0.433	-3.888§	0.400	-0.729§	0.000
	(1.181)	(0.246)	(1.836)	(0.370)	(1.740)	(0.664)	(1.186)	(0.242)	(0.365)	
mil_t	0.279	-0.098§	0.283	-0.092§	0.321	-0.154§	0.190	-0.080	0.000	-0.042§
	(0.171)	(0.036)	(0.175)	(0.036)	(0.185)	(0.075)	(0.181)	(0.037)		(0.009)
k_t	0.000	0.000	0.000	0.000	1.209	0.223	0.000	0.000	1.814§	0.000
					(0.924)	(0.358)			(0.244)	
$i_t - \Delta p_t$	0.000	0.000	0.000	0.000	0.000	0.063NC	0.121	-0.023	0.198§	0.000
						(0.024)	(0.192)	(0.038)	(0.047)	
T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
r^2	4		4		4		4		4	
ll_{r^2}	2278.1		2278.1		2278.1		2278.1		2278.1	
q	14		12		10		12		13	
ll_q	2269.0		2270.0		2275.3		2269.1		2270.8	
$X_{LR}^2(q - r^2)$	$X^2(10)$= 18.142 [0.053]		$X^2(8)$= 16.076 [0.041]		$X^2(6)$= 5.606 [0.469]		$X^2(8)$= 17.857 [0.022]		$X^2(9)$= 14.441§ [0.107]	

Table 9.3. Identification process and estimation of long run elasticities, Italy

Note: These estimations were carried with 94 observations covering the period between 1984q3 to 2007q4. Asymptotic standard errors for each β coefficient are provided in brackets. § indicates significant at 5% and * indicates significant at 10%. NC indicates that the coefficient is subject to a theoretical restriction for which we failed to obtain converging results, and hence had to be left unrestricted. r^2=Number of just identified restrictions, and q= Number of total restrictions imposed, i.e. over-identifying restrictions. ll_{r^2} is the maximum value of the log-likelihood function obtained under r^2 just identified restrictions. ll_q is the maximum value of the log-likelihood function obtained under q over-identifying restrictions. $X_{LR}^2(q - r^2)$ is the chi-square statistics for the log-likelihood Ratio (LR) test. P-values for this test are provided in square brackets.

Hence, evidence seems to support the four sets of restrictions albeit at different levels of significance. β_{ASR} appears to be the set of restrictions that is better supported by the data, but β_{ASR} is also significant at the standard 5%, and β_{BS} and β_{RH} are marginally significant. We interpret these results as a sign that there is some truth in all of them, in other words, that there is a β_{Hybrid}, which combines some of their features that is supported by the data. In particular, a variant of β_{ASR} that incorporates some of the restrictions from the other nested NAIRU models.

To test this hypothesis, we build a sequence of restrictions taking β_{ASR} as our base and experiment adding restrictions from other nested models, and exclusion restrictions to coefficients that appear to be individually insignificant, until we find a $\hat{\beta}_{Hybrid}$ supported by the data. Results of this process are reported in the last column of Table 9.3.

The set of restrictions described by $\hat{\beta}_{Hybrid}$ is significant at the standard 5%, the LR test is a $X^2_{(9)}$=14.441 with a p-value equal to [0.107]. Furthermore, according to the asymptotic standard errors (in brackets), all the unrestricted coefficients are individually significant at the standard levels. This combination of significant restrictions and significant unrestricted coefficients, suggest that $\hat{\beta}_{Hybrid}$ accommodates the statistical properties of the data better than the rest of β matrices examined in Table 9.3 and consequently we adopt it as our preferred long run specification.

The following equations show the unemployment and real wages cointegrated vectors implied by $\hat{\beta}_{Hybrid}$ (asymptotic standard errors in brackets), recall that the coefficients of these equations can be interpreted as long run elasticities because all variables are measured in logarithms.

$$u_t = +\underset{(0.400)}{2.044}(y_t - l_t) + \underset{(0.034)}{0.102}grr_t + \underset{(0.365)}{0.729}t_t^w - \underset{(0.244)}{1.814}k_t - \underset{(0.047)}{0.198}(i_t - \Delta p_t) + \hat{\xi}_{1,t} \tag{9.2}$$

$$(w_t - p_t) = (y_t - l_t) - \underset{(0.010)}{0.040}grr_t + \underset{(0.009)}{0.042}mil_t + \hat{\xi}_{2,t} \tag{9.3}$$

According to equation 9.2 Italy's NAIRU is determined by some features of the labour market, such as unemployment benefits and labour taxation, as also reported in Stockhammer (2004a), Arestis et al. (2007) or Gianella et al. (2008). Although contrary to LNJ's propositions, the NAIRU is not exclusively determined by these exogenous factors:

First, the NAIRU is also affected by productivity, although it has a perverse effect, our estimates suggest that an increase in productivity of 1% would increase the NAIRU by 2.044%. According to our theoretical model, this evidence suggests that either the impact of productivity over real wages is greater than its impact on firms mark-up[70], or that productivity increases firms' mark-up rather than moderate them[71]. Given the tendency of the Italian wage share to fall during the sample period, see panel (c) of Figure 6.14, the second possibility seems more likely. Our finding is consistent with Modigliani et al. (1986), who also find a positive relationship between productivity and unemployment equilibrium, but it is in contrast to Schreiber (2012), who did not find evidence of cointegration between unemployment and productivity in the Italian case.

Second, the NAIRU is also influenced by the size of capital stock, our estimates suggest that an increase in capital stock of 1% would reduce the NAIRU by 1.814%. As discussed in the UK's section, this evidence suggests that capital stock limits firms' ability to mark-up wages. Our finding reinforces previous evidence that capital stock reduces the NAIRU in Italy, particularly that from Arestis et al. (2007) who also find unemployment negatively cointegrated with capital stock, but also Miaouli (2001) who report a positive long run elasticity of employment with respect to capital stock, see also Stockhammer (2004a).

Third, the NAIRU is determined by real long term interest rates, our estimates suggest that an increase in real long term interest rates of 1% would reduce the NAIRU by 0.198%. The sign of this coefficient is unexpected and we speculate it could be the result of the wealth or/and the debt effect discussed in UK's section. In any case, this finding reinforces previous evidence that real interest rates affect the NAIRU in Italy, see Ball (1999) and Gianella et al. (2008) although in these studies the relationship found has the conventional positive sign. Considering the importance of capital stock highlighted by our results, and that these studies do not account for it, a possible explanation for this sign discrepancy is that their positive real interest rate coefficient is in fact capturing the negative influence of capital stock over the NAIRU.

It is worth noting, that we do not find evidence of labour market hysteresis determining the NAIRU, as also reported in Arestis et al. (2007) but in contrast to the findings from Stockhammer (2004b) who find evidence of employment and unemployment persistence.

Turning now to equation 9.3, the real wages equilibrium is positively affected by productivity on one-to-one basis, suggesting that productivity gains are fully reflected in the long run real wages equilibrium. This is in contrast to Schreiber (2009), who finds no evidence of long run unit proportionality between real wages and productivity. Workers' militancy also increases the long run real wages equilibrium, suggesting that strike action increases real wages in the

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[70] As per equation 4.4 $\beta_{12} = \frac{\omega_2 - \varphi_3}{\omega_1 + \varphi_1}$, hence finding $\hat{\beta}_{12} > 0$ requires $\varphi_3 < \omega_2$. As long as, the denominator is positive, i.e. $\omega_1 + \varphi_1 > 0$.

[71] In terms of equation 4.1 $\varphi_3 < 0$.

long run. On the other hand, unemployment benefits reduce the long run real wages equilibrium suggesting that greater benefits generosity eases pressure over real wages in the long run.

Finally, combining the evidence of long run unit proportionality, between productivity and real wages, with the positive effect of productivity over the NAIRU suggests three possible scenarios[72]: First, one where unemployment reduces firms ability to mark-up wages ($\varphi_1 > 0$) but firms reaction to productivity gains is below unity ($\varphi_3 < 1$). Second, a scenario where unemployment has no influence on firms' ability to mark-up wages ($\varphi_1 = 0$) and firms' reaction to productivity gains is equal to unity ($\varphi_3 = 1$). Third, one where unemployment increases firms' ability to mark-up wages ($\varphi_1 < 0$) but firms' reaction to productivity gains is above unity ($\varphi_3 > 1$).

9.2.4 Short-run dynamics of unemployment and the anchor properties of the NAIRU

To analyse the behaviour of unemployment around the NAIRU, we estimate the ECM equation for Δu_t using the residuals from 9.2 and 9.3 as error correction terms. The resultant Δu_t, estimated with 94 observations over the period between 1984q3-2007q4, is the following:

9.4
$$\underset{[0.093]}{\Delta u_t = -2.278} + \underset{[0.111]}{0.078}\hat{\xi}_{1,t-1} + \underset{[0.696]}{0.047}\hat{\xi}_{2,t-1} - \underset{[0.914]}{0.031}\Delta(w_{t-1} - p_{t-1}) + \underset{[0.113]}{0.656}\Delta(y_{t-1} - l_{t-1})$$
$$+\underset{[0.685]}{0.054}\Delta u_{t-1} - \underset{[0.104]}{0.195}\Delta lu_{t-1} + \underset{[0.589]}{0.013}\Delta grr_{t-1} + \underset{[0.925]}{0.035}\Delta t^w_{t-1} + \underset{[0.484]}{0.002}\Delta mil_{t-1}$$
$$\underset{[0.032]}{-4.634}\Delta k_{t-1} - \underset{[0.501]}{0.021}\Delta(i_{t-1} - \Delta p_{t-1}) - \underset{[0.655]}{0.001}\Delta p^{vm}_{t-1} + \hat{\varepsilon}_{3t}$$

Adj. R^2=0.171

$X^2_{SC}(4)$= 5.934 [0.204], X^2_{FF} (1)= 0.257 [0.612]

$X^2_{Norm}(2)$= 2.921 [0.232], $X^2_{Het}(1)$= 3.563 [0.059]

$\hat{\xi}_{1,t} = u - 2.044(y-l) - 0.102grr - 0.729t^w + 1.814k + 0.198(i - \Delta p)$

$\hat{\xi}_{2,t} = (w-p) - (y-l) + 0.040grr - 0.042mil$

$\sigma_{\hat{\varepsilon}_3} = 0.0238$

Where Adj. R^2, X^2_{SC}, X^2_{FF}, X^2_{Norm}, X^2_{Het} have the same meaning as above. $\sigma_{\hat{\varepsilon}_3}$is the standard deviation of the error term in equation 9.4. p-values for t-tests and diagnostic tests are reported in square brackets[73].

According to equation 9.4 the coefficient for $\hat{\xi}_{1,t-1}$ is not significantly different from zero, meaning that deviations from the NAIRU have no significant

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[72] As per equation 4.5 $\beta_{22} = \left(\varphi_1 \frac{\omega_2 - \varphi_3}{\omega_1 + \varphi_1} + \varphi_3\right)$, hence if $\hat{\beta}_{22} = 1$ and $\hat{\beta}_{12} = \frac{\omega_2 - \varphi_3}{\omega_1 + \varphi_1} > 0$ rewriting β_{22}as follows; $\varphi_1 \frac{\omega_2 - \varphi_3}{\omega_1 + \varphi_1} = 1 - \varphi_3$, we can see that:

If $\varphi_1 > 0$ then $\varphi_3 < 1$
If $\varphi_1 = 0$ then $\varphi_3 = 1$
If $\varphi_1 < 0$ then $\varphi_3 > 1$

[73] All diagnostic tests are passed at the standard 5% significance level.

influence on unemployment dynamics. In other words, there is no evidence of the NAIRU acting as an anchor. This estimate falls within the low end of existing estimates, which vary widely, Arestis et al. (2007) and Schreiber (2012) find that deviations from the NAIRU have little or no explanatory power over unemployment dynamics, like us. Whereas, Miaouli (2001) find that deviations from labour demand are corrected immediately, suggesting that the NAIRU is a strong anchor. The coefficient for $\hat{\xi}_{2,t-1}$ is also insignificant, suggesting that deviations of real wages from their long run equilibrium have no impact on unemployment.

9.2.5 Impulse response and the effects of an unemployment shock

We complete our analysis simulating an unemployment shock of one standard deviation in equation 9.4, i.e. $\sigma_{\hat{\varepsilon}_3} = 0.0238$, which amounts to a rise in unemployment of 9.52% in annual terms. Figure 9.1 shows the effect of this shock using GIR functions:

Unemployment in panel (a), shows no sign of returning to its baseline after the shock, instead drifts upwards for about five years until it stabilizes at a level 25% greater than its pre-shock value. This behaviour suggests that the NAIRU has no anchor properties and reinforces the results from equation 9.4. Our estimate is more pessimistic than previous impulse response estimates. Duval and Vogel (2008) find that Italy needs more than five years to close the output gap, but the overall conclusion is similar, the NAIRU does not seem to be a strong anchor.

The reaction of long term unemployment to the shock, shown in panel (b), is described by a J-curve. As discussed in the UK's section, this illustrates that the effect of the shock changes over time. Real wages and productivity, panels (c) and (d), both grow as a consequence of the shock, the rise in productivity is more pronounced than that of real wages. This suggests that the wage share falls as a result of the shock.

The unemployment shock causes a J-curve reaction in capital stock, panel (e), and after a fall on impact, it increases permanently. Real long term interest rates, panel (f), falls sharply on impact reaching its minimum after two years and thereafter it starts a very sluggish return towards its baseline.

The last three panels refer to the wage-push factors considered in our model. Unemployment benefits and labour taxation, panels (g) and (h), increase after the shock until they stabilize above their baseline. As discussed in the UK's case, this could either be the result of a fall in wages, or a rise in social provisions and taxes, respectively. Finally, workers' militancy panel (i), fluctuates widely on impact, probably reflecting greater volatility in industrial relations after the shock, and it end ups stabilizing at a level 30% above its baseline. This suggests that the climate of industrial relations worsen permanently after the shock.

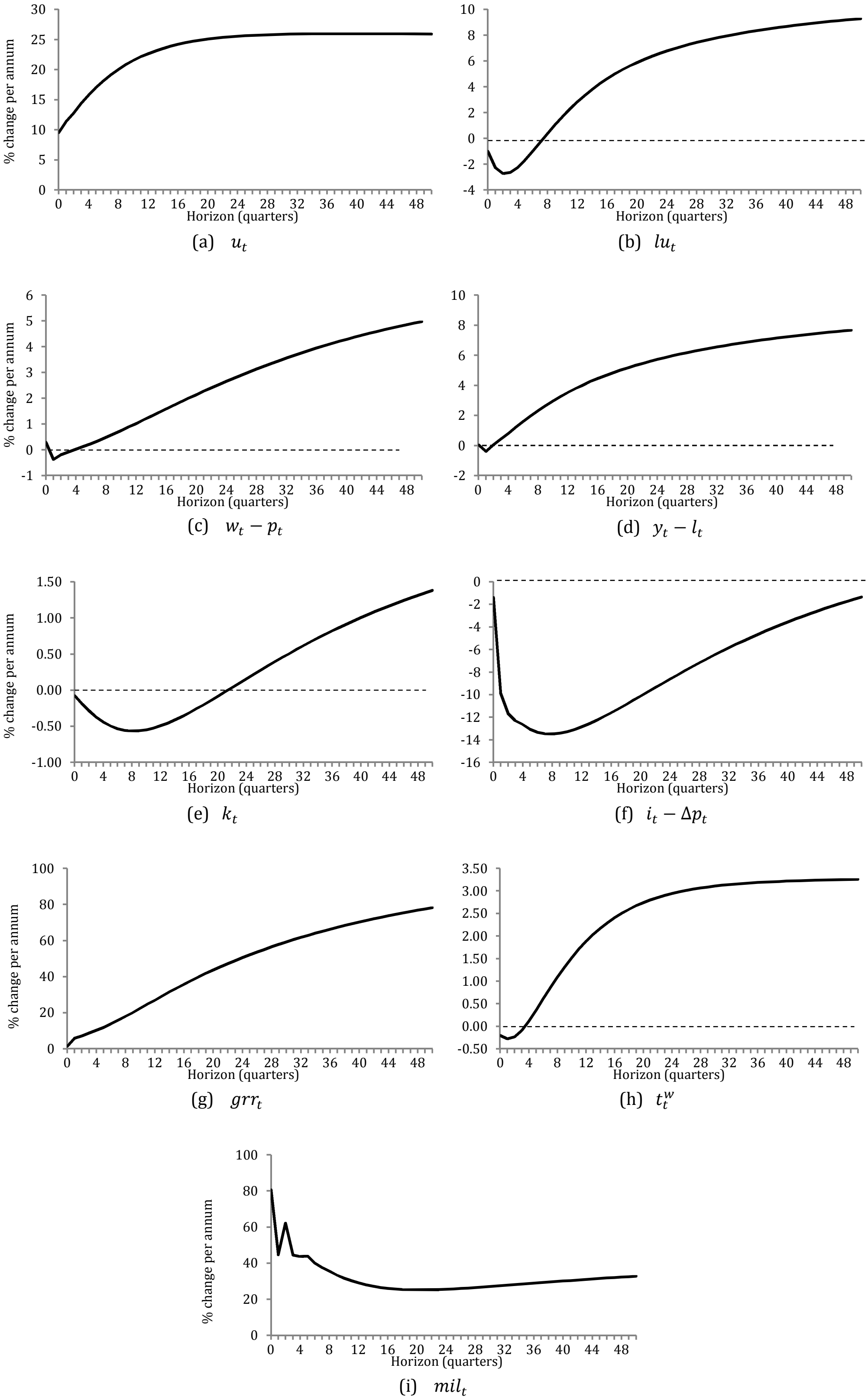

Figure 9.1 GIRF of a standard deviation shock to unemployment on all variables, Italy

9.3 Spain

9.3.1 Data properties and model specification

We turn now to the Spanish case, data properties of Spain's data set are very similar to those of Italy, for evidence from unit root and stationary tests suggest that all variables contained in Spain's $z_t = (w_t - p_t, y_t - l_t,\ u_t,\ lu_t,\ grr_t,\ t_t^w,\ mil_t,\ k_t,\ i_t - \Delta p_t)'$ are $I(1)$, see Appendix II, which justifies the use of the CVAR approach.

We follow the same modelling strategy as in Italy's case. The starting point is the CVAR's benchmark equation 5.1. The composition of C is decided after visual inspection of the data in Figure II.6, which reveals that some of the variables of z_t exhibit a time trend. To avoid the problem of quadratic trends this could cause we adopt equation's 5.5 specification.

The choice of lag order and the composition of x_t, are decided drawing from the model selection criteria reported in Table 9.4, and after extensive experimentation with several specifications. After this process, the following VAR (2) expression with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm}, D87q4)'$ is adopted as our preferred specification[74]:

$$9.5 \quad \Delta \mathrm{z}_t = \mathrm{c}_0 + \Phi_1 \Delta \mathrm{z}_{t-1} + \gamma \beta' \mathrm{z}_t^* + \lambda \mathrm{x}_t + \varepsilon_t \quad \text{where } z_t = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ mil_t \\ k_t \\ i_t - \Delta p_t \end{pmatrix}, z_t^* = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ mil_t \\ k_t \\ i_t - \Delta p_t \\ T \end{pmatrix}, \mathrm{x}_t = \begin{pmatrix} \Delta p_{t-1}^{vm} \\ \Delta p_{t-2}^{vm} \\ D87q4 \end{pmatrix}$$

Variables in z_t, z_t^* and x_t have the same meaning as in Chapter 6. This specification seems to provide the best balance between parsimony, a rich and informative lag structure[75] and satisfactory diagnostic test results for Spain's data set.

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[74] We experimented with more parsimonious models (than our preferred specification), such as a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm})$ and a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm})'$. Models of similar dimensions to equation 9.5, such as VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm}, \Delta p_{t-3}^{vm})'$.
And less parsimonious models such as a VAR(3) specification following AIC's suggestions. However, these specifications are unable to accommodate serial correlation problems, in some cases despite consuming greater degrees of freedom than our preferred specification, and consequently are discarded.

[75] Equivalent to an $ARMA(18{,}16)$, (Hamilton, 1994, p.349)

Lag order	AIC	SBC
5	2620.1	2020.8
4	2546.3	2054.9
3	2570.5	2186.9
2	2597.6	2321.9
1	2418.0	2250.2
0	1327.4	1267.5

Table 9.4. Lag order selection criteria, Spain

Note: The test is carried out with 106 observations covering the period between 1981q3 to 2007q4. Statistics reported here are obtained from estimating an unrestricted VAR model for the variables contained in the vector z_t, with a constant and a time trend, two lags of Δp^{vm} and the dummy variable $D87q4$.

9.3.2 Cointegration tests

Table 9.5 presents the results of testing for cointegration among the variables of z_t. The Maximum Eigenvalue test (λ_{max}) fails to reject the null hypothesis of having three long run relationships, while the Trace test (λ_{trace}) fails to reject the null hypothesis of having eight cointegrated vectors. Hence, both tests suggest that there are more long run relationships than our theoretical model, although they disagree about the exact number.

		λ_{max}		λ_{trace}	
H_0	H_1	Statistic	95% Critical values	Statistic	95% Critical values
r=0	*r=1*	108.85	61.27	425.25	222.62
r≤1	*r=2*	90.73	55.14	316.40	182.99
r≤2	*r=3*	65.26	49.32	225.68	147.27
r≤3	*r=4*	41.18	43.61	160.42	115.85
r≤4	*r=5*	36.40	37.86	119.23	87.17
r≤5	*r=6*	32.40	31.79	82.83	63.00
r≤6	*r=7*	22.93	25.42	50.43	42.34
r≤7	*r=8*	20.45	19.22	27.49	25.77
r≤8	*r=9*	7.04	12.39	7.04	12.39

Table 9.5. Results from cointegration tests, Spain

Note: Test statistics are obtained from applying the Maximum Eigenvalue and Trace test to z_t using a VAR(2) model with unrestricted intercepts and restricted trend coefficients, two lags of Δp^{vm}, and the dummy variable $D87q4$, with 109 observations covering the period between 1980q4 to 2007q4. Critical values are chosen according to this specification.

As discussed in section 5.5, in these circumstances it is necessary to weight the tests results against their potential biases and economic theory. In this case, we have a reasonable large sample of 112 observations, but we are estimating a large VAR(2) with nine variables, and some of its residuals are not normally distributed. Hence, it seems reasonable to suspect that the test results might suffer of size biases. To overcome these problems, we follow the approach adopted in the UK's case, and proceed under the assumption of *r*=2 as suggested by economic theory.

9.3.3 Identifying the long run relations

In order to identify which variables take part in these two long run relationships, we use the four sets of restrictions from Table 5.1 (β_{LNJ}, β_{BS}, β_{ASR} and β_{RH}) as identifying schedules. Table 9.6 reports the results of this process:

z_t^*	$\hat{\beta}_{LNJ}$		$\hat{\beta}_{BS}$		$\hat{\beta}_{ASR}$		$\hat{\beta}_{RH}$		$\hat{\beta}_{\text{Hybrid}}$	
$w_t - p_t$	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
$y_t - l_t$	-3.146§NC	-1.000	-2.734§NC	-1.000	-2.822§	-1.000	-3.505§NC	-1.000	-1.922§	-1.000
	(0.272)		(0.510)		(0.130)		(0.312)		(0.415)	
u_t	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
lu_t	0.000	0.000	-0.134	0.138	0.000	0.000	0.000	0.000	0.000	-0.131§
			(0.172)	(0.552)						(0.033)
grr_t	-0.337	-0. 803§	0.583	-0.595	-0.341	-0.634§	0.194	-0.121	0.000	0.000
	(0.226)	(0.367)	(0.996)	(2.094)	(0.240)	0.299	(0.487)	(0.375)		
${t^w}_t$	-1.459§	0.395	-2.817	2.644	-0.824§	-2.937§	-2.411	0.734	0.000	0.000
	(0.670)	(1.065)	(1.628)	(5.385)	(0.246)	(1.004)	(1.543)	(1.295)		
mil_t	0.037	0.141§	-0.153	0.302	0.076§	-0.024	-0.137	0.114	0.112§	0.077§
	none	(0.059)	(0.124)	(0.531)	(0.030)	None	(0.093)	(0.076)	(0.050)	(0.024)
k_t	0.000	0.000	0.000	2.555 NC	1.211§	-2.395	0.000	0.000	4.140§	0.000
				(5.556)	(0.053)	None			(0.889)	
$i_t - \Delta p_t$	0.000	0.123 NC	0.000	-0.079 NC	0.000	0.000	0.038	-0.113	0.000	0.110§
		None		(0.170)			(0.088)	(0.064)		(0.040)
T	0.016§NC	0.005§NC	0.009 NC	-0.027 NC	0.000	0.032NC	0.015§NC	0.000	-0.040§	0.002§
	(0.000)	(0.000)	(0.006)	(0.059)		none	(0.001)		(0.012)	(0.000)
r^2	4		4		4		4		4	
ll_{r^2}	2756.6		2756.6		2756.6		2756.6		2756.6	
q	10		7		10		10		12	
ll_q	2733.1		2746.8		2725.2		2740.6		2750.0	
$X_{LR}^2(q - r^2)$	$X^2(6)$=46.889 [0.000]		$X^2(3)$=19.590 [0.000]		$X^2(6)$=62.769 [0.000]		$X^2(6)$=32.023 [0.000]		$X^2(8)$=13.171§ [0.106]	

Table 9.6. Identification process and estimation of long run elasticities, Spain

Note: These estimations were carried with 109 observations covering the period between 1980q4 to 2007q4. Asymptotic standard errors for each β coefficient are provided in brackets. § indicates significant at 5% and * indicates significant at 10%. NC indicates that the coefficient is subject to a theoretical restriction for which we failed to obtain converging results, and hence had to be left unrestricted. r^2=Number of just identified restrictions, and q= Number of total restrictions imposed, i.e. over-identifying restrictions. ll_{r^2} is the maximum value of the log-likelihood function obtained under r^2 just identified restrictions. ll_q is the maximum value of the log-likelihood function obtained under q over-identifying restrictions. $X_{LR}^2(q - r^2)$ is the chi-square statistics for the log-likelihood Ratio (LR) test. P-values for this test are provided in square brackets.

We start by imposing the restrictions contained in β_{LNJ}. This set of restrictions is insignificant at the standard 5%, its log-likelihood ratio (LR) test is a $X^2{}_{(6)}$=46.889 with a p-value equal to [0.000]. Hence, evidence seems to lean against β_{LNJ}. Next, we test the validity of the restrictions contained in β_{BS}, which are also insignificant as a whole with a p-value for the LR test equal to [0.000]. Following, we introduce the set of restrictions of β_{ASR}, for which evidence is not very supportive either, since it is insignificant with a p-value for the LR test equal to [0.000]. Finally, the set of restrictions contained in β_{RH} is also found insignificant, with a p-value for the LR test equal to [0.000].

It should be noted, that we encountered convergence problems when introducing all the sets of restrictions, which forces us to leave a number of coefficients unrestricted in each case. When introducing $\hat{\beta}_{LNJ}$, the coefficients β_{12}, β_{110}, β_{29} and β_{210} are left unrestricted, similarly with β_{12}, β_{110}, β_{28}, β_{29} and β_{210} when imposing $\hat{\beta}_{BS}$. These problems improve when we introduce $\hat{\beta}_{ASR}$, because only $\beta_{210} = 0$ produces non-converging results. Similarly, only β_{12} and β_{110} need to be left unrestricted in $\hat{\beta}_{RH}$.

Hence, evidence does not seem to yield support to any of the four sets of restrictions drawn from each of the nested NAIRU models. As in previous cases, we interpret these results as a sign that the unemployment and real wages cointegrated vectors are more complex than as portrayed by theoretical models. In fact, evidence from the trial and error process by which these sets of restrictions are introduced reveals some suggestive features of the data[76]: Introducing $\beta_{18} = 0$ pushes $\hat{\beta}_{LNJ}$, $\hat{\beta}_{BS}$ and $\hat{\beta}_{RH}$ into rejection. In the case of $\hat{\beta}_{ASR}$, it is imposing $\beta_{24} = 0$ and $\beta_{29} = 0$ that pushes the set of restrictions into rejection. On the other hand, $\beta_{22} = -1$ seems supported by the data in all cases. This evidence suggests that some form of hybrid between β_{ASR} (where $\beta_{18} \neq 0$), β_{BS} (where $\beta_{24} \neq 0$) and β_{RH} (where $\beta_{29} \neq 0$), along with $\beta_{22} = -1$ might be supported by the data.

As in the UK's case, we test this hypothesis building a sequence of restrictions denoted by β_{Hybrid}, which contains these features, and experiment until we find a $\hat{\beta}_{Hybrid}$ supported by the data, here reported in the last column of Table 9.6. In this case, $\hat{\beta}_{Hybrid}$ is significant at the standard 5%, the LR test is a $X^2{}_{(8)}$=13.171 with a p-value equal to [0.106]. It must be noted that all the unrestricted coefficients are individually significant at the standard levels (see asymptotic standard errors in brackets). $\hat{\beta}_{Hybrid}$ is clearly more significant than the rest of β matrices examined in Table 9.6 and consequently we adopt it as our preferred long run specification.

[76] As in the UK's case, it must be noted that comments regarding the importance of individual restrictions reported here, are consistent with different ordering of the restrictions.

The following equations show the unemployment and real wages cointegrated vectors implied by $\hat{\beta}_{Hybrid}$ (asymptotic standard errors in brackets), recall that the coefficients of these equations can be interpreted as long run elasticities because all variables are measured in logarithms.

$$u_t = +\underset{(0.415)}{1.922}(y_t - l_t) - \underset{(0.050)}{0.112}mil_t - \underset{(0.889)}{4.140}k_t + \underset{(0.012)}{0.040}T + \hat{\xi}_{1,t} \tag{9.6}$$

$$(w_t - p_t) = (y_t - l_t) + \underset{(0.033)}{0.131}lu_t - \underset{(0.024)}{0.077}mil_t - \underset{(0.040)}{0.110}(i_t - \Delta p_t) - \underset{(0.000)}{0.002}T + \hat{\xi}_{2,t} \tag{9.7}$$

As per equation 9.6, Spain's NAIRU is determined workers' militancy as also reported in Dolado et al. (1986), Estrada et al. (2000) or Gianella et al. (2008). Although contrary to LNJ's propositions, the NAIRU is not exclusively determined by exogenous factors:

First, the NAIRU is also affected by productivity, although it has a perverse effect, our estimates suggest that an increase in productivity of 1% would increase the NAIRU by 1.922%. As in the Italian case, this suggests that either the impact of productivity over real wages is greater than its impact on firms mark-up, or that productivity increases firms' mark-up rather than moderate them. This finding is consistent with Dolado et al. (1986) and Dolado and Jimeno (1997), who also find a positive long run relationship between productivity and unemployment, but it is in contrast to simulations from Ballabriga et al. (1993), which suggest that there is a negative relationship.

Second, the NAIRU is also influenced by the size of capital stock, our estimates suggest that an increase in capital stock of 1% would reduce the NAIRU by 4.140%. As discussed in the UK's section, this evidence suggests that capital stock limits firms' ability to mark-up wages. Our finding reinforce previous evidence that capital stock reduces the NAIRU in Spain, particularly that from Arestis et al. (2007) who also find unemployment negatively cointegrated with capital stock, but also Miaouli (2001) and Karanassou and Sala (2008) who report a positive long run elasticity of employment with respect to capital, see also Ballabriga et al. (1993). Further, this finding also reinforces doubts about the robustness of Dorado's et al (1986) early results, who find no evidence of a link between the NAIRU and capital stock.

Finally, we find significant evidence of the NAIRU having a time trend. It is worth noting, that we do not find evidence of labour market hysteresis having any impact on the NAIRU, as also reported in Arestis et al. (2007), but in contrast to the findings from Dolado and Jimeno (1997). This is an important finding, because it contradicts the widely accepted view that the "Spanish Disease" is the result of interactions between shocks and labour market institutions, i.e. hysteresis (Bentolila et al., 1990, Blanchard and Jimeno, 1995).

Further, there is no evidence of real long term interest rates playing a significant role in determining the NAIRU, contrary to Ball (1999) and Gianella et al. (2008). Having controlled for long term interest rates in our analysis, we suspect that the real cost of borrowing in these studies, might be capturing the effect of some omitted variables, which here have a significant influence on the NAIRU.

Turning now to equation 9.7, real wages equilibrium is positively affected by productivity on one-to-one basis, suggesting that productivity gains are fully reflected in the long run real wage equilibrium. Sala (2009) also reports a long run elasticity of real wages to productivity in the vicinity of unity 0.80, although the estimates from Karanassou and Sala (2008) and Raurich et al. (2009) are more modest, 0.52 and 0.65 respectively. Long term unemployment also increases the long run real wages equilibrium, suggesting that workers who are out of work for a year or more are unable to exert downward pressure over real wage claims.

On the other hand, workers' militancy, long term real interest rates and a time trend reduce the long run real wages equilibrium. This suggests that strike action either has a perverse effect over real wages or that it has been unable to prevent real wages stagnation noted in panel (d) of Figure 6.14. Similarly, the sign of long term real interest rates suggests that workers are unable to compensate rises in the cost of borrowing with greater real wages in the long run.

Further, as discussed in Italy's case, combining the evidence of long run unit proportionality between productivity and real wages, with the positive effect of productivity over the NAIRU suggests three possible scenarios: First, one where unemployment reduces firms ability to mark-up wages ($\varphi_1 > 0$) but firms reaction to productivity gains is below unity ($\varphi_3 < 1$). Second, a scenario where unemployment has no influence on firms' ability to mark-up wages ($\varphi_1 = 0$) and firms' reaction to productivity is equal to unity ($\varphi_3 = 1$). Third, one where unemployment increases firms' ability to mark-up wages ($\varphi_1 < 0$) but firms' reaction to productivity is above unity ($\varphi_3 > 1$).

9.3.4 Short-run dynamics of unemployment and the anchor properties of the NAIRU

To analyse the behaviour of unemployment around the NAIRU, we estimate the ECM equation for Δu_t using the residuals from 9.6 and 9.7 as error correction terms. The resultant Δu_t, estimated with 109 observations over the period 1980q4-2007q4, is the following:

9.8 $\Delta u_t = \underset{[0.000]}{24.11} - \underset{[0.000]}{0.250}\hat{\xi}_{1,t-1} + \underset{[0.000]}{0.406}\hat{\xi}_{2,t-1} - \underset{[0.000]}{1.176}\Delta(w_{t-1} - p_{t-1}) + \underset{[0.747]}{0.071}\Delta(y_{t-1} - l_{t-1})$

$+\underset{[0.000]}{0.289}\Delta u_{t-1} - \underset{[0.310]}{0.077}\Delta lu_{t-1} - \underset{[0.029]}{0.390}\Delta grr_{t-1} + \underset{[0.302]}{0.215}\Delta t^{w}_{t-1} - \underset{[0.408]}{0.001}\Delta mil_{t-1}$

$-\underset{[0.000]}{11.38}\Delta k_{t-1} + \underset{[0.981]}{0.000}\Delta(i_{t-1} - \Delta p_{t-1}) - \underset{[0.731]}{0.000}\Delta p^{vm}_{t-1} + \underset{[0.857]}{0.000}\Delta p^{vm}_{t-2} - \underset{[0.011]}{0.047}D87q4$

Adj. R^2=0.729

$X^2_{SC}(4)$= 5.238 [0.264], X^2_{FF} (1)= 0.000 [0.996]

$X^2_{Norm}(2)$= 1.613 [0.446], $X^2_{Het}(1)$= 0.035 [0.852]

$\hat{\xi}_{1,t} = u - 1.922(y - l) + 0.112mil + 4.140k - 0.040T$

$\hat{\xi}_{2,t} = (w - p) - (y - l) - 0.131lu + 0.077mil + 0.110(i - \Delta p) + 0.002T$

$\sigma_{\hat{\varepsilon}_3} = 0.0182$

Where Adj. R^2, X^2_{SC}, X^2_{FF}, X^2_{Norm}, X^2_{Het} have the same meaning as above. $\sigma_{\hat{\varepsilon}_3}$is the standard deviation of the error term in equation's 9.8. *p*-values for *t*-tests and diagnostic tests are reported in square brackets[77].

As per equation 9.8 the coefficient for $\hat{\xi}_{1,t-1}$ is negative and significantly different from zero. It implies that 25% of the gap between unemployment and the NAIRU is corrected each quarter, which amount to a half-life of about three quarters, and a 90% life of two years. Hence, the NAIRU seems to act as an anchor, although the speed of adjustment suggests that it is a rather weak one. Our estimate falls within the low end of existing estimates, which vary widely, Arestis et al. (2007) find that only 11.9% of the gap between the NAIRU and unemployment is corrected each quarter, half of what it is implied by our estimate. Whereas, Miaouli (2001) find that deviations from labour demand are corrected immediately.

The coefficient for $\hat{\xi}_{2,t-1}$, is significant and positive. This suggests that setting real wages above their long run equilibrium increase unemployment. According to Bhaduri and Marglin's dichotomy, this estimate suggests that Spain operates under a "profit-led regime".

9.3.5 Impulse response and the effects of an unemployment shock

We complete our analysis simulating an unemployment shock of one standard deviation in equation 9.8, i.e. $\sigma_{\hat{\varepsilon}_3} = 0.0182$, which amounts to a rise in unemployment of 7.27% in annual terms. Figure 9.2 shows the effect of this shock using GIR functions:

[77] All diagnostic tests are passed at the standard 5% significance level.

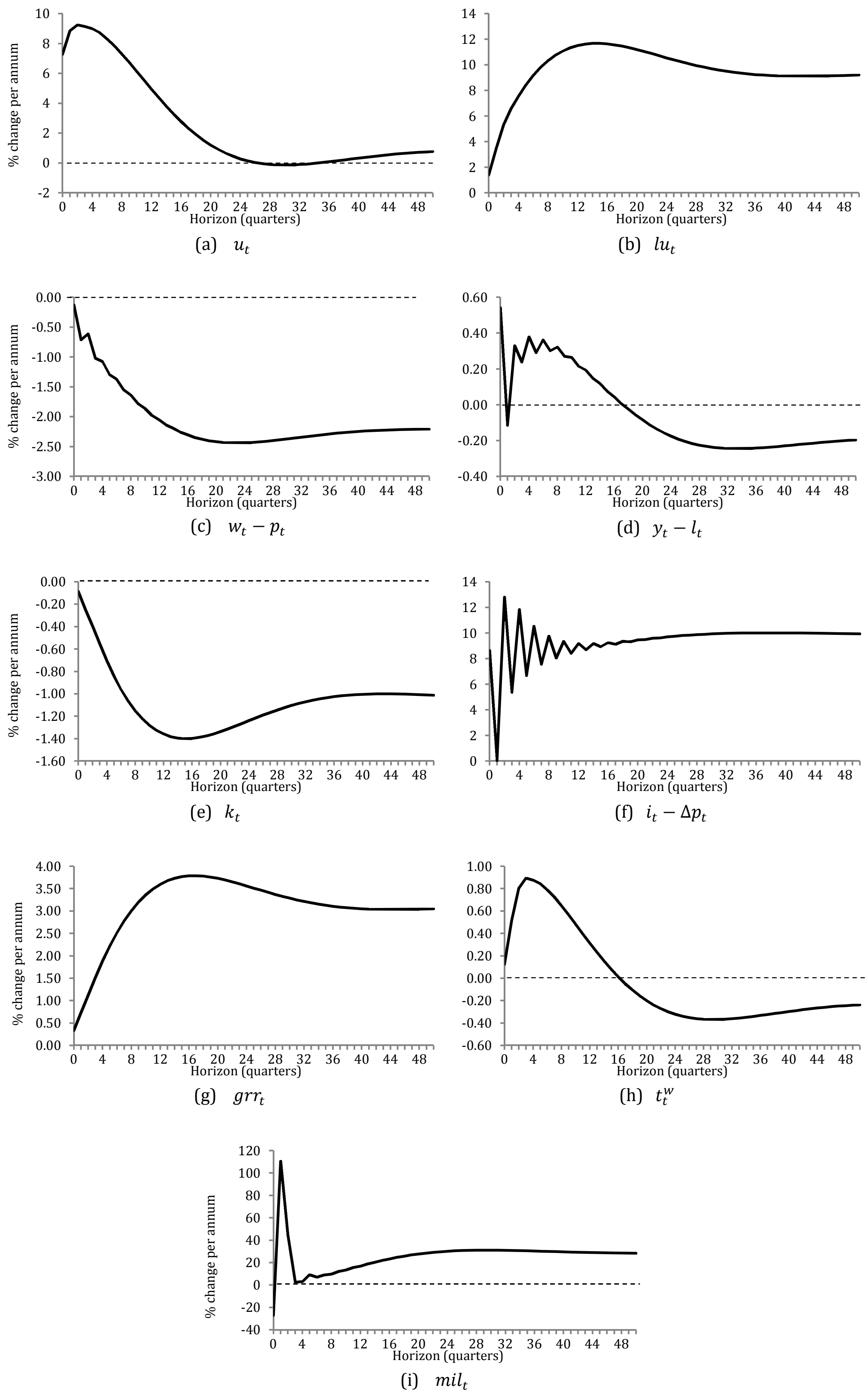

Figure 9.2 GIRF of a standard deviation shock to unemployment on all variables, Spain

Unemployment in panel (a), drifts upwards for the first year, and after peaking at 9% above the baseline, it returns slowly to its pre-shock level more than six years later. This protracted return to its baseline, suggests that the NAIRU is a rather weak anchor, as pointed out by our estimates in equation 9.8. This timing is slightly slower than that reported by Duval and Vogel (2008), who find that Spain needs between four and five years to close the output gap.

As a consequence of the shock, long term unemployment increases, panel (b), until it stabilizes at a level 9% above its pre-shock situation. Real wages and productivity, panels (c) and (d), both fall as a result of the shock although the fall in real wages is more pronounced than that of productivity, the latter even grows on impact. While $w_t - p_t$ stabilizes at a level 2.4% smaller than its pre-shock value, $y_t - l_t$ stabilizes 0.2% below its baseline. This suggests that the wage share falls as a result of the shock.

Capital stock, panel (e), falls as a consequence of the shock until it stabilizes at a level 1.1% smaller than its baseline. This reaction to the rise in unemployment is very suggestive of the type of negative long run relationship that we find in our econometric analysis. Real long term interest rates, panel (f), fluctuates widely on impact, although it ends stabilizing at a level 9% above its baseline.

The last three panels refer to the wage-push factors of our model. Unemployment benefits, panel (g), increase after the shock until it stabilizes above its baseline. Labour taxation, panel (h), follows an inverted J-curve evolution, and after an initial rise it stabilizes at a level below its baseline. Workers' militancy panel (i), fluctuates widely on impact, probably reflecting greater volatility in industrial relations after the shock, and it end ups stabilizing at a level 20% above its baseline. The latter suggests that the climate of industrial relations worsen permanently after the shock.

9.4 Summary

In this chapter we have used the CVAR approach to study the determinants of the NAIRU and its anchor properties in Italy and Spain. This methodology allows us to study the determinants of the NAIRU by testing the long run restrictions required by each of the models nested in our encompassing model (β_{LNJ}, β_{BS}, β_{ASR} and β_{RH}). Panel *i*) of Table 9.7 summarizes the results of this process. In the Italian case, $\hat{\beta}_{ASR}$ is strongly significant although a $\hat{\beta}_{\text{Hybrid}}$ that combines some of its features with $\hat{\beta}_{RH}$ is our preferred long run choice. In the Spanish case none of the set of restrictions is individually significant. However, evidence is very supportive of a $\hat{\beta}_{\text{Hybrid}}$ that combines different features of β_{BS}, β_{ASR} and β_{RH}.

Panel *ii)* of Table 9.7 presents these $\hat{\beta}_{\text{Hybrid}}$. In Italy, the NAIRU is determined by some wage-push factors together with productivity, capital stock and real long term interest rates. In the Spanish case, the NAIRU is determined by some labour market institutions along with productivity and capital stock. Hence, according to our results for these countries the NAIRU is *not* exclusively determined by exogenous factors contrary to what LNJ's model suggests. It is also worth noting that our results for Spain do not provide support for the hysteresis hypothesis. Further, these results add to the body of literature that questions the claim that time series from Italy and Spain support LNJ's propositions, as for instance suggested by Saint-Paul (2004). Neither do our findings support the claim that the evolution of unemployment in Spain provides support to the hysteresis hypothesis, as proposed by Bentolila's et al. (1990).

	Italy	Spain
i) Identification process		
$\hat{\beta}_{LNJ}$	[0.053]	[0.000]
$\hat{\beta}_{BS}$	[0.041]	[0.000]
$\hat{\beta}_{ASR}$	[0.469]	[0.000]
$\hat{\beta}_{RH}$	[0.022]	[0.000]
$\hat{\beta}_{Hybrid}$	[0.107]	[0.106]
ii) NAIRU determinants		
grr	0.102	*NS*
t^w	0.729	*NS*
mil	*NS*	-0.112
$y-l$	2.044	1.922
lu	*NS*	*NS*
k	-1.814	-4.140
$i-\Delta p$	-0.198	*NS*
T	*NS*	0.040
iii) NAIRU's anchor properties		
$\hat{\xi}_{1,t-1}$	*NS*	-0.250
Time required to return to baseline (GIR)	*No Return*	+6 years

Table 9.7. Summary of findings Italy and Spain

Note: *i)* Results for the identification process are drawn from Table 9.3 in the Italian case and from Table 9.6 for Spain. *ii)* Values for the NAIRU elasticities are drawn from each country's unemployment cointegrated vector, equations 9.2 and 9.6 respectively. *iii)* Coefficients of $\hat{\xi}_{1,t-1}$ are drawn from equations 9.4 and 9.8 respectively. "Time required to return to baseline" draws from Figure 9.1 and Figure 9.2 respectively. *NS* not significant and "*No return*" indicates that unemployment does not return to its baseline.

In fact, our findings raise questions about the validity of the Spanish time series literature in which such claims are grounded for the following reasons. First, our results cast doubts on the robustness of studies that find the NAIRU neutral to capital stock, for instance Dolado et al. (1986), or previous studies which find evidence of hysteresis effects such as Dolado and Jimeno (1997). Second, our finding that productivity and capital stock influence the NAIRU, suggests that some of the time series studies which are usually cited to vindicate LNJ's claims, for instance Estrada et al. (2000) are misspecified because they omit productivity and capital stock. The same applies to studies used to vindicate the hysteresis hypothesis that omit these variables in their analysis, such as Dolado and Jimeno (1997). Stockhammer (2004a,p.20) and Arestis et al. (2007, p.144) already warn of these potential biases.

The CVAR approach also allows us to examine the anchor properties of the NAIRU by estimating a VECM model and GIR functions. Our results are summarized in Panel *iii)* of Table 9.7. According to our VECM estimations, in Italy deviations from the NAIRU have no significant influence on unemployment's dynamics, which questions the ability of the NAIRU to act as an anchor. While in the Spanish case, our VECM results suggest that the NAIRU is a very weak anchor.

These findings are reinforced by the results of simulating and unemployment shock using GIR functions. In Italy, GIR estimates suggest that unemployment drifts away from its pre-shock value, rather than returning to it as it would be expected if the NAIRU acted as an anchor. In Spain, GIR estimates suggest that unemployment returns to its baseline but it needs more than six years to do so, which in line with our VECM estimations suggests that the NAIRU is a very weak anchor.

Hence, our VECM and GIR results question LNJ's claim about the anchor properties of the NAIRU, although they are in tune with the bulk of existing literature, which suggest that the NAIRU in Italy and Spain is at best a weak anchor for economic activity.

In sum, our findings for Italy and Spain presented in this chapter challenge the validity of LNJ's propositions and the hysteresis hypothesis, the time series literature that provides support to these models and consequently policy recommendations inspired by these approaches. For instance, OECD's (2003,p.22, 2005a) calls for labour market reforms in Italy that increase incentives to work and make the wage setting framework more flexible. Or calls to reduce workers bargaining power in Spain (Brandt et al., 2005,p.60,66, Bentolila et al., 2011, Jaumotte, 2011). Policy implications are discussed further in Chapter 11.

Chapter 10 Determinants of the NAIRU and its anchor properties, evidence from Denmark and Finland.

10.1 Introduction

This chapter presents the results of applying the CVAR approach to data for Denmark and Finland. We start by summarizing the time series literature reviewed in Chapter 3 that refers to these economies. A summary table of this literature can also be found in Table I.4 in Appendix I.

The Danish experience has received less attention in the empirical literature than other of the economies studied in this thesis, and evidence remains scattered. It is sometimes argued that the evolution of unemployment in this country provides support to LNJ's approach (Siebert, 1997, OECD, 2000b,p.223). Hansen and Warne (2001), Nymoen and Rødseth (2003) find no evidence of a link between productivity and the NAIRU, as suggested by LNJ, but there is no clear evidence of a link between unemployment and labour market institutions either (Arestis et al., 2007, Gianella et al., 2008), which runs contrary to LNJ's propositions.

On the other hand, Nymoen and Rødseth (2003) find that participation in the labour market reduces unemployment, which suggests that the NAIRU is subject to hysteresis effects. Further, Karanassou et al. (2008a) find evidence of long run positive link between capital stock and employment. Finally, there is also evidence of a link between the NAIRU and real interest rates (Ball, 1999, Gianella et al., 2008).

There is also a limited literature examining the anchor properties of the NAIRU, but it all suggests that at best, it is a weak anchor. Karanassou et al. (2008b) and Duval and Vogel (2008) find that after a shock, unemployment and output fluctuate away from their respective long run equilibria for prolonged periods of time.

Finland has received a bit more of attention than Denmark due to the abrupt rise in unemployment that it suffered in the 1990s. It is generally thought that the evolution of unemployment in this country provides support to LNJ's claims, particularly because evidence suggests that there is a significant link between labour taxation and the NAIRU (Kiander and Pehkonen, 1999, Honkapohja and Koskela, 1999, Nickell, 1999). Further, it is also generally accepted that real interest rates affect the NAIRU, see Kiander and Pehkonen (1999), Honkapohja and Koskela (1999) and (Gianella et al., 2008).

Evidence of the influence of other demand factors is more ambiguous. Fregert and Pehkonen (2008) attribute the influence of real interest rates to hysteresis, but when measured with long term unemployment, there is no evidence of such hysteresis effects (Arestis et al., 2007). The impact of productivity is also ambiguous (Honkapohja and Koskela, 1999, Nymoen and Rødseth, 2003). Only evidence of a negative long run link between capital stock and unemployment (Arestis et al., 2007) and a positive one with employment seem to be robust (Karanassou et al., 2008a).

Furthermore, as in the Danish case, there is a limited literature studying the anchor properties, but all suggests that the NAIRU is at best a weak anchor because deviations from the NAIRU have little influence on unemployment dynamics (Arestis et al., 2007) and because adjustment after a shock appear to be very sluggish (Duval and Vogel, 2008).

The rest of the chapter is structured as follows: Section 10.2 presents our results for Denmark, section 10.3 our results for Finland. Each of them contains five subsections devoted to the five CVAR stages. And section 10.4 closes the chapter with a summary of key findings.

10.2 Denmark

10.2.1 Data properties and model specification

In order to confirm that the CVAR approach can be applied to Denmark's data set, we examine the stationary properties of the data. According to the unit root and stationarity tests results, reported in Appendix II, all the variables in Denmark's $z_t = (w_t - p_t, y_t - l_t,\ u_t, lu_t, grr_t, t_t^w, mil_t, k_t, i_t - \Delta p_t)'$ are $I(1)$. These results justify the use of cointegration techniques such as the CVAR which we proceed to model now.

The starting point is the CVAR benchmark specification, equation 5.1. The composition of its deterministic component C is decided after visual inspection of the data in Figure II.7. This inspection reveals that some of the variables of z_t exhibit a time trend, which could cause the problem of quadratic trends discussed in section 5.4. In order to avoid this phenomenon, we decompose the matrix of deterministic components C into intercepts and time trends, and restrict the time trend to the long run term, as per equation 5.5.

The choice of lag order for this specification draws from the standard model selection criteria, reported in Table 10.1, and along with the composition of x_t, is the result of extensive experimentation with several specifications. After this process we adopt the following VAR (2) expression with $\mathrm{x}_t = (\Delta p_{t-1}^{vm}, \Delta p_{t-2}^{vm}, \Delta p_{t-3}^{vm},\ \Delta p_{t-4}^{vm})'$ as our preferred specification[78]:

[78] We experimented with more parsimonious models (than our preferred specification), such as a VAR(1) specification with $\mathrm{x}_t = (\Delta p_{t-1}^{vm})$, this lag order draw from SBC indications in Table 10.1. Or a VAR(1) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm})'$, a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm})$, a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm})'$, and a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm}, \Delta p_{t-3}^{vm})'$. However, these specifications are unable to accommodate serial correlation problems, and consequently are discarded. Experimenting with less parsimonious models, such as VAR models with higher lag

$$10.1 \quad \Delta \mathrm{z}_t = \mathrm{c}_0 + \Phi_1 \Delta \mathrm{z}_{t-1} + \gamma \beta' \mathrm{z}_t^* + \lambda \mathrm{x}_t + \varepsilon_t \quad \text{where } z_t = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ mil_t \\ k_t \\ i_t - \Delta p_t \end{pmatrix}, z_t^* = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ mil_t \\ k_t \\ i_t - \Delta p_t \\ T \end{pmatrix}, \mathrm{x}_t = \begin{pmatrix} \Delta p_{t-1}^{vm} \\ \Delta p_{t-2}^{vm} \\ \Delta p_{t-3}^{vm} \\ \Delta p_{t-4}^{vm} \end{pmatrix}$$

Variables in z_t, z_t^* and x_t have the same meaning as in Chapter 6. We adopt this specification, because it appears to deliver the best balance between parsimony, a rich and informative lag structure[79] and satisfactory diagnostic test results for Denmark's data set.

Lag order	AIC	SBC
5	1939.3	1436.8
4	1707.5	1293.6
3	1653.4	1328.2
2	1652.0	1415.5
1	1603.4	1455.6
0	1128.1	1069.0

Table 10.1. Lag order selection criteria, Denmark

Note: The test is carried out with 66 observations covering the period between 1991q3 to 2007q4. Statistics reported here are obtained from estimating an unrestricted VAR model for the variables contained in the vector z_t, with a constant and a time trend, and four lags of Δp^{vm}.

10.2.2 Cointegration tests

Following, we test for cointegration among the variables of z_t, Table 10.2 presents the results of the Maximum Eigenvalue (λ_{max}) and Trace (λ_{trace}) tests:

		λ_{max}		λ_{trace}	
H_0	H_1	Statistic	95% Critical values	Statistic	95% Critical values
r=0	*r=1*	85.55	61.27	333.71	222.62
r≤1	*r=2*	55.11	55.14	248.16	182.99
r≤2	*r=3*	52.30	49.32	193.04	147.27
r≤3	*r=4*	44.70	43.61	140.74	115.85
r≤4	*r=5*	37.28	37.86	96.05	87.17
r≤5	*r=6*	24.90	31.79	58.77	63.00
r≤6	*r=7*	19.87	25.42	33.87	42.34
r≤7	*r=8*	9.43	19.22	14.00	25.77
r≤8	*r=9*	4.57	12.39	4.57	12.39

Table 10.2. Results from cointegration tests, Denmark

Note: Test statistics are obtained from applying the Maximum Eigenvalue and Trace test to our vector z_t using a VAR(2) model with unrestricted intercepts and restricted trend coefficients and four lags of Δp^{vm}, with 67 observations covering the period between 1991q2 to 2007q4. Critical values are chosen according to this specification.

The Maximum Eigenvalue test fails to reject the null hypothesis of having one long run relationships, while the Trace test fails to reject the null hypothesis of

order following AIC's suggestions, is deemed unnecessary because diagnostic test issues are already addressed by our preferred specification.

[79] Equivalent to an $ARMA$(18,16), (Hamilton, 1994, p.349)

having five cointegrated vectors. That is, λ_{max} suggests there is one cointegrated vector less than our theoretical model, while the λ_{trace} suggests that there are three cointegrated vectors more than we expected. As discussed in section 5.5, the finite sample properties of these tests are not well known yet, and interpreting their results should be done with caution. Given the uncertainty around the validity of the tests results, we follow the advice of Pesaran and Pesaran (2003,p.293) and Garrat et al. (2006,p.198), and relying on the predictions from economic theory rather than the tests' results, we proceed under the assumption of *r*=2.

10.2.3 Identifying the long run relationships

In order to identify which variables take part in these two long run relationships, we use the four sets of theoretically driven restrictions detailed in Table 5.1 (β_{LNJ}, β_{BS}, β_{ASR} and β_{RH}) as identifying schedules. Table 10.3 reports the results of this process.

We start by imposing the restrictions contained in β_{LNJ}. This set of restrictions is insignificant at the standard 5%, its log-likelihood ratio (LR) test is a $X^2{}_{(10)}$=60.970 with a p-value equal to [0.000]. Hence, evidence seems to lean against β_{LNJ}. Next, we test the validity of the restrictions contained in β_{BS}, which are also insignificant as a whole at the standard 5%, although they are marginally significant at 1%, with a p-value equal to [0.014]. Following, we introduce the set of restrictions of β_{ASR}[80], for which evidence is not very supportive either, since it is insignificant with a p-value for the LR test equal to [0.002]. Finally, the set of restrictions contained in β_{RH} is also found insignificant with a p-value for the LR test equal to [0.004].

Hence, evidence does not seem to yield support to any of the four sets of restrictions drawn from each of the nested NAIRU models at the standard 5% significance level. As in previous cases, we interpret these results as a sign that the unemployment and real wages cointegrated vectors are more complex than as portrayed by theoretical models. In fact, evidence from the trial and error process by which these sets of restrictions are introduced reveals some suggestive features of the data[81]: Introducing $\beta_{14} = 0$ pushes $\hat{\beta}_{\mathrm{LNJ}}$, $\hat{\beta}_{\mathrm{ASR}}$ and $\hat{\beta}_{\mathrm{RH}}$ into rejection, whereas $\beta_{22} = -1$ seems to be supported by the data in most cases. Furthermore, $\hat{\beta}_{\mathrm{BS}}$ is marginally significant. This evidence suggests that some variant of β_{BS} (where $\beta_{14} \neq 0$ and $\beta_{22} = -1$) might be supported by the data.

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[80] The coefficients β_{19} and β_{22} are left unrestricted because we fail to obtain converging results when introducing $\beta_{19} = 0$ and $\beta_{22} = -1$, despite introducing β_{ASR} following different sequences.

[81] As in the UK's case, it must be noted that comments regarding the importance of individual restrictions reported here, are consistent with different ordering of the restrictions.

z_t^*	$\hat{\beta}_{LNJ}$		$\hat{\beta}_{BS}$		$\hat{\beta}_{ASR}$		$\hat{\beta}_{RH}$		$\hat{\beta}_{\text{Hybrid}}$	
$w_t - p_t$	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
$y_t - l_t$	0.000	-1.000	0.000	-1.000	-9.464	-1.130§NC	0.000	-1.000	0.000	-1.000
					None	(0.036)				
u_t	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
lu_t	0.000	0.000	-1.332§	0.012	0.000	0.000	0.000	0.000	-1.000	0.000
			(0.405)	(0.015)						
grr_t	1.767	0.218§	-0.093	0.224§	1.341	0.233	-1.038	0.252§	0.000	0.247§
	none	(0.013)	(0.500)	(0.019)	None	None	(0.983)	(0.023)		(0.018)
${t^w}_t$	-8.772	-0.161§	2.221	-0.224§	1.663	-0.155	-15.71§	−0.045	0.000	0.000
	None	(0.038)	(2.549)	(0.097)	None	(0.277)	(4.852)	(0.115)		
mil_t	-0.174	-0.155§	-0.198	-0.018§	-0.149	-0.025	0.549§	−0.022§	0.000	-0.024§
	none	(0.003)	(0.114)	(0.004)	None	None	(0.273)	(0.006)		(0.003)
k_t	0.000	0.000	0.000	0.000	6.832	0.054	0.000	0.000	0.000	0.000
					none	None				
$i_t - \Delta p_t$	0.000	0.000	0.000	0.000	0.848§NC	0.000	1.537§	-0.023	0.000	-0.027§
					(0.275)		(0.688)	(0.016)		(0.005)
T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	$\hat{\beta}_{LNJ}$	$\hat{\beta}_{BS}$	$\hat{\beta}_{ASR}$	$\hat{\beta}_{RH}$	$\hat{\beta}_{\text{Hybrid}}$
r^2	4	4	4	4	4
ll_{r^2}	1796.8	1796.8	1796.8	1796.8	1796.8
q	14	12	9	12	13
ll_q	1766.3	1787.2	1787.1	1785.4	1785.7
$X_{LR}^2(q-r^2)$	X^2(10)=60.970 [0.000]	X^2(8)=19.178 [0.014]	X^2(5)=19.234 [0.002]	X^2(8)=22.750 [0.004]	X^2(9)=22.192§ [0.052]

Table 10.3. Identification process and estimation of long run elasticities, Denmark

Note: These estimations were carried with 67 observations covering the period between 1991q2 to 2007q4. Asymptotic standard errors for each β coefficient are provided in brackets. § indicates significant at 5% and * indicates significant at 10%. NC indicates that the coefficient is subject to a theoretical restriction for which we failed to obtain converging results, and hence had to be left unrestricted. r^2=Number of just identified restrictions, and q= Number of total restrictions imposed, i.e. over-identifying restrictions. ll_{r^2} is the maximum value of the log-likelihood function obtained under r^2 just identified restrictions. ll_q is the maximum value of the log-likelihood function obtained under q over-identifying restrictions. $X_{LR}^2(q-r^2)$ is the chi-square statistics for the log-likelihood Ratio (LR) test. P-values for this test are provided in square brackets.

As in the UK's case, we test this hypothesis building a sequence of restrictions denoted by β_{Hybrid}, which contains these features, and experiment until we find a $\hat{\beta}_{Hybrid}$ supported by the data, here reported in the last column of Table 10.3. In this case, $\hat{\beta}_{Hybrid}$ is significant at the standard 5%, the LR test is a $X^2{}_{(9)}$=22.192 with a p-value equal to [0.052]. Furthermore, according to the asymptotic standard errors (in brackets), all the unrestricted coefficients are individually significant at the standard levels. $\hat{\beta}_{Hybrid}$ is clearly more significant than the rest of β matrices examined in Table 10.3 and consequently we adopt it as our preferred long run specification.

The following equations show the unemployment and real wages cointegrated vectors implied by $\hat{\beta}_{Hybrid}$ (asymptotic standard errors in brackets), recall that the coefficients of these equations can be interpreted as long run elasticities because all variables are measured in logarithms.

10.2 $$u_t = lu_t + \hat{\xi}_{1,t}$$

10.3 $$(w_t - p_t) = (y_t - l_t) - \underset{(0.018)}{0.247} grr_t + \underset{(0.003)}{0.024} mil_t + \underset{(0.005)}{0.027} (i_t - \Delta p_t) + \hat{\xi}_{2,t}$$

According to equation 10.2 Denmark's NAIRU is exclusively determined by the long term unemployment rate, with which unemployment has a long term one-to-one relationship. As discussed in France's section, this suggests that workers that have been out of work for a year or more cannot exert downward pressure over real wages claims, causing labour market hysteresis. Hansen and Warne (2001) find that greater labour participation in the labour market reduces the NAIRU, which is also suggestive of hysteresis effects.

It is worth noting, that we do not find significant evidence of exogenous factors having any impact on the NAIRU. This is on line with previous studies, which found difficulties to establish a link between Denmark's unemployment evolution and its labour market institutions (Arestis et al., 2007, Gianella et al., 2008). Further, there is no significant evidence of productivity having any impact on the NAIRU, as also reported in Hansen and Warne (2001) and Nymoen and Rødseth (2003).

Further, there is no evidence of capital stock playing a significant role in determining the NAIRU contrary to Karanassou et al. (2008a). Neither there is evidence of real long term interest rates playing a significant role in determining the NAIRU contrary to Ball (1999) and Gianella et al. (2008). Having controlled for capital stock and long term interest rates in our analysis, we suspect that in previous studies, these variables might be capturing the effect of hysteresis which they omit.

Turning now to equation 10.3, the real wages equilibrium is positively affected by productivity on one-to-one basis, suggesting that productivity gains are fully reflected in the long run real wages equilibrium. Hansen and Warne (2001) also report a long run elasticity of real wages to productivity in the vicinity of unity, although Karanassou's et al., (2008a) estimate are more modest 0.46. Workers' militancy and long term real interest rates also increase the long run real wages equilibrium. This suggests that strike action increases real wages in the long run and that workers are able to compensate rises in the cost of borrowing with greater real wages in the long run.

On the other hand, unemployment benefits reduce the long run real wages equilibrium suggesting that greater benefits ease pressure over real wages in the long run. Given the evidence in favour of labour market hysteresis from 10.2, it is somehow surprising to find that long term unemployment has no effect over real wages equilibrium. According to our theoretical model this is possible as long as firms' price mark-up are insensitive to unemployment[82].

10.2.4 Short-run dynamics of unemployment and the anchor properties of the NAIRU

To analyse the behaviour of unemployment around the NAIRU, we estimate the ECM equation for Δu_t using the residuals from 10.2 and 10.3 as error correction terms. The resultant Δu_t, estimated with 67 observations over the period 1991q2-2007q4, is the following:

10.4
$$\Delta u_t = \underset{[0.843]}{0.012} - \underset{[0.345]}{0.052}\hat{\xi}_{1,t-1} - \underset{[0.098]}{1.480}\hat{\xi}_{2,t-1} + \underset{[0.440]}{0.891}\Delta(w_{t-1} - p_{t-1}) - \underset{[0.045]}{1.318}\Delta(y_{t-1} - l_{t-1})$$
$$+\underset{[0.800]}{0.045}\Delta u_{t-1} - \underset{[0.631]}{0.120}\Delta lu_{t-1} - \underset{[0.130]}{0.820}\Delta grr_{t-1} + \underset{[0.502]}{1.400}\Delta t^{w}{}_{t-1} - \underset{[0.837]}{0.007}\Delta mil_{t-1}$$
$$-\underset{[0.612]}{2.659}\Delta k_{t-1} - \underset{[0.798]}{0.013}\Delta(i_{t-1} - \Delta p_{t-1}) - \underset{[0.378]}{0.002}\Delta p^{vm}_{t-1} - \underset{[0.493]}{0.001}\Delta p^{vm}_{t-2}$$
$$-\underset{[0.053]}{0.004}\Delta p^{vm}_{t-3} - \underset{[0.075]}{0.003}\Delta p^{vm}_{t-4} + \hat{\varepsilon}_{3t}$$

Adj. R^2=0.102

X^2_{SC}(4)= 6.180 [0.186], X^2_{FF} (1)= 1.968 [0.161]

X^2_{Norm}(2)= 0.380 [0.827], X^2_{Het}(1)= 0.085 [0.771]

$\hat{\xi}_{1,t} = u - lu$

$\hat{\xi}_{2,t} = (w - p) - (y - l) + 0.247\text{grr} - 0.024mil - 0.027(i - \Delta p)$

$\sigma_{\hat{\varepsilon}_3} = 0.0514$

Where Adj. R^2, X^2_{SC}, X^2_{FF}, X^2_{Norm}, X^2_{Het} have the same meaning as above. $\sigma_{\hat{\varepsilon}_3}$ is the standard deviation of the error term in equation 10.4. p-values for t-tests and diagnostic tests are reported in square brackets[83].

According to 10.4 the coefficient for $\hat{\xi}_{1,t-1}$ is not significantly different from zero, meaning that deviations from the NAIRU have no significant influence on

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[82] As per equations 4.4 and 4.5 $\beta_{14} = \frac{\omega_{11}}{\omega_1+\varphi_1}$ and $\beta_{24} = \left(\varphi_1 \frac{\omega_{11}}{\omega_1+\varphi_1}\right)$ respectively. Hence, if $\hat{\beta}_{14} = 1$ and $\hat{\beta}_{24} = 0$, φ_1 must be equal to zero.

[83] All diagnostic tests are passed at the standard 5% significance level.

unemployment dynamics. In other words, there is no evidence of the NAIRU acting as an anchor. Karanassou et al. (2008b) concludes similarly after separating the structural and the cyclical component of unemployment, and noting that actual unemployment fluctuates away from its long run equilibrium for most of their sample period.

The coefficient for $\hat{\xi}_{2,t-1}$ is significant -albeit only at 10% and by a very narrow margin- and negative. This suggests that setting real wages above their long run equilibrium reduces unemployment. According to the dichotomy proposed by Bhaduri and Marglin (1990), this estimate suggests that Denmark operates under a "wage-led regime".

10.2.5 Impulse response and the effects of an unemployment shock

We complete our analysis simulating an unemployment shock of one standard deviation in equation 10.4, i.e. $\sigma_{\hat{\varepsilon}_3} = 0.0514$, which amounts to a rise in unemployment of 20.58% in annual terms. Figure 10.1 shows the effect of this shock using GIR functions:

Unemployment in panel (a), drifts upwards for the first year, and after peaking at 23% above the baseline, it falls moderately thereafter until it stabilizes at a level 18.4% greater than its pre-shock value. The reaction of long term unemployment to the shock, shown in panel (b), approximates a J-curve: On impact, lu_t falls in the immediate quarters after the shock, although as time goes by, some of these workers remain unemployed, and the long term unemployment rate rises until it stabilizes at a level 18.4% above its baseline. Hence, the shock has identical long run impact on u_t and lu_t. This reinforces evidence of a one-to-one long run relationship between these variables found in equation 10.2.

Further, although unemployment does not return to its baseline, the fact that it stabilizes at the same level as lu_t suggests that it stabilizes at a new NAIRU after the shock. Five years are needed for both variables to align after the shock, the sluggishness of this process might explain why our coefficient for $\hat{\xi}_{1,t-1}$ in equation 10.4 is insignificant. This timing is slightly slower than that reported by Duval and Vogel (2008), who find that Denmark needs between three and four years to close the output gap.

Real wages and productivity, panels (c) and (d), both grow as a consequence of the shock, although the rise in productivity is more pronounced than that of real wages. While $y_t - l_t$ stabilizes at a level 1.3% greater than its pre-shock value, $w_t - p_t$ stabilizes 0.4% above its baseline. This suggests that the wage share falls as a result of the shock. Capital stock and real long term interest rates, panels (e) and (f), fall as a consequence of the shock until they stabilize at a level 1%, and 15% respectively, smaller than their baselines.

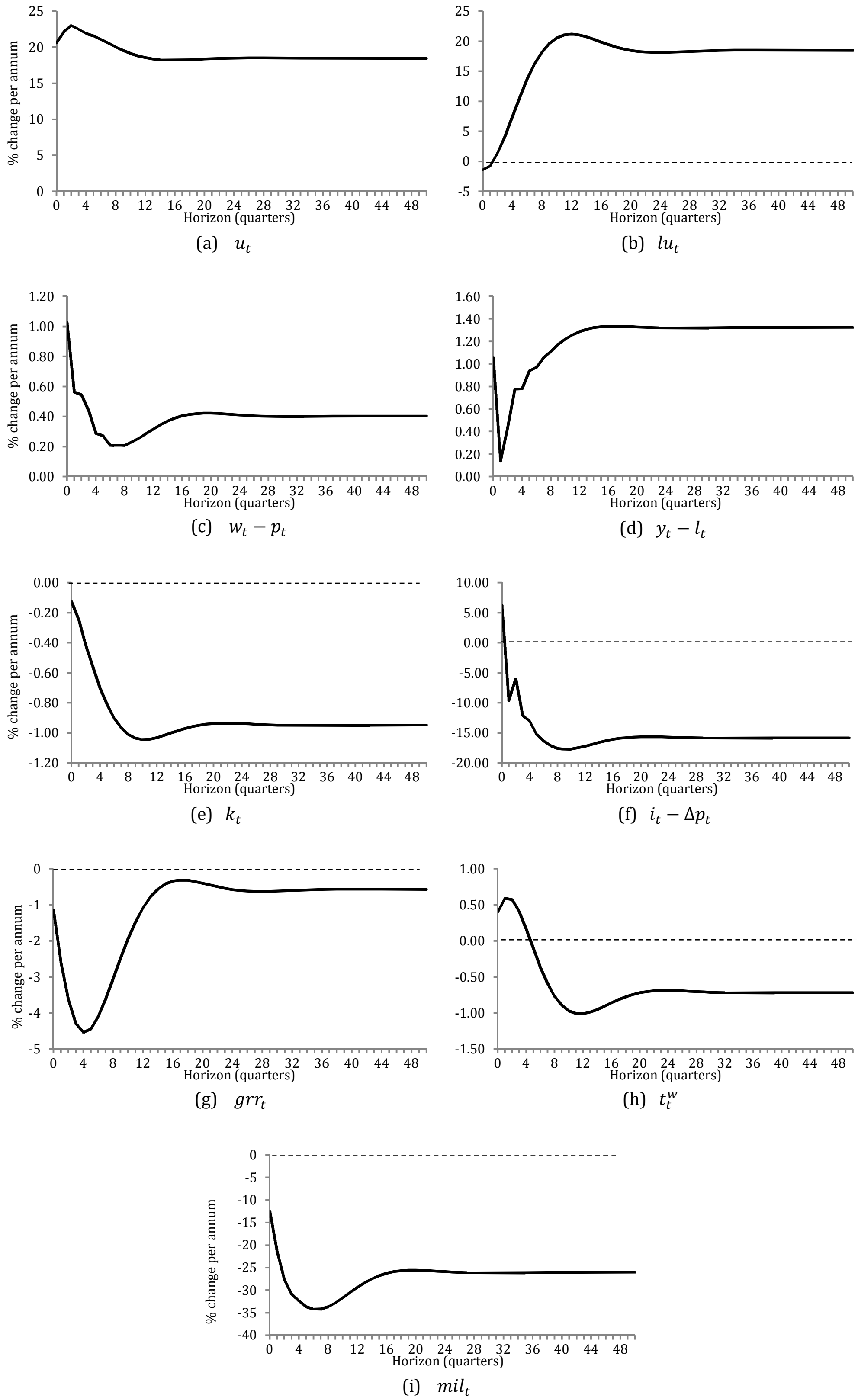

Figure 10.1 GIRF of a standard deviation shock to unemployment on all variables, Denmark

The last three panels refer to the wage-push factors considered in our model. Unemployment benefits and labour taxation, panels (g) and (h), both fall after the shock although on impact they react differently: After an initial sharp fall, unemployment benefits stabilize at a level slightly below its baseline. Whereas, labour taxation follows an inverted J-curve evolution, and after an initial rise it stabilizes at a level below its baseline. Workers' militancy panel (i), falls sharply after the shock, until it stabilizes at a level 26% below its pre-shock situation.

10.3 Finland

10.3.1 Data properties and model specification

We turn now to the Finnish case, data properties of Finland's data set are very similar to those of Denmark, for evidence from unit root and stationary tests suggest that all variables contained in Denmark's' $z_t = (w_t - p_t, y_t - l_t,\ u_t,\ lu_t,\ grr_t, t_t^w,\ mil_t,\ k_t,\ i_t - \Delta p_t)'$ are $I(1)$, see Appendix II, which justifies the use of the CVAR approach.

We follow the same modelling strategy as in Denmark's case. The starting point is the CVAR's benchmark equation 5.1. The composition of C is decided after visual inspection of the data in Figure II.8, which reveals that some of the variables of z_t exhibit a time trend. To avoid the problem of quadratic trends this could cause, we adopt equation's 5.5 specification.

The choice of lag order and the composition of x_t, are decided drawing from the model selection criteria reported in Table 10.4, and after extensive experimentation with several specifications. After this process, the following VAR (2) expression with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm}, D97q123)'$ is adopted as our preferred specification[84]:

10.5 $$\Delta \mathrm{z}_t = \mathrm{c}_0 + \Phi_1 \Delta \mathrm{z}_{t-1} + \gamma\beta' \mathrm{z}_t^* + \lambda \mathrm{x}_t + \varepsilon_t$$

$$\text{where } z_t = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ mil_t \\ k_t \\ i_t - \Delta p_t \end{pmatrix}, z_t^* = \begin{pmatrix} w_t - p_t \\ y_t - l_t \\ u_t \\ lu_t \\ grr_t \\ t_t^w \\ mil_t \\ k_t \\ i_t - \Delta p_t \\ T \end{pmatrix}, \mathrm{x}_t = \begin{pmatrix} \Delta p_{t-1}^{vm} \\ \Delta p_{t-2}^{vm} \\ D97q123 \end{pmatrix}$$

Variables in z_t, z_t^* and x_t have the same meaning as in Chapter 6. This specification seems to provide the best balance between parsimony, a rich and

[84] We experimented with more parsimonious models (than our preferred specification), such as a VAR(1) specification with $\mathrm{x}_t = (\Delta p_{t-1}^{vm})$, this lag order draw from SBC indications in Table 10.4. Or a VAR(1) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm})'$, a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm})$, and a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm})'$. Models of similar dimensions to equation 10.5, such as a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm}, D97q1)'$, and a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm}, D97q123)'$ where $D97q123$ is the dummy considered in equation 10.5.And less parsimonious models, such as VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm}, \Delta p_{t-3}^{vm},\ \Delta p_{t-4}^{vm})'$,a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm}, \Delta p_{t-3}^{vm}, D97q123)'$,a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm}, \Delta p_{t-3}^{vm},\ \Delta p_{t-4}^{vm}, D97q1)'$ and a VAR(2) with $\mathrm{x}_t = (\Delta p_{t-1}^{vm},\ \Delta p_{t-2}^{vm}, \Delta p_{t-3}^{vm},\ \Delta p_{t-4}^{vm}, D97q123)'$. More parsimonious specifications and models of similar dimensions to that of our preferred specification, fail to pass the corresponding diagnostic tests, in particular serial correlation. Whereas, less parsimonious passed the serial correlation tests, but at the expenses of consuming greater degrees of freedom than our preferred specification, and consequently are discarded.

informative lag structure[85] and satisfactory diagnostic test results for Finland's' data set.

Lag order	AIC	SBC
5	2022.4	1503.9
4	1813.6	1388.5
3	1776.1	1444.4
2	1793.1	1554.6
1	1709.7	1564.5
0	1053.5	1001.7

Table 10.4. Lag order selection criteria, Finland

Note: The test is carried out with 74 observations covering the period between 1989q3 to 2007q4. Statistics reported here are obtained from estimating an unrestricted VAR model for the variables contained in the vector z_t, with a constant and a time trend, two lags of Δp^{vm}, and the dummy variable $D97q123$.

10.3.2 Cointegration tests

Table 10.5 presents the results of testing for cointegration among the variables of z_t. The Maximum Eigenvalue test (λ_{max}) fails to reject the null hypothesis of having six long run relationships, while the Trace test (λ_{trace}) fails to reject the null hypothesis of having nine cointegrated vectors. Hence, both tests suggest that there are more long run relationships than our theoretical model, although they disagree about the exact number.

		λ_{max}		λ_{trace}	
H_0	H_1	Statistic	95% Critical values	Statistic	95% Critical values
r=0	*r=1*	104.29	61.27	435.11	222.62
r≤1	*r=2*	79.31	55.14	330.82	182.99
r≤2	*r=3*	66.60	49.32	251.51	147.27
r≤3	*r=4*	56.45	43.61	184.91	115.85
r≤4	*r=5*	40.90	37.86	128.46	87.17
r≤5	*r=6*	34.00	31.79	87.56	63.00
r≤6	*r=7*	23.10	25.42	53.56	42.34
r≤7	*r=8*	18.01	19.22	30.45	25.77
r≤8	*r=9*	12.44	12.39	12.45	12.39

Table 10.5. Results from cointegration tests, Finland

Note: Test statistics are obtained from applying the Maximum Eigenvalue and Trace test to z_t using a VAR(2) model with unrestricted intercepts and restricted trend coefficients, two lags of Δp^{vm}, and the dummy variable $D97q123$, with 77 observations covering the period between 1988q4 to 2007q4. Critical values are chosen according to this specification.

As discussed in section 5.5, in these circumstances it is necessary to weight the tests results against their potential biases and economic theory. Considering that in Finland's data set we only have 80 observation, that we are estimating a large VAR(2) with nine variables and that some of its residuals are not normally distributed, it seems reasonable to suspect that the test results might suffer of size biases.

In the case of Finland, there is another telling sign of these biases. λ_{trace} suggests that there are nine cointegrated vectors among the nine variables

[85] Equivalent to an $ARMA(18,16)$, (Hamilton, 1994, p.349)

contained in z_t. That amounts to say that each variable describes a stationary process, which is strongly contradicted by the results from the ADF-GLS and KPSS test reported in Appendix II. Thus, as in the UK's case, it seems reasonable to rely on the predictions from economic theory rather than the tests' results and proceed under the assumption of *r*=2.

10.3.3 Identifying the long run relations

In order to identify which variables take part in these two long run relationships, we use the four sets of restrictions from Table 5.1 (β_{LNJ}, β_{BS}, β_{ASR} and β_{RH}) as identifying schedules. Table 10.6 reports the results of this process.

We start by imposing the restrictions contained in β_{LNJ}. This set of restrictions is insignificant at the standard 5%, its log-likelihood ratio (LR) test is a $X^2{}_{(10)}$=48.392 with a p-value equal to [0.000]. Hence, evidence seems to lean against β_{LNJ}. Next, we test the validity of the restrictions contained in β_{BS}, which are also insignificant as a whole at the standard 5%, although they are marginally significant at 1%, with a p-value equal to [0.013]. Following, we introduce the set of restrictions of β_{ASR}, for which evidence is not very supportive either, since it is insignificant with a p-value for the LR test equal to [0.000]. Finally, the set of restrictions contained in β_{RH} is also found insignificant, with a p-value for the LR test equal to [0.000].

Hence, evidence does not seem to yield support to any of the four sets of restrictions drawn from each of the nested NAIRU models at the standard 5% significance level. As in previous cases, we interpret these results as a sign that the unemployment and real wages cointegrated vectors are more complex than as portrayed by theoretical models. In fact, evidence from the trial and error process by which these sets of restrictions are introduced reveals some suggestive features of the data[86]: In all cases, $\beta_{22} = -1$ seems supported by the data, whereas $\beta_{19} = 0$ pushes β_{LNJ}, β_{BS}, β_{ASR} into rejection, and $\beta_{24} = 0$ does the same with β_{LNJ} and β_{RH}. Furthermore, $\hat{\beta}_{\mathrm{BS}}$ is marginally significant. This evidence suggests that some form of hybrid between β_{BS} (where $\beta_{24} \neq 0$) and β_{RH} (where $\beta_{19} \neq 0$), along with $\beta_{22} = -1$ might be supported by the data.

[86] As in the UK's case, it must be noted that comments regarding the importance of individual restrictions reported here, are consistent with different ordering of the restrictions.

z_t^*	$\hat{\beta}_{LNJ}$		$\hat{\beta}_{BS}$		$\hat{\beta}_{ASR}$		$\hat{\beta}_{RH}$		$\hat{\beta}_{\text{Hybrid}}$	
$w_t - p_t$	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000
$y_t - l_t$	0.000	-1.000	0.000	-1.000	-3.627	-1.000	0.000	-1.000	0.000	-1.000
					(4.017)					
u_t	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
lu_t	0.000	0.000	0.307	0.061§	0.000	0.000	0.000	0.000	0.000	0.039§
			(0.614)	(0.031)						(0.006)
grr_t	8.946§	-1.758§	17.06	-0.357	-4.581	-1.535§	-2.906	-1.572§	0.000	-1.081§
	(4.004)	(0.272)	(18.02)	(0.924)	(4.259)	(0.331)	(2.452)	(0.250)		(0.163)
${t^w}_t$	-3.574§	-0.279§	-3.589§	-0.298§	-7.237§	-0.194	-7.474§	-0.217§	-5.663§	-0.294§
	(0.685)	(0.048)	(1.036)	(0.058)	(1.340)	(0.112)	(1.016)	(0.103)	(0.575)	(0.036)
mil_t	-0.161	0.020§	-0.228	0.008	0.070	0.016	-0.097	0.018§	0.000	0.019§
	(0.120)	(0.008)	(0.239)	(0.013)	(0.097)	(0.008)	(0.070)	(0.007)		(0.004)
k_t	0.000	0.000	0.000	0.000	1.688	0.039	0.000	0.000	0.000	0.000
					(3.647)	(0.048)				
$i_t - \Delta p_t$	0.000	0.000	0.000	0.000	0.000	0.000	0.610§	-0.010	0.338§	0.000
							(0.150)	(0.015)	(0.082)	
T	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
r^2	4		4		4		4		4	
ll_{r^2}	1921.8		1921.8		1921.8		1921.8		1921.8	
q	14		12		11		12		14	
ll_q	1921.8		1912.2		1901.5		1905.0		1913.5	
$X_{LR}^2(q - r^2)$	$X^2(10)$=48.392 [0.000]		$X^2(8)$=19.287 [0.013]		$X^2(7)$= 40.664 [0.000]		$X^2(8)$=33.587 [0.000]		$X^2(10)$=16.644§ [0.083]	

Table 10.6. Identification process and estimation of long run elasticities, Finland

Note: These estimations were carried with 77 observations covering the period between 1988q4 to 2007q4. Asymptotic standard errors for each β coefficient are provided in brackets. § indicates significant at 5% and * indicates significant at 10%. r^2=Number of just identified restrictions, and q= Number of total restrictions imposed, i.e. over-identifying restrictions. ll_{r^2} is the maximum value of the log-likelihood function obtained under r^2 just identified restrictions. ll_q is the maximum value of the log-likelihood function obtained under q over-identifying restrictions. $X_{LR}^2(q - r^2)$ is the chi-square statistics for the log-likelihood Ratio (LR) test. P-values for this test are provided in square brackets.

As in the UK's case, we test this hypothesis building a sequence of restrictions denoted by β_{Hybrid}, which contains these features, and experiment until we find a $\hat{\beta}_{Hybrid}$ supported by the data, here reported in the last column of Table 10.6. In this case, $\hat{\beta}_{Hybrid}$ is significant at the standard 5%, the LR test is a $X^2{}_{(10)}$=16.644 with a p-value equal to [0.083]. It must be noted that all the unrestricted coefficients are individually significant at the standard levels (see asymptotic standard errors in brackets). $\hat{\beta}_{Hybrid}$ is clearly more significant than the rest of β matrices examined in Table 10.6 and consequently we adopt it as our preferred long run specification.

The following equations show the unemployment and real wages cointegrated vectors implied by $\hat{\beta}_{Hybrid}$ (asymptotic standard errors in brackets), recall that the coefficients of these equations can be interpreted as long run elasticities because all variables are measured in logarithms.

10.6 $$\underset{(0.575)}{u_t = 5.663t_t^w} - \underset{(0.082)}{0.338(i_t - \Delta p_t)} + \hat{\xi}_{1,t}$$

10.7 $$(w_t - p_t) = (y_t - l_t) - \underset{(0.006)}{0.039lu_t} + \underset{(0.163)}{1.081grr_t} + \underset{(0.036)}{0.294t_t^w} - \underset{(0.004)}{0.019mil_t} + \hat{\xi}_{2,t}$$

As per equation 10.6 Finland's NAIRU is determined by labour taxation, as also reported in Kiander and Pehkonen (1999), Honkapohja and Koskela (1999) or Gianella et al. (2008). Although contrary to LNJ's propositions, the NAIRU is not exclusively determined by exogenous factors, it is also influenced by long term real interest rates. To be more precise, our estimates suggest that an increase in real long term interest rates of 1% would reduce the NAIRU by 0.338%.

The sign of this coefficient is unexpected and we speculate it could be the result of the wealth or/and the debt effect discussed in UK's section. Although this finding reinforces previous evidence that real interest rates affect the NAIRU in Finland, the sign of our estimate is at odds with that from previous studies, for Honkapohja and Koskela (1999), Kiander and Pehkonen (1999) and Gianella et al. (2008) all find the conventional positive relationship between real long term interest rates and the NAIRU. Furthermore, Honkapohja and Koskela find no evidence of a relationship between the cost of borrowing and wages claims, which could arise as a result of the debt effect. Although, this does mean that in our study with a different sample it might be the case. In fact, the same authors find evidence of wealth effects over consumption between 1960 and 1996, although they do not investigate their potential influence on the NAIRU.

It is worth noting, that we do not find evidence of productivity having any impact on the NAIRU, as also reported in Honkapohja and Koskela (1999), but in contrast to the findings from Nymoen and Rødseth (2003). Further, there is no evidence of labour market hysteresis playing a significant role in determining the NAIRU as also reported in Honkapohja and Koskela (1999), but in contrast to the findings from Arestis et al. (2007). Finally, there is no evidence of capital stock playing a significant role in determining the NAIRU, contrary to Arestis et al. (2007) and Karanassou et al. (2008a). Having controlled for capital stock in our analysis, we suspect that in previous studies, this variable might be capturing the effect of long term interest rates, which they omit.

Turning now equation 10.7, the real wages equilibrium is positively affected by productivity on one-to-one basis, suggesting that productivity gains are fully reflected in the long run real wages equilibrium. Similar findings are reported by Karanassou et al. (2008a), who find a long run elasticity of real wages to productivity in the vicinity of unity. Unemployment benefits and labour taxation also increase the long run real wages equilibrium, suggesting that benefits and taxation increases pressure over real wages in the long run.

On the other hand, workers' militancy and long term unemployment reduce the long run real wages equilibrium. This suggests that strike action either has a perverse effect over real wages or that it has been unable to revert the phases of real wages stagnation noted in panel (b) of Figure 6.15. Similarly, the sign of long term unemployment suggests that workers, who are out of work for a year or more, are still able to exert downward pressure over real wage claims.

10.3.4 Short-run dynamics: The NAIRU as an anchor?

To analyse the behaviour of unemployment around the NAIRU, we estimate the ECM equation for Δu_t using the residuals from 10.6 and 10.7 as error correction terms. The resultant Δu_t, estimated with 77 observations over the period between 1988q4-2007q4, is the following:

10.8
$$\Delta u_t = \underset{[0.000]}{8.078} + \underset{[0.083]}{0.049}\hat{\xi}_{1,t-1} + \underset{[0.000]}{1.340}\hat{\xi}_{2,t-1} - \underset{[0.517]}{0.354}\Delta(w_{t-1} - p_{t-1}) + \underset{[0.030]}{1.051}\Delta(y_{t-1} - l_{t-1})$$
$$-\underset{[0.026]}{0.280}\Delta u_{t-1} - \underset{[0.222]}{0.030}\Delta lu_{t-1} + \underset{[0.000]}{3.930}\Delta grr_{t-1} + \underset{[0.933]}{0.077}\Delta t^{w}_{t-1} - \underset{[0.082]}{0.033}\Delta mil_{t-1}$$
$$-\underset{[0.077]}{6.221}\Delta k_{t-1} - \underset{[0.004]}{0.105}\Delta(i_{t-1} - \Delta p_{t-1}) + \underset{[0.665]}{0.001}\Delta p^{vm}_{t-1} - \underset{[0.335]}{0.002}\Delta p^{vm}_{t-2}$$
$$-\underset{[0.001]}{0.085}D97123 + \hat{\varepsilon}_{3t}$$

Adj. R^2=0.675

$X^2_{SC}(4)$= 4.909 [0.297], X^2_{FF} (1)= 3.435 [0.064]

$X^2_{Norm}(2)$= 1.534 [0.464], $X^2_{Het}(1)$= 6.262 [0.012]

$$\hat{\xi}_{1,t} = u - 5.663t^{w} + 0.338(i - \Delta p)$$

$$\hat{\xi}_{2,t} = (w - p) - (y - l) + 0.039\text{lu} - 1.081\text{grr} - 0.294t^{w} + 0.019mil$$

$$\sigma_{\hat{\varepsilon}_3} = 0.0384$$

Where Adj. R^2, X^2_{SC}, X^2_{FF}, X^2_{Norm}, X^2_{Het} have the same meaning as above. $\sigma_{\hat{\varepsilon}_3}$ is the standard deviation of the error term in equation 10.8. p-values for t-tests and diagnostic tests are reported in square brackets[87].

As per equation 10.8 the coefficient for $\hat{\xi}_{1,t-1}$ is positive but very small, meaning that deviations from the NAIRU have a negligible influence on unemployment dynamics, and consequently it is unlikely to act as an anchor. Arestis et al. (2007) also find that deviations from the NAIRU have little influence on unemployment, as per their estimates, only a modest 6.6% of the deviation is corrected each quarter.

The coefficient for $\hat{\xi}_{2,t-1}$ is significant and positive. This suggests that setting real wages above their long run equilibrium increases unemployment. According to Bhaduri and Marglin's dichotomy, this estimate suggests that Finland operates under a "profit-led regime".

10.3.5 Impulse response and the effects of an unemployment shock

We complete our analysis simulating an unemployment shock of one standard deviation in equation 10.8, i.e. $\sigma_{\hat{\varepsilon}_3} = 0.0384$, which amounts to a rise in unemployment of 15.37% in annual terms. Figure 10.2 shows the effect of this shock using GIR functions.

Unemployment in panel (a), overshoots on impact, peaking two years after the shock at a level 21.7% above the baseline, an although it falls thereafter it does not return to its pre-shock value, instead it stabilizes eleven years after the shock, at a level 10% greater than its baseline. This behaviour suggests that the NAIRU has no anchor properties and reinforces our findings from equation10.8. Our estimate is more pessimistic than previous impulse response estimates. Duval and Vogel (2008) find that the Finland needs between four and five years to close the output gap, but the overall conclusion is similar, the NAIRU does not seem to be a strong anchor.

The reaction of long term unemployment to the shock, shown in panel (b), is very volatile on impact, but it ends stabilizing at a level 13% below its baseline. This might be indicative of long term unemployed workers leaving the labour market. The shock has not permanent effect on real wages, panel (c) despite some fluctuations, whereas productivity, panel (d) increases until it stabilizes at a level 1% above its baseline. This suggests that the wage share falls as a result of the shock.

---

[87] All diagnostic tests are passed at the standard 5% significance level, except the heteroscedasticity tests. Hence, although our estimates are still unbiased, inference using the t-test needs to be taken with caution because heteroscedasticity reduces the power of the test. That is, the individual significance test is less likely to reject the null hypothesis of not significantly different from zero.

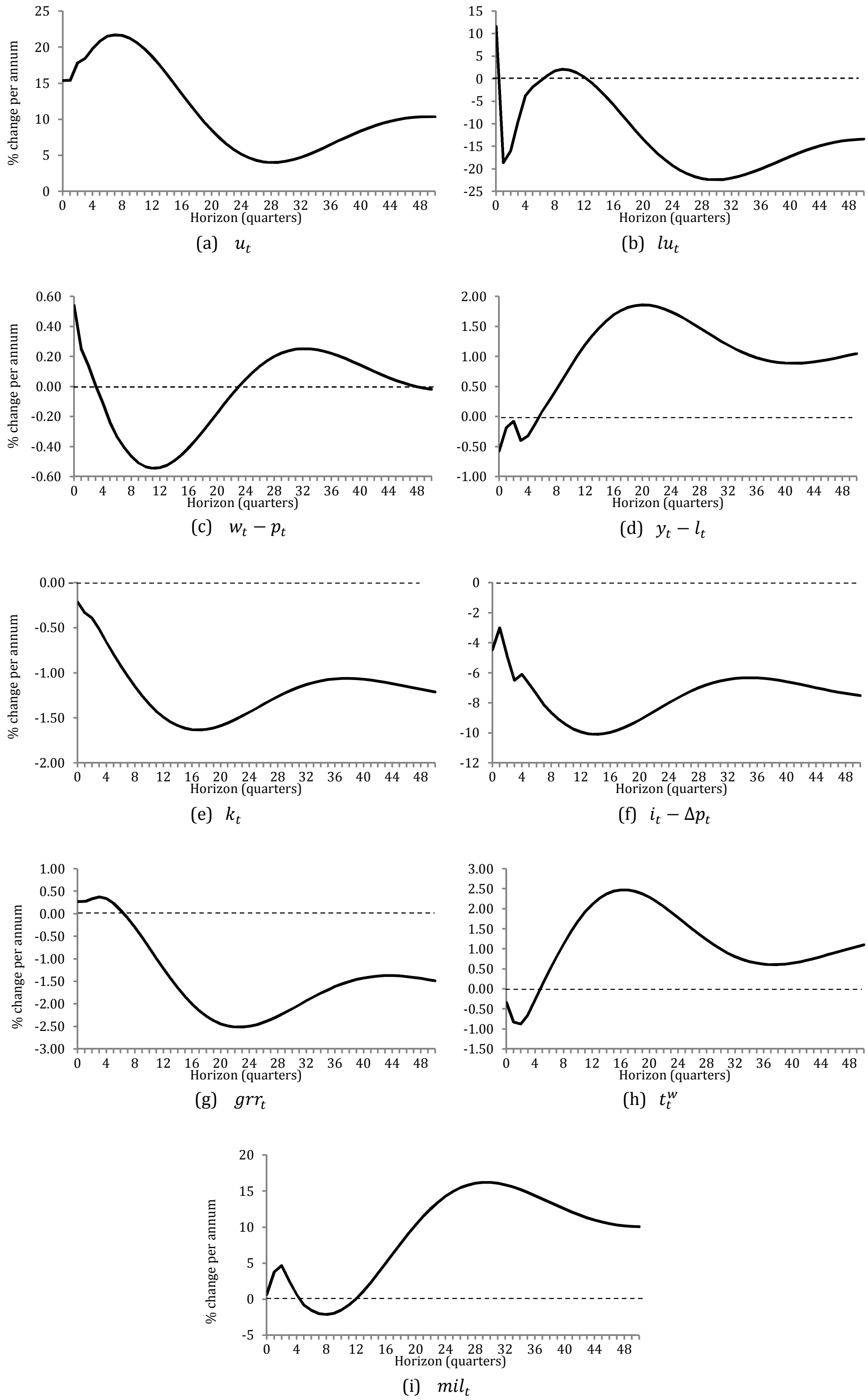

Figure 10.2 GIRF of a standard deviation shock to unemployment on all variables, Finland

Capital stock and real long term interest rates, panels (e) and (f), fall as a consequence of the shock until they stabilize at a level 1.2% and 8% smaller than their baselines, respectively. The reaction of $i_t - \Delta p_t$ to the rise in unemployment is very suggestive of the type of negative long run relationship that we find in our econometric analysis.

The last three panels refer to the wage-push factors of our model. Unemployment benefits panel (g), and labour taxation panel (h), follow opposite patterns after the shock in unemployment: Benefits follow an inverted J-curve evolution, and after an initial rise it stabilizes at a level below its baseline. t_t^w follows a standard J-curve evolution, it falls on impact, but stabilizes above its baseline. Workers' militancy panel (i), fluctuates widely on impact, probably reflecting greater volatility in industrial relations after the shock, and it end ups stabilizing at a level 10% above its pre-shock situation. This suggests that the climate of industrial relations worsen permanently after the shock.

10.4 Summary

In this chapter we have used the CVAR approach to study the determinants of the NAIRU and its anchor properties in Denmark and Finland. This methodology allows us to study the determinants of the NAIRU by testing the long run restrictions required by each of the models nested in our encompassing model (β_{LNJ}, β_{BS}, β_{ASR} and β_{RH}). Panel *i*) of Table 10.7 summarizes the results of this process. According to our estimations, none of the set of restrictions is individually significant, although evidence is very supportive of a $\hat{\beta}_{\text{Hybrid}}$ that combines different features of β_{BS} and β_{RH} in each country.

	Denmark	Finland
i) Identification process		
$\hat{\beta}_{LNJ}$	[0.000]	[0.000]
$\hat{\beta}_{BS}$	[0.014]	[0.013]
$\hat{\beta}_{ASR}$	[0.002]	[0.000]
$\hat{\beta}_{RH}$	[0.004]	[0.000]
$\hat{\beta}_{\text{Hybrid}}$	[0.052]	[0.083]
ii) NAIRU determinants		
grr	*NS*	*NS*
t^w	*NS*	5.663
mil	*NS*	*NS*
$y-l$	*NS*	*NS*
lu	1.000	*NS*
k	*NS*	*NS*
$i-\Delta p$	*NS*	-0.338
T	*NS*	*NS*
iii) NAIRU's anchor properties		
$\hat{\xi}_{1,t-1}$	*NS*	0.049
Time required to return to baseline (GIR)	5 years	*No Return*

Table 10.7. Summary of findings for Denmark and Finland

Note: *i)* Results for the identification process are drawn from Table 10.3 in Denmark's case and from Table 10.6 for Finland. *ii)* Values for the NAIRU elasticities are drawn from each country's unemployment cointegrated vector, equations 10.2 and 10.6 respectively. *iii)* Coefficients of $\hat{\xi}_{1,t-1}$ are drawn from equations 10.4 and 10.8 respectively. "Time required to return to baseline" draws from Figure 10.1 and Figure 10.2 respectively. *NS* not significant and "*No return*" indicates that unemployment does not return to its baseline.

Panel *ii)* of Table 10.7 presents these $\hat{\beta}_{\text{Hybrid}}$. In Denmark, the NAIRU is exclusively determined by long term unemployment. While in Finland, the NAIRU is determined by some wage-push factors together with long term interest rates. Hence, according to our results for these countries, the NAIRU is *not* exclusively determined by exogenous factors contrary to what LNJ's model suggests. Further, these results add to the body of literature that questions the claim that time series evidence for Denmark and Finland support LNJ's propositions, as for instance suggested by Nickell (1999).

The CVAR approach also allows us to examine the anchor properties of the NAIRU by estimating a VECM model and GIR functions. Our results are summarized in Panel *iii)* of Table 10.7.

According to our VECM estimations, deviations from the NAIRU in Denmark and Finland have no or negligible influence on unemployment's dynamics. These findings are reinforced by the results of simulating and unemployment shock using GIR functions. In Denmark, GIR estimates suggests that unemployment reaches a new NAIRU after a very protracted adjustment of five years, which might explain why our coefficient for $\hat{\xi}_{1,t-1}$ is insignificant. GIR estimates for Finland suggests that after this shock unemployment drifts away from its baseline, rather than returning to it as it would be expected if the NAIRU acted as an anchor.

Hence, our VECM and GIR results question LNJ's claim about the anchor properties of the NAIRU, although they are in tune with the existing literature, which suggest that the NAIRU in Denmark and Finland is at best a weak anchor for economic activity.

In sum, our findings for Denmark and Finland presented in this chapter challenge the validity of LNJ's propositions and consequently policy recommendations inspired by this approach. For example, calls for labour market reforms that increase incentives to work in Finland (OECD, 2000a, 2006b). Policy implications are discussed further in Chapter 11.

Chapter 11 Concluding remarks

11.1 Introduction

In this thesis we have presented the results of our *novel* empirical assessment of the determinants of the NAIRU and its anchor properties. More precisely, we have examined if the NAIRU is exclusively determined by exogenous factors, as proposed by the influential LNJ model, or otherwise, as suggested by critics of this approach. Further, we have assessed whether the NAIRU acts as an anchor for economic activity as also suggested by LNJ.

To answer these questions, we have analysed data from eight EU economies, *viz*: the United Kingdom, the Netherlands, Germany, France, Italy, Spain, Denmark and Finland. The data cover the period from 1980 to 2007. We have employed time series techniques to analyse these data sets, more specifically the Cointegrated Vector Autoregressive (CVAR) approach. This was applied to a theoretical model that encompasses the conflicting views of the NAIRU that we aimed to assess.

The main novelty of our research is the use of this encompassing model, as shown in section 4.4 this is the first time that such an approach has been employed in the literature. The second novelty of our work is that our sample extends the analysis to the 2000s, a period which has rarely been studied previously.

The aim of this final chapter is to summarize the results of our research, highlight their contribution to the existing empirical literature, and discuss their implications for economic theory and policy. The chapter is structured as follows. Section 11.2 summarizes the results presented in previous chapters. Section 11.3 discusses the implications of these findings for economic theory debates. Section 11.4 explains how our research contributes to extant empirical literature. Section 11.5 discusses the policy implications that can be extracted from our findings. Section 11.6 closes the chapter, and indeed the thesis, identifying avenues for potential future research.

11.2 Summary of findings

We start the summary of our findings by recapitulating our results with regard to the determinants of the NAIRU. Table 11.1 reports the estimated elasticities of the NAIRU in the economies considered here, i.e. the coefficient that each variable takes in the unemployment cointegrated vector of each country.

	NAIRU determinants						
	Exogenous factors			Endogenous factors			
	grr	t^w	mil	$y-l$	lu	k	$i-\Delta p$
UK	0.991	*NS*	0.112	*NS*	*NS*	-11.40	-0.646
Netherlands	-1.334	-2.483	*NS*	-6.418	*NS*	-1.586	-0.408
Germany	-0.831	4.617	*n/a*	-8.633	*NS*	1.312	*NS*
France	*NS*	*NS*	-0.761	*NS*	2.374	1.278	*NS*
Italy	0.102	0.729	*NS*	2.044	*NS*	-1.814	-0.198
Spain	*NS*	*NS*	-0.112	1.922	*NS*	-4.140	*NS*
Denmark	*NS*	*NS*	*NS*	*NS*	1.000	*NS*	*NS*
Finland	*NS*	5.663	*NS*	*NS*	*NS*	*NS*	-0.338

Table 11.1. Summary of the NAIRU determinants

Note: Values reported in this table correspond to the coefficients of each variable in the unemployment cointegrated vector denoted by equations 7.2, 7.6, 8.2, 8.6, 9.2, 9.6, 10.2, 10.6. NS means not significant.

Table 11.1 follows the structure of Tables 4.2 to Tables 4.5, and is divided into two blocks. First, "exogenous factors", which refer to the variables of our model that are exogenous to demand, i.e. unemployment benefits grr, labour taxation t^w and unions' power mil. The second block, contains the variables that are endogenous to aggregate demand, i.e. productivity $y-l$, long term unemployment lu, capital stock k and real long term interest rates $i-\Delta p$.

Dividing Table 11.1 into these two blocks illustrates our main finding. In all the economies in our sample, with the exception of Denmark, the NAIRU is determined by a mix of exogenous wage-push factors and endogenous variables. In the case of the UK, the NAIRU is determined by exogenous factors together with capital stock and real long term interest rates. In the Netherlands and Italy, the NAIRU is determined by exogenous factors along with productivity, capital stock and real long term interest rates.

In Germany, the NAIRU is determined by unemployment benefits and labour taxation, together with productivity and capital stock. In France, workers' militancy along with long term unemployment and capital stock determine the NAIRU. In Spain, workers' militancy along with productivity and capital stock determine the NAIRU. In Finland, the NAIRU is determined by labour taxation along with the real long term interest rates. In the only exception country, Denmark, the NAIRU is exclusively determined by a variable that is endogenous to aggregate demand, long term unemployment.

A second key finding that is clear from Table 11.1, is that determinants of the NAIRU differ across countries. If we look at the block of exogenous variables, it is only in the Netherlands, Germany and Italy that the NAIRU is affected by the same factors, namely unemployment benefits and labour taxation. But even in these cases, the size and the sign of these variables differ. If we look at the block of endogenous variables we also find substantial differences across countries. Productivity affects the NAIRU in four economies, but the sign of this relationship depends on the economy. It is negative in the Netherlands and Germany, but positive in Italy and Spain.

Long term unemployment only affects the NAIRU in France and Denmark. Capital stock is the most common factor, influencing the NAIRU in six out of eight countries, although it has a perverse negative sign in Germany and France. Further, the size of the coefficient for capital stock also varies substantially across countries. In most cases estimates are slightly above unity, but in the UK and Spain these elasticities are a lot larger, particularly in the UK. Finally, real long term interest rates only determine the NAIRU in the UK, the Netherlands, Italy and Finland. In fact, considering both exogenous and endogenous variables, only in the Netherlands and Italy do we find the NAIRU determined by the same variables. Nonetheless, as can be seen in Table 11.1, even in these cases, the size and the sign of most variables also differ between the two countries.

In general, these differences suggest that the parameters of the structural equations of our model, i.e. equation 4.1 and 4.2, vary across countries. Let's show why. We start with productivity. As per equation 4.4, the elasticity of the NAIRU to productivity is $\beta_{12} = \frac{\omega_2 - \varphi_3}{\omega_1 + \varphi_1}$, where φ_3 denotes the impact of productivity on firms mark-up (equation 4.1) and ω_2 the influence of productivity on workers real wages claims (equation 4.2). Hence, in economies where $\hat{\beta}_{12} < 0$, such as the Netherlands or Germany, our results suggest that workers cannot fully absorb productivity gains, i.e. $\varphi_3 > \omega_2$. This seems a plausible possibility in the Netherlands and Germany because the wage share in both countries has fallen in the period studied here, see Figure 6.13 (b) and Figure 6.14 (a) respectively.

On the other hand, in economies such as Italy or Spain where $\hat{\beta}_{12} > 0$, our results suggests that the impact of productivity on real wages is greater than its impact on firms mark-up, i.e. $\omega_2 > \varphi_3$. As we discussed in Chapter 9, this seems unlikely given the overall downward trend of the wage share in these economies, particularly in Italy, see Figure 6.14. In section 9.2.3 we speculated about an alternative explanation, that is, productivity increases firms' mark-up rather than moderate them. In terms of equation 4.1 this means that $\varphi_3 < 0$.

Differences in the impact of long term unemployment suggest that there are hysteresis mechanisms in France and Denmark that do not exist in the rest of the countries. Because we are controlling for unemployment benefits or unions' power in our study, we can infer that hysteresis mechanisms in these countries are not associated with these factors. Further research would be needed to identify the specific hysteresis mechanisms operating in France and Denmark.

With regards to capital stock, the elasticity of the NAIRU is $\beta_{18} = -\frac{\varphi_2}{\omega_1 + \varphi_1}$, where φ_2 denotes the influence of capital stock on firms' mark-up, see equations 4.1 and 4.4. In Denmark and Finland where $\hat{\beta}_{18} = 0$, our results suggest that capital stock does not influence firms' mark-up, i.e. $\varphi_2 = 0$. In countries such as the UK, the Netherlands, Italy and Spain where $\hat{\beta}_{18} < 0$, our results suggest that capital stock limits the ability of firms to mark-up labour costs, i.e. $\varphi_2 > 0$.

The opposite seems to happen in Germany and France where $\hat{\beta}_{18} > 0$. In these countries our results suggest that capital stock increases firms' capacity to mark-up labour costs, which in terms of equation 4.1 means that $\varphi_2 < 0$. In chapter 8, we speculated with a second possibility, namely that capital stock might also increase workers real wage claims, and that this effect dominates the impact of capital stock over the NAIRU, see section 8.2.3 for further details. This possibility seems plausible in the French case, because we find evidence of a positive long run relationship between capital stock and real wages in equation 8.7.

Finally real long term interest rates. As per equation 4.4 the elasticity of the NAIRU to the real cost of borrowing is $\beta_{19} = \frac{\varphi_5}{\omega_1+\varphi_1}$, where φ_5 denotes the influence of real long term interest rates over firms' mark-up (equation 4.1). In countries such as Germany, France, Spain and Denmark where $\hat{\beta}_{19} = 0$, our results suggest that real long term interest rates do not influence firms' mark-up, i.e. $\varphi_5 = 0$. On the other hand, in countries where $\hat{\beta}_{19} < 0$, such as the UK, the Netherlands, Italy and Finland, our results suggest that real long term interest rates reduce firms' mark-up, which in terms of equation 4.1 means that $\varphi_5 < 0$.

Turning now to the anchor properties of the NAIRU, Table 11.2 presents a summary of our VECM estimates and GIR simulations. The first column of the table denotes the elasticity of changes of unemployment to deviations from the NAIRU ($\hat{\xi}_{1,t-1}$), as per each country's VECM model. The second column reports the time required by unemployment to return to its baseline after a shock according to GIR functions.

	$\hat{\xi}_{1,t-1}$	Time required to return to baseline
UK	*NS*	*No Return*
Netherlands	*NS*	*No Return*
Germany	0.027	*No Return*
France	0.012	*No Return*
Italy	*NS*	*No Return*
Spain	-0.250	+6 years
Denmark	*NS*	5 years
Finland	0.049	*No Return*

Table 11.2 Summary of the NAIRU anchor properties

Note: Values reported in this table correspond to the coefficients of $\hat{\xi}_{1,t-1}$ in the VECM models denoted by equations 7.4, 7.8, 8.4, 8.8, 9.4, 9.8, 10.4 and 10.8. *NS* means not significant. "Time required to return to baseline" draws from the GIR functions shown in Figures 7.1, 7.2, 8.1, 8.2, 9.1, 9.2, 10.1, 10.2. "*No return*" indicates that unemployment does not return to its baseline.

Estimates from the VECM suggest that deviations from the NAIRU have no significant (*NS*) influence on unemployment fluctuations in the UK, the Netherlands, Italy and Denmark. Deviations from the NAIRU have a significant but negligible influence in Germany, France, and Finland. Spain is the country with the largest $\hat{\xi}_{1,t-1}$ coefficient, but as discussed in section 8.3.4 our estimate still implies a protracted adjustment, which suggests that the NAIRU has weak anchor properties this economy.

Evidence from GIR functions provides similar results. In most countries unemployment drifts away from its baseline rather than returning to it, as it would be expected if the NAIRU acted as an anchor. Spain and Denmark are the only two exceptions. In the Spanish case, our simulations show that unemployment requires more than six years to return to its pre-shock levels, and hence is consistent with our VECM estimations, which also suggests that the NAIRU is only a weak anchor in Spain. In the Danish case, as per GIR simulations unemployment needs five years to reach a new equilibrium, which is likely to explain why the VECM finds no evidence of anchor properties in this country.

Thus, our main finding concerning the anchor properties of the NAIRU is that in the countries in our sample, the NAIRU is either a weak anchor, in Spain and Denmark, or it has no anchor properties, in the rest of cases.

11.3 Implications for economic theory

First, our findings with regard to the determinants of the NAIRU are in stark contrast to LNJ's propositions, who argue that the NAIRU is exclusively determined by factors that are exogenous to aggregate demand. Instead, our findings provide support to the critics of LNJ's approach, who argue that the NAIRU might be determined by exogenous factors, but also by variables that are sensitive to changes in demand policies, such as productivity, long term unemployment, capital stock and real long term interest rates.

Second, as illustrated by differences across countries, although evidence clearly contradicts LNJ's propositions, there is not a clear winner among alternative theories. The model proposed by Sawyer (1982) and Rowthorn (1995) seems to be a front runner among LNJ's critics. Recall that as per our results the NAIRU is determined by capital stock in six out of eight countries, and in four of those cases the NAIRU is also influenced by productivity, as suggested by Sawyer and Rowthorn. But real long term interest rates and long term unemployment also play a significant role in at least half of the countries in our sample and their links with the NAIRU cannot be neglected.

This suggests that when studying the determinants of the NAIRU, we need to take a broad view. On the one hand, we cannot constrain our analysis to LNJ's model, but on the other hand, we should not restrict our analysis to a particular alternative formulation. Instead, we need to consider the wider spectrum of models available and use encompassing models of the type used employed this thesis.

Third, our findings with regard to the anchor properties of the NAIRU are also in contrast to LNJ's propositions, who argue that the NAIRU acts as an anchor for unemployment. Instead, our findings provide support to those who argue that there are mechanisms that prevent the NAIRU from having such properties.

In sum, our results challenge LNJ's propositions about the determinants of the NAIRU and its anchor properties. Further, our findings suggest that different alternative theories might be relevant in different countries and consequently it is advisable to use encompassing NAIRU models that consider a wide range of theories.

11.4 Contribution to the existing empirical literature

We start by discussing how our findings fit within the existing time series literature devoted to the study of the determinants of the NAIRU. Our results reinforce previous studies that find evidence of a long run link between unemployment and variables such as productivity, long term unemployment, capital stock and real long term interest rates. In doing so, our results raise further questions about the robustness of time series studies, which find no evidence of such links, and that are usually cited to vindicate LNJ's claims, for instance Layard and Nickell (1986) or Dolado et al. (1986).

Furthermore, our findings for the determinants of the NAIRU, suggests that some of the time series studies which are usually cited to vindicate LNJ's claims, for instance Nickell and Bell (1995) or Estrada et al. (2000), are likely to be misspecified because these studies omit variables that could make the NAIRU endogenous to aggregate demand, e.g. capital stock or productivity. This possibility has already been suggested by Stockhammer (2004a,p.20) and Arestis et al. (2007, p.144). It should also be noted that according to our results, the danger of misspecification biases also affects the growing literature that examines the links between the NAIRU and demand. The reason being that in most cases, as shown in section 4.4, these studies only consider one maybe two demand-NAIRU links, as for instance in Dolado and Jimeno (1997) or Ball (1999).

Further, it should be noted that with regard to the anchor properties of the NAIRU, our findings are consistent with extant time series literature, which finds that the NAIRU is at best a weak anchor.

The evidence presented in this thesis is also of relevance for the wider empirical debates presented in Chapter 3. First, our results adds to the literature that challenges the claims that time series evidence complements the case for a NAIRU *a la* LNJ made by panel data studies, as it is argued by Layard et al. (1991, p.443) and Nickell (1998, p.814). Second, by warning that time series studies ignoring the NAIRU-demand links might be misspecified, our results reinforce similar claims made in the panel data literature by Blanchard and Wolfers (2000,c1/2) and Storm and Naastepad (2009,P.313). Third, according to our findings the determinants of the NAIRU are markedly different across countries. These cross-country heterogeneity reinforces concerns that panel data methods, in assuming coefficient homogeneity across countries, are ill suited to study the determinants of the NAIRU, as already noted by Stockhammer (2004a), Arestis et al. (2007) or Gianella et al. (2008).

Thus, we conclude that the empirical evidence presented in this thesis reinforces the case against a NAIRU a la LNJ. Further, our findings suggest that studies usually cited to vindicate LNJ's claims in the time series and the panel data literature might be misspecified because they omit relevant variables. Further, our results question the suitability of panel data techniques to study the determinants of the NAIRU due to the existence of cross-country differences.

11.5 Policy implications

11.5.1 Can structural reforms *a la* LNJ deliver lower unemployment?

We start by assessing LNJ's policy recommendations. According to LNJ's model, the only policy that can achieve long lasting reductions of unemployment is one that tackles the exogenous factors that determine the NAIRU. These policies are commonly referred to as structural reforms. In our model we use unemployment benefits grr, labour taxation t^w and unions' power mil to control for the exogenous factors that determine the NAIRU. Hence, we can proxy structural reforms *a la* LNJ by assuming reductions in unemployment benefits, labour taxation and unions' power. The first question we want to answer in this section is: Can reforms *a la* LNJ, i.e. reductions of unemployment benefits, labour taxation and unions' power deliver lower unemployment?

Our results suggest that in the countries in our sample, structural reforms *a la* LNJ *cannot* achieve long lasting reductions of unemployment because they are either ineffective to reduce the NAIRU or because the NAIRU has no anchor properties or because both things happen at the same time.

In the UK, Italy and Finland structural reforms can reduce the NAIRU, as per Table 11.1 cuts in unemployment benefits, labour taxation and unions' power would reduce their NAIRU. However, we find no evidence of the NAIRU acting as an anchor in these economies, see Table 11.2. Therefore a fall in the NAIRU caused by structural reforms would not trigger a reduction in unemployment. In other words, in the UK, Italy and Finland, reforms *a la* LNJ would not generate the necessary demand to reduce unemployment, despite being able to reduce the NAIRU.

In Germany, the effect of reforms on the NAIRU is ambiguous, cuts in labour taxation can reduce the NAIRU but cuts in unemployment benefits would increase it. In any case, the NAIRU does not seem to act as an anchor in Germany, and consequently even if we assume that reforms can reduce its NAIRU, this fall would not be followed by a reduction in actual unemployment, as it was also the case in as in the UK, Italy and Finland.

In the Netherlands, France and Denmark structural reforms would either have counter-productive effect on the NAIRU, i.e. they would increase it or they would have no effect whatsoever on the NAIRU, see Table 11.1. Furthermore, in the Netherlands, France and Denmark the NAIRU does not seem to act as an anchor, and consequently structural reforms can reduce neither the NAIRU nor unemployment in these economies.

In Spain, the NAIRU seems to be weak anchor for economic activity, which means that reforms that reduce the NAIRU would be followed by a sluggish fall in unemployment. Still, this does not mean that reforms *a la* LNJ can deliver lower unemployment in Spain, because our findings indicate that reforms would have counter-productive effects, that is, they would increase the NAIRU rather than reduce it.

Thus, according to our results structural reforms *a la* LNJ cannot achieve long lasting reductions of unemployment in any of the countries in our sample.

Furthermore, our results suggest that structural reforms *a la* LNJ are *unnecessary*. The first reason being that in all the countries in our sample, the NAIRU is determined by at least one of the following variables: Capital stock, productivity, long term unemployment and real long term interest rates. These variables are sensitive to demand policies and therefore provide avenues or channels for aggregate demand to reduce the NAIRU, regardless of the structure of the labour and the goods market.

We discussed these mechanisms in section 2.3.2. The rationale is that authorities, using expansive macroeconomic policies can engineer high levels of demand that will increase firms' capacity utilization and profitability, which will encourage investment in new capital stock, which in turn will reduce the NAIRU, for instance in countries like the UK, Netherlands, Italy and Spain. Similarly, rapid growth as the result of stimuli policies can foster productivity, through the so called "Kaldor-Verdoon effects" and/or workers participation in the labour market, which will also reduce the NAIRU, for example in France and Denmark.

Real long term interest rates deserve a special mention, because in the light of debates about the links between Central Bank rates and long run yields discussed in section 2.3.3, and current debates about "austerity" it is unclear what type of macroeconomic policy should be used to exploit the link between real long term interest rates and the NAIRU. If the Central Bank can modify long run yields, then according to the *sign* of our estimates, monetary authorities can reduce the NAIRU by raising interest rates. However, if the Central Bank cannot affect real long term interest rates, it all depends on the effect of fiscal policy over long term cost of borrowing. This issue is well beyond the scope of this thesis and hence we only notice that demand policies which affect real long term interest rates can reduce the NAIRU, although it is unclear what form these policies need to take.

The second reason that makes structural reforms unnecessary is that using expansive macroeconomic policies to exploit the links between the NAIRU and variables such as capital stock, productivity and long term unemployment, has the upshot that in stimulating economic activity, demand policies will also reduce actual unemployment. This is crucial in the countries in our sample because our findings suggest that the NAIRU has no (or very weak) anchor properties.

Finally, it is necessary to note that some might argue that our findings do not make structural reforms unnecessary. Nicoletti and Scarpetta (2003) and OECD (2007b) argue that reforms foster innovation and productivity by generating more competitive and dynamic environments. Hence, they might argue that reforms can successfully reduce unemployment by exploiting the link between productivity and the NAIRU without resorting to demand policies. We are wary of this possibility because other studies, see for instance Vergeer and Kleinknecht (2010) and Lucidi and Kleinknecht (2010), show that labour market institutions have the opposite effect on productivity, that is, they enhance productivity.

Bean (1989, p. 44, 1994, p.612) argues that structural reforms would reduce the NAIRU, even if this is determined by capital stock as long as reforms reduce wage demands. The rationale behind Bean's claim is that by reducing wages, reforms would increase firms' profits and therefore funds available for new investment. Franz and König (1986, p. 236) and Malinvaud (1986, p.216) argue similarly. We are also sceptical of this possibility, because it relies on the implicit assumption that the economy operates under a profit-led regime, i.e. that redistribution away from wages has an overall positive impact on aggregate demand. However, if the economy operates under a wage-led regime, as some of the countries in our sample seem to do, reducing wages would have an overall negative effect on demand, which arguably would reduce firms' incentive to invest in new capital stock.

Further, Krugman (1994) and Blanchard and Katz (1997) argue that some structural reforms, such as reducing benefits or unions' power, can also prevent hysteresis. The rationale being that the mechanism that cause hysteresis might be associated with those wage-push factors. However, since our econometric specification controls for benefits and unions' power, hysteresis in countries such as France and Denmark in our sample must be due to other mechanisms and therefore structural reforms of this type would still be ineffective to achieve long lasting reductions of unemployment.

In any case, even if we were ready to accept that the effects of structural reforms can be channelled to the NAIRU via productivity, capital stock or long term unemployment, as Nicoletti, Scarpetta, Bean or Krugman argue, there is still no solution to the lack of anchor properties of the NAIRU. Thus, although we acknowledge their claims, we are sceptical of the effectiveness of their policy recommendation, and maintain our assessment that structural reforms *cannot* and are *unnecessary* to achieve long lasting reductions of unemployment.

11.5.2 Can the "Fiscal Compact" reduce unemployment?

The current crisis has generated not only a substantial rise in unemployment in European economics, but also large budget deficits. The European Union has reacted to these developments by agreeing upon the so-called "Fiscal Compact". This coordinates the agenda of structural reforms known as "Europe 2020", and the deficit (and debt) targets of the Stability and Growth Pact (SGP). The question is can the "Fiscal Compact" reduce unemployment in Europe?

The agenda "Europe 2020", draws heavily from LNJ characterization of the NAIRU, these are some of the policy guidelines suggested by this agenda: Monitoring the efficiency of benefits and labour taxation to "make work pay", favouring less constraining labour contracts, and ensuring the well-functioning of competition in the goods and services markets (European Commission, 2010b). These guidelines are equivalent to the structural reforms analysed in the previous section and consequently our assessment is the same, "Europe 2020" *cannot* and is indeed *unnecessary* to achieve long lasting reductions of unemployment in the countries in our sample.

Let's now turn to the fiscal policy targets of the "Fiscal Compact", i.e. the commitment of Members States to reduce their budget deficits. These fiscal policy targets prevent authorities from engineering the type of stimuli that could generate higher capital stock, productivity or participation in the labour market, which in turn could reduce the NAIRU as discussed above. Hence, according to our findings budget targets embedded in the "Fiscal Compact", constitute a self-imposed constrain to reduce unemployment. Galbraith (1997), Arestis and Sawyer (1998) and Fontana and Palacio-Vera (2007) make similar assessments of the Maastricht's Criteria and the SGP.

In fact, considering that the "Fiscal Compact" is forcing most countries to cut deficits despite rising unemployment, for instance in Spain or Italy, our results suggest that fiscal consolidation will have a perverse long lasting effect over unemployment in these economies. The UK is the only country in our sample that has not signed the "Fiscal Compact", however, considering the commitment to fiscal consolidation of the current Coalition Government, the same could be said about the UK. Thus, in the light of our results, we can only be sceptical about the effectiveness of the "Fiscal Compact" to deliver lower levels of unemployment in Europe.

11.5.3 Ideas for an alternative employment policy

This policy discussion would seem incomplete without a set of alternative policies that draw from our findings. First, our results suggest that reforms that aim at de-regulating the labour market, particularly increasing incentives to work and reducing unions' power are unable to achieve long lasting reductions of unemployment. Hence, these policies ought to be abandoned.

Second, our findings suggest that stimuli policies that exploit the relationship between the NAIRU and variables such as capital stock, productivity and long term unemployment can reduce the NAIRU. Hence, it seems more appropriate to adopt macroeconomic policies that allow us to exploit these links.

Third, these packages must be country specific, because according to our results, the determinants of the NAIRU differ across countries. This means that European policy makers need to abandon the "one size fits" type of approach that underlines current fiscal and monetary policy rules.

Fourth, stimuli policies might generate some inflation (or deflation) pressures because unemployment and the NAIRU will not necessarily fall at the same pace (Sawyer, 2002, p.90). Hence, authorities need to acknowledge this situation and tolerate these pressures.

11.6 New avenues for future research

In closing this thesis, we identify some avenues for future research in this field. We envisage the following possibilities:

Our study can easily be extended by considering new dimensions of the labour market. One that might be of interest is Employment Protection Legislation (EPL). Data might be a problem because OECD's series for this variable only starts in 1985, in fact that is why we could not consider it in our analysis. Nonetheless, in coming years when the number of observations available increase, it is a path worth pursuing.

A particularly interesting possibility for research using EPL measures, is to consider how differences of EPL among workers, what is known as "dualization of the labour market", might affect the NAIRU (Bentolila et al., 2011). In recent years, “dualization” has become a popular culprit for unemployment performance in countries like Spain, Italy or France (OECD, 2005a, Jamet, 2006, Jaumotte, 2011).

Our results suggest that the NAIRU in France and Denmark is affected by long term unemployment. However, as discussed above, we cannot identify what hysteresis mechanisms create this link. Further research would be necessary to identify the specific hysteresis mechanisms operating in France and Denmark.

Another interesting extension of our study would be to incorporate exogenous price push factors into the analysis. Again, data availability might be an issue, although OECD publishes a measure of Product Market Regulation (PMR) that can captures these factors, its time span and frequency are unsatisfactory to perform any reliable time series study. Hence, a possible path for further research is to create alternative measures of exogenous price push factors, and then replicate our study with these new variables.

The NAIRU is by definition the locus where distributional claims are made consistent, hence, it seems reasonable to extend the analysis to include distributional variables. One possibility is to consider the role of adaptive income aspirations in determining the NAIRU (Skott, 2005, Setterfield and Lovejoy, 2006). Another possibility is to consider whether income or wage distribution affect the NAIRU, Karanassou and Sala (2011) provides a recent example in this direction.

Overall, our results reinforce previous evidence that capital stock affects the NAIRU. However, an issue that remains unclear is the role of public capital stock in this relationship. This avenue might also be confronted with data difficulties given that data series on public capital stock are rare. Nonetheless, considering public capital stock would be extremely useful for policy purposes, some examples can already be found for instance in Raurich et al. (2009).

Finally, our results suggest that real long term interest rates might have a negative long run relationship with unemployment. We speculate that this negative relationship is the result of a wealth or a debt effect, but we have no examined these possibilities. Further, we have no evidence of whether this influence on the NAIRU arises from the wage or the price side of the model. These issues require further research. Further, if wealth effects do have an effect on the NAIRU, it would be interesting to examine if the evolution of house prices have had any influence on the NAIRU in the last two decades.

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Appendix I. Time series literature summary tables

In this appendix we present four tables summarizing the time series literature that examines our research questions for the eight countries in our sample. Information presented in the tables of this appendix is consistent with that of Tables 4.1, 4.2, 4.3. In fact, the information presented in the tables of Chapter 4 has been extracted from the information compiled in the tables of this appendix.

We group the country literature in four tables: Table I.1 presents the summary of the time series literature for the UK and the Netherlands. Table I.2 for Germany and France. Table I.3 for Italy and Spain. And Table I.4 for Finland and Denmark. Each table has ten columns denoted with roman numbers: Column *i)* to *viii)* summarize the evidence each paper reports regarding the NAIRU determinants. These columns are then divided in two groups, columns *i)* to *iv)* summarizes evidence from “exogenous factors”, in columns *i)* to *iii)* we report the evidence for the wage-push factors used in our study (unemployment benefits grr, labour taxationt^w and worker militancy or union’s power mil) while in column *iv)* we report evidence for other exogenous factors, although we only report those that are found significant in the cited papers. The second group, columns *v)* to *viii)* summarizes evidence from four variables, which according to our survey in section 2.3 can render the NAIRU endogenous to aggregate demand, hence the label “endogenous factors”. We report the sign of the unemployment long run elasticity to the variables in the heading of the column. In some cases, it might be employment long run elasticity but we indicate it with the corresponding superindex. Further, column *ix)* summarizes the evidence each paper reports regarding the anchor properties of the NAIRU. Unless the contrary is indicated, a measure of unemployment is the dependent variable. This evidence comes in different forms and in each case the corresponding superindex explains which in each case. Finally, column *x)* reports evidence with regard to real wages long run elasticity with respect to productivity.

Our own findings with regard to the NAIRU, its anchor properties and the long run elasticity of real wages to productivity, presented in Chapter 7 to Chapter 10, are also reported in these tables, we label them as “our estimates” and highlight them with a shadowed row. This provides a visual comparative of our results with those of previous literature, which we use in our discussion of findings in the corresponding chapters.

	i)	ii)	iii)	iv)	v)	vi)	vii)	viiii)	ix)	x)
UK	**NAIRU determinants**								**Anchor**	**w-p*[88]**
	Exogenous factors				**Endogenous factors**					
	grr	t^w	mil	**Other**[89]	y-l	lu	k	i-Δp		y-l
Layard and Nickell (1986)	+	+	+	*mm+ipd*	*NS*		$NS^{L=1}$		$HL = 5y^{L^d}$	
Layard et al. (1991,p.441)	+	+	+	*mm*						
Nickell and Bell (1995)[90]	+	*NS*	*NS*	*mm*						
Nickell (1998)	*NS*	+	*mix*[91]	*mm*				$+^{st}$		
Arestis and Biefang-Frisancho Mariscal (1998)	*NS*	*NS*	+			+	-		*ECM*=-0.024	=1
Ball (1999)								$+^{st}$		
Arestis and Biefang-Frisancho Mariscal (2000)		*NS*				+	-		*ECM*=-0.021	
Henry et al. (2000)[92]									*Stab=14-20*$y^{IR\ L^d}$	
Stockhammer (2004a)[93]	*NS*	+	-			$+^{u-1}$	$-^{\Delta k}$			
Hatton (2007)					-					
Gianella et al. (2008)	+	+	*NS*	*PMR*				+		
Duval and Vogel (2008)									*Stab=2-3y*$^{ygap\text{-}IR}$	
Our estimates	+	*NS*	+		*NS*	*NS*	-	-	*ECM=.028NS*	=1.335
Netherlands	**NAIRU determinants**								**Anchor**	**w-p***
	Exogenous factors				**Endogenous factors**					
	grr	t^w	mil	**Other**	y-l	lu	k	i-Δp		y-l
Driehuis (1986)							$-^{\Delta k}$			
Ball (1999)								$+^{st}$		
Arestis et al. (2007)	+	+	+			*NS*	-		*ECM*=-0.068	
Duval and Vogel (2008)									*Stab=3-4y*$^{ygap\text{-}IR}$	
Gianella et al. (2008)	+	+	*NS*	*PMR*				+		
Schreiber (2012)									r= -0.216	=1
Our estimates	-	-	*NS*		-	*NS*	-	-	ECM=-0.042 NS	= 1

Table I.1Summary table of time series literature for the UK and the Netherlands

Abbreviations: grr, t^w, mil, *Other*, y-l, lu, k, and i-Δp, and *w-p** have the same meaning as above, see Table 4.2. *mm* denotes a variable capturing skills miss-match, *ipd* denotes an income policy dummy for 1976 and 1977, *PMR* stands for OECD's measure of Product Market Regulation. r=stands for the coefficient of correlation, squaring them we can obtain the coefficient of determination r^2 or R^2, which "measures the proportion or percentage of the total variation in Y explained by X" (Gujarati, 2003, p.84). HL=half life of a shock. *Stab*=(un-)employment returns to its baseline or output gap is closed. *ECM*=denotes the value of the ECM term, coefficient must be multiplied by 100 to find out what % of the gap is closed in each period. y=years.

Signs and significance: +/- indicates a significant positive/negative impact on the NAIRU of the variable in the heading of the column. NS indicates no significant at 5% level.

Superindex: st, indicates that the measure of interest rate used in the article of reference is a measure of short term interest rates. Δk, indicates that results are obtained using investment, accumulation rather than capital stock. ^{IR} indicates that evidence is obtained using impulse response diagrams. u-1 denotes results are obtained using lagged value of unemployment. L^d denotes results are inferred from a labour demand equation.

88 Results referring to the long run elasticity of real wages to productivity are not reported in the literature review of Chapter 3, because they refer to long run distributional patterns but not to the NAIRU or its anchor.

89 All variables reported in this column are found significant in the reported papers.

90 Results refer to the "long run solution of a general dynamic model" reported in page 58, other specifications did not provide evidence of statistical significance.

91 Authors consider two variables to capture the impact of workers' militancy: IT=industrial turbulence, and UP=Union's power. Only one of them is significant, and hence we treat it as mixed evidence.

92 See footnote 105. Anchor reported results refer to Figure 2c/d in the reference article.

93 Results reported here refer to Table 5 of the paper cited.

	i)	ii)	iii)	iv)	v)	vi)	vii)	viiii)	ix)	x)
Germany	**NAIRU determinants**								**Anchor**	**w-p***
	Exogenous factors				**Endogenous factors**					
	grr	t^w	mil	**Other**	y-l	lu	k	i-Δp		y-l
Ball (1999)								$+^{st}$		
Arestis and Biefang-Frisancho Mariscal (2000)		+				*NS*	-		*ECM*=-0.015	
Carstensen and Hansen (2000)[94]				*NS* w^{IR}	$-^{L+}$				*Stab*=+13y$^{IR\ L}$	
Stockhammer (2004a)[95]	*NS*	+	-			$+^{u-1}$	$-^{\Delta k}$			
Logeay and Tober (2006)						+			cl^{ugap}=8.5y	
Arestis et al. (2007)	-	*NS*	*NS*			-	-		*ECM=NS*	
Duval and Vogel (2008)									*Stab=3-4y$^{ygap-IR}$*	
Gianella et al. (2008)	+	+	*NS*	*PMR*				+		
Schreiber (2012)		-			-				r=-0.434	*NS*
Our estimates	-	+	*NS*		-	*NS*	+	*NS*	*ECM= .027 het*	= -1
France	**NAIRU determinants**								**Anchor**	**w-p***
	Exogenous factors				**Endogenous factors**					
	grr	t^w	mil	**Other**	y-l	lu	k	i-Δp		y-l
Malinvaud (1986)[96]							+			
Ball (1999)								$+^{st}$		
Miaouli (2001)[97]							$-^{L+}$		ECM^{L^d} =0.118	
L'Horty and Rault (2003)		+		*mm+ qr*	-					
Stockhammer (2004a)[98]	*NS*	+	*NS*			$+^{u-1}$	$-^{\Delta k}$			
Arestis et al. (2007)	+	*NS*	-			*NS*	-		*ECM*=0.064	
Duval and Vogel (2008)									*Stab=+5y$^{ygap-IR}$*	
Gianella et al. (2008)	+	+	*NS*	*PMR*				+		
Schreiber (2012)		-			-				r= -0.599	*NS*
Our estimates	*NS*	*NS*	-		*NS*	+	+	*NS*	*ECM=.012 het/nn*	*NS*

Table I.2 Summary table of time series literature for Germany and France

Abbreviations: grr, t^w, mil, *Other*, y-l, lu, k, and i-Δp, and *w-p** have the same meaning as above, see Table 4.3. *mm* denotes a variable capturing skills miss-match, *PMR* stands for OECD's measure of Product Market Regulation. *qr* stands for the quit ratio. w^{IR} denotes simulations of wage and prices using impulse response functions. r=stands for the coefficient of correlation, squaring them we can obtain the coefficient of determination r^2 or R^2, which "measures the proportion or percentage of the total variation in Y explained by X" (Gujarati, 2003, p.84). *Stab*=(un-)employment returns to its baseline or output gap is closed. *ECM*=denotes the value of the ECM term, coefficient must be multiplied by 100 to find out what % of the gap is closed in each period. cl^{ugap}= unemployment gap cycle length. y=years.

Signs and significance: +/- indicates a significant positive/negative impact on the NAIRU of the variable in the heading of the column. NS indicates no significant at 5% level.

Superindex: st, indicates that the measure of interest rate used in the article of reference is a measure of short term interest rates. L +, indicates that in the original paper it is reported a positive long run relationship between employment and capital stock/or productivity. Δk, indicates that results are obtained using investment, accumulation rather than capital stock. ^{IR} indicates that evidence is obtained using impulse response diagrams. u-1 denotes results are obtained using lagged value of unemployment. L^d denotes results are inferred from a labour demand equation.

[94] Evidence reported here refers to the IR for unemployment in page 487. Anchor reported results refer to page 492.

[95] See footnote 93

[96] Not used in discussion of findings due to methodological caveats discussed in chapter 3.

[97] An ECM term coefficient equal to 0.12 implies a half-life of the shock (calculated as ln2/0.118) equal to 5.874 quarters, just below a year and a half.

[98] See footnote 93

	i)	ii)	iii)	iv)	v)	vi)	vii)	viiii)	ix)	x)
Italy	**NAIRU determinants**								**Anchor**	**w-p***
	Exogenous factors				**Endogenous factors**					
	grr	t^w	mil	**Other**	y-l	lu	k	i-Δp		y-l
Modigliani et al. (1986)					+					
Ball (1999)								$+^{st}$		
Miaouli (2001)							$-^{L+}$		ECM^{L^d} =-1.445	
Stockhammer (2004a)[99]	-	+	*NS*			$+^{u-1}$	$-^{\Delta k}$			
Arestis et al. (2007)	+	+	*NS*			-	-		*ECM*=0.043	
Duval and Vogel (2008)									*Stab=+5y*$^{ygap\text{-}IR}$	
Gianella et al. (2008)	+	+	*NS*	*PMR*				+		
Schreiber (2012)		*NS*			NS				r= -0.463	*NS*
Our estimates	+	+	*NS*		+	*NS*	-	-	*ECM=NS*	= 1
Spain	**NAIRU determinants**								**Anchor**	**w-p***
	Exogenous factors				**Endogenous factors**					
	grr	t^w	mil	**Other**	y-l	lu	k	i-Δp		y-l
Dolado et al. (1986)[100]	+	+	+	*mm+ fc*	+		$NS^{L=1}$			
Ballabriga et al. (1993)[101]					-		$-^{L+}$			
Dolado and Jimeno (1997)[102]				*+ w&p*^{IR}	$+^{IR}$	$+^{IR,D}$				
Ball (1999)								$+^{st}$		
Estrada et al. (2000)	+	+	+							
Miaouli (2001)							$-^{L+}$		ECM^{L^d} =-1.112	
Arestis et al. (2007)	*NS*	*NS*	*NS*			-	-		*ECM=-0.119*	
Duval and Vogel (2008)									*Stab=4-5y*$^{ygap\text{-}IR}$	
Karanassou and Sala (2008)[103][104]	+	+					$-^{L+}$			=0.52
Gianella et al. (2008)	+	+	+	*PMR*				+		
Sala (2009)										=0.8
Raurich et al. (2009)										=0.65
Our estimates	*NS*	*NS*	-		+	*NS*	-	*NS*	*ECM=-.250*	= 1

Table I.3 Summary table of time series literature for Italy and Spain

Abbreviations: grr, t^w, mil, *Other*, y-l, lu, k, and i-Δp, and *w-p** have the same meaning as above, see Table 4.4. *mm* denotes a variable capturing skills miss-match, *PMR* stands for OECD's measure of Product Market Regulation. *qr* stands for the quit ratio, *fc* stands for firing costs, *w&p*^{IR} denotes simulations of wage and prices using impulse response functions. r=stands for the coefficient of correlation, squaring them we can obtain the coefficient of determination r^2 or R^2, which "measures the proportion or percentage of the total variation in Y explained by X" (Gujarati, 2003, p.84). *Stab*=(un-)employment returns to its baseline or output gap is closed. *ECM*=denotes the value of the ECM term, coefficient must be multiplied by 100 to find out what % of the gap is closed in each period. y=years and q=quarters.

Signs and significance: +/- indicates a significant positive/negative impact on the NAIRU of the variable in the heading of the column. NS indicates no significant at 5% level.

Superindex: st, indicates that the measure of interest rate used in the article of reference is a measure of short term interest rates. L +, indicates that in the original paper it is reported a positive long run relationship between employment and capital stock/or productivity. Δk, indicates that results are obtained using investment, accumulation rather than capital stock. ^{IR} indicates that evidence is obtained using impulse response diagrams. u-1 denotes results are obtained using lagged value of unemployment. *D* denotes a demand shock. L^d denotes results are inferred from a labour demand equation.

[99] See footnote 93

[100] Authors use technical change as measure of productivity.

[101] Counterfactual simulations are not reported, because they do not provide any inside of anchor properties, but of variables that can affect unemployment permanently.

[102] See section 3.3.2.1 for a critical appraisal of these results. Anchor and IR: It reports a demand IR plot but not a labour demand or unemployment shock, hence we do not consider it provides equivalent evidence to our IR.

[103] See footnote 105. Johansen estimates of long run relationship between employment and capital stock reported in their Table 7, page 28.

[104] Results for NAIRU refer to Table 6, page 27. The impact of their variable capturing stock market return might resemble the wealth effect interest rates found in some of our countries, but since this measure is not directly comparable with our interest rate measure we ignore it here. Counterfactual simulations are not reported, because they do not provide any inside of anchor properties, but of variables that can affect unemployment permanently.

	i)	ii)	iii)	iv)	v)	vi)	vii)	viiii)	ix)	x)
Denmark	**NAIRU determinants**								**Anchor**	**w-p***
	Exogenous factors				**Endogenous factors**					
	grr	t^w	mil	**Other**	y-l	lu	k	i-Δp		y-l
Ball (1999)								$+^{st}$		
Hansen and Warne (2001)					*NS*	$+^{LF}$				≈ 1
Nymoen and Rødseth (2003)	+				*NS*					
Duval and Vogel (2008)									*Stab=3-4y*$^{ygap-IR}$	
Gianella et al. (2008)	*NS*	*NS*	+	*PMR*				+		
Karanassou et al. (2008a)[105]							$-^{L+}$			=0.46
Karanassou et al. (2008b)									NS	
Our estimates	*NS*	*NS*	*NS*		*NS*	+	*NS*	*NS*	*ECM=-.052NS*	= 1
Finland	**NAIRU determinants**								**Anchor**	**w-p***
	Exogenous factors				**Endogenous factors**					
	grr	t^w	mil	**Other**	y-l	lu	k	i-Δp		y-l
Kiander and Pehkonen (1999)	+	+	+					+		
Honkapohja and Koskela (1999)	+	+			*NS*	*NS*		+		
Nymoen and Rødseth (2003)	*mix*[106]				-					
Arestis et al. (2007)	*NS*	*NS*	+			-	-		*ECM*=-0.066	
Duval and Vogel (2008)									*Stab=4-5y*$^{ygap-IR}$	
Gianella et al. (2008)	+	+	+	*PMR*				+		
Karanassou et al. (2008a)[107] [108]							$-^{L+}$			≈ 1
Our estimates	*NS*	+	*NS*		*NS*	*NS*	*NS*	-	*ECM=.049 het*	= 1

Table I.4. Summary table of time series literature for Denmark and Finland

Abbreviations: grr, t^w, mil, *Other*, y-l, lu, k, and i-Δp, and *w-p** have the same meaning as above, see Table 4.5. *PMR* stands for OECD's measure of Product Market Regulation. r=stands for the coefficient of correlation, squaring them we can obtain the coefficient of determination r^2 or R^2, which "measures the proportion or percentage of the total variation in Y explained by X" (Gujarati, 2003, p.84). *Stab*=(un-)employment returns to its baseline or output gap is closed. *ECM*=denotes the value of the ECM term, coefficient must be multiplied by 100 to find out what % of the gap is closed in each period. y=years.

Signs and significance: +/- indicates a significant positive/negative impact on the NAIRU of the variable in the heading of the column. NS indicates no significant at 5% level.

Superindex: st, indicates that the measure of interest rate used in the article of reference is a measure of short term interest rates. LF, indicates evidence is provided by estimating the long run elasticity of unemployment to labour force shocks. L +, indicates that in the original paper it is reported a positive long run relationship between employment and capital stock/or productivity. ^{IR} indicates that evidence is obtained using impulse response diagrams.

[105] Although authors regard frictional growth as a source of limitation of anchor properties, their results with regard to long run elasticity of employment with respect to capital stock (and real wages with regard to productivity) are directly comparable with our estimations because these elasticities are found using cointegration, see page 992. Authors consider other variables in their analysis (for instance lagged unemployment) but since they do not report their long run elasticity we ignore them here.

[106] Authors consider two specifications, in both cases it turns out to be positive, but only in one is significant, hence, we treat it as mixed evidence.

[107] See footnote 105.

[108] A real long term interest rates variables is not considered in the Johansen's estimation, despite been included in an earlier estimation of the labour demand in page 992.

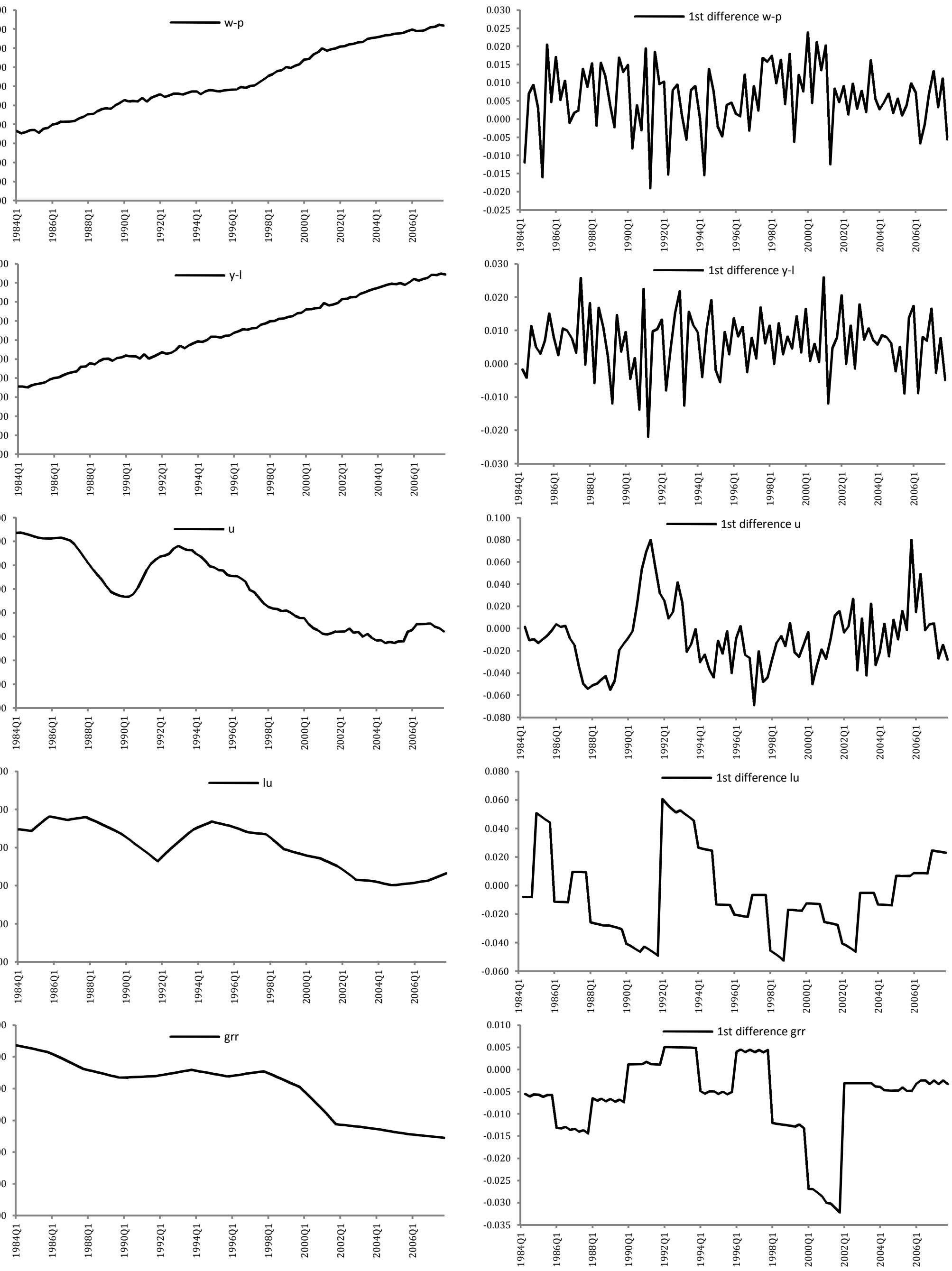
Appendix II. ADF-GLS and KPSS test results

In this appendix we present the results for the tests used to decide whether the variables employed in our empirical work are I(0) or I(1). Following recommendations in Kwiatkowski et al. (1992), we use two test for this purpose. First, we use a test with null hypothesis of unit root, in our case ADF-GLS proposed by Elliott et al. (1996). Second, we employ a test with null hypothesis of stationary, KPSS advanced by Kwiatkowski et al. (1992). This allows to cross-check the results from one test against the results of the other.

The appendix is divided in eight sections, one for each country in our sample, and in each section we provide diagrams of the levels and first difference of all variables. This is used to inspect the data visually, and decide whether a version of test with a time trend, or without a time trend, should be used. Furthermore, each section contains a table with the results from ADF-GLS for several lags, and those of the KPSS for different window size.

In most cases, both tests suggest that variables are I(1), and consequently we treat them as such. There are some exceptions, where there is certain ambiguity. This generally takes the form of the ADF-GLS test failing to reject the null of a unit root in the first difference as lag order increases, for instance $\Delta\left(w_t\text{-}p_t\right)$ and $\Delta\left(y_t\text{-}l_t\right)$ in the UK. Or rejecting the null of stationarity with a small window size in the KPSS test, for instance Δgrr_t in the Netherlands. But after considering the results of both tests, inspecting the first difference diagrams, and considering the well-known power problems of the ADF-GLS and the size problems of the KPSS test (Maddala and Kim, 1998Chapter 4), we conclude that it is safe to treat all variables as I(1) and we proceed as such.

II.1 UK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y-l
1st difference y-l
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1st difference u
lu
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grr
1st difference grr

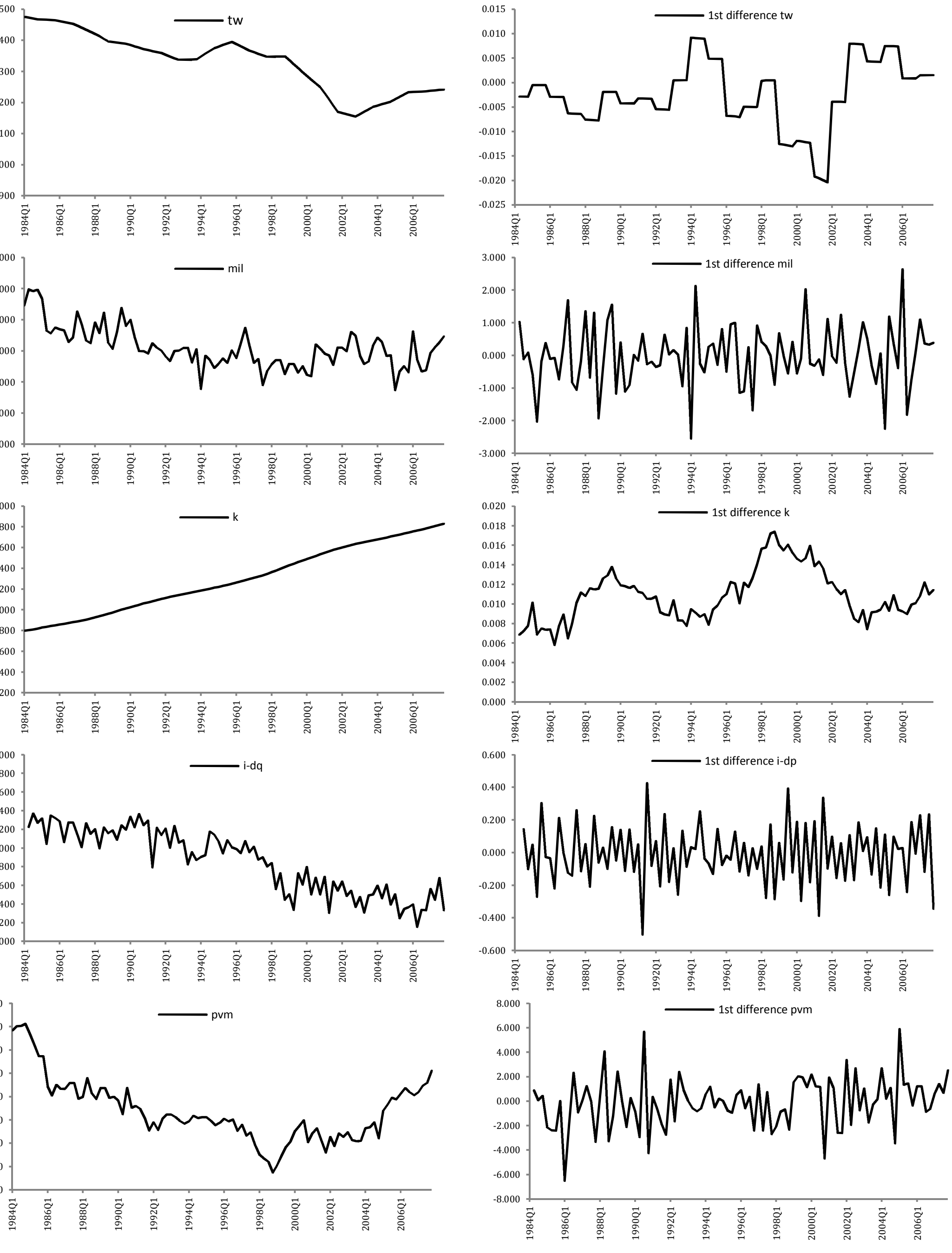


Figure II.1 Level and first difference of all variables, UK

Variable	ADF-GLS(1)	ADF-GLS(2)	ADF-GLS(3)	ADF-GLS(4)	ADF-GLS(5)
(i) For the first differences					
$\Delta(w_t\text{-}p_t)$	-2.311	-2.019	-0.923	-0.976	-0.855
$\Delta(y_t\text{-}l_t)$	-4.633	-3.701	-1.768	-1.446	-1.150
Δu_t	-2.484	-2.719	-2.910	-2.975	-3.472
Δlu_t	-3.109	-3.181	-3.320	-2.686	-2.713
Δgrr_t	-2.313	-2.356	-2.422	-2.510	-2.524
Δt_t^w	-2.458	-2.535	-2.622	-2.535	-2.609
Δmil_t	-3.090	-2.646	-2.365	-1.704	-1.459
Δk_t	-1.000	-0.098	-1.122	-1.372	-1.372
$\Delta(i_t\text{-}\Delta p_t)$	-4.257	-4.151	-1.760	-1.742	-1.536
Δp_t^{vm}	-6.274	-4.334	-3.099	-3.341	-2.888
(ii) For the levels					
$w_t\text{-}p_t$	-1.415	-1.613	-1.339	-2.138	-1.812
$y_t\text{-}l_t$	-2.039	-1.942	-1.485	-2.173	-2.298
u_t	-2.083	-3.600	-3.334	-3.102	-2.994
lu_t	-2.800	-2.711	-2.553	-2.363	-2.842
grr_t	-2.493	-2.457	-2.390	-2.295	-2.174
t_t^w	-3.098	-3.042	-2.967	-2.869	-2.981
mil_t	-4.947	-3.537	-3.077	-2.344	-1.712
k_t	-2.191	-2.715	-2.770	-2.492	-2.034
$i_t\text{-}\Delta p_t$	-2.884	-3.490	-2.017	-3.080	-2.426
p_t^{vm}	-0.312	-0.338	-0.531	-0.902	-0.526

Table II.1 Results from ADG-GLS unit root test, UK

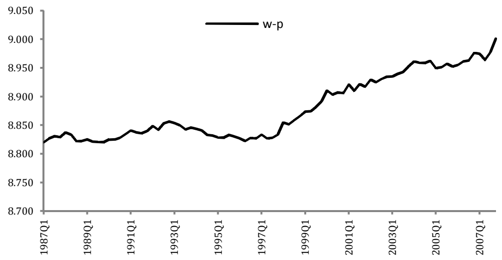
Note: ADF-GLS(*p*) represents Elliott et al. (1996) GLS augmented Dickey-Fuller unit root statistic for *p* lags. Test is carried with data covering the period between 1984q1-2007q4. (i) For the 1st difference equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable and an intercept. (ii) For the level equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable, an intercept and a time trend. Critical value, at 5%, for regressions without trend is -1.950, and for regressions with trend is -3.043.

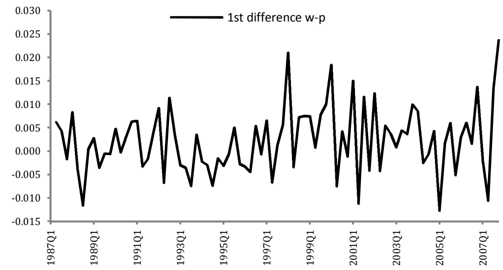
Variable	KPSS(0)	KPSS(2)	KPSS(4)	KPSS(6)	KPSS(8)	KPSS(10)	KPSS(12)
(i) For the first differences							
$\Delta(w_t\text{-}p_t)$	0.105	0.127	0.121	0.115	0.104	0.096	0.090
$\Delta(y_t\text{-}l_t)$	0.032	0.059	0.066	0.066	0.066	0.069	0.073
Δu_t	0.302	0.135	0.094	0.079	0.072	0.071	0.072
Δlu_t	0.424	0.167	0.117	0.097	0.087	0.082	0.080
Δgrr_t	0.723	0.268	0.176	0.139	0.120	0.109	0.103
Δt_t^w	0.629	0.236	0.158	0.126	0.110	0.102	0.098
Δmil_t	0.050	0.084	0.140	0.173	0.193	0.210	0.255
Δk_t	1.650	0.599	0.380	0.287	0.238	0.210	0.193
$\Delta(i_t\text{-}\Delta p_t)$	0.010	0.022	0.032	0.046	0.059	0.069	0.077
Δp_t^{vm}	0.500	0.637	0.557	0.563	0.566	0.563	0.557
(ii) For the levels							
$w_t\text{-}p_t$	1.180	0.414	0.257	0.191	0.155	0.133	0.119
$y_t\text{-}l_t$	1.020	3.990	0.255	0.193	0.161	0.142	0.131
u_t	0.579	0.199	0.126	0.096	0.081	0.073	0.069
lu_t	1.000	0.344	0.216	0.164	0.137	0.121	0.112
grr_t	1.600	0.540	0.331	0.243	0.195	0.167	0.148
t_t^w	0.561	0.193	0.121	0.092	0.077	0.068	0.064
mil_t	0.860	0.423	0.328	0.277	0.242	0.221	0.206
k_t	1.410	0.486	0.302	0.225	0.184	0.159	0.144
$i_t\text{-}\Delta p_t$	0.367	0.220	0.168	0.146	0.133	0.123	0.116
p_t^{vm}	1.620	0.601	0.390	0.302	0.255	0.227	0.207

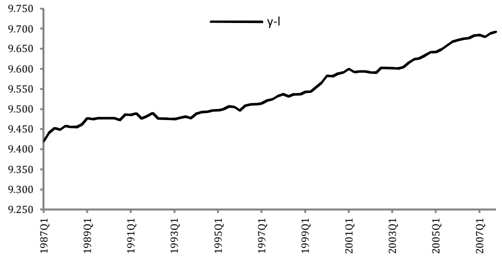
Table II.2 Results from KPSS stationary test, UK

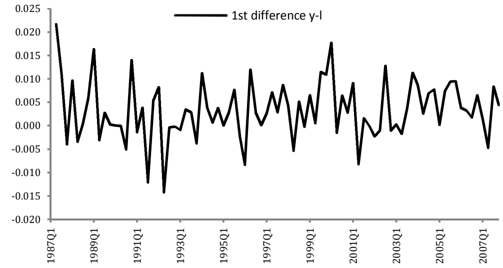
Note: KPSS(*l*) represents Kwiatkowski et al. (1992) stationarity test based on the Bartlett window for size *l*. Test is carried with data covering the period between 1984q1-2007q4. (i) For 1st difference equations, KPSS test statistics are computed from a regression with and intercept and "*l*" lagged truncation parameter. (ii) For level equations, KPSS test statistics are computed from a regression with and intercept, time trend and "*l*" lagged truncation parameter. Critical values at 5% for regressions without trend is 0.463, for regressions with trend is 0.146.

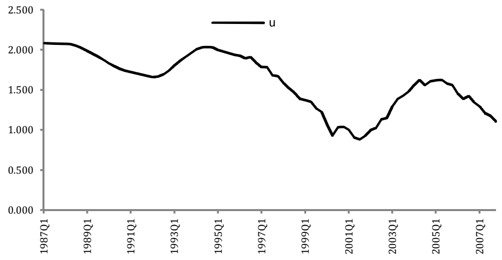
II.2 Netherlands

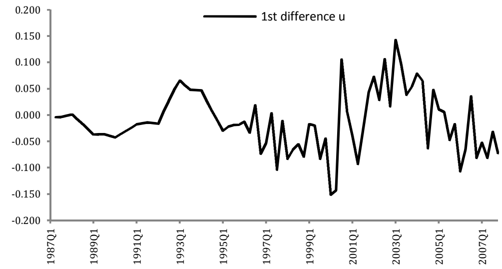


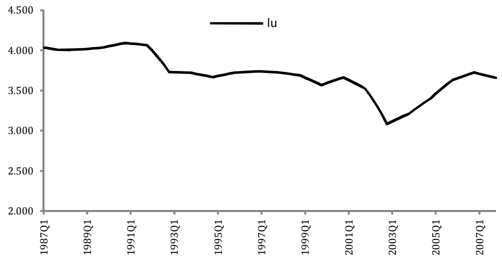


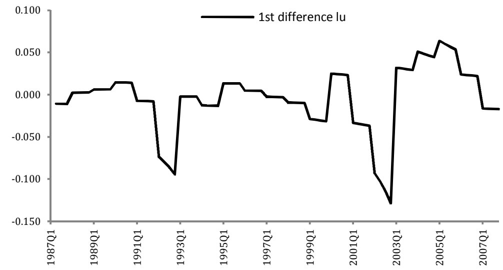


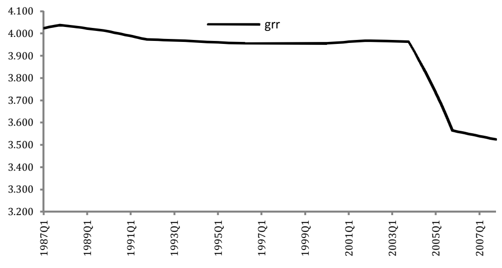


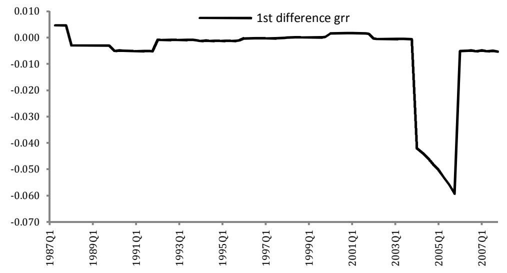












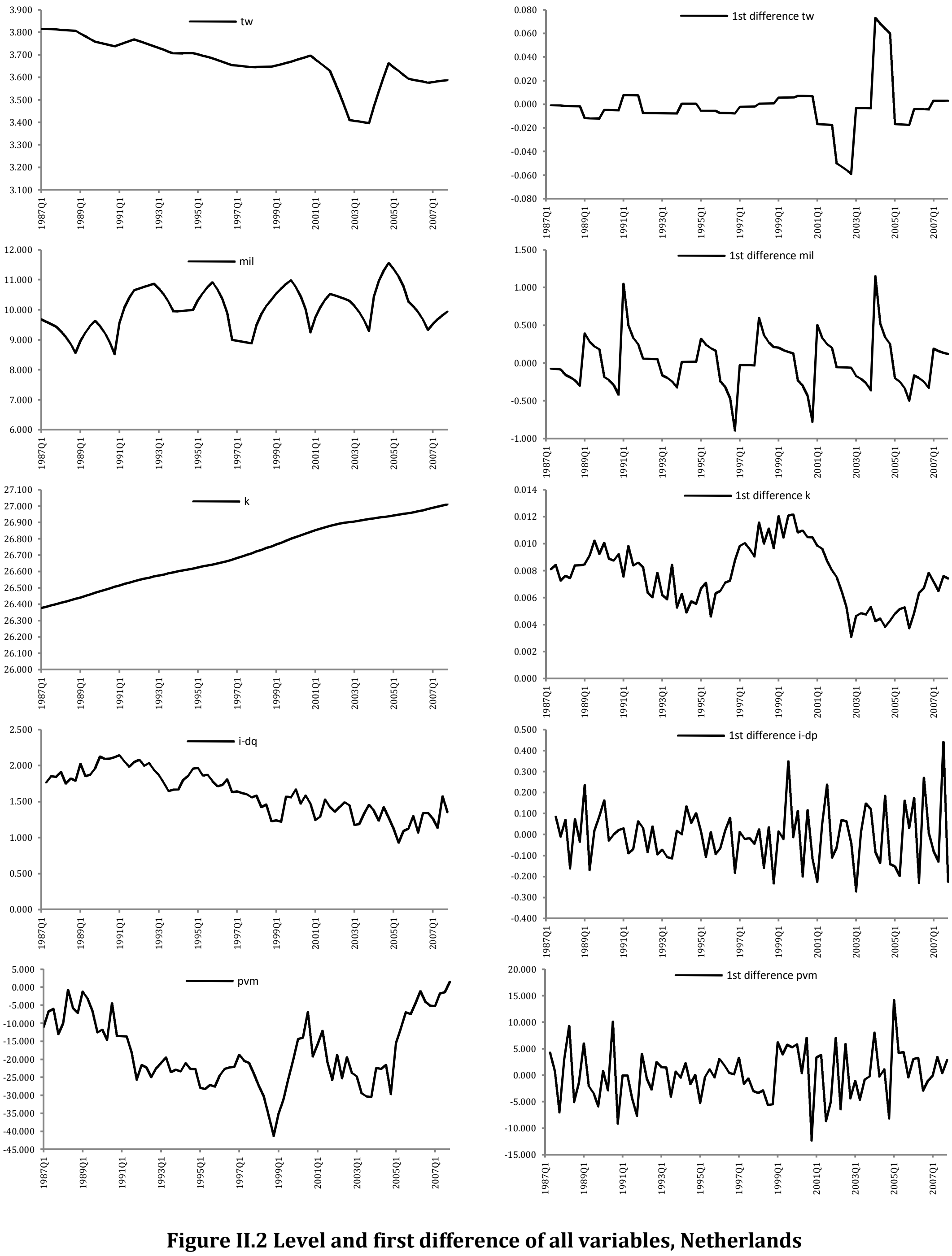


Figure II.2 Level and first difference of all variables, Netherlands

Variable	ADF-GLS(1)	ADF-GLS(2)	ADF-GLS(3)	ADF-GLS(4)	ADF-GLS(5)
(i) For the first differences					
$\Delta(w_t\text{-}p_t)$	-4.481	-3.614	-2.271	-2.102	-1.781
$\Delta(y_t\text{-}l_t)$	-1.981	-1.326	-0.920	-0.821	-0.634
Δu_t	-3.442	-2.562	-2.127	-1.683	-1.761
Δlu_t	-3.167	-3.287	-3.476	-2.928	-3.041
Δgrr_t	-2.149	-2.199	-2.231	-2.298	-2.364
Δt_t^w	-3.602	-3.935	-4.425	-3.877	-4.138
Δmil_t	-4.734	-4.645	-5.385	-4.806	-4.560
Δk_t	-1.491	-1.513	-1.739	-1.769	-1.941
$\Delta(i_t\text{-}\Delta p_t)$	-6.047	-5.515	-2.898	-3.300	-3.046
Δp_t^{vm}	-4.318	-3.162	-2.260	-2.363	-1.942
(ii) For the levels					
$w_t\text{-}p_t$	-0.878	-0.900	-0.088	-1.410	-1.381
$y_t\text{-}l_t$	-1.366	-1.336	-1.401	-1.720	-1.625
u_t	-1.682	-2.194	-2.771	-3.313	-4.312
lu_t	-3.012	-2.901	-2.712	-2.432	-2.850
grr_t	-2.144	-2.086	-1.975	-1.877	-1.722
t_t^w	-4.343	-4.145	-3.771	-3.200	-3.484
mil_t	-4.010	-4.364	-4.278	-3.398	-3.389
k_t	-2.205	-3.852	-4.106	-3.870	-4.176
$i_t\text{-}\Delta p_t$	-2.635	-2.508	-1.890	-2.704	-1.978
p_t^{vm}	-1.493	-1.605	-1.687	-1.989	-1.580

Table II.3 Results from ADG-GLS unit root test, Netherlands

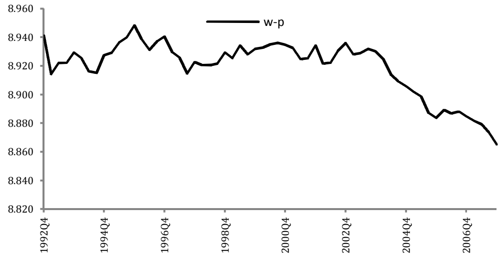
Note: ADF-GLS(*p*) represents Elliott et al. (1996) GLS augmented Dickey-Fuller unit root statistic for *p* lags. Test is carried with data covering the period between 1987q1-2007q4. (i) For the 1st difference equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable and an intercept. (ii) For the level equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable, an intercept and a time trend, except in the case of p_t^{vm} where no time trend is considered. Critical value, at 5%, for regressions without trend is -1.950, and for regressions with trend is -3.081.

Variable	KPSS(0)	KPSS(2)	KPSS(4)	KPSS(6)	KPSS(8)	KPSS(10)	KPSS(12)
(i) For the first differences							
$\Delta(w_t\text{-}p_t)$	0.370	0.412	0.373	0.332	0.308	0.295	0.289
$\Delta(y_t\text{-}l_t)$	0.160	0.182	0.170	0.165	0.162	0.159	0.160
Δu_t	0.235	0.125	0.088	0.070	0.061	0.057	0.056
Δlu_t	0.436	0.181	0.134	0.118	0.114	0.116	0.123
Δgrr_t	1.750	0.663	0.446	0.360	0.320	0.301	0.290
Δt_t^w	0.149	0.065	0.051	0.050	0.057	0.070	0.089
Δmil_t	0.054	0.033	0.032	0.039	0.052	0.075	0.094
Δk_t	1.290	0.466	0.295	0.223	0.185	0.163	0.151
$\Delta(i_t\text{-}\Delta p_t)$	0.033	0.052	0.063	0.086	0.107	0.106	0.115
Δp_t^{vm}	0.153	0.196	0.186	0.199	0.227	0.251	0.275
(ii) For the levels							
$w_t\text{-}p_t$	1.580	0.561	0.350	0.261	0.214	0.184	0.165
$y_t\text{-}l_t$	1.650	0.585	0.368	0.277	0.228	0.198	0.179
u_t	0.609	0.209	0.131	0.099	0.083	0.075	0.071
lu_t	0.605	0.213	0.138	0.110	0.097	0.092	0.091
grr_t	1.230	0.429	0.270	0.205	0.172	0.153	0.142
t_t^w	0.254	0.092	0.063	0.054	0.053	0.056	0.062
mil_t	0.266	0.103	0.078	0.073	0.076	0.082	0.088
k_t	0.770	0.264	0.165	0.124	0.103	0.091	0.085
$i_t\text{-}\Delta p_t$	0.309	0.148	0.111	0.099	0.094	0.092	0.093
p_t^{vm}	1.250	0.472	0.312	0.246	0.213	0.194	0.183

Table II.4 Results from KPSS stationary test, Netherlands

Note: KPSS(*l*) represents Kwiatkowski et al. (1992) stationarity test based on the Bartlett window for size *l*. Test is carried with data covering the period between 1987q1-2007q4. (i) For 1st difference equations, KPSS test statistics are computed from a regression with and intercept and "*l*" lagged truncation parameter. (ii) For level equations, KPSS test statistics are computed from a regression with and intercept, time trend and "*l*" lagged truncation parameter, except in the case of p_t^{vm} where no time trend is considered. Critical values at 5% for regressions without trend 0.463, for regressions with trend 0.146.

II.3 Germany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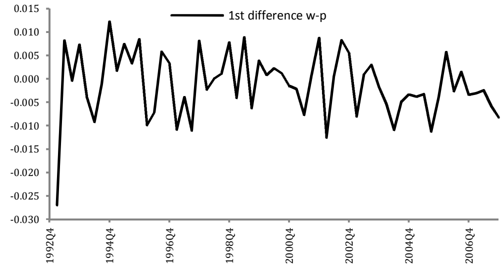
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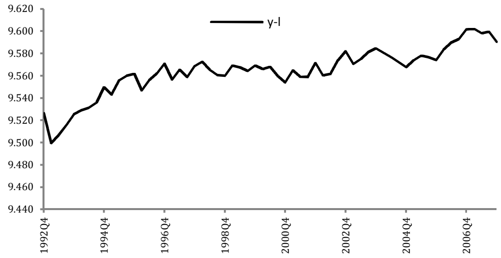
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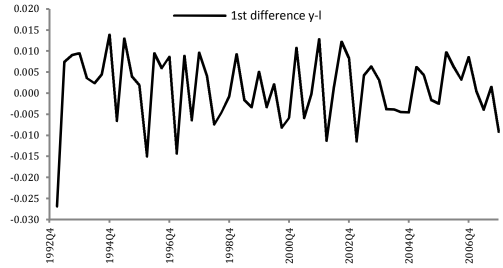
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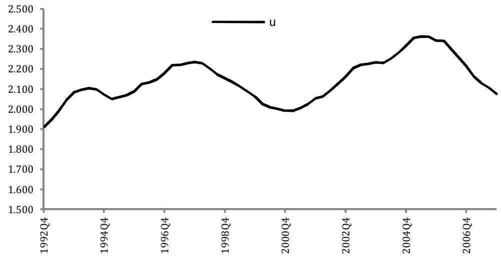
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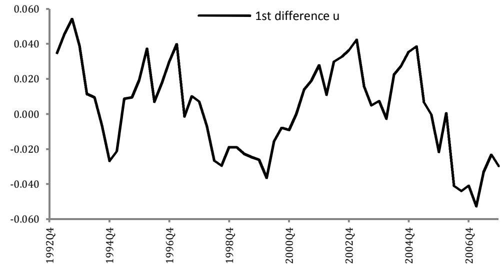
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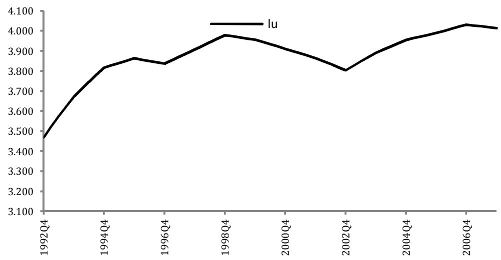
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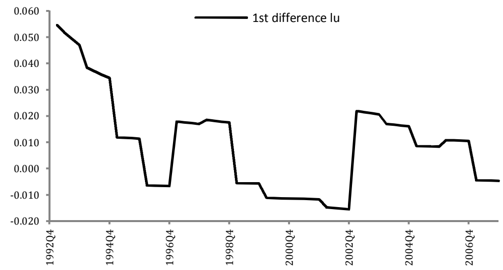
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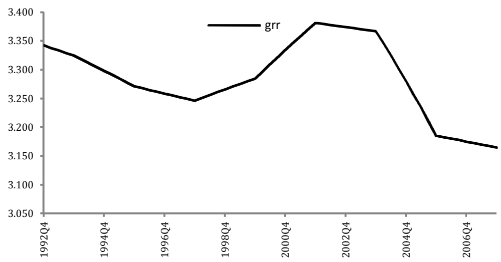
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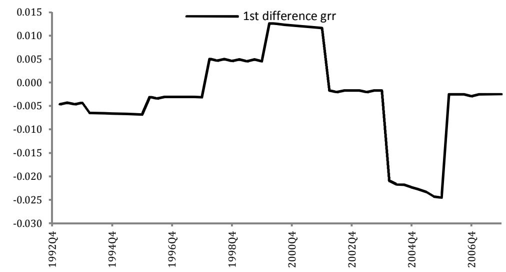
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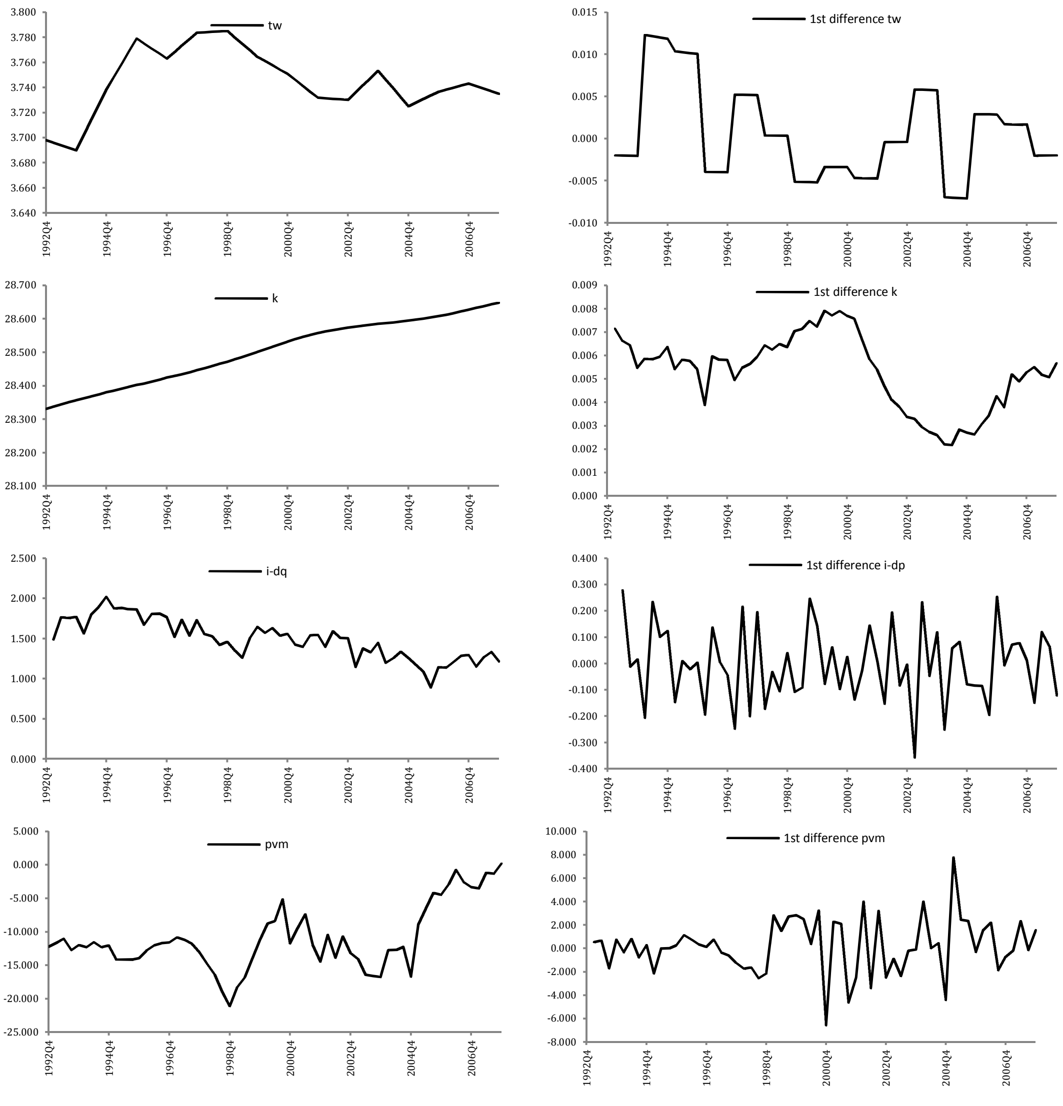


Figure II.3 Level and first difference of all variables, Germany

Variable	ADF-GLS(1)	ADF-GLS(2)	ADF-GLS(3)	ADF-GLS(4)	ADF-GLS(5)
(i) For the first differences					
$\Delta(w_t\text{-}p_t)$	-1.342	-0.974	-0.679	-0.663	-0.583
$\Delta(y_t\text{-}l_t)$	-1.641	-1.212	-1.033	-1.016	-0.864
Δu_t	-1.443	-1.497	-1.809	-1.833	-1.516
Δlu_t	-0.730	-0.748	-0.768	-0.773	-0.798
Δgrr_t	-1.775	-1.781	-1.803	-1.872	-1.920
Δt_t^w	-3.143	-3.394	-3.731	-2.507	-2.584
Δk_t	-0.918	-1.151	-1.254	-1.816	-1.979
$\Delta(i_t\text{-}\Delta p_t)$	-2.314	-1.763	-0.900	-0.737	-0.556
Δp_t^{ym}	-4.995	-3.990	-3.106	-3.277	-2.819
(ii) For the levels					
$w_t\text{-}p_t$	-1.275	-1.159	-1.136	-1.410	-1.542
$y_t\text{-}l_t$	-2.399	-2.092	-1.967	-2.209	-2.248
u_t	-2.482	-2.839	-2.771	-2.387	-2.241
lu_t	-1.928	-1.831	-1.733	-1.636	-1.571
grr_t	-2.557	-2.531	-2.575	-2.599	-2.546
t_t^w	-1.888	-1.640	-1.374	-1.101	-1.598
k_t	-2.778	-3.656	-3.138	-3.046	-2.159
$i_t\text{-}\Delta p_t$	-2.363	-2.318	-1.731	-1.992	-1.837
p_t^{ym}	-1.638	-1.885	-1.964	-2.308	-1.997

Table II.5 Results from ADG-GLS unit root test, Germany

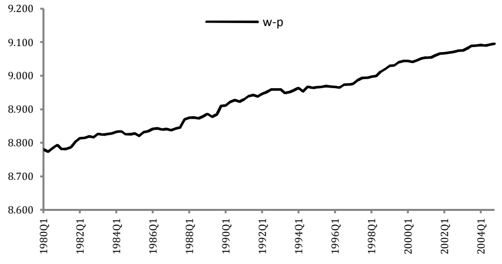
Note: ADF-GLS(*p*) represents Elliott et al. (1996) GLS augmented Dickey-Fuller unit root statistic for *p* lags. Test is carried with data covering the period between 1992q4-2007q4. (i) For the 1st difference equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable and an intercept. (ii) For the level equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable, an intercept and a time trend. Critical value, at 5%, for regressions without trend is -1.950 and for regressions with trend is -3.155.

Variable	KPSS(0)	KPSS(2)	KPSS(4)	KPSS(6)	KPSS(8)	KPSS(10)	KPSS(12)
(i) For the first differences							
$\Delta(w_t-p_t)$	0.192	0.223	0.235	0.221	0.232	0.254	0.281
$\Delta(y_t-l_t)$	0.039	0.059	0.071	0.075	0.087	0.109	0.124
Δu_t	0.762	0.308	0.220	0.190	0.181	0.180	0.185
Δlu_t	1.580	0.610	0.418	0.342	0.309	0.294	0.288
Δgrr_t	1.000	0.368	0.241	0.189	0.162	0.147	0.140
Δt_t^w	0.884	0.379	0.294	0.270	0.264	0.260	0.250
Δk_t	2.130	0.757	0.478	0.363	0.305	0.272	0.255
$\Delta(i_t-\Delta p_t)$	0.046	0.081	0.111	0.129	0.142	0.143	0.150
Δp_t^{vm}	0.133	0.155	0.150	0.156	0.182	0.212	0.241
(ii) For the levels							
w_t-p_t	1.000	0.387	0.257	0.202	0.175	0.160	0.152
y_t-l_t	0.480	0.206	0.146	0.122	0.111	0.108	0.107
u_t	0.372	0.135	0.091	0.075	0.068	0.066	0.068
lu_t	0.709	0.264	0.177	0.142	0.125	0.116	0.112
grr_t	0.903	0.311	0.196	0.149	0.125	0.112	0.106
t_t^w	0.919	0.325	0.211	0.167	0.145	0.133	0.126
k_t	1.270	0.436	0.272	0.204	0.169	0.149	0.137
$i_t-\Delta p_t$	0.119	0.070	0.057	0.055	0.057	0.061	0.070
p_t^{vm}	0.608	0.241	0.167	0.141	0.131	0.130	0.134

Table II.6 Results from KPSS stationary test, Germany

Note: KPSS(*l*) represents Kwiatkowski et al. (1992) stationarity test based on the Bartlett window for size *l*. Test is carried with data covering the period between 1992q4-2007q4. (i) For 1st difference equations, KPSS test statistics are computed from a regression with and intercept and "*l*" lagged truncation parameter. (ii) For level equations, KPSS test statistics are computed from a regression with and intercept, time trend and "*l*" lagged truncation parameter. Critical values at 5% for regressions without trend 0.463, for regressions with trend 0.146.

II.4 France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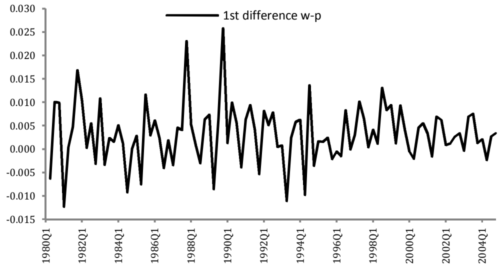
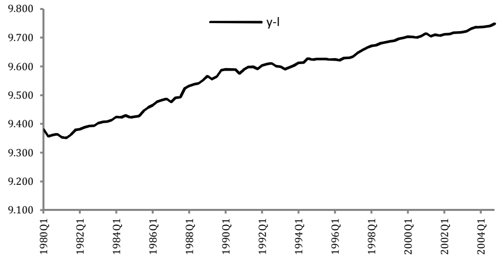
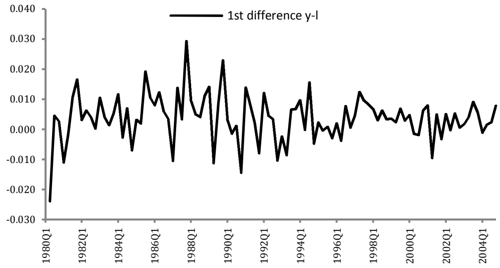

1st difference w-p


y-l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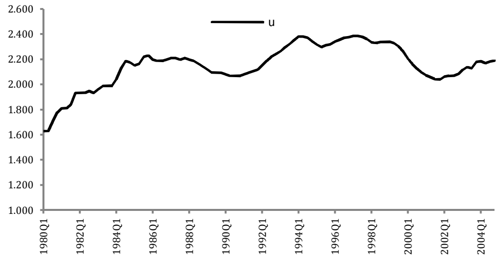
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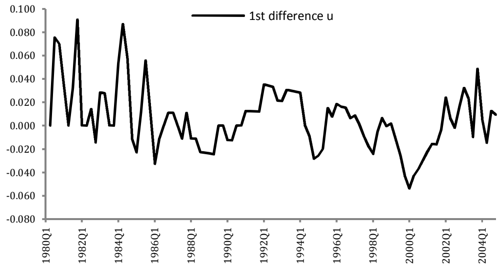
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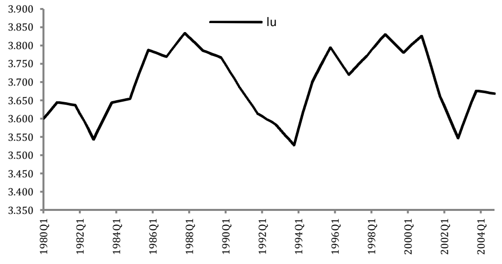
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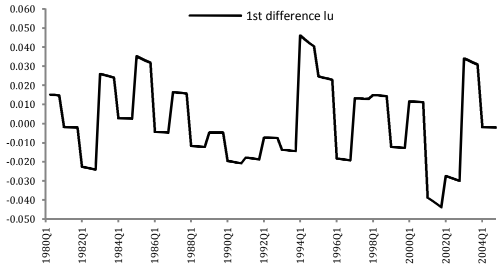
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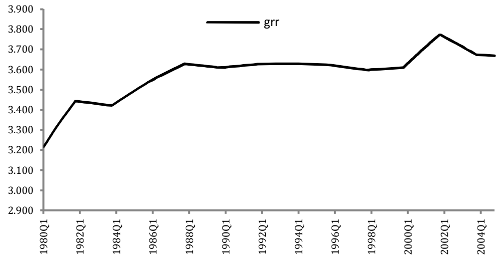
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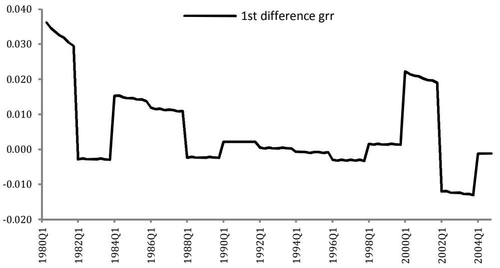
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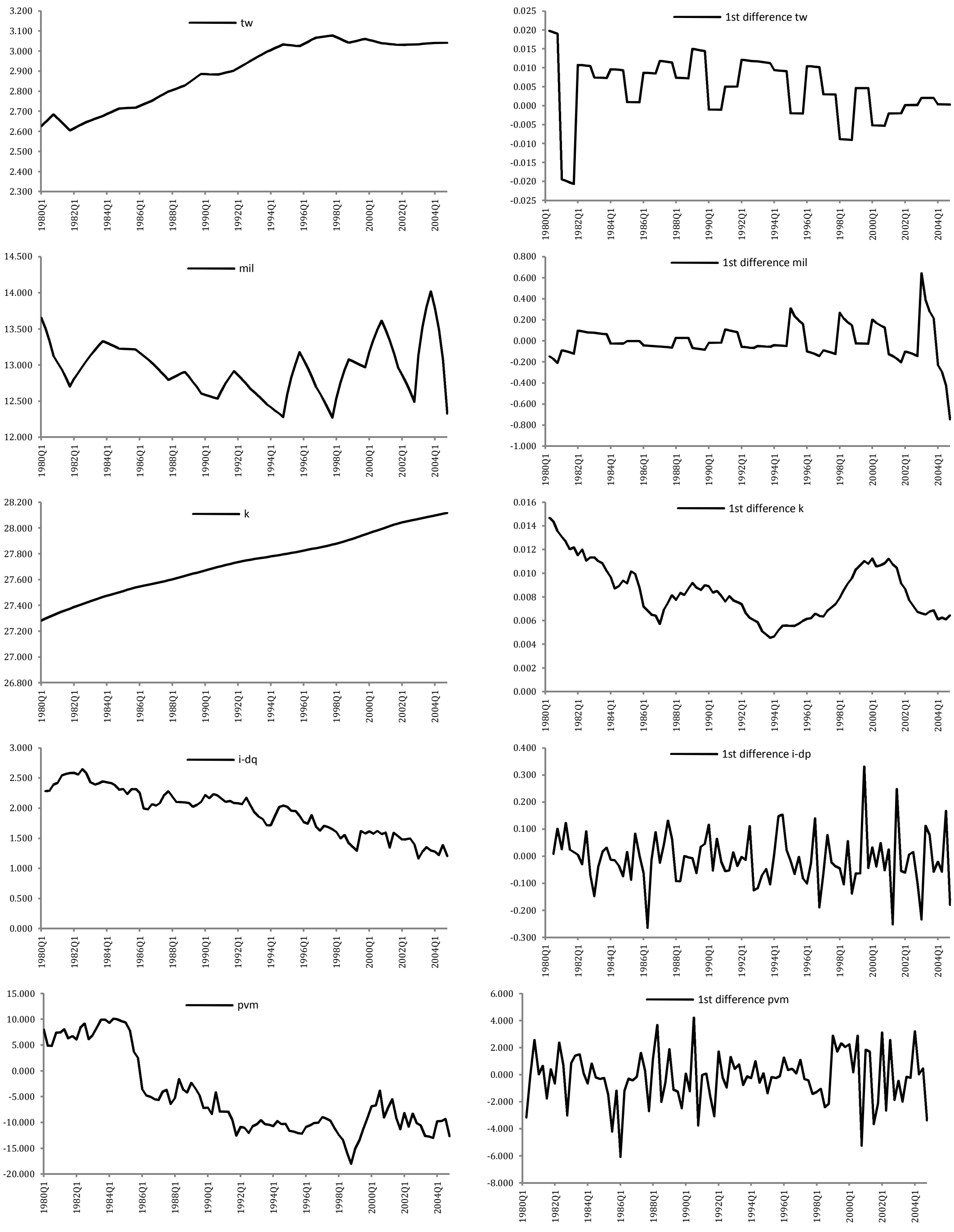


Figure II.4 Level and first difference of all variables, France

Variable	ADF-GLS(1)	ADF-GLS(2)	ADF-GLS(3)	ADF-GLS(4)	ADF-GLS(5)
(i) For the first differences					
$\Delta(w_t\text{-}p_t)$	-3.509	-2.656	-1.895	-1.575	-1.370
$\Delta(y_t\text{-}l_t)$	-1.497	-1.208	-0.783	-0.657	-0.475
Δu_t	-5.173	-3.499	-3.079	-2.733	-3.198
Δlu_t	-3.646	-3.903	-4.253	-2.581	-2.638
Δgrr_t	-0.996	-1.026	-1.053	-1.090	-1.118
Δt_t^w	-3.025	-3.026	-3.158	-1.568	-1.562
Δmil_t	-2.550	-2.780	-3.624	-2.737	-2.517
Δk_t	-0.136	-0.504	-0.437	-0.495	-0.354
$\Delta(i_t\text{-}\Delta p_t)$	-7.941	-7.160	-5.040	-5.517	-6.178
Δp_t^{vm}	-3.111	-2.134	-1.651	-1.765	-1.362
(ii) For the levels					
$w_t\text{-}p_t$	-2.491	-2.402	-2.212	-2.319	-2.249
$y_t\text{-}l_t$	-2.066	-2.125	-1.901	-2.033	-1.874
u_t	-1.093	-0.907	-1.346	-1.542	-1.802
lu_t	-2.443	-2.139	-1.807	-1.454	-2.095
grr_t	-1.640	-1.488	-1.310	-1.135	-0.975
t_t^w	-1.257	-1.064	-0.708	-0.297	-1.346
mil_t	-4.167	-4.056	-3.462	-2.079	-2.057
k_t	-3.031	-2.357	-1.748	-1.787	-1.676
$i_t\text{-}\Delta p_t$	-2.920	-2.694	-2.336	-2.784	-2.259
p_t^{vm}	-1.809	-1.954	-2.174	-2.400	-1.918

Table II.7 Results from ADG-GLS unit root test, France

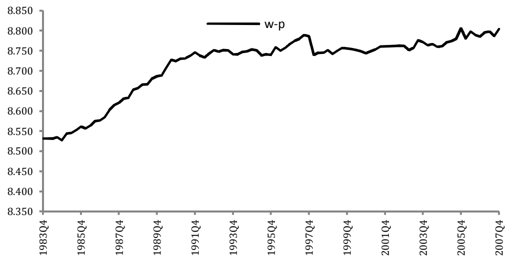
Note: ADF-GLS(*p*) represents Elliott et al. (1996) GLS augmented Dickey-Fuller unit root statistic for *p* lags. Test is carried with data covering the period between 1980q1-2004q4. (i) For the 1st difference equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable and an intercept. (ii) For the level equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable, an intercept and a time trend, except in the case of lu_t, where no time trend is considered. Critical value, at 5%, for regressions without trend is -1.950, and for regressions with trend is -3.030.

Variable	KPSS(0)	KPSS(2)	KPSS(4)	KPSS(6)	KPSS(8)	KPSS(10)	KPSS(12)
(i) For the first differences							
$\Delta(w_t\text{-}p_t)$	0.040	0.048	0.054	0.059	0.059	0.054	0.055
$\Delta(y_t\text{-}l_t)$	0.125	0.124	0.123	0.124	0.127	0.117	0.116
Δu_t	1.190	0.616	0.471	0.386	0.351	0.327	0.309
Δlu_t	0.260	0.114	0.092	0.087	0.086	0.087	0.088
Δgrr_t	1.980	0.768	0.532	0.447	0.420	0.418	0.425
Δt_t^w	1.120	0.516	0.442	0.430	0.411	0.387	0.363
Δmil_t	0.104	0.054	0.050	0.060	0.080	0.103	0.117
Δk_t	2.610	0.927	0.591	0.450	0.374	0.329	0.300
$\Delta(i_t\text{-}\Delta p_t)$	0.064	0.080	0.091	0.120	0.144	0.152	0.160
Δp_t^{vm}	0.078	0.086	0.080	0.085	0.096	0.111	0.129
(ii) For the levels							
$w_t\text{-}p_t$	0.361	0.138	0.091	0.071	0.061	0.055	0.052
$y_t\text{-}l_t$	1.770	0.623	391.000	0.291	0.237	0.202	0.180
u_t	1.420	0.501	0.318	0.240	0.199	0.174	0.158
lu_t	0.837	0.291	0.186	0.143	0.121	0.108	0.101
grr_t	1.330	0.484	0.315	0.245	0.207	0.184	0.168
t_t^w	1.980	0.681	0.423	0.314	0.253	0.216	0.190
mil_t	1.000	3.890	0.282	0.246	0.228	0.212	0.195
k_t	1.160	0.407	0.257	0.193	0.159	0.139	0.125
$i_t\text{-}\Delta p_t$	0.302	0.139	0.107	0.099	0.096	0.095	0.096
p_t^{vm}	1.560	0.565	0.363	0.279	0.234	0.206	0.186

Table II.8 Results from KPSS stationary test, France

Note: KPSS(*l*) represents Kwiatkowski et al. (1992) stationarity test based on the Bartlett window for size *l*. Test is carried with data covering the period between 1980q1-2004q4. (i) For 1st difference equations, KPSS test statistics are computed from a regression with and intercept and "*l*" lagged truncation parameter. (ii) For level equations, KPSS test statistics are computed from a regression with and intercept, time trend and "*l*" lagged truncation parameter, except in the case of lu_t, where no time trend is considered. Critical values at 5% for regressions without trend 0.463, for regressions with trend 0.146.

II.5 Italy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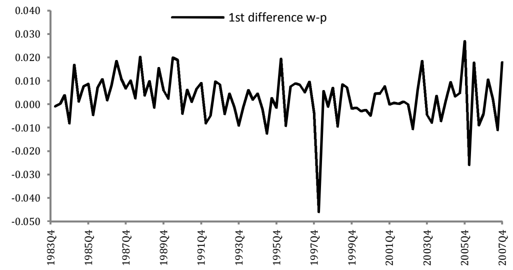
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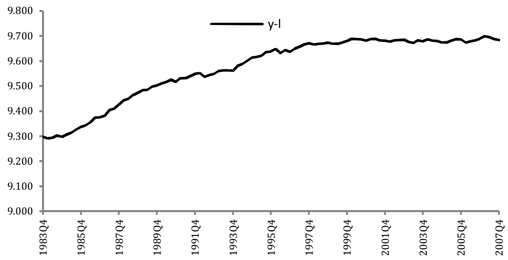
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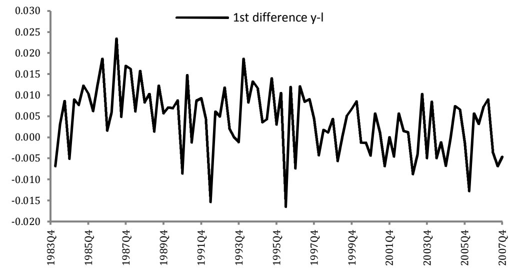
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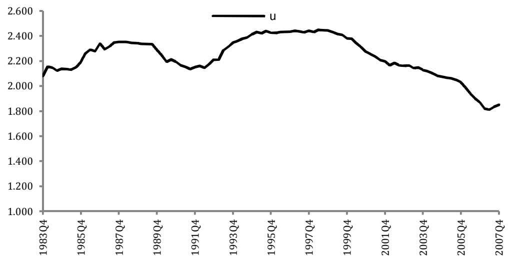
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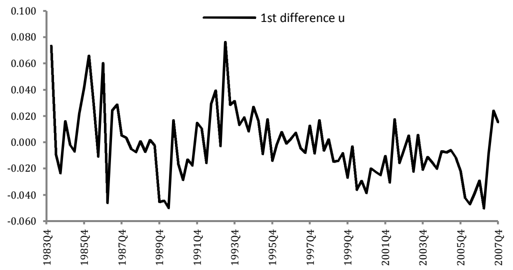
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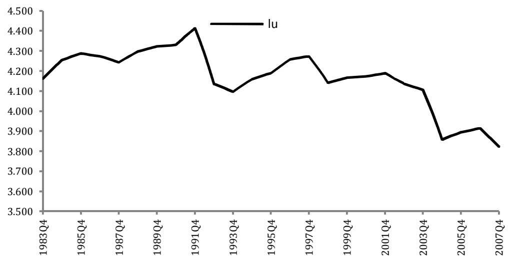
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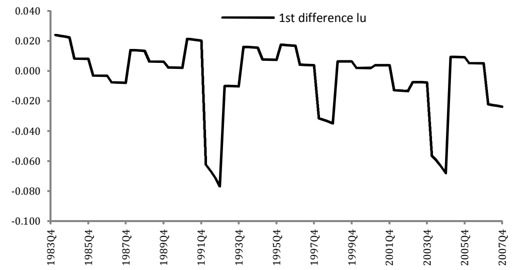
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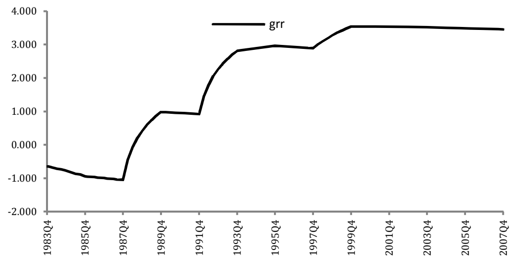
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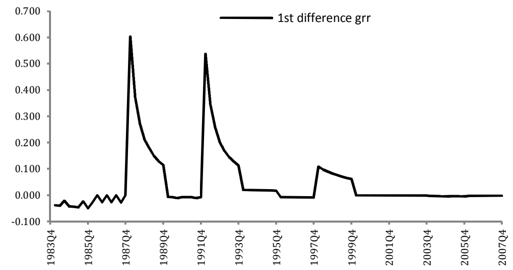
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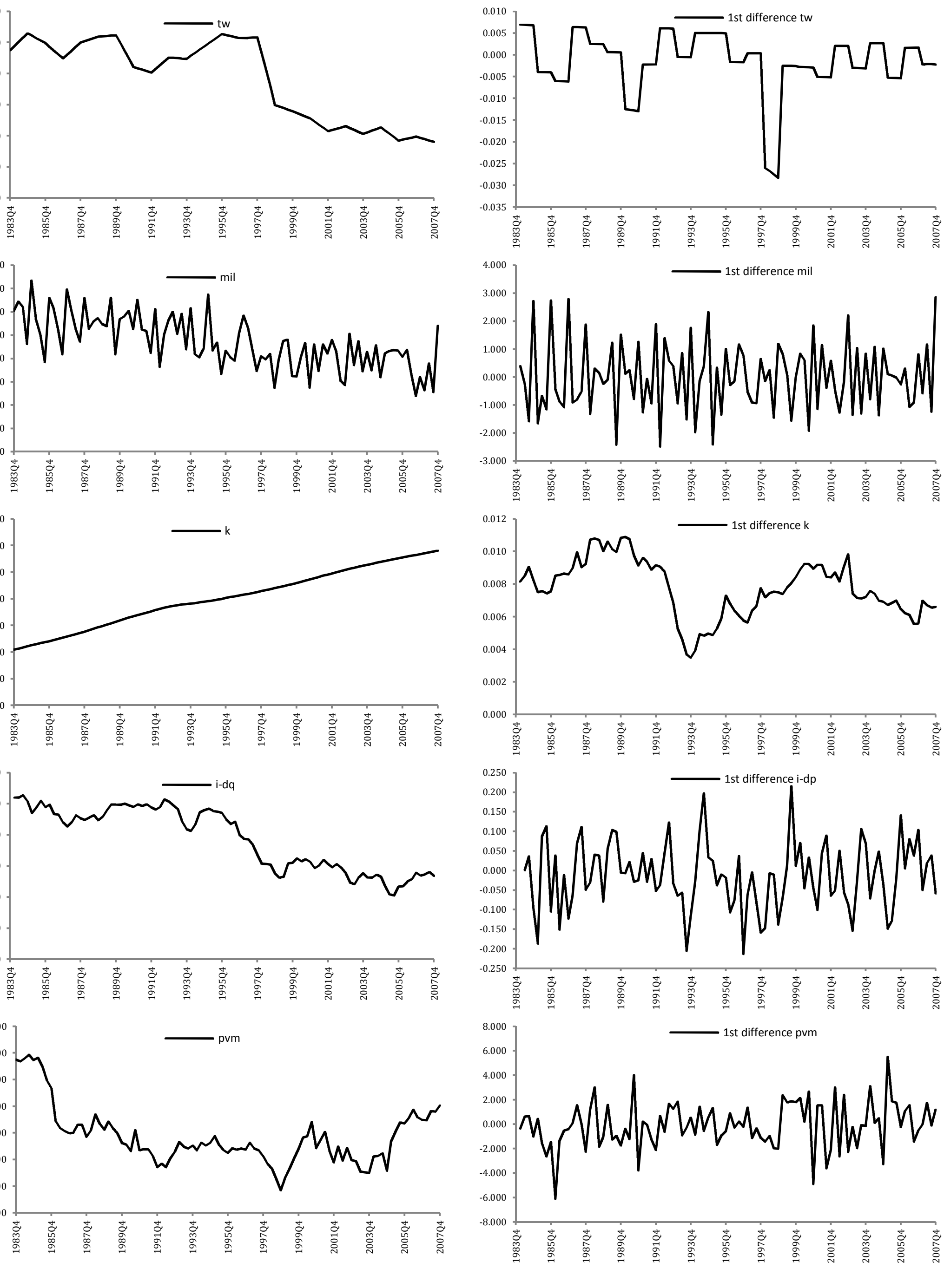


Figure II.5 Level and first difference of all variables, Italy

Variable	ADF-GLS(1)	ADF-GLS(2)	ADF-GLS(3)	ADF-GLS(4)	ADF-GLS(5)
(i) For the first differences					
$\Delta(w_t\text{-}p_t)$	-6.600	-4.712	-3.896	-3.644	-2.884
$\Delta(y_t\text{-}l_t)$	-2.842	-2.379	-1.838	-1.393	-1.018
Δu_t	-1.446	-1.115	-1.172	-1.006	-0.917
Δlu_t	-2.919	-3.094	-3.330	-2.043	-2.062
Δgrr_t	-3.306	-2.929	-2.790	-2.635	-2.632
Δt_t^w	-2.895	-3.036	-3.208	-1.898	-1.928
Δmil_t	-7.193	-6.581	-3.142	-2.559	-2.083
Δk_t	-1.803	-1.676	-1.902	-1.725	-1.714
$\Delta(i_t\text{-}\Delta p_t)$	-6.448	-5.367	-4.360	-4.543	-4.753
Δp_t^{vm}	-6.169	-4.721	-3.742	-4.152	-3.691
(ii) For the levels					
$w_t\text{-}p_t$	-0.805	-0.824	-0.929	-0.987	-0.941
$y_t\text{-}l_t$	0.050	-2.600	-0.258	-0.434	-0.782
u_t	-0.424	-1.265	-1.754	-1.511	-1.587
lu_t	-2.105	-1.777	-1.405	-0.993	-1.616
grr_t	-1.410	-1.492	-1.558	-1.510	-1.482
t_t^w	-2.350	-2.066	-1.755	-1.424	-2.150
mil_t	-6.273	-6.069	-3.478	-4.092	-3.633
k_t	-2.788	-2.469	-2.665	-2.362	-2.555
$i_t\text{-}\Delta p_t$	-2.372	-2.117	-2.105	-2.291	-1.992
p_t^{vm}	-0.980	-1.193	-1.338	-1.559	-1.210

Table II.9 Results from ADG-GLS unit root test, Italy

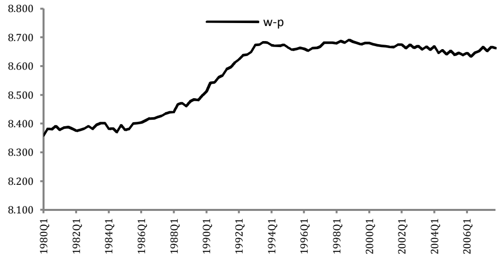
Note: ADF-GLS(*p*) represents Elliott et al. (1996) GLS augmented Dickey-Fuller unit root statistic for *p* lags. Test is carried with data covering the period between 1983q4-2007q4. (i) For the 1st difference equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable and an intercept. (ii) For the level equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable, an intercept and a time trend. Critical value, at 5%, for regressions without trend is -1.950, and for regressions with trend is -3.040.

Variable	KPSS(0)	KPSS(2)	KPSS(4)	KPSS(6)	KPSS(8)	KPSS(10)	KPSS(12)
(i) For the first differences							
$\Delta(w_t-p_t)$	0.430	0.512	0.476	0.451	0.421	0.379	0.339
$\Delta(y_t-l_t)$	1.680	1.340	1.110	0.886	0.747	0.663	0.590
Δu_t	1.520	0.896	0.647	0.531	0.464	0.426	0.403
Δlu_t	0.804	0.354	0.285	0.275	0.282	0.297	0.313
Δgrr_t	0.846	0.391	0.292	0.253	0.241	0.242	0.246
Δt_t^w	0.431	0.186	0.147	0.137	0.133	0.132	0.133
Δmil_t	0.014	0.038	0.057	0.079	0.107	0.115	0.137
Δk_t	1.830	0.648	0.412	0.312	0.258	0.226	0.206
$\Delta(i_t-\Delta p_t)$	0.081	0.065	0.066	0.073	0.078	0.078	0.082
Δp_t^{vm}	0.391	0.410	0.365	0.367	0.388	0.405	0.428
(ii) For the levels							
w_t-p_t	2.010	0.698	0.432	0.319	0.257	0.218	0.193
y_t-l_t	2.250	0.780	0.484	0.357	0.289	0.246	0.218
u_t	1.760	0.613	0.385	0.289	0.238	0.207	0.187
lu_t	1.070	0.383	0.251	0.198	0.170	0.154	0.145
grr_t	2.030	0.696	0.433	0.322	0.262	0.225	0.200
t_t^w	1.270	0.440	0.278	0.210	0.174	0.152	0.139
mil_t	0.066	0.078	0.086	0.098	0.104	0.097	0.094
k_t	1.220	0.416	0.257	0.190	0.154	0.133	0.119
$i_t-\Delta p_t$	0.972	0.352	0.230	0.178	0.150	0.133	0.122
p_t^{vm}	1.340	0.497	0.327	0.259	0.225	0.206	0.195

Table II.10 Results from KPSS stationary test, Italy

Note: KPSS(*l*) represents Kwiatkowski et al. (1992) stationarity test based on the Bartlett window for size *l*. Test is carried with data covering the period between 1983q4-2007q4. (i) For 1st difference equations, KPSS test statistics are computed from a regression with and intercept and "*l*" lagged truncation parameter. (ii) For level equations, KPSS test statistics are computed from a regression with and intercept, time trend and "*l*" lagged truncation parameter. Critical values at 5% for regressions without trend 0.463, for regressions with trend 0.146.

II.6 Spain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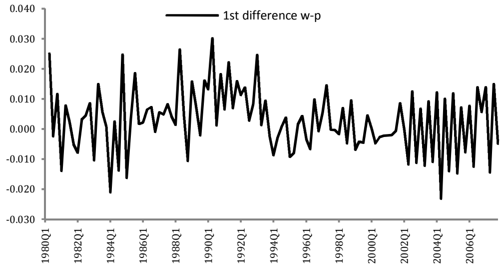
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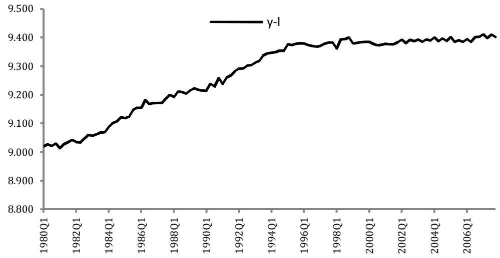
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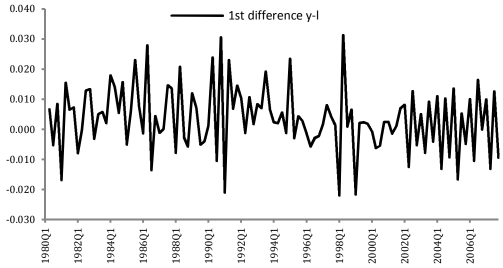
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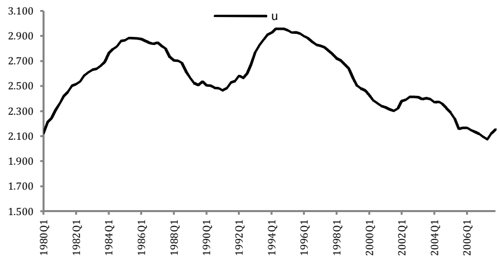
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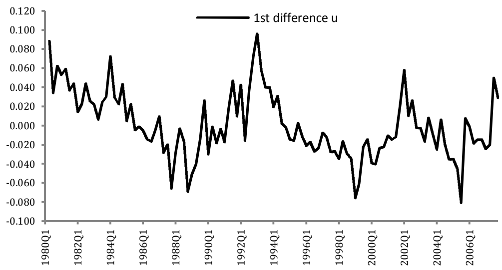
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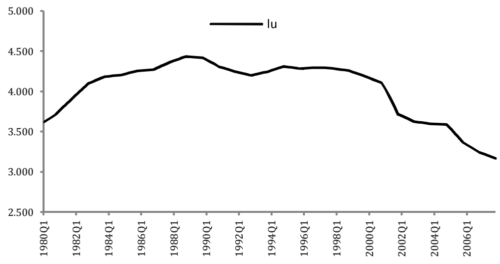
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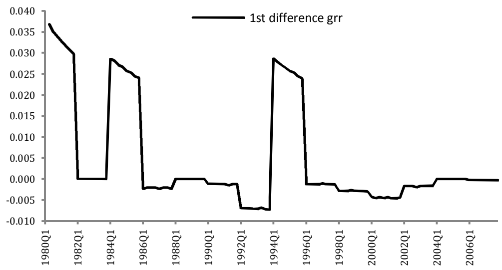
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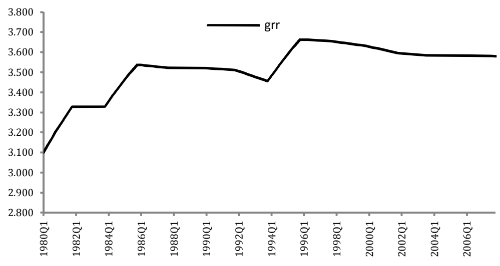
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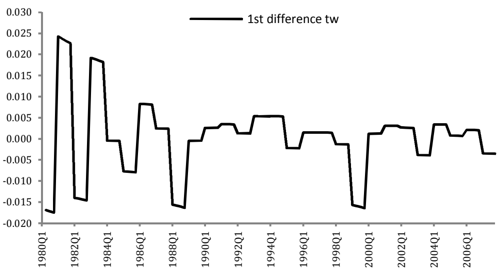
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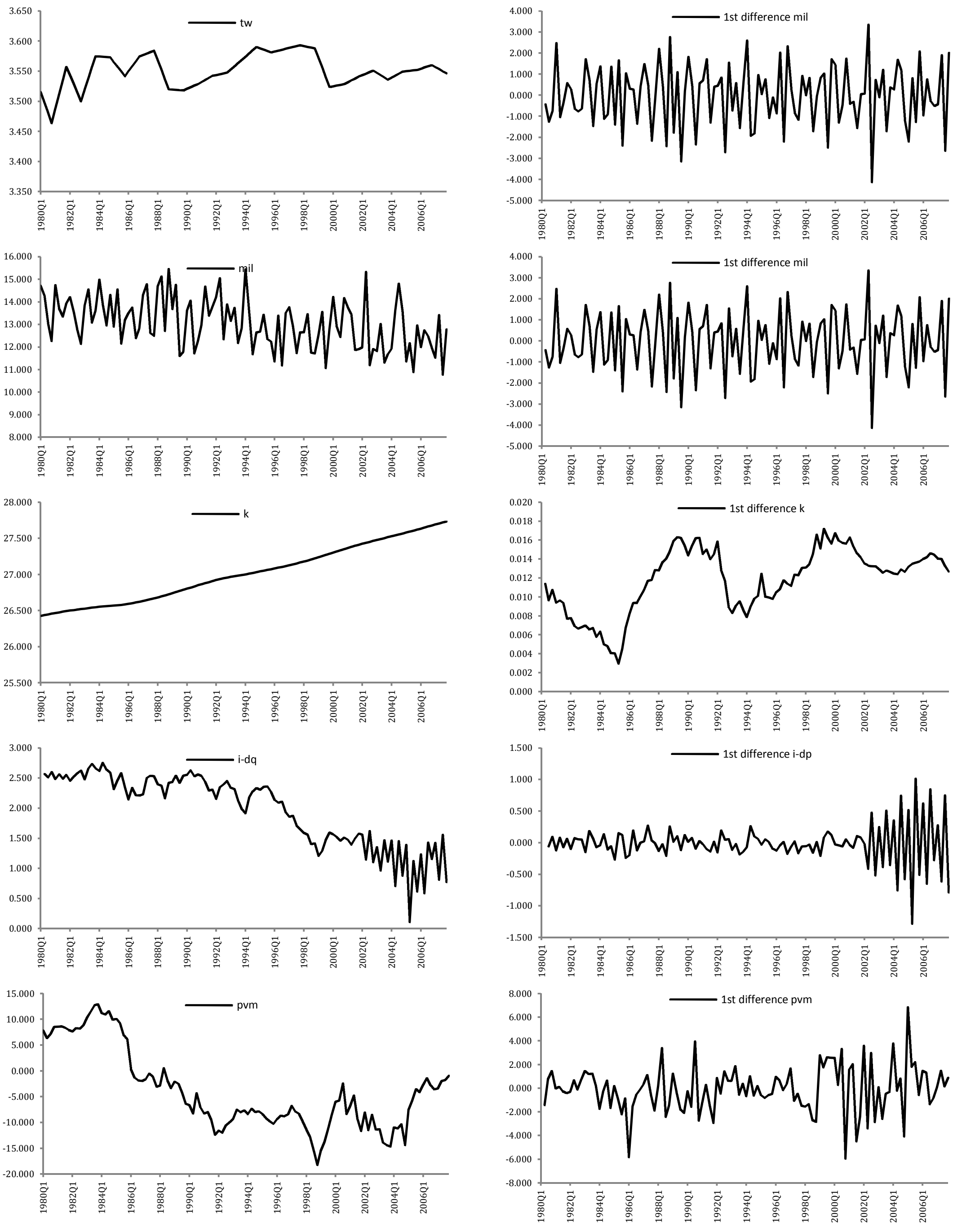


Figure II.6 Level and first difference of all variables, Spain

Variable	ADF-GLS(1)	ADF-GLS(2)	ADF-GLS(3)	ADF-GLS(4)	ADF-GLS(5)
(i) For the first differences					
$\Delta(w_t\text{-}p_t)$	-1.965	-1.498	-0.880	-0.824	-0.772
$\Delta(y_t\text{-}l_t)$	-6.968	-5.798	-4.057	-3.227	-2.291
Δu_t	-1.400	-1.197	-0.920	-0.738	-0.682
Δlu_t	-1.843	-1.859	-1.896	-1.386	-1.374
Δgrr_t	-1.153	-1.163	-1.181	-1.200	-1.223
Δt_t^w	-3.195	-3.243	-3.382	-1.494	-1.496
Δmil_t	-11.266	-11.359	-6.481	-4.979	-3.743
Δk_t	-1.528	-1.823	-1.921	-1.786	-2.171
$\Delta(i_t\text{-}\Delta p_t)$	-6.098	-6.466	-3.141	-3.056	-3.203
Δp_t^{vm}	-5.381	-3.976	-3.080	-3.168	-2.700
(ii) For the levels					
$w_t\text{-}p_t$	-0.141	-0.670	-0.778	-1.502	-1.589
$y_t\text{-}l_t$	-0.069	-0.277	-0.209	-0.421	-0.587
u_t	-1.025	-1.249	-1.320	-1.536	-1.720
lu_t	-0.866	-0.813	-0.739	-0.649	-0.896
grr_t	-1.415	-1.274	-1.130	-0.979	-0.832
t_t^w	-3.356	-2.881	-2.134	-1.329	-2.544
mil_t	-7.666	-6.389	-3.992	-4.008	-3.801
k_t	-2.505	-2.432	-1.995	-1.876	-2.012
$i_t\text{-}\Delta p_t$	-2.122	-2.681	-1.745	-2.510	-2.197
p_t^{vm}	-1.153	-1.404	-1.559	-1.798	-1.455

Table II.11 Results from ADG-GLS unit root test, Spain

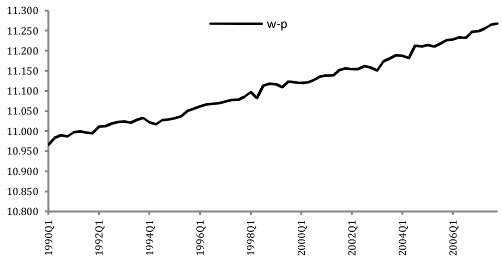
Note: ADF-GLS(*p*) represents Elliott et al. (1996) GLS augmented Dickey-Fuller unit root statistic for *p* lags. Test is carried with data covering the period between 1980q1-2007q4. (i) For the 1st difference equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable and an intercept. (ii) For the level equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable, an intercept and a time trend, except in the case of u_t and lu_t, where no time trend is considered. Critical value, at 5%, for regressions without trend is -1.950, and for regressions with trend is -3.018.

Variable	KPSS(0)	KPSS(2)	KPSS(4)	KPSS(6)	KPSS(8)	KPSS(10)	KPSS(12)
(i) For the first differences							
$\Delta(w_t\text{-}p_t)$	0.586	0.611	0.483	0.402	0.347	0.310	0.282
$\Delta(y_t\text{-}l_t)$	0.489	0.771	0.796	0.692	0.618	0.560	0.513
Δu_t	1.930	0.852	0.585	0.457	0.389	0.349	0.327
Δlu_t	5.480	2.040	1.350	1.050	0.895	0.796	0.730
Δgrr_t	2.400	0.930	0.640	0.533	0.494	0.480	0.472
Δt_t^w	0.125	0.063	0.064	0.078	0.089	0.093	0.096
Δmil_t	0.006	0.018	0.030	0.037	0.054	0.059	0.072
Δk_t	4.300	1.490	0.926	0.689	0.561	0.485	0.436
$\Delta(i_t\text{-}\Delta p_t)$	0.016	0.039	0.054	0.075	0.093	0.114	0.131
Δp_t^{vm}	0.219	0.233	0.211	0.213	0.230	0.246	0.264
(ii) For the levels							
$w_t\text{-}p_t$	2.270	0.774	0.472	0.344	0.274	0.231	0.202
$y_t\text{-}l_t$	2.620	0.904	0.555	0.406	0.324	0.273	0.238
u_t	3.540	1.220	0.761	0.567	0.462	0.398	0.356
lu_t	4.890	1.690	1.040	0.771	0.621	0.527	0.463
grr_t	1.560	0.557	0.356	0.272	0.226	0.198	0.179
t_t^w	0.731	0.263	0.177	0.142	0.123	0.111	0.103
mil_t	0.032	0.038	0.042	0.044	0.051	0.057	0.066
k_t	1.950	0.674	0.418	0.310	0.252	0.217	0.193
$i_t\text{-}\Delta p_t$	0.977	0.498	0.340	0.271	0.231	0.205	0.187
p_t^{vm}	1.840	0.662	0.422	0.322	0.268	0.235	0.213

Table II.12 Results from KPSS stationary test, Spain

Note: KPSS(*l*) represents Kwiatkowski et al. (1992)stationarity test based on the Bartlett window of size *l*. Test is carried with data covering the period between 1980q1-2007q4. (i) For 1st difference equations, KPSS test statistics are computed from a regression with and intercept and "*l*" lagged truncation parameter. (ii) For level equations, KPSS test statistics are computed from a regression with and intercept, time trend and "*l*" lagged truncation parameter, except in the case of u_t and lu_t, where no time trend is considered. Critical values at 5% for regressions without trend 0.463, for regressions with trend 0.146.

II.7 Denmark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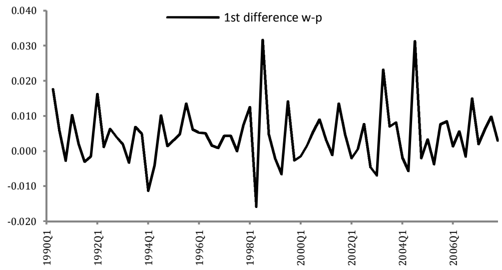
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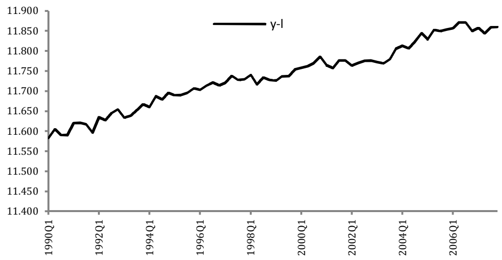
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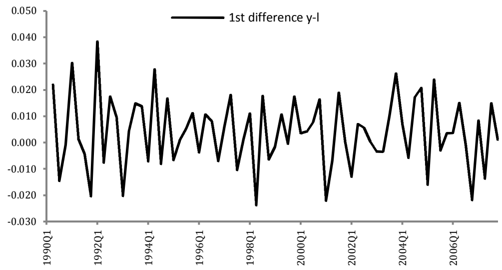
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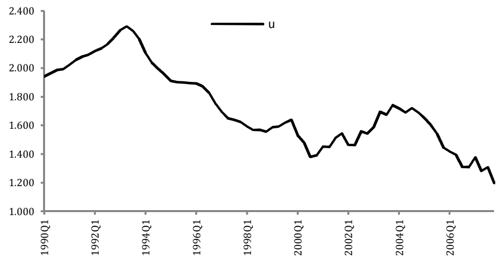
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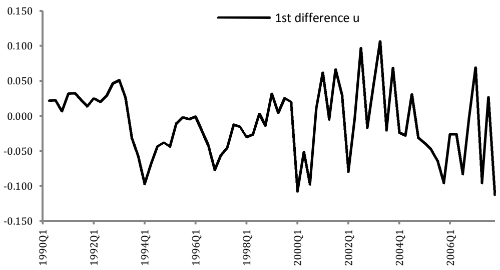
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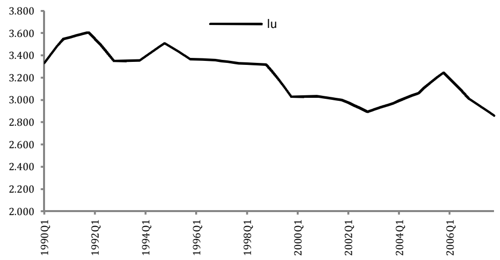
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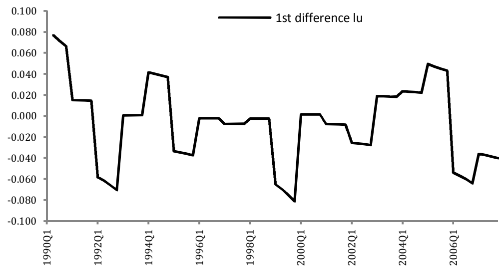
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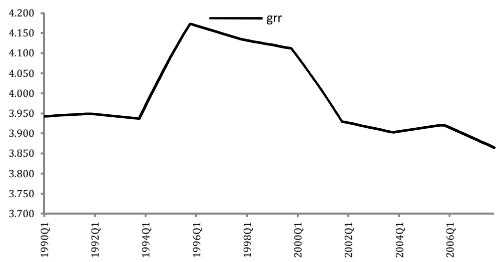
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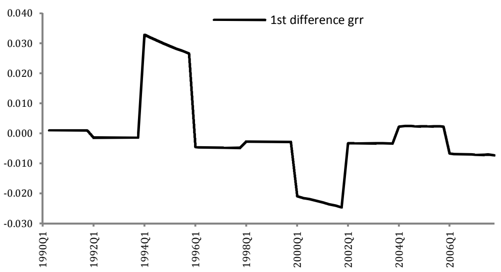
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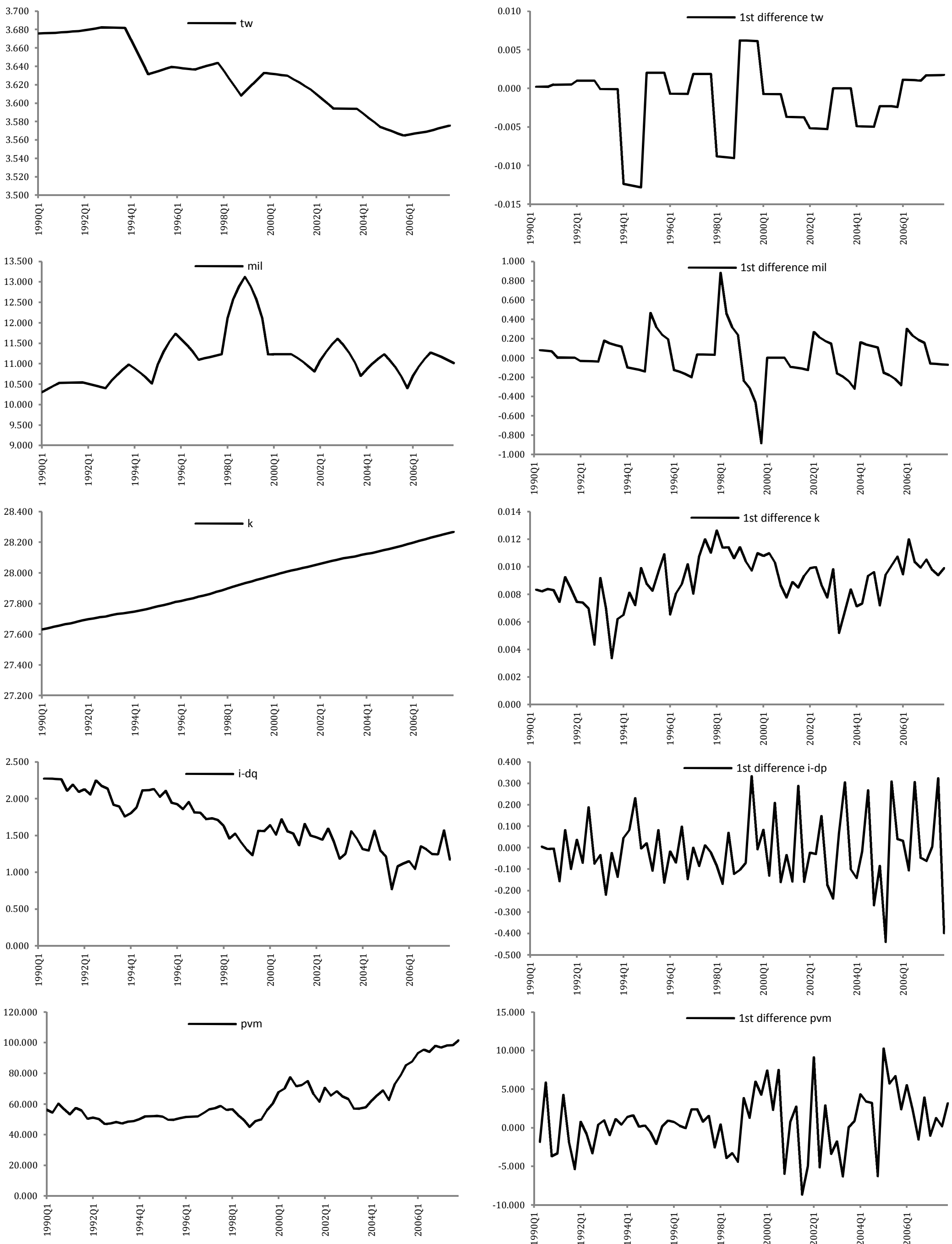


Figure II.7 Level and first difference of all variables, Denmark

Variable	ADF-GLS(1)	ADF-GLS(2)	ADF-GLS(3)	ADF-GLS(4)	ADF-GLS(5)
(i) For the first differences					
$\Delta(w_t-p_t)$	-3.619	-2.301	-1.470	-1.166	-1.104
$\Delta(y_t-l_t)$	-3.835	-2.253	-1.415	-0.971	-0.643
Δu_t	-3.558	-2.596	-3.427	-2.743	-1.978
Δlu_t	-1.628	-1.694	-1.781	-0.964	-1.016
Δgrr_t	-2.130	-2.191	-2.263	-2.351	-2.460
Δt_t^w	-3.771	-4.255	-5.023	-2.590	-2.723
Δmil_t	-4.159	-4.486	-6.174	-4.269	-3.781
Δk_t	-2.760	-1.807	-1.725	-2.251	-2.022
$\Delta(i_t-\Delta p_t)$	-6.721	-7.776	-3.292	-4.811	-5.161
Δp_t^{vm}	-3.991	-2.963	-2.514	-3.247	-2.509
(ii) For the levels					
w_t-p_t	-3.070	-2.381	-2.116	-2.348	-2.496
y_t-l_t	-2.499	-1.969	-1.901	-2.102	-2.158
u_t	-1.528	-1.965	-2.382	-1.562	-1.753
lu_t	-3.213	-2.884	-2.491	-2.025	-2.544
grr_t	-1.972	-1.872	-1.770	-1.658	-1.533
t_t^w	-3.841	-3.384	-2.749	-1.979	-3.259
mil_t	-2.910	-2.825	-2.354	-1.445	-1.617
k_t	-1.104	-1.496	-2.210	-2.302	-1.760
$i_t-\Delta p_t$	-3.517	-3.612	-2.334	-4.860	-3.262
p_t^{vm}	-1.138	-1.605	-1.974	-2.226	-1.418

Table II.13 Results from ADG-GLS unit root test, Denmark

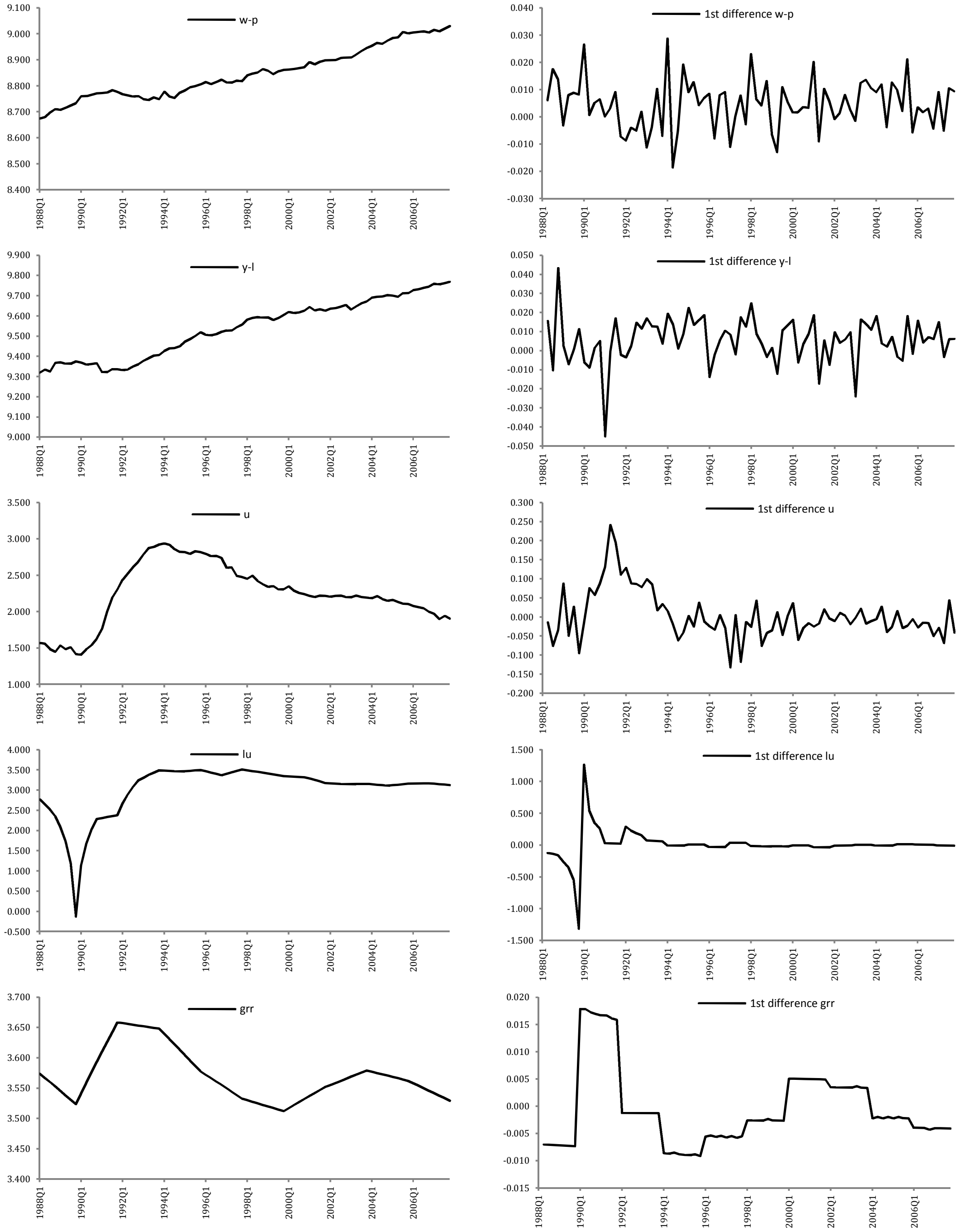
Note: ADF-GLS(*p*) represents Elliott et al. (1996) GLS augmented Dickey-Fuller unit root statistic for *p* lags. Test is carried with data covering the period between 1990q1-2007q4. (i) For the 1st difference equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable and an intercept. (ii) For the level equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable, an intercept and a time trend. Critical value, at 5%, for regressions without trend is -1.950, and for regressions with trend is -3.120.

Variable	KPSS(0)	KPSS(2)	KPSS(4)	KPSS(6)	KPSS(8)	KPSS(10)	KPSS(12)
(i) For the first differences							
$\Delta(w_t\text{-}p_t)$	0.038	0.077	0.091	0.111	0.142	0.159	0.159
$\Delta(y_t\text{-}l_t)$	0.036	0.083	0.093	0.105	0.122	0.129	0.152
Δu_t	0.278	0.183	0.149	0.139	0.132	0.128	0.129
Δlu_t	0.313	0.138	0.111	0.109	0.119	0.135	0.152
Δgrr_t	1.450	0.546	0.366	0.294	0.262	0.246	0.236
Δt_t^w	0.124	0.059	0.053	0.059	0.066	0.075	0.089
Δmil_t	0.147	0.081	0.081	0.107	0.140	0.162	0.181
Δk_t	1.110	0.533	0.357	0.287	0.247	0.224	0.210
$\Delta(i_t\text{-}\Delta p_t)$	0.017	0.028	0.035	0.050	0.067	0.078	0.089
Δp_t^{vm}	0.343	0.311	0.256	0.255	0.264	0.281	0.304
(ii) For the levels							
$w_t\text{-}p_t$	0.669	0.317	0.225	0.187	0.168	0.156	0.146
$y_t\text{-}l_t$	0.375	0.180	0.127	0.106	0.096	0.093	0.093
u_t	0.633	0.227	0.147	0.116	0.100	0.092	0.088
lu_t	0.524	0.191	0.130	0.107	0.097	0.091	0.089
grr_t	1.460	0.498	0.309	0.230	0.180	0.163	0.147
t_t^w	0.235	0.089	0.064	0.058	0.057	0.061	0.067
mil_t	0.946	0.349	0.241	0.199	0.175	0.159	0.148
k_t	0.904	0.314	0.198	0.151	0.126	0.112	0.105
$i_t\text{-}\Delta p_t$	0.200	0.108	0.088	0.086	0.090	0.096	0.103
p_t^{vm}	0.833	0.311	0.209	0.170	0.154	0.148	0.148

Table II.14 Results from KPSS stationary test, Denmark

Note: KPSS(*l*) represents Kwiatkowski et al. (1992) stationarity test based on the Bartlett window for size *l*. Test is carried with data covering the period between 1990q1-2007q4. (i) For 1st difference equations, KPSS test statistics are computed from a regression with and intercept and "*l*" lagged truncation parameter. (ii) For level equations, KPSS test statistics are computed from a regression with and intercept, time trend and "*l*" lagged truncation parameter. Critical values at 5% for regressions without trend 0.463, for regressions with trend 0.146.

II.8 Finland


w-p
1st difference w-p
y-l
1st difference y-l
u
1st difference u
lu
1st difference lu
grr
1st difference grr

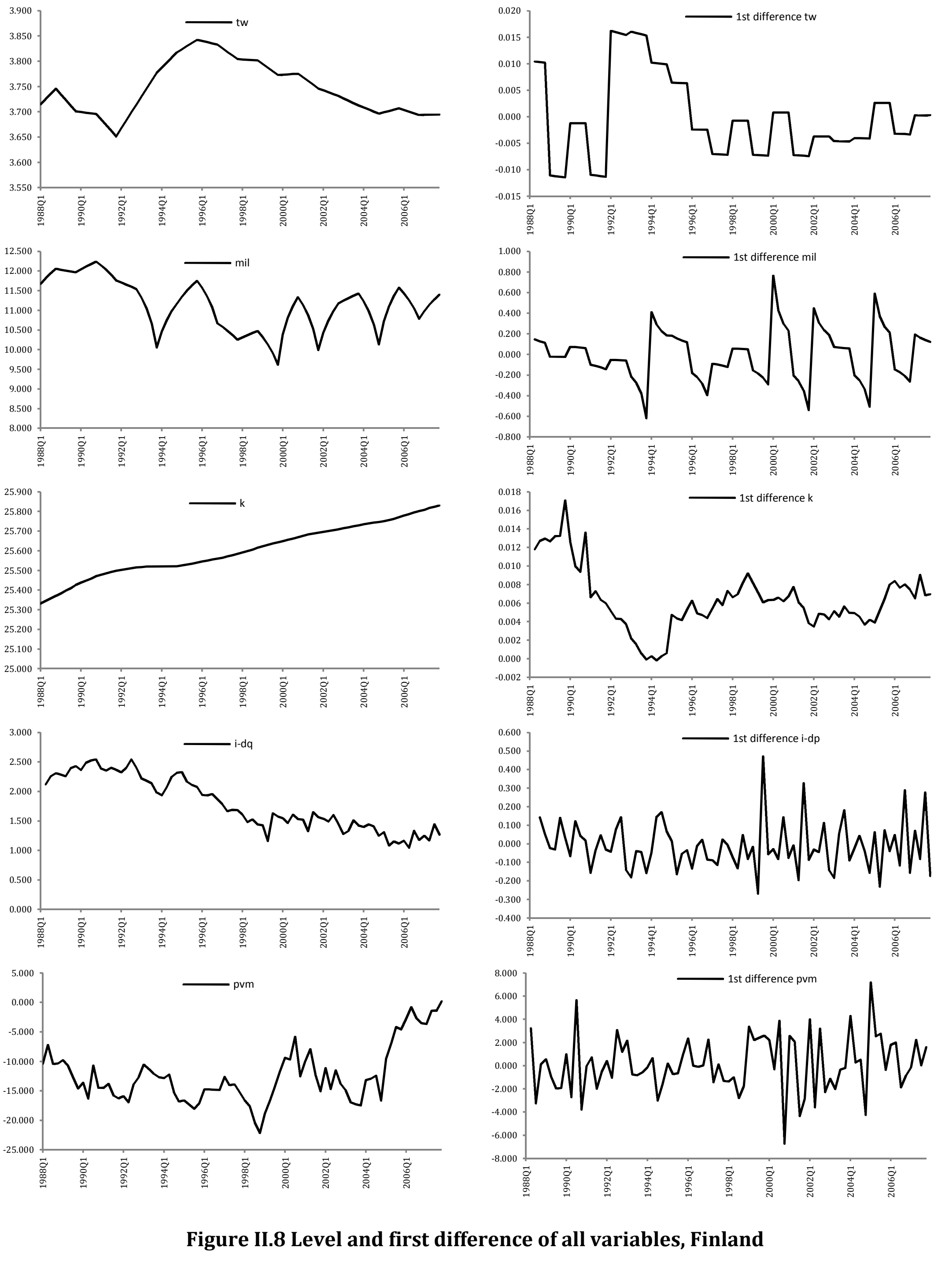


Figure II.8 Level and first difference of all variables, Finland

Variable	ADF-GLS(1)	ADF-GLS(2)	ADF-GLS(3)	ADF-GLS(4)	ADF-GLS(5)
(i) For the first differences					
$\Delta(w_t\text{-}p_t)$	-6.067	-3.734	-3.778	-3.124	-2.558
$\Delta(y_t\text{-}l_t)$	-4.551	-3.283	-2.383	-2.279	-2.022
Δu_t	-2.349	-2.167	-1.922	-2.049	-2.190
Δlu_t	-5.476	-4.654	-4.326	-3.672	-3.168
Δgrr_t	-2.080	-2.118	-2.115	-2.209	-2.276
Δt_t^w	-2.353	-2.371	-2.444	-1.479	-1.482
Δmil_t	-4.462	-4.470	-5.166	-3.615	-3.138
Δk_t	-1.229	-1.181	-1.138	-1.464	-1.478
$\Delta(i_t\text{-}\Delta p_t)$	-4.132	-3.326	-1.621	-1.817	-1.675
Δp_t^{vm}	-3.584	-2.599	-2.052	-1.917	-1.616
(ii) For the levels					
$w_t\text{-}p_t$	-1.597	-1.618	-2.122	-1.913	-2.151
$y_t\text{-}l_t$	-1.945	-1.947	-2.085	-2.470	-2.322
u_t	-1.129	-1.784	-1.865	-2.047	-1.889
lu_t	-2.264	-2.254	-2.162	-1.960	-1.949
grr_t	-2.699	-2.594	-2.485	-2.368	-2.206
t_t^w	-1.892	-1.768	-1.606	-1.434	-2.178
mil_t	-3.186	-3.068	-2.602	-1.770	-1.900
k_t	-2.436	-3.130	-3.406	-3.752	-2.822
$i_t\text{-}\Delta p_t$	-2.091	-2.019	-1.578	-2.326	-1.727
p_t^{vm}	-1.466	-1.687	-1.803	-1.996	-1.781

Table II.15 Results from ADG-GLS unit root test, Finland

Note: ADF-GLS(*p*) represents Elliott et al. (1996) GLS augmented Dickey-Fuller unit root statistic for *p* lags. Test is carried with data covering the period between 1988q1-2007q4. (i) For the 1st difference equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable and an intercept. (ii) For the level equations, ADF-GLS test statistics are computed using *p* lagged first differences of the dependent variable, an intercept and a time trend, except in the case of u_t, lu_t, grr_t and t_t^w, where no time trend is considered. Critical value, at 5%, for regressions without trend is -1.950, and for regressions with trend is -3.094.

Variable	KPSS(0)	KPSS(2)	KPSS(4)	KPSS(6)	KPSS(8)	KPSS(10)	KPSS(12)
(i) For the first differences							
$\Delta(w_t\text{-}p_t)$	0.086	0.105	0.096	0.087	0.087	0.091	0.095
$\Delta(y_t\text{-}l_t)$	0.074	0.079	0.074	0.072	0.071	0.076	0.076
Δu_t	1.450	0.672	0.455	0.362	0.311	0.282	0.265
Δlu_t	0.076	0.065	0.068	0.074	0.078	0.080	0.084
Δgrr_t	0.449	0.172	0.116	0.095	0.086	0.083	0.082
Δt_t^w	0.908	0.370	0.269	0.225	0.197	0.180	0.173
Δmil_t	0.105	0.065	0.071	0.098	0.128	0.144	0.147
Δk_t	1.110	0.412	0.266	0.206	0.175	0.159	0.150
$\Delta(i_t\text{-}\Delta p_t)$	0.051	0.082	0.090	0.116	0.123	0.125	0.126
Δp_t^{vm}	0.160	0.206	0.202	0.210	0.241	0.272	0.304
(ii) For the levels							
$w_t\text{-}p_t$	1.130	0.414	0.266	0.204	0.173	0.156	0.146
$y_t\text{-}l_t$	0.574	0.210	0.136	0.107	0.092	0.084	0.081
u_t	1.460	0.502	0.312	0.233	0.192	0.167	0.152
lu_t	2.640	0.947	0.610	0.468	0.391	0.345	0.315
grr_t	2.160	0.737	0.459	0.345	0.286	0.251	0.229
t_t^w	1.640	0.559	0.345	0.256	0.208	0.179	0.160
mil_t	1.010	0.382	0.268	0.223	0.196	0.178	0.164
k_t	0.438	0.158	0.103	0.082	0.072	0.067	0.066
$i_t\text{-}\Delta p_t$	0.425	0.192	0.137	0.116	0.105	0.098	0.094
p_t^{vm}	0.891	0.351	0.239	0.196	0.177	0.168	0.166

Table II.16 Results from KPSS stationary test, Finland

Note: KPSS(*l*) represents Kwiatkowski et al. (1992) stationarity test based on the Bartlett window for size *l*. Test is carried with data covering the period between 1988q1-2007q4. (i) For 1st difference equations, KPSS test statistics are computed from a regression with and intercept and "*l*" lagged truncation parameter. (ii) For level equations, KPSS test statistics are computed from a regression with and intercept, time trend and "*l*" lagged truncation parameter, except in the case of u_t, lu_t, grr_t and t_t^w, where no time trend is considered. Critical values at 5% for regressions without trend 0.463, for regressions with trend 0.146.