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80

Pablo F. Salvador

Labour Market Dynamics in the Nordic Countries according to the Chain Reaction Theory

JYVÄSKYLÄN YLIOPISTO

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ABSTRACT

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The purpose of this thesis is to review the distinct conceptions of the labour market offered by the major approaches dealing with the macroeconomics of the labour market and provide information on the main driving forces shaping unemployment in Denmark, Finland and Sweden according to the chain reaction theory. The thesis consists of an introductory chapter and four essays. The first essay deals with three major approaches to the macroeconomics of the labour market: (i) the *frictionless equilibrium view* of unemployment; (ii) the *hysteresis hypothesis*; and (iii) the chain reaction theory (CRT), or *prolonged adjustment view*, of unemployment. It argues that the CRT is not simply the middle ground between the frictionless equilibrium view and the hysteresis hypothesis since it explains the unemployment problem by recognising the interaction of growth and dynamics in the labour market. The second essay reassesses the role of the natural rate of unemployment (NRU) in policy making and argues that in the presence of frictional growth unemployment does not gravitate towards the NRU - instead, it can be described as chasing after a moving target. This essay focuses on Denmark and shows that the NRU can only explain one third of the variation in unemployment, while frictional growth accounts for the remaining two thirds. The third essay focuses on the relationship between capital stock and unemployment and shows that capital accumulation can explain the diverse unemployment experiences of the Nordic countries. It shows that capital stock explains around 30% of the Danish unemployment increase in the aftermath of the oil price shocks and near 15% of the increase in the crisis of the early 1990s. In Sweden, capital accumulation contributes to 50% of the unemployment upsurge during the 1990s. Finally, the unemployment rate in Finland would have been 5 percentage points lower without the 1992 permanent drop of its capital stock growth rate. The fourth essay provides an account of the unemployment performance of Denmark, Finland, and Sweden since the 1980s. It explores the unemployment effects of different explanatory variables in four different periods and examines the adjustment process of the unemployment rate to a temporary shock to capital stock. This essay shows that capital stock had an important role in the unemployment trajectory of the three Nordic countries and that the external sector significantly influenced the Finnish unemployment trajectory. Finally, it shows that it takes several years before a temporary shock is completely absorbed by the labour market. In particular, Finland experienced the greatest initial impact of the shock and the shock was far more persistent.

Keywords: Unemployment, labour market dynamics, capital stock, Nordic countries, chain reaction theory

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Pablo F. Salvador

CONTENTS

1 INTRODUCTION

1.1 Background and aims of the thesis

A wide variety of explanations have been proposed for the observed movements in European unemployment. Since the study of Layard, Nickell and Jackman (1991) much effort has been put to explain these movements by focusing on the role of shocks and institutions (see also Blanchard and Wolfers, 2000), institutions alone (for example, Nickell, Nunziata and Ochel, 2005 and Belot and van Ours, 2004), and the structure of the economy (see, for example, Phelps, 1994 and Phelps and Zoega, 2001). Nevertheless, there is an increasing interest among macro-labour economists to examine the role of growing variables such as capital stock in the evolution of the European unemployment rate. The resulting literature is extensive and fast growing - see, among others, Karanassou, Sala and Snower (2003, 2004), Stockhammer (2004), and Arestis, Baddeley and Sawyer (2007).

We distinguish three major approaches to the macroeconomics of the labour market. First, the *frictionless equilibrium view* of unemployment according to which the labour market adjusts quickly to external shocks. Second, the *hysteresis hypothesis* where the equilibrium unemployment rate no longer returns to levels before the shock once the temporary shock reverses, and therefore reaches a new equilibrium. Third, the chain reaction theory (CRT), or *prolonged adjustment view*, of unemployment which postulates that labour markets react to external shocks but only slowly given that labour market decisions are subject to adjustment costs.

In this thesis, we first review the prior evidence on the main determinants shaping unemployment in Europe since the 1960s. We focus on the mainstream literature accounting for the observed movements of unemployment in Europe as a whole. Then, we turn our attention to the Nordic countries – Denmark, Finland, and Sweden - and review some of the most salient features of the labour market structure in these economies and the prior evidence on the forces driving their unemployment rates. We then assess the distinct conceptions of the labour market offered by the three approaches and show that the CRT is not simply the middle ground between the frictionless equilibrium view and the hysteresis hypothesis. We illustrate that the CRT explains the unemployment problem by recognising the interaction of growth and dynamics in the labour market. Finally, we offer a comprehensive account of the three Nordic countries' labour market performance and provide information on the main driving forces shaping unemployment in Denmark, Finland and Sweden according to the CRT.

The structure of this introductory chapter is as follows. Section 1.2 deals with the reasons why we focus on the Nordic countries. Section 1.3 reviews the prior evidence on the unemployment determinants in Europe and the Nordic countries and some salient features of the labour market structure in Denmark, Finland, and Sweden. Section 1.4 provides a summary and the main results of the essays. Finally, Section 1.5 introduces topics for further research.

1.2 The Nordic countries as the focus of our empirical analysis

We focus our empirical analysis on the Nordic countries - Denmark, Finland, and Sweden - for three reasons.[1]

First, these economies are normally grouped because of their well-developed welfare state system, low levels of income inequality and successful performance opposite continental Europe. Nevertheless, the unemployment trajectories of Denmark, Finland and Sweden display significant disparities that are usually overlooked. While Sweden and Finland came out of the oil crises with hardly any damage, Denmark witnessed a large increase in its unemployment over the late 1970s and early 1980s. In contrast, although the 1990s crisis first hit Denmark, it did so less intensively than in Sweden and Finland. The analysis of the labour market of Finland and Sweden is of special interest. The unemployment trajectories of these countries were alike in the timing of the rise in unemployment from the trough in 1990 to the peak in 1994, but they differed in the size of the rise and in the unemployment evolution after the peak.

Second, the Nordic experience is much more volatile than the international average boom-bust pattern (Jonung, Schuknecht, and Tujula, 2006). For example, the Finnish unemployment increase in the early 1990s was not experienced by any other OECD country and in almost no other country the amplitude of the cycle was so large (Bordes, Currie and Söderström, 1993). Honkaphoja *et al.* (2009) argue that the Finnish depression of the 1990s was the most serious economic crisis in its peacetime history and more severe than the 1930s depression in many indicators and in words of Berg and Gröttheim (1997,

1 We omit Norway in this study for two reasons. First, Norway is not a member state of the EU. Second, Norway is mainly an oil-exporting economy, which makes it different from the rest of the Nordic countries.

p. 141), in the early 1990s Sweden experienced the worst recession since the 1930s.

Third, while studies on the CRT have focused on countries such as Germany, the UK, the US, and Spain and on panels of European countries, they have not directly examined the labour market performance of the Nordic countries individually providing, thus, a potential new avenue of research.

1.3 Prior evidence on the determinants of European and Nordic unemployment

1.3.1 Evolution of unemployment in Europe

In the 1960s and mid-1970s European unemployment was low and stable - around 2% (see Figure 1). However, after the two oil crises unemployment rates went up in almost all European countries. By the late 1970s, unemployment increased to 5% and continued to increase in the 1980s. In the mid-1980s, European unemployment exceeded 9% and hovered around 8% until the late 1980s. In the 1990s, unemployment rose again and remained over 8% almost throughout the decade. European unemployment started declining in the late 1990s, but stagnated close to 8% in the 2000s.

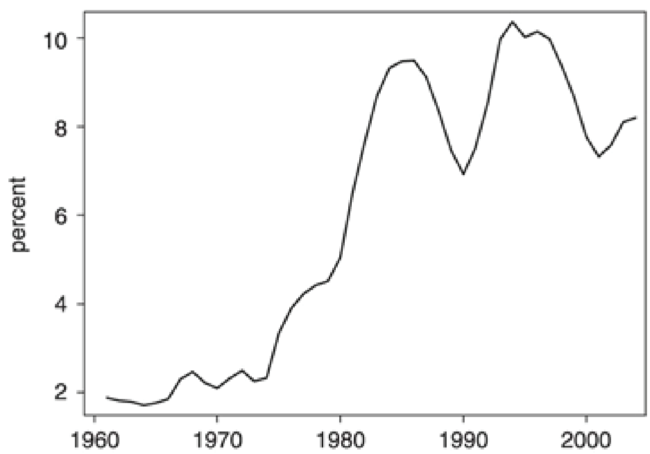

FIGURE 1 Unemployment rates: EU15

Many studies credit the rise of European unemployment in the mid-1970s and 1980s to oil price increases and higher real interest rates. Phelps (1994), for example, claims that higher oil prices and higher interest rates were the most important determinants of unemployment in Europe and that direct and payroll taxes were important in explaining the diverse experiences across countries. Phelps and Zoega (1998) extend the role of interest rates to the 1990s and restrict the effects of taxes mainly to the 1960s and 1970s. Furthermore, Phelps and Zoega (1997, 1998) find that the slowdown of productivity since the mid-1970s played a role as well.

Blanchard and Wolfers (2000) also point to oil price increases, and a sustained decrease in total factor productivity (TFP) growth in the mid-1970s and early 1980s. According to this study, an increase in "employment-unfriendly" institutions also exerted a crucial role. In this study, decreases in TFP growth, higher interest rates, tight macroeconomic policy, and demand shifts contributed to higher unemployment in the 1980s and 1990s. Interest rates have also been assigned a major role in the work of Blanchard (2006) according to which the high European unemployment of the 1980s was mainly driven by tight monetary policy used to reduce the inflation originated by accommodating monetary policy in response to adverse shocks of the 1970s. Blanchard and Summers (1986, 1987) argue that not only the shocks of the 1970s, but also their protracted effects were responsible for the high and persistent European unemployment of the late 1970s and 1980s.[2] According to these studies, interactions between shocks and labour market institutions led to a larger effect of shocks on unemployment. The study of Layard, Nickell and Jackman (1991) is one of the first to examining interactions between shocks and labour market institutions in Europe. It claims that the impact of the shock on unemployment differs across countries, given it depends on "time invariant" institutions, with different sets of institutions affecting the degree of unemployment persistence.[3] Scarpetta (1996) and Elmeskov, Martin, and Scarpetta (1998) also explain the rise of European unemployment in the 1980s and early 1990s by focusing on labour market institutions, shocks, and interactions between them. Furthermore, Scarpetta (1996) finds that labour market institutions matter not only for the unemployment level, but also for the speed of adjustment of the labour market.

However, according to Nickell, Nunziata and Ochell (2005) and Belot and van Ours (2004) interactions between labour market institutions and shocks did not help to explain unemployment patterns in Europe. Both studies rely on "changing" institutions to explain movements of unemployment in Europe between 1960 and the early 1990s. While in the former changing institutions alone account for most of these movements in the latter interactions between institutions also matter.[4]

In sum, the studies of the previous paragraph explain European unemployment by focusing on either the role of institutions and shocks or the role of institutions alone. While the latter group relies on changing institutions, the former one focuses on stable institutions. Independently of this assumption

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2 Subsequent studies have focused on the persistent effects of temporary shocks in the 1970s (see, among others, Alogoskoufis and Manning, 1988; Bianchi and Zoega, 1998; Hughes-Hallett and Piscitelli, 2002; Pivetta and Reis, 2004; and Logeay and Tober, 2006). Although their different approaches to interpreting the permanent shift of unemployment - as a change in the equilibrium rate of unemployment or as evidence of multiple equilibria - the main mechanisms explaining hysteresis are the ones proposed by Blanchard and Summers (1986, 1987) (see, Essay 1).

3 Nickell (1997) also attributes the great heterogeneity across countries in the 1980s and early 1990s to differences in institutions.

4 In the work of Nickell, Nunziata and Ochell (2005), changing institutions explain around 55% of the rise in European unemployment from the 1960s to the first half of the 1990s.

- changing or stable institutions - the labour market institutions used in these studies are classified in four groups: (i) unemployment protection legislation, with several measures of the generosity of unemployment benefits; (ii) employment protection legislation, with several indices indicating the strictness of the legislation on fixed-term and permanent contracts; (iii) union power, through different measures of union coverage and density and wage bargaining co-ordination; and (iv) taxes, including indirect, direct and payroll taxes as well as the fiscal wage. In turn, shocks refer mostly to oil price increases and the decline in TFP growth in the 1970s, and the rise of real interest rates, tight macroeconomic policy, and demand shifts in the 1980s and 1990s.

This interpretation of European unemployment focusing on (i) the structure of the economy, (ii) the role of shocks and institutions, and (iii) the role of institutions alone – defined in Essay 1 as the frictionless equilibrium view of unemployment – differs from the view of the CRT. According to this approach, the rise in European unemployment over the 1970s and first half of the 1980s was mainly driven by adverse permanent shocks, while temporary shocks accounted for the unemployment increase in the mid-1990s. In broader terms, the CRT explains the behaviour of European unemployment as follows. In the 1960s and mid-1970s, the labour force increased rapidly in Europe. This supposed a permanent shock – taking a long time to feed through the labour market - that manifested in a steady rise in unemployment in the 1970s. Two other permanent shocks further increasing European unemployment in this period were the productivity slowdown and the decline in capital accumulation. The after-effects of these permanent changes coupled with some temporary shocks – oil price increases, a rise in interest rates and a fall in competitiveness - kept European unemployment rising through the mid-1980s.[5] In the 1980s and 1990s, the labour force shock reversed. This permanent shock again took a long time to manifest itself and contributed to reduce European unemployment during the second half of the 1980s and the second half of the 1990s. However, high real interest rates and low competitiveness were the temporary shocks that pushed unemployment up in the early 1990s, taking some time before the unemployment rate came down significantly (Karanassou, Sala and Snower 2003, 2004).[6]

As noted, much emphasis has been put to explain movements of European unemployment in the last decades. Since the study of Layard, Nickell and Jackman (1991) the effort has been mainly targeted to the role of labour market institutions, shocks and interactions between them. Nevertheless, there is an increasing interest among macro-labour economists to examine the role of growing variables such as capital stock in the evolution of the European

[5] Competitiveness is measured as the ratio of import prices to GDP deflators.

[6] Most CRT studies explain part of the European unemployment increase by pointing to permanent labour force shocks – more precisely, the rise in working-age population. Nevertheless, in our empirical analysis of the Nordic countries, this variable exerts no significant influence on the labour supply; instead, we capture demographic influences on the labour supply movements through the participation rate.

unemployment rate. The resulting literature is extensive and fast growing. For example, Bean and Dréze (1991) focus on the sluggish wage response to the productivity growth slowdown in Europe in the aftermath of the oil price shocks and show that wage stickiness reduced employment and, hence, the capital stock profit rate. In turn, this prompted a decline in investment and capital accumulation that further increased unemployment. Stockhammer (2004) finds that capital accumulation is significantly related to the unemployment rate in the core European economies. Blanchard (2005) claims that capital accumulation has influenced the evolution of European unemployment rate over three decades. Arestis, Baddeley and Sawyer (2007) find a robust negative relationship between capital accumulation and unemployment in nine EMU countries.[7]

1.3.2 Labour market structure and unemployment trajectory in the Nordic countries

Before reviewing the mainstream literature accounting for the observed movements of unemployment in Denmark, Finland, and Sweden, we first briefly review the most salient features of the Danish, Finnish, and Swedish labour market structure. In particular, we focus on the following labour market institutions: (i) trade unions and wage bargaining system, (ii) unemployment protection legislation, and (iii) employment protection legislation.

1.3.2.1 Labour market structure in the Nordic countries

Trade unions and wage bargaining system

The Nordic countries are characterised by strong unions with wide membership and a relatively centralised and highly co-ordinated wage bargaining system.

According to OECD data, union density has increased since the 1970s in all three countries and current unionisation rates place around 70%. Collective agreements cover also non-union members and coverage rates are among the highest in Europe, between 80% and 90%.[8]

Apart from trade union density and coverage, an important feature of the wage bargaining system is the degree of wage bargaining centralisation and co-ordination.

In the 1970s, Denmark, Finland, and Sweden were among the most centralised and highly co-ordinated countries. Since then, Denmark and Sweden have moved towards greater decentralisation and lower co-ordination. Denmark joined the relatively decentralised group of countries in the 1980s and, since then, it has continuously moved in this direction. Sweden has moved from the relatively centralised group of countries to the intermediate group.

7 See Essay 3 for a discussion on the relationship between capital stock and unemployment.

8 See Visser (2006) and OECD employment outlook 2004.

In Denmark, the decentralisation has involved changes in both the horizontal and vertical dimension. In the horizontal dimension, it has implied a shift from general negotiations to sector specific negotiations, and a move to a less synchronised structure of bargaining. In the vertical dimension, collective agreements stipulate only general conditions – e.g. working hours, rules for flexible working hours, and minimal wages – and leave wage settlement to local negotiations (Andersen, 2003). In Sweden, the shift has been towards informal wage co-ordination in wage bargaining. Also, a national mediation institute was created in 2000 with the power to appoint mediators even without the consent of the parties concerned (see Holmlund, 2006 and Nymoen and Rødseth, 2003).

Finland has maintained a relatively high degree of centralisation and co-ordination in wage bargaining. However, according to Uusitalo (2005), Finland shows substantial differences in the degree of centralisation across time. Although most wage bargaining negotiations have been at the national level, some bargaining rounds have been at the industry level. Besides, the share of unions accepting the central bargain has also varied. Snellman (2005) argues that the Finnish collective bargaining system has, to some extent, moved towards decentralisation, mostly about working conditions and working hours, but sometimes in the design of payment schemes. Pekkarinen and Alho (2005, p. 65) claim that the Finnish bargaining system is a case of "managed decentralisation" because the average wage increase is relatively effectively co-ordinated by centralised agreements or pattern bargaining and, on the other hand, the wage structure is also shaped by decisions at the local level. Andersen (2005) asserts that changes towards a centralised decentralisation occurred in all Nordic countries once wage formation came under pressure in the 1980s and 1990s.

The wage bargaining system in the Nordic countries have, to a greater or lesser extent, shifted towards greater decentralisation and lower degree of co-ordination in recent decades. According to Andersen (2005), this trend is set to continue as further international integration poses new challenges to wage formation and other labour market institutions by increasing interdependencies across partners, by making wage formation to be more dependent on workers' qualifications and on firms and sectors' conditions, and by making foreign wage development more important for wage setting. This issue is of special importance in the Nordic countries where it may become more difficult or costly to maintain centralised wage bargaining arrangements with solidaristic elements (see also Alho, 2005).

Unemployment protection legislation

The unemployment benefit system is organised on a voluntary basis in the Nordic countries. Nevertheless, the accessibility conditions differ among them.

In Denmark, the unemployment benefit system distinguishes between unemployed ensured persons who voluntary join unemployment insurance funds (UI-funds) and receive unemployment benefits (UB) and unemployed uninsured persons entitled social assistance. The UI-funds are private associations of employees or self-employed persons, which purpose is to ensure economic support if unemployment. These associations are regulated and subsidised by the state and administered by the trade unions. The public assistance is administered by the municipalities. UB are taxable and cannot exceed 90% of the previous wage or a maximum amount of money. The maximum duration of benefits is 4 years, and the right to benefits can be regained by regular work for at least 6 months within the last 36 months. However, there are certain activation requirements. When UB expire, the individual would normally be eligible for social assistance. The social assistance's benefit depends, among other, on age and martial status.[9] Several reforms have been implemented since the mid-1990s, which purpose has been to move from a passive focus on income maintenance to a more active focus on bringing unemployed into employment. The most important reforms have been: (i) to shorten the benefit period, ii) to implement activation requirements both in the unemployment insurance scheme and in the social assistance scheme, and iii) to eliminate benefits eligibility by participating in activation measures (Andersen and Svarer, 2007, p. 402).[10]

In Finland, unemployment benefits consist of: (i) an earnings-related unemployment allowance, (ii) a basic unemployment allowance, and (iii) labour market subsidies. The former component is administered by trade unions, whereas the Social Insurance Institution administers the latter two. The earnings-related unemployment allowance consists of a basic component equal to the basic allowance, and an earnings-related component. The earnings-related component is 45% of the difference between previous daily earnings and the basic allowance. If the monthly salary exceeds 90 times the basic allowance, the earnings-related allowance declines to 20% for the part in excess. The basic unemployment allowance and the labour market subsidies are paid unlimited, while the earnings-related unemployment allowance is paid for a maximum of 500 days. Those unemployed who have already received unemployment allowance for 500 days, can receive a labour market subsidy from the state. The right to benefits can be regained when the claimant has been in employment for 34 weeks of at least 18 hours a week during a 24-month period. UB are taxable and cannot exceed 90% of the previous daily wage.[11] The major reform introduced in 2003 allows a benefit recipient to receive unemployment allowance after the 500-day maximum period. The rules of these additional days differ for persons born before and after 1950.[12]

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9 See, among others, Westergaard-Nielsen (2001) and Parsons, Tranaes and Lilleør (2003).

10 See Clasen and Viebrock (2008) for some recent reforms of the Danish and Swedish unemployment benefit systems.

11 For more detailed information visit the Federation of Unemployment Funds in Finland, http://www.tyj.fi/.

12 See, for example, Lassila (2005), Pekkarinen and Alho (2005), and Fregert and Pehkonen (2009).

In Sweden, unemployment benefits consist of: (i) an earnings-related unemployment insurance, and (ii) a basic insurance. The former is administered by trade unions and the latter by the government. All persons who work in Sweden are covered by the basic insurance and those who join UI-funds and satisfy member conditions and work requirements are entitled to receive earnings-related unemployment insurance. The basic insurance's amount depends on the average hours worked. In the earnings-related insurance, the daily benefit cannot exceed 80% of the previous daily wage during the first 200 days of benefit and 70% during the remaining 100 days. UB are taxable and the duration of benefits is 300 days. The right to benefits can be regained when the claimant has been in employment for at least 6 months during the past 12 months before becoming unemployed. The work during the six months must be at least 80 hours in a month or work for at least 480 hours during the last uninterrupted six-month period, with a breakdown such that the person has worked for at least 50 hours during each month.[13] The major UB reform introduced in 2001 allows a benefit recipient to restrict job search to his or her occupation and local labour market during the first 100 days of unemployment. After this period, the search area must be expanded.[14]

Another important component of the benefit system refers to expenditures on active labour market policies (ALMPs). Among the Nordic countries, Denmark has the highest ALMP spending as a percentage of GDP – roughly 2%, followed by Sweden with 1.5%, and finally Finland with roughly 1%. Most of the reforms over the past decades have been geared towards increasing the effectiveness of active programmes rather than rising ALMP spending. Some reforms include, among others, enhanced job placement efforts, early intervention in the unemployment spell and compulsory participation in programmes, and more efficient administration of public employment activities (see OECD, 2006).

Employment protection legislation

According to the OECD, Denmark, Finland, and Sweden are middle-ranked countries in employment protection legislation (EPL). The OECD provides measures on the strictness of EPL in three points in time: the late 1980s, the late 1990s and the year 2003.[15] These measures are summarised in three main areas: (i) regular employment, (ii) temporary employment, and (iii) collective dismissals. Also, the OECD provides an overall measure of EPL. The overall strictness of EPL varies among the Nordic countries; nevertheless, there has been some convergence to a less strict position, mostly in the 1990s. This change was slight in Finland and substantial in Denmark and Sweden. Denmark remains the least regulated Nordic country.

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13 For more detailed information visit the Swedish Federation of Unemployment Insurance Funds, http://www.samorg.org/.

14 See, Holmlund (2006), Eichhorst and Konle-Seidl (2006), and Fregert and Pehkonen (2009), among others.

15 See OECD employment outlook 2004, Table 2.A2.4.

Finland has introduced greater flexibility in the regulation of permanent employment in the late 1990s, while Denmark and Sweden have introduced more flexibility in the regulation of temporary employment. In particular, in Finland there is now more flexibility in local arrangements about working time. In addition, the period of notice in case of individual dismissals has been reduced and the negotiation period for collective dismissals has been shortened. In Sweden, private temporary agencies – providing brokerage services and renting temporary workers - were allowed in the early 1990s, and restrictions on temporary work contracts were relaxed (see, Fregert and Pehkonen, 2009). In Denmark, more employment categories are allowed to use temporary employment contracts, there are no longer limitations on how often the temporary contracts can be renewed, and there are no upper limits about how long one can be employed on temporary contracts (see, Andersen and Svarer, 2007).

1.3.2.2 Unemployment trajectory in the Nordic countries

As shown in Figure 2, unemployment in the Nordic countries has also been subject to lengthy variations. During the 1960s and mid-1970s unemployment remained low in the three Nordic countries - close to 1% in Denmark and around 2% in Finland and Sweden. However, this pattern changed after the two oil crises. Unemployment increased in the mid-1970s and continued to increase in the first part of the 1980s. By the mid-1980s, unemployment rose to almost 4%, 6% and 9% in Sweden, Finland and Denmark, respectively and declined by roughly 2 percentage points at the end of the decade. In the early 1990s, unemployment rates went up sharply. Finnish unemployment rose 15 percentage points between 1990 and 1994. In Sweden and Denmark unemployment rose, respectively, 7 and 5 percentage points between the late 1980s and 1993. In the second part of the 1990s, these rates started a fast lessening up to 2001. Finnish unemployment fell by 8.6 percentage points, from 18.2% in 1994 to 9.6% in 2001. Swedish unemployment went down by 4.5 percentage points, from 8.6% in 1993 to 4.1% in 2001. Danish unemployment fell almost 6 percentage points, from 10.0% in 1993 to 4.3% in 2001. Since 2001, unemployment stopped its falling path: it increased in Denmark and Sweden and stabilised in Finland. In 2005, these rates were close to, respectively, 5%, 6% and 9%.

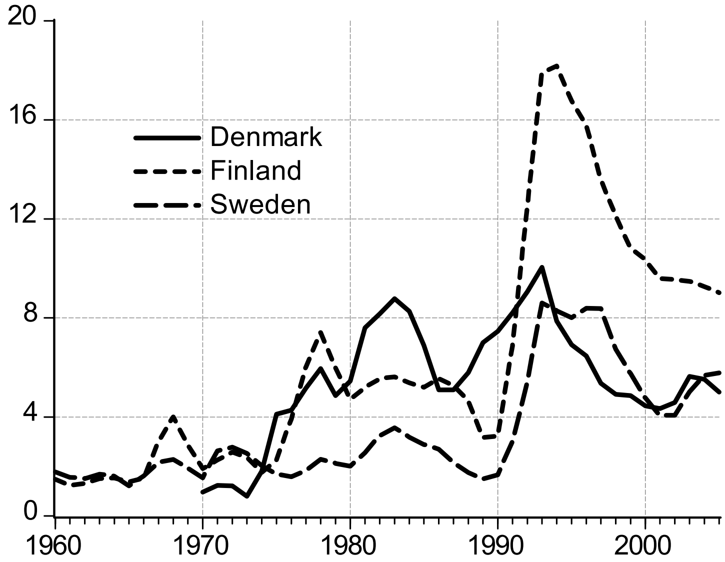

FIGURE 2 Unemployment rates: Nordic countries

The rise of Finnish unemployment in the mid-1970s and first part of the 1980s has been mostly ascribed to insufficient aggregate demand, labour force growth, and higher interest rates. According to Blomqvist (1987), the rise of unemployment in Finland is mainly explained by insufficient aggregate demand and to a lesser extent by the labour force growth. Besides, changes in income and payroll tax rates and changes in labour productivity also accounted for the changes in the unemployment rate in this period. Pehkonen (1989) also points to the rise in payroll taxes and increased labour force participation. Nevertheless, the rise in the availability of benefits while out of work, increased union activities, and adverse supply shocks - deterioration of the terms of trade caused mainly by the oil shocks – also played a role. Changes in payroll, income, and consumption taxes and enhanced bargaining power of unions are also assigned a role in the study of Kiander and Pehkonen (1999), which also stresses the important influence exerted by higher interest rates. Green-Pedersen (2001) and Green-Pedersen and Lindbom (2005) explain the unemployment hikes of the 1970s and early 1980s in Denmark by pointing to the two oil crises and a misguided fiscal and exchange rate poly.[16]

Contrary to the mid-1970s unemployment upturn, interest rates are the single most important factor explaining the unprecedented unemployment

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16 The 2 percentage points decline of the Finnish and Swedish unemployment rates in the late 1980s has been mainly an outcome of the financial liberalisation, expansionary domestic policies, and the international upswing. The surge in aggregate demand contributed to a fall in unemployment along with a gradual increase in inflation. The interaction of financial deregulation, progressive taxes and generous rules for deducting interest payments created the preconditions for a strong credit expansion. Asset prices rose, output and employment increased, and inflationary pressures were built up. By the end of the decade, the Nordic economies were overheated (see, for example, Holmlund, 2006; and Kiander, 2004). According to Christensen and Topp (1997), monetary policy and a significant tightening of the fiscal policy exerted a crucial role in the decline of Danish unemployment in the early 1980s (see also Andersen and Svarer, 2007).

upturn of the early 1990s in these economies. Honkapohja and Koskela (1999) describe the Finnish unemployment upturn of the early 1990s as a combination of bad lack - in the form of shocks - and bad policies. Shocks refer to the slow international growth, the fall in the terms of trade, high interest rates resulting from the German unification, and the collapse of trade with the Soviet Union. Bad policies refer to the mix of pro-cyclical fiscal policies and the fixed exchange rate policy, which jointly with a poorly designed deregulation of financial markets and foreign indebtedness of firms further increased interest rates and reinforced the rise of unemployment (see also Kiander and Pehkonen, 1999; Honkaphoja *et al.*, 2009; and Dahlman, Routti and Anttila, 2006). According to Koskela and Uusitalo (2006), shocks explained the rapid increase in unemployment in the early 1990s and interactions between them and stable institutions led unemployment to persist. Conesa, Kehoe, and Ruhl (2007), point to a combination of a drop in TFP and an increase in taxes on labour income and consumption. Holmlund (1996, 2006) argue that the Swedish unemployment upturn of the early 1990s was also a mix of bad lack - foreign macroeconomic shocks - and bad policies – domestic macroeconomic shocks. Foreign shocks refer to the international recession, the fall in the terms of trade, and the rise of real interest rates resulting from the German unification. On the other hand, domestic shocks refer to the tight monetary policy to defend the fixed exchange rate, the wavering fiscal policy (too lax in the late 1980s and restrictive in the early 1990s), and the badly timed tax-reform. However, institutional factors, such as the increase in the generosity of unemployment insurance reinforced the rise of Swedish unemployment (see also Forslund, 1995; Lindbeck, 1997; and Berg and Gröttheim, 1997). According to Alexius and Holmlund (2008), shocks to monetary policy caused around 30% of the variations of unemployment in this period, while institutional factors played only a minor role (see also Furåker, 2002). Green-Pedersen (2001) and Green-Pedersen and Lindbom (2005) point to the wavering fiscal policy, the deteriorated international wage competitiveness, and the badly timed tax-reform in the mid-1980s as the main causes that contributed to the collapse of aggregate demand and increased unemployment in Denmark in the early 1990s. Nannestad and Green-Pedersen (2001) also attribute the unemployment increase to a failure of economic policy. According to Westergaard-Nielsen (2001), the tight fiscal policy and the loss of competitiveness because of higher wages pushed unemployment up in the 1980s (see also Andersen *et al.*, 2001).

Like in the early 1990s, the behaviour of unemployment in the second part of the decade is mainly explained by monetary and fiscal policies and shocks (see, Jonung, Schuknecht, and Tujula, 2006; Holmlund, 2006; Alexius and Holmlund, 2008; and Fregert and Pehkonen, 2009). According to Kiander (2004), the revival in Finnish employment towards the end of the 1990s took place without any deep labour market reforms. In turn, the breakthrough of information and communication technologies (ICT) improved competitiveness and increased exports rapidly (see also Koski and Ylä-Anttila, 2006 and Honkaphoja *et al.*, 2009). In Denmark, measures reducing the labour force (leave schemes and early-retirement schemes) and good luck - the German unification that increased Danish exports - also accounted for the unemployment decline (Green-Pedersen, 2001; Westergaard-Nielsen, 2001; and Christensen and Topp, 1997).

In sum, Finland and Sweden experienced similar crises in the early 1990s. The origin of the slump can be traced to the second part of the 1980s when these economies deregulated their financial markets. The slump was mainly driven by a combination of bad luck and bad policies. Monetary and exchange rate policies were not used to stabilise the Finnish and Swedish economies in the 1990s as in the 1970s and 1980s, instead they were used to defend the exchange rates by rising interest rates (Kiander, 2004). Nevertheless, Finland had more bad luck than Sweden given the collapse of trade with the Soviet Union. In addition, fiscal policy was more consistently countercyclical in Sweden than in Finland (Honkapohja and Koskela, 1999) and the rise in interest rates, shocks and tax changes had a smaller impact in Sweden (Fregert and Pehkonen, 2009). Although Denmark experienced similar macroeconomic developments, it did not suffer a similar banking crisis, which Edey and Hviding (1995) attribute to a more prudential supervision of Danish banks and tighter capital standards.

In the following subsection, we present a summary and the main results of the four essays of this thesis, which contain our view of the main determinants shaping unemployment in Denmark, Finland, and Sweden from the CRT's perspective.

1.4 Summary and main results of the essays

1.4.1 Three major approaches to the macroeconomics of the labour market

Essay 1 deals with three major approaches to the macroeconomics of the labour market: (i) the *frictionless equilibrium view* of unemployment; (ii) the *hysteresis hypothesis*; and (iii) the chain reaction theory (CRT), or *prolonged adjustment view*, of unemployment.

This essay reviews the distinct conceptions of the labour market offered by the three approaches. It illustrates that the CRT explains the unemployment problem by recognising the interaction of growth and dynamics in the labour market and that one of its most salient features is that unemployment may substantially deviate from what is commonly perceived as its natural rate, even in the long-run. Finally, it argues that the CRT is not simply the middle ground between the frictionless equilibrium view and the hysteresis hypothesis, since the prolonged adjustments cover a wide diversity of phenomena explaining the movements of employment and unemployment and, most important, the CRT gives them individual and explicit attention rather than placing them between the other two views.

1.4.2 The (ir)relevance of the NRU for policy making: the case of Denmark

Essay 2 reassesses the role of the NRU in policy making and argues that in the presence of frictional growth unemployment does not gravitate towards the NRU – instead, it can be described as chasing after a moving target. This essay focuses on Denmark as this economy challenges the NRU predictions. It is one of the successful economies in Europe having recovered, after experiencing serious unemployment problems, an unemployment rate close to full-employment levels that is half the European average. The Danish labour market is among the most flexible and dynamic ones across Europe, resembling more the Anglo-Saxon model than the continental European labour markets.

Results from Essay 2 reveal that actual unemployment in Denmark does not evolve around its natural rate. The NRU can only explain one third of the variation in unemployment, while frictional growth accounts for the remaining two thirds. The analytic and empirical findings contained in this essay question the prominent role of the NRU in policy modelling.

1.4.3 Capital accumulation and unemployment: new insights on the Nordic experience

Essay 3 focuses on the relationship between capital stock and unemployment. It examines the proposition that the slowdown in the growth rate of capital is responsible for the rise in the Danish, Finnish and Swedish unemployment rate. It argues that capital stock is a determinant of unemployment, both in the short- and the long-run, and shows that capital accumulation can explain the diverse unemployment experiences of the Nordic countries. Essay 3 only focuses on the episodes of “high unemployment” in the Nordic countries and evaluates the extent to which capital accumulation is responsible for their diverse unemployment upturns over the last decades. Specifically, it examines the rise in Danish unemployment in the aftermath of the oil price shocks and the large unemployment increases in the early 1990s in all three economies. To link these unemployment upturns and the trajectory of capital stock, it first identifies the downturns in the growth rate of capital stock using kernel density analysis. It then conducts dynamic simulations to measure the contributions of capital stock to unemployment movements. These contributions quantify the unemployment effects of capital accumulation.

Results from Essay 3 show that capital stock explains around 30% of the Danish unemployment increase in the aftermath of the oil price shocks and near 15% of the increase in the crisis of the early 1990s. In Sweden, capital accumulation contributes to 50% of the unemployment upsurge during the 1990s. Finally, the unemployment rate in Finland would have been 5 percentage points lower without the 2 percentage points permanent drop of its capital stock growth rate in 1992.

1.4.4 The Nordic experience revisited: explaining labour market booms and slumps since the 1980s

Essay 4 provides an account of the unemployment performance of Denmark, Finland, and Sweden during their recent labour market booms and slumps. It uses the empirical models of the previous essays to conduct new simulation exercises and further explore the determinants of unemployment. The analysis of this essay differs in three respects. First, it examines the unemployment effects of the whole set of explanatory variables, not only of changes in capital stock, on the Danish, Finnish, and Swedish unemployment trajectories. Second, it evaluates the impact of these exogenous variables in four different periods since 1980, instead of just focusing on the episodes of high unemployment. Third, it examines the process of adjustment of the unemployment rate to a temporary shock to capital stock.

Results from Essay 4 suggest that capital stock had an important role in the unemployment trajectory of the three countries, especially during the Finnish unemployment upturn in the 1990s. Fiscal policy also played an important role in Denmark and Sweden in the mid-1980s and in Finland during the first part of the 1990s, but its role was modest in the rest of the periods analysed. The external sector significantly influenced the Finnish unemployment trajectory. Variations in participation rates also had an impact on Danish, Finnish, and Swedish labour markets. Finally, the analysis also shows that it takes several years before a temporary shock to capital stock is completely absorbed by the labour market. In particular, Finland experienced the greatest initial impact of the shock and the shock was far more persistent. Nevertheless, the impact and persistence of the shock were also significant in Denmark and Sweden.

1.5 Topics for further research

The empirical essays of this thesis illustrate the importance of non-standard labour market variables in examining the unemployment trajectory of the Nordic countries. In particular, this study reveals that capital stock played the most important role in explaining the diverse unemployment experience of Denmark, Finland, and Sweden in the last decades.

Given the significant unemployment contributions of capital accumulation, we argue in this study that policies related to R&D activities, policies promoting innovations and productivity growth, or policies directly fostering investment and capital accumulation, can enhance the performance of the labour market. According to Chusseau and Hellier (2008), this is especially the case in the Nordic countries where the policy design combines subsidies to R&D and a great effort of redistribution and this results in higher growth, low inequality, and full employment. Piekkola (2006), however, finds evidence of a positive effect of public subsidies to R&D on productivity growth only in small- and medium-sized Finnish firms and improved employment in companies with highly-paid R&D workers. Honkaphoja *et al.* (2009) agree on the importance of R&D policies and the role that the production and use of ICT plays in the Nordic countries. Plougmann and Madsen (2005) acknowledge this role in Denmark and Sweden. Other studies emphasising the role of ICT and R&D investments with a particular focus on the Finnish economy are Ebersberger (2004), Kiander (2004), and Dahlman, Routti and Ylä-Anttila (2006). Herbertsson (2003) points to both physical and human capital accumulation as a source of growth in the Nordic countries. According to Dahlman, Routti and Ylä-Anttila (2006), education is the most important element in a knowledge-based, innovation-driven economy, and human capital and skilled labour complement technological advances. In words of Honkaphoja *et al.* (2009, p. 83) investments in education and investments in R&D can be considered as investment in human capital and accumulation of human capital increases productivity and contributes to the economic growth.

The previous paragraph confirms how important is to (i) model technical change, (ii) include measures of R&D investments, (iii) evaluate the efficiency of the dual tax system on capital accumulation, and (iv) examine to which extent human capital accumulation is a source of growth and accounts for different unemployment experiences, in the analysis of the labour market of the Nordic countries. Given that in this study we have not explicitly considered these issues, they provide an avenue for future work.

REFERENCES

Alexius, A. and B. Holmlund (2008), "Monetary policy and Swedish unemployment fluctuations", *Economics: The Open-Access, Open-Assessment E-Journal*, 2, 2008-4.

Alho, K. (2005), "Productivity, Incentives and Relative Wages", in Piekkola, H. and K. Snellman (eds), *Collective bargaining and wage formation - performance and challenges*, Physica-Verlag, Heidelberg.

Alogoskoufis, G. and A. Manning (1988), "On the persistence of unemployment", *Economic Policy*, 3 (2), pp. 427-469.

Andersen, T. (2003), "Changes in Danish labour market bargaining. The prototypical case of organised decentralization?, in Dølvik, J.E. and F. Englestad (eds.), *National regimes of collective bargaining in transformation: Nordic trends in comparative perspective*, Makt-og demokratiutredningen, Norge**.**

Andersen, T. (2005), "International product market integration and wage bargaining", in Piekkola, H. and K. Snellman (eds), *Collective bargaining and wage formation - performance and challenges*, Physica-Verlag, Heidelberg.

Andersen, T. and M. Svarer (2007), "Flexicurity - labour market performance in Denmark", *CESifo Economic Studies*, 53 (3), pp. 389-429.

Andersen, T., B. Dalum, H. Linderoth, V. Smith and N. Westergaard-Nielsen (2001), *The Danish economy, an international perspective*, DJØF Publishing, Copenhagen.

Arestis, P., M. Baddeley and M. Sawyer (2007), "The relationship between capital stock, unemployment and wages in nine EMU countries", *Bulletin of Economic Research*, 59 (2), pp. 125-148.

Bean, Ch. and J. Dréze (1991), *Europe's unemployment problem*, The MIT Press, Cambridge MA.

Belot, M. and J. van Ours (2004), "Does the recent success of some OECD countries in lowering their unemployment rates lie in the clever design of their labour market reforms?", *Oxford Economic Papers*, 56 (4), pp. 621-642.

Berg, C. and R. Gröttheim (1997), "Monetary policy in Sweden since 1992", pp. 140-182, in *Monetary policy in the Nordic countries: experiences since 1992, BIS Policy Papers*, 2.

Bianchi, M. and G. Zoega (1998), "Unemployment persistence: does the size of the shock matter?", *Journal of Applied Econometrics*, 13 (3), pp. 283-304.

Blanchard, O. (2005), "Monetary policy and unemployment", in Semmler, W. (ed.), *Monetary policy and unemployment - US, Euro-area, and Japan*, Routledge, London.

Blanchard, O. (2006), "European unemployment: the evolution of facts and ideas", *Economic Policy*, 21 (45), pp. 5-59.

Blanchard, O. and L. Summers (1986), "Hysteresis and the European unemployment problem", pp. 15-77, *NBER Macroeconomics Annual*, 1, The MIT Press, Cambridge MA.

Blanchard, O. and L. Summers (1987), "Hysteresis in unemployment", *European Economic Review*, 31, 1/2, pp. 288-295.

Blanchard, O. and J. Wolfers (2000), "The role of shocks and institutions in the rise of European unemployment: the aggregate evidence", *The Economic Journal*, 110 (462), pp. C1-C33.

Blomqvist, H. C. (1987), "The causes of unemployment in Finland 1970-1982: some empirical evidence", *Applied Economics*, 19 (5), 687-694.

Bordes, C., D. Currie and H.T. Söderström (1993), "Three assessments of Finland's economic crisis and economic policy", *Bank of Finland Publications*, C:9.

Christensen, A. M. and J. Topp (1997), "Monetary policy in Denmark since 1992", pp. 5-23, in *Monetary policy in the Nordic countries: experiences since 1992*, *BIS Policy Papers*, 2.

Chusseau, N. and J. Hellier (2008), "Social policies and R&D subsidies: impact on inequality, unemployment, growth and the tax burden", *International Journal of Manpower*, 29 (3), pp. 239-262.

Clasen, J. and E. Viebrock (2008), "Voluntary unemployment insurance and trade union membership: investigating the connections in Denmark and Sweden", *Journal of Social Policy*, 37 (3), pp. 433–451.

Conesa, J.C., T. Kehoe and K. Ruhl (2007), "Modeling great depressions: the depression in Finland in the 1990s", *Quarterly Review*, Nov, pp. 16-44.

Dahlman, C., J. Routti and P. Ylä-Anttila (2006), *Finland as a knowledge economy. Elements of success and lessons learned*, World Bank, Washington DC.

Ebersberger, B. (2004), "Labor demand effect of public R&D funding", *VTT Working Papers*, 9.

Edey, M. and K. Hviding (1995), "An assessment of financial reform in OECD countries", in *OECD Economics Studies, 25*, OECD Publishing.

Eichhorst, W. and R. Konle-Seidl (2006), "The interaction of labor market regulation and labor market policies in welfare state reform", *Comparative Labor Law and Policy Journal*, 28 (1), pp. 1-42.

Elmeskov, J., J. Martin, and S. Scarpetta (1998), "Key lessons for labour market reforms: evidence from OECD countries' experiences", *Swedish Economic Policy Review*, 5 (2), pp. 205-252.

Forslund, A. (1995), "Unemployment - is Sweden still different?", *Swedish Economic Policy Review*, 2 (1), pp. 15-58.

Fregert, K. and J. Pehkonen (2009), "The crises of the 1990s and unemployment in Finland and Sweden", in Jonung, L., J. Kiander and P. Vartia (eds.), *The crises of the 1990s in Finland and Sweden*, Edward Elgar. (forthcoming)

Furåker, B. (2002), "Is high unemployment due to welfare state protection? Lessons from the Swedish experience", pp. 123-42, in Goul Andersen, J., J. Clasen, W. van Oorschot and K. Halvorsen (eds), *Europe's new state of welfare. Unemployment, employment policies and citizenship,* Policy Press, Bristol.

Green-Pedersen, C. (2001), "Minority governments and party politics: the political and institutional background to the "Danish Miracle"", *Journal of Public Policy*, 21 (1), pp. 53-70.

Green-Pedersen, C. and A. Lindbom (2005), "Employment and unemployment in Denmark and Sweden: success or failure for the universal welfare model", pp. 65-85, in Becker, U. and H. Schwartz (eds.), *Employment "miracles" in critical comparison. The Dutch, Scandinavian, Swiss, Australian and Irish cases versus Germany and the USA*, Amsterdam University Press, Amsterdam.

Herbertsson, T.T. (2003), "Accounting for human capital externalities with an application to the Nordic countries, *European Economic Review*, 47 (3), pp. 553-567.

Holmlund, B. (1996), "The evolution of unemployment in Sweden", mimeo, University of Uppsala.

Holmlund, B. (2006), "The rise and fall of Swedish unemployment", pp. 103-132, in Werding, M. (ed), *Structural unemployment in western Europe: reasons and remedies*, The MIT Press, Cambridge MA.

Honkapohja, S. and E. Koskela (1999), "Finland's depression: a tale of bad luck and bad policies", *Economic Policy*, 14 (29), 400-436.

Honkapohja, S., E. Koskela, W. Leibfritz and R. Uusitalo (2009), *Economic prosperity recaptured: the Finnish path from crisis to rapid growth*, The MIT Press, Cambridge MA.

Hughes-Hallett, A.J. and L. Piscitelli (2002), "Testing for hysteresis against nonlinear alternatives", *Journal of Economic Dynamics and Control*, 27 (2), pp. 303-327.

Jonung, L., L. Schuknecht and M. Tujula (2006), "The boom-bust cycle in Finland and Sweden 1984-1995 in an international perspective", *CFS Working Paper*, 2006/13.

Karanassou, M., H. Sala and D.J. Snower (2003), "Unemployment in the European Union: a dynamic reappraisal", *Economic Modelling*, 20 (2), pp. 237-273.

Karanassou, M., H. Sala and D.J. Snower (2004), "Unemployment in the European Union: institutions, prices and growth", *CESifo Working Paper Series*, 1247.

Kiander, J. (2004), "The evolution of the Finnish model in the 1990s: from depression to high-tech boom", *VATT Discussion Papers*, 344.

Kiander, J. and J. Pehkonen (1999), "Finnish unemployment: observations and conjectures", *Finnish Economic Papers*, 12 (2), pp. 94-108.

Koskela, E. and R. Uusitalo (2006), "The unintended convergence: how Finnish unemployment reached the European level", pp. 159-185, in Werding, M. (ed), *Structural unemployment in western Europe: reasons and remedies*, The MIT Press, Cambridge MA.

Koski, H. and P. Ylä-Anttila (2006), "Structural changes in the Finnish economy: from agriculture to high-tech", in Dahlman, C., J. Routti and P. Ylä-Anttila (eds.): *Finland as a knowledge economy. Elements of success and lessons learned,* World Bank, Washington DC.6.

Lassila, J. (2005), "Bargaining on pensions: the Finnish pension reform of 2001-2002", in Piekkola, H. and K. Snellman (eds), *Collective bargaining and wage formation - performance and challenges*, Physica-Verlag, Heidelberg.

Layard, R., S. Nickell, and R. Jackman (1991), *Unemployment: macroeconomic performance and the labour market*, Oxford University Press, Oxford.

Lindbeck, A. (1997), "The Swedish experiment", *Journal of Economic Literature*, 35 (3), pp. 1273-1319.

Logeay, C. and S. Tober (2006), "Hysteresis and the NAIRU in the Euro area", *Scottish Journal of Political Economy*, 53 (4), pp. 409-429.

Nannestad, P. and C. Green-Pedersen (2001), "Keep the bumblebee flying: economic policy in the welfare state of Denmark, 1973-1999", in AlbÆk, E. *et al.* (eds.), *Managing the Danish welfare state under pressure: towards a theory of the dilemmas of the welfare state*, Aarhus University Press, Aarhus. (forthcoming)

Nickell, S. (1997), "Unemployment and labor market rigidities: Europe versus North America", *Journal of Economic Perspectives*, 11 (3), pp. 55-74.

Nickell, S., L. Nunziata and W. Ochel (2005), "Unemployment in the OECD since the 1960s: what do we know?", *The Economic Journal*, 115 (500), pp. 1-27.

Nymoen, R. and A. Rødseth (2003), "Explaining unemployment: some lessons from Nordic wage formation", *Labour Economics*, 10 (1), pp. 1-29.

OECD (2006), *Employment outlook*, Paris.

Parsons, D., T. Tranæs and H. Lilleør (2003), "Voluntary public unemployment insurance", *CESifo Working Paper Series*, 1010.

Pehkonen, J. (1989), "The causes of unemployment in Finland 1970-82: some further empirical evidence", *Applied Economics*, 21 (6), 723-739.

Pekkarinen, J. and K. Alho (2005), "The Finnish bargaining system: actors' perceptions", in Piekkola, H. and K. Snellman (eds), *Collective bargaining and wage formation - performance and challenges*, Physica-Verlag, Heidelberg.

Phelps, E. (1994), *Structural slumps: the modern equilibrium theory of unemployment, interest and assets*, Harvard University Press, Cambridge MA.

Phelps, E. and G. Zoega (1997), "The rise and downward trend of the natural rate", *The American Economic Review Papers and Proceedings*, 87 (2), pp. 283-289.

Phelps, E. and G. Zoega (1998), "Natural rate theory and OECD unemployment", *The Economic Journal*, 108 (448), pp. 782-801.

Phelps, E. and G. Zoega (2001), "Structural booms: productivity expectations and asset valuations", *Economic Policy,* 32 (16), pp. 85-126.

Piekkola, H. (2006), *Knowledge and innovation subsidies as engines for growth – The competitiveness of Finnish regions*, Taloustieto Oy, Helsinki.

Pivetta, F. and R. Reis (2004), "The persistence of inflation in the United States", *manuscript*, Harvard University.

Plougmann, P. and P.K. Madsen (2005), "Labor market policy, flexibility and employment performance: Denmark and Sweden in the 1990s", in Howell, D.R. (ed.), *Fighting unemployment: the limits of free market orthodoxy*, Oxford University Press, Oxford.

Scarpetta, S. (1996), “Assessing the role of labour market policies and institutional settings on unemployment: a cross-country study”, *OECD Economic Studies*, 26, pp. 43-98.

Snellman, K. (2005), “Finnish wage bargaining - actual behaviour and preferentes”, in Piekkola, H. and K. Snellman (eds), *Collective bargaining and wage formation - performance and challenges*, Physica-Verlag, Heidelberg.

Stockhammer, E. (2004), “Explaining European unemployment: testing the NAIRU theory and a Keynesian approach”, *International Review of Applied Economics*, 18 (1), pp. 3-23.

Uusitalo, R. (2005), ”Do centralized bargains lead to wage moderation? Time-series evidence from Finland”, in Piekkola, H. and K. Snellman (eds), *Collective bargaining and wage formation - performance and challenges*, Physica-Verlag, Heidelberg.

Visser, J. (2006), “Union Membership statistics in 24 countries”, *Monthly Labor review*, 129 (1), pp. 38-49.

Westergaard-Nielsen, N. (2001), "Danish labour market policy: is it worth it?", *CLS Working Papers*, 01-10.

2 ESSAY 1: THREE MAJOR APPROACHES TO THE MACROECONOMICS OF THE LABOUR MARKET

ABSTRACT. This paper examines three major approaches to the macroeconomics of the labour market: (i) the *frictionless equilibrium view* of unemployment; (ii) the *hysteresis hypothesis*; and (iii) the chain reaction theory (CRT), or *prolonged adjustment view*, of unemployment. It shows that the CRT is not simply the middle ground between the frictionless equilibrium view and the hysteresis hypothesis, since it explains the unemployment problem by recognising the interaction of growth and dynamics in the labour market.

2.1 Introduction

During the last decades much attention has been placed on the labour market performance of Europe and the differing experiences across countries. The low and stable behaviour of unemployment in the 1960s and early 1970s led many economists to think on the idea of a "natural rate" to which unemployment would tend after short-run variations. However, after the two oil crises unemployment rates went up in almost all European countries. The high and rising European unemployment during the 1980s and its persistence led to reconsider the existence of a natural rate of unemployment (NRU), and brought the hysteresis hypothesis into the scene. In the early 1990s, European unemployment rose again fuelled by the international recession and the German reunification. Although European unemployment started to decline in the late 1990s, it stagnated at high rates in the 2000s.

Since the study of Layard, Nickell and Jackman (1991), much effort has been put to explain movements of European unemployment by focusing on the role of shocks and institutions (see also Blanchard and Wolfers, 2000). However, some studies focus purely on the role of institutions (for example, Nickell, Nunziata and Ochel, 2005 and Belot and van Ours, 2004). While others such as

Phelps (1994) and Phelps and Zoega (2001) focus on the structure of the economy. Nevertheless, there is an increasing interest among macro-labour economists to examine the role of growing variables such as capital stock in the trajectory of European unemployment - see, among others, Karanassou, Sala and Snower (2003, 2004).

These explanations proposed for the observed movements in European unemployment may be grouped in three: (i) the *frictionless equilibrium view* of unemployment; (ii) the *hysteresis hypothesis*; and (iii) the chain reaction theory (CRT), or *prolonged adjustment view*, of unemployment.

In this paper, we refer to each approach and show that the CRT is not simply the middle ground between the frictionless equilibrium view and the hysteresis hypothesis, since it explains the unemployment problem by recognising the interaction of growth and dynamics in the labour market.

2.2 Main theoretical conceptions

A wide variety of explanations have been proposed for the observed movements in European unemployment since the 1960s. The effort has been mainly put on the role of shocks and institutions, institutions alone, the structure of the economy and, more recently, on the role of growing variables.

Karanassou, Sala and Snower (2007) group the currently literature dealing with the macroeconomics of the labour market in three. First, the *frictionless equilibrium view* of unemployment according to which the labour market adjusts quickly to external shocks. Second, the *hysteresis hypothesis* where the equilibrium unemployment rate no longer returns to levels before the shock once the temporary shock reverses, and therefore reaches a new equilibrium. Third, the chain reaction theory (CRT), or *prolonged adjustment view*, of unemployment which postulates that labour markets react to external shocks but only slowly given that labour market decisions are subject to adjustment costs.

In what follows, we review and assess the distinct conceptions of the labour market offered by these approaches.

2.2.1 The frictionless equilibrium view

According to this view, the labour market adjusts quickly to external shocks and spends most of the time at or near its frictionless equilibrium position. In the case of static multi-equation models, labour market adjustments are ignored and in the case of dynamic single-equation unemployment rate models, all adjustments are suppressed into the autoregressive coefficients of the unemployment equation. In other words, the frictionless equilibrium view ignores the existence of lagged adjustment processes in labour market representations. Therefore, it follows that unemployment evolves around "an equilibrium rate of unemployment" or natural rate of unemployment (NRU), which is conceived as an attractor of actual unemployment (Karanassou, Sala and Snower, 2007).

Within this view we find those studies that focus purely on the role of institutions – institutionalist view – (e.g., Nickell, Nunziata and Ochel, 2005), on the role of shocks and institutions (see, among others, Layard, Nickell and Jackman, 1991, and Blanchard and Wolfers, 2000) and those that focus on the structure of the economy - structuralist view - (see, for example, Phelps, 1994, and Phelps and Zoega, 2001).

2.2.1.1 Definition of the NRU

The concept of the NRU dates back to the late 1960s, when Friedman (1968) and Phelps (1967, 1968) conveyed the notion of an equilibrium level of unemployment consistent with a stable inflation.[17] This means that at any moment there is some level of unemployment consistent with the equilibrium in the structure of real wage rates. A lower level of unemployment indicates an excess-demand for labour, and produces upward pressure on real wage rates. A higher level of unemployment indicates an excess-supply of labour, and produces downward pressure on real wage rates. This trade-off between inflation and unemployment is always temporary and not permanent.[18]

The simplest representation of the NRU is:

$$u_t = u^n + \varepsilon_t, \tag{1}$$

where u_t is the unemployment rate at time t, u^n is the natural rate, and ε_t is a strict white noise stochastic process.

The concept of the NRU has been gradually refined since the 1970s. This is what we study in the following sections.

2.2.1.2 The NAIRU model

Since the late 1960s, the NRU has received notorious attention by macro and labour macro literature. However, while the former treats the NRU as an exogenous variable, the latter considers it endogenous.

Macro literature has put much effort to explain inflation dynamics rather than explaining the determinants of the unemployment rate and for this reason it treats the NRU as an exogenous variable. In other words, macro literature estimates the NRU as the unemployment rate compatible with inflation

17 According to Vickrey (1993, p. 2), the expression ""natural" rate of unemployment, is one of the most vicious euphemisms ever coined."

18 The NRU concept is closely related to the Phillips curve. The temporary trade-off implies that the Phillips curve is vertical in the long-run. Along this work we are not concerned with Phillips curve models, for an overview, see Karanassou, Sala and Snower (2009).

stability, which is referred to as the non-Accelerating Inflation Rate of Unemployment (NAIRU).[19]

This approach consists of two equations: (i) a downward slopping price setting curve, which reflects the fact that imperfectly competitive firms equate marginal revenue with marginal cost, and (ii) an upward slopping wage setting curve determined by a bargaining process between the firm and the union. Prices, p_t, are set as a mark-up on the expected wages, w_t^e, and wages, w_t, are set as a mark-up on the expected prices, p_t^e, and these mark-ups tend to rise with the level of activity, represented by the unemployment rate, u_t. A baseline representation of this approach is given by:

$$p_t = w_t^e + \alpha_0 - \alpha_1 u_t \tag{2}$$

$$w_t = p_t^e + \beta_0 - \beta_1 u_t \tag{3}$$

where α_0 represents price push factors; β_0 represents wage push factors; α_1 captures price flexibility; and β_1 captures wage flexibility. Unemployment is in equilibrium only when there is consistency between the two intended mark-ups. In the absence of nominal surprises ($p_t = p_t^e$ and $w_t = w_t^e$), the solution gives the NRU-NAIRU:

$$u^n = \frac{\beta_o + \alpha_o}{\beta_1 + \alpha_1} \tag{4}$$

Any factor accounting for higher flexibility in real wages, β_1, or prices, α_1, reduces the equilibrium rate. In turn, any factor that raises the wage, β_0, or price, α_0, push factors raises the NAIRU. On the other hand, with nominal surprises and by solving price expectations assuming a random walk model, the actual unemployment rate is characterised as:

$$u_t = u^n - b(\pi_t - \pi_{t-1}) \tag{5}$$

where lower unemployment is associated with positive price surprises and higher unemployment is associated with negative price surprises.

Alternatively, we can express equation (5) as

$$\pi_t = \pi_{t-1} - b(u_t - u^n) \tag{6}$$

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19 The acronym NAIRU was introduced by Modigliani and Papademos (1975) and then popularised by Layard and Nickell (1986) and Layard, Nickell and Jackman (1991). For a complete analytical development of the NAIRU approach see Layard, Nickell and Jackman (1991).

Thus the NAIRU, u^n, is the unemployment rate at which inflation is stabilised in the long-run.

This approach made possible the distinction between a short- and a long-run NAIRU. The long-run NAIRU, consistent with stable unemployment and inflation, is the rate of unemployment to which the system tends to return, while the short-run NAIRU, apart from implying consistency with stable inflation, shows a dependence on last year's unemployment.

Some other extensions of this concept took place during the 1980s and 1990s. First, the "triangle model of inflation" developed by Gordon (1982, 1997 and 1998), according to which the lack of supply shocks in the relationship creates a problem of omitted variables and biases the coefficient of unemployment towards zero. The triangle model of inflation is

$$\pi_t = \pi_{t-1} - b(u_t - u^n) + dz_t \tag{7}$$

where z_t is a vector of supply shocks. The term "triangle" refers to the dependence of the inflation rate on three determinants: (i) inertia, given by the lagged rate of inflation; (ii) an index of excess demand; and (iii) supply shocks. Second, the idea of a TV-NAIRU proposed by Gordon (1997) and Staiger, Stock and Watson (1997a and 1997b), which extends the triangle model by allowing the "nature" of the economy to change over time.

Contrary to macro literature, labour macro literature aims to identify the determinants and the size of the unemployment rate. That is, unemployment rate models endogenise the NRU and determine the economic factors which influence it. These "endogenous" NRU models explain the long-run changes in equilibrium unemployment by distinguishing two components. First, the so-called "business cycle" or conjunctural unemployment movements usually ascribed to temporary shocks. Second, the so-called "trend" or long-run equilibrium movements arising from permanent changes in the determinants of unemployment.

The first attempt to determine the size of the natural rate is found in Phelps (1968).[20] Phelps (1995, p.16) recalls that "there was a tendency among quite a few scholars, myself included, to forget that my 1968 paper on equilibrium unemployment sketched a substantive model of the determination of the size of the natural unemployment rate and the course of the equilibrium unemployment rate path which leads to it."[21] Phelps himself, however,

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20 Phelps (1968) was the first one to model expectations in the natural rate theory by adopting the adaptive expectations hypothesis. In the 1970s, adaptive expectations were replaced by the assumption of agents forming their expectations rationally, a goal attributed to Lucas (1972a, 1972b and 1973). The adaptive and rational expectations are compatible in the sense that only a temporary trade-off between inflation and unemployment is possible.

21 As an example, Phelps (1968) mentions that a faster growth of the labour force or a faster steady growth, if it entailed a higher average rate of layoff in the economy, would produce a higher natural rate.

recognises the need for a general equilibrium view of the natural rate given that the NRU has been treated as a parameter by the literature (Phelps, 1994, p. 1).

In his 1994's book, Phelps models some general-equilibrium extensions of the incentive-wage theory of the natural rate and places the focus on the structure of the economy - giving rise to the structuralist theory (ST). The structure consists of: (i) firm's assets, which drive the labour demand; and (ii) the income from the worker's wealth that drives the wage setting curve. The aim of the ST is to disclose "the nonmonetary mechanisms through which various nonmonetary forces are capable of propagating slumps and booms in the contemporary world economy." (Phelps, 1994, p. 1)

According to the ST, the actual unemployment rate can only temporarily deviate from its NRU. The objective of the ST is, thus, to identify the driving forces of the NRU. The set of NRU determinants in Phelps (1994) includes country-specific variables, world-wide variables and shocks. The country-specific variables are capital stock, real public debt, real government spending, tax rates and some other institutional variables, price mark-ups induced by exchange rates, and some demographic variable. The world-wide variables include the real interest rate and the real price of oil. More recent ST studies also include the slowdown of productivity, the share of social expenditures in GDP, the educational composition of the labour force, and asset valuation in the determination of unemployment (see, for example, Phelps and Zoega, 1998, 2001 and Fitoussi *et al.*, 2000). In these papers, asset prices are the centrepiece of the ST.

2.2.1.3 The short, medium, and long-run

Macroeconomic literature usually views unemployment as two separated, and independent, components. These are the so-called "cyclical" (or business cycle) component and the "structural" (or trend) component of unemployment. The former refers to high-frequency movements or short-run variations usually ascribed to temporary shocks. While the latter points to low-frequency movements (or changes in the long-run equilibrium) arising from permanent changes in the determinants of unemployment. In other words, the evolution of unemployment is generally seen as short-run variations around a long-run equilibrium rate, which is the NRU or NAIRU.[22] In this way, the natural rate serves as an attractor of the actual unemployment rate (Karanassou, Sala and Snower, 2007).

This view of unemployment as two separated components conforms with the frictionless equilibrium view – institutionalists, structuralists, and studies that focus on the role of shocks and institutions. According to this view, the labour market adjusts quickly to external shocks and thus this market spends most of the time at or near its frictionless equilibrium position. This means that only temporary shocks affect unemployment and these shocks have only temporary effects. This approach ignores the influence of permanent shocks. In

22 See Blanchard and Fischer (1989), and Blanchard, Nordhaus and Phelps (1997).

particular, the ST cannot analyse the effects of permanent shocks on unemployment since it models unemployment dynamics through a stationary single equation that can only feature temporary labour market shocks.

2.2.1.4 The frictionless equilibrium view and the invariance hypothesis

This section deals with a questionable restriction always imposed to the frictionless equilibrium view of unemployment. The restriction is that, according to this view, the long-run unemployment rate is independent of growing exogenous variables. This restriction is what Karanassou and Snower (2004) call the "unemployment invariance hypothesis." This hypothesis implies that the behaviour of the labour market, by itself, ensures that the long-run unemployment rate is independent of trended variables and contains all the equilibrating mechanisms that guarantee unemployment invariance.

There are two forms of the unemployment invariance hypothesis: (i) the "strong invariance" and (ii) the "weak invariance" hypothesis.[23] The former asserts that any change in capital stock, total factor productivity (TFP) or working-age population leads to opposite shifts in the labour demand, wage setting, and labour supply curves to keep the unemployment rate at its original equilibrium level. This is in line with the institutionalist view of unemployment. An example of this type of unemployment invariance is found in the work of Layard, Nickell and Jackman (1991). The weak invariance hypothesis, on the other hand, asserts that the long-run unemployment rate can be influenced by capital stock, TFP and working-age population, but only in trendless transformations. This is in line with the structuralist view of unemployment according to which the unemployment rate may depend, for example, on the ratio of capital to labour (see Phelps, 1994 and Fitoussi *et al.* 2000).

2.2.2 The hysteresis hypothesis

The strong unemployment persistence in Europe during the 1980s reflected no consistence with the NRU and NAIRU theories and manifested in the necessity of alternative explanations. This gave rise to the idea of hysteresis.[24] There are plenty of definitions and interpretations of hysteresis in the labour market literature.[25] However, in this section we refer to two different approaches. First, the mainstream literature, which assumes that unemployment follows an autoregressive process of order p and the sum of the autoregressive coefficients, usually unity, is the measure of persistence. Second, a broader approach that allows for changes in the mean rate of unemployment over time as part of the definition of unemployment persistence.

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23 See Karanassou and Snower (2004).

24 See Cross (1988) for a compilation about the hysteresis hypothesis and the natural rate theory.

25 See Rϕed (1997).

2.2.2.1 Traditional definition

The traditional definition of hysteresis postulates an extreme persistence of unemployment and focuses on the protracted effects of temporary shocks on unemployment. According to this view, the equilibrium unemployment rate no longer returns to the original equilibrium path once a temporary shock is reversed. Instead, the effects of the shock become permanent and the equilibrium unemployment rate reaches a new equilibrium.

A formal definition of the hysteresis hypothesis is:

$$u_t = u_{t-1} + \varepsilon_t, \tag{8}$$

where u_t is the unemployment rate at time t, u_{t-1} is the unemployment rate in the previous period, and ε_t is a strict white noise stochastic process. This formulation assumes that unemployment follows a unit root process.

2.2.2.2 Three theoretical mechanisms

The initial formulation of the hysteresis hypothesis is found in the seminal works of Blanchard and Summers (1986, 1987), which focus on the mechanisms explaining the propagation of adverse supply and demand shocks over long periods of time. In particular, these mechanisms are the "insider-outsider", "human capital", and "physical capital" arguments.

The insider-outsider mechanism is explained by assuming that the unions' utility function only depends on the employed workers. Wages therefore are set by bargaining between employed workers - the insiders - and firms, with no role for the outsiders. Under this assumption, the insiders are concerned by maintaining their jobs, which has two implications: (i) in the absence of shocks, any level of employment of insiders is "self-sustaining" with insiders just setting the wage so as to remain employed, and (ii) in the presence of shocks, employment follows a random walk process; after an adverse shock, which reduces employment, some workers lose their insider status and the new smaller group of insiders sets the wage so as to maintain its new lower level of employment. This suggests that, if wage bargaining is a prevalent feature of the labour market, the dynamic interactions between employment and the size of the group of insiders may generate substantial employment and unemployment persistence. The key assumption in the analysis is the relation between the employment status and the insider status. The possibility of persistent fluctuations in employment arises because changes in employment may change the group's membership (Blanchard and Summers, 1986, p. 16).

The human capital argument holds that workers who are unemployed lose the opportunity to maintain and update their skills by working. Particularly for the long term unemployed, the atrophy of skills may combine with disaffection from the labour force associated with the inability to find a job, to reduce the effective supply of labour (Blanchard and Summers, 1986, p. 14).

The physical capital argument states that reductions in the capital stock associated with the reduced employment that accompanies adverse shocks diminish the subsequent demand for labour, and cause protracted unemployment (Blanchard and Summers, 1986, p. 13).

In short, Blanchard and Summers' main claim is that persistent high unemployment can be understood in terms of hysteresis mechanisms. In this context, membership effects - the distinction between insiders and outsiders - jointly with wage rigidity are important sources of hysteresis. According to Blanchard and Summers (1986), only unexpected nominal and real shocks have permanent effects on employment. Once employment has decreased, it remains, in the absence of other shocks, permanently at the lower level. Finally, they stress the importance of identifying the circumstances under which persistence is likely to arise. That is, if hysteresis is the result of: (i) specific labour market structures; (ii) the presence of unions; or (iii) whether it is itself the result of adverse shocks which, by increasing unemployment, trigger the insider-outsider dynamics.

In a well-known contribution, Alogoskoufis and Manning (1988) disagree with Blanchard and Summers' statement about the speed at which the unemployed workers become outsiders and the assumption of insiders just caring about their employment prospects.[26] If insiders also care about their real wages, then they should balance their employment target against their wage aspirations. In this case, an analysis of wage setting and alternative sources of unemployment persistence is needed. These sources are "membership of the group of insiders", "wage aspirations", and "demand for labour."

When unions are just concerned with the employment of their members, the evolution of union membership is then one of the determinants of the evolution of employment and unemployment. The union sets the wage as high as is consistent with the full employment of insiders, so the wage setting curve is vertical at the unemployment level where all insiders are employed. When an unanticipated deflationary shock pushes unemployment up and all the newly unemployed immediately lose their insider status, the union stops being concerned about their re-employment prospects. The wage setting curve shifts to the right and then wages will be set to ensure that only those who did not lose their jobs remain employed. Therefore, the current equilibrium unemployment rate becomes a new and permanent equilibrium unemployment rate.[27] This is the extreme case of hysteresis postulated by Blanchard and Summers. On the contrary, when unions care about both employment and real wages, the wage setting curve is downward sloping. An adverse disturbance displaces the equilibrium point, causing an upward shift in the wage setting

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26 See Alogoskoufis and Manning (1988, p. 464-467) for a complete analytical development.

27 If unions also care about the newly unemployed, we return to the initial equilibrium level. The speed of adjustment depends on the weight given to the currently employed.

curve and, in the absence of further shocks; unemployment is higher than the original equilibrium, but lower than the unemployment rate immediately after the shock. Unemployment gradually converges to the equilibrium value, as the wage setting curve gradually shifts downwards when the temporary shock disappears. Hysteresis does not occur anymore, although unemployment exhibits persistence (Alogoskoufis and Manning, 1988, pp. 432-436).

The second source of unemployment persistence is wage aspirations developed by wage setters and their unions. The sluggish real wage's effect is introduced with a short-run wage setting curve flatter than the long-run wage setting curve. An unanticipated adverse shock displaces the equilibrium point and in the absence of further shocks, unemployment and real wages next period will be lower than immediately after the shock. Thus, both start adjusting downwards along the labour demand curve, as the short-run wage setting curve gradually shifts towards its long-run position. The persistence of unemployment depends on the persistence of real wage aspirations and is higher, the steeper the labour demand schedule, and the larger the weight put by insiders on wages relatively to employment (Alogoskoufis and Manning, 1988, pp. 436-437).

Finally, the third source of persistence, demand for labour, is analysed with a short-run labour demand steeper than a long-run one. An unanticipated deflationary shock disturbs the initial equilibrium and increases unemployment and real wages. In the absence of further shocks, the short-run equilibrium in the following period is at the intersection of the new short-run labour demand curve with the wage setting curve. Over time, the short-run labour demand curve shifts to the left, unemployment gradually falls, and real wages rise towards equilibrium. Persistence of unemployment depends positively on persistence in labour demand, and is higher the steeper the short-run labour demand curve, and the larger the weight assigned by unions to wages relatively to employment (Alogoskoufis and Manning, 1988, pp. 437-438).

In general, unemployment does not display hysteresis and converges to its equilibrium rate because unions wish to trade off real wages for unemployment.

2.2.2.3 A broader definition of unemployment persistence

According to Bianchi and Zoega, "the conventional definition of unemployment persistence fails to distinguish between the persistence of different shocks by taking into account the possibility of large shocks changing the model parameters" (1998, p. 285). For this reason, they provide a broader definition of unemployment persistence that allows the mean rate of unemployment to change abruptly over time. A formal representation is of the following form:

$$u_t = \mu_i + u_{t-1} + \varepsilon_t \tag{9}$$

where u_t is the unemployment rate at time t, μ_i is the mean value of unemployment in a specific subsample,[28] u_{t-1} is the unemployment rate in the previous period, and ε_t is a strict white noise stochastic process.

Bianchi and Zoega (1998) argue that the traditional approach, which explains unemployment persistence only by the effect of lagged unemployment on equilibrium unemployment, is inconsistent with the data. The reason is that the evidence shows that the autoregressive parameter is less than one. Therefore, changes in the part of the natural rate that is independent of past unemployment levels, μ, are necessary. In their 1998 study, they mention two sets of models that account for these changes: (i) models with multiple equilibria, and (ii) models attempting to explain changes in the natural rate over time.[29]

When abrupt shifts occur in the model parameters, Bianchi and Zoega attribute them to structural changes, or large shocks, in the economy. They assume that a mean shift is always observed as the result of a large shock. This is the reason why they call their model the "shifting mean value" (SMV) model.

The SMV is a generalisation of the traditional definition (equation (8)) in the sense that if there is only one equilibrium in the series, the mean unemployment rate, μ, is constant over the sample period, rather than infrequently changing and the broader definition reduces to the traditional one. On the other hand, if there is more than one equilibrium in the series, there are regime shifts in unemployment.

As pointed out in Bianchi and Zoega (1998), in empirical exercises both the traditional and the broader definitions aim at obtaining an estimate of the persistence of shocks. However, whereas the original definition of hysteresis only requires the estimation of an autoregressive process, the broader approach requires first an estimation of the number of mean shifts and the dating of the mean shifts.

2.2.2.4 The unobserved components model

Next, we refer to the study of Jaeger and Parkinson (1994), which introduces an innovative approach: they apply the Kalman-filter technique to an unobserved components (UC) model of the unemployment rate to evaluate the data in search for hysteresis effects.[30]

These authors find unnecessarily restrictive the association of the word hysteresis to the cases where the unemployment series has a unit root and take hysteresis as a phenomenon whereby changes in cyclical unemployment affect the natural rate, with which both the natural rate and cyclical unemployment do not evolve independently of each other. In this new specific framework the

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28 See Bianchi and Zoega (1998, p. 285).

29 For a broader explanation about the workings of these two models see Bianchi and Zoega (1998, p. 301-302). See also Hughes-Hallett and Piscitelli (2002), and Raurich, Sala and Sorolla (2006) for theoretical developments in multiple equilibria.

30 See also Logeay and Tober (2006) for a similar analysis.

observed unemployment rate, u_t, is decomposed into a non-stationary natural rate component, u_t^n, and a stationary cyclical component, u_t^c:

$$u_t = u_t^n + u_t^c, \tag{10}$$

Hysteresis effects are introduced by allowing cyclical unemployment to have a lagged effect on the natural rate:

$$u_t^n = u_{t-1}^n + \varepsilon_t^n + \alpha u_{t-1}^c, \tag{11}$$

Finally, the model is completed with a third equation, which defines the cyclical component of the unemployment rate as a stationary second-order autoregressive process:

$$u_t^c = \phi_1 u_{t-1}^c + \phi_2 u_{t-2}^c + \varepsilon_t^c, \tag{12}$$

where ε_t^c and ε_t^n are mutually uncorrelated shocks.

This framework allows for hysteresis not just entering through the dependence of actual unemployment on past values, but from the influence of cyclical unemployment on the natural rate.

From the perspective of the UC model, a unit root in unemployment is a necessary but not a sufficient condition for hysteresis, because a unit root in unemployment may be induced by natural rate shocks and be entirely independent of the existence of hysteresis. By contrast, in the UC model, hysteresis in unemployment occurs if movements in the cyclical component also affect the natural rate component.

2.2.2.5 Hysteresis and the invariance hypothesis

Like the frictionless equilibrium view of unemployment, the hysteresis hypothesis is also imposed the restriction that the long-run unemployment rate is independent of growing exogenous variables.

This approach also ignores the influence of trended exogenous variables - e.g., capital stock, TFP or working-age population – on the trajectory of unemployment. Given that trended variables are overlooked in labour market representations, the hysteresis hypothesis also presupposes that the labour market, by itself, contains all the equilibrating mechanisms that guarantee unemployment invariance (Karanassou and Snower, 2004).

Unlike the frictionless equilibrium view of unemployment where both forms of the unemployment invariance hypothesis – strong and weak – are possible, only the strong form applies to the hysteresis hypothesis.

2.2.2.6 The short, medium, and long-run

According to the frictionless equilibrium view of unemployment, the short- and long-run states of the labour market are compartmentalised. This compartmentalisation implies that the unemployment rate evolves around the NRU from which it only temporarily deviates. This compartmentalisation does not apply to the hysteresis hypothesis. Recall this approach asserts that unemployment reaches a different equilibrium path and stays permanently on it once a shock affects the unemployment trajectory. That is, temporary shocks lead to permanent changes in the unemployment rate. Given that each cyclical variation becomes permanent, the distinction between the short- and long-run states of the labour market no longer holds.[31]

Like the frictionless equilibrium view, the hysteresis hypothesis only considers the influence of temporary shocks disturbing the equilibrium and ignores the influence of permanent shocks. However, while in the former approach temporary labour market shocks have only temporary unemployment repercussions, under the latter approach temporary shocks lead to permanent changes in the unemployment rate.

2.2.3 The CRT or prolonged adjustment view

The third approach concerned with the macroeconomics of the labour market is the CRT, or *prolonged adjustment view*, of unemployment initially developed by Karanassou and Snower (1996).

According to the CRT, the labour market adjusts only slowly to external shocks because many labour market decisions are subject to adjustment costs: (i) employment adjustments arising from labour turnover costs (hiring, training and firing costs); (ii) wage and price staggering; (iii) insider membership effects; (iv) long-term unemployment effects; and (v) labour force adjustments, among others.[32] Consequently, current decisions may depend on past labour market outcomes.

Like the structuralist and institutionalist theories, the CRT aims at identifying the economic factors responsible for the evolution of the unemployment rate. Nevertheless, unlike the structuralist and institutionalist theories, the CRT is an interactive dynamics approach: it applies dynamic multi-equation systems with spillover effects to the labour market to explain the time path of unemployment (Karanassou, Sala and Snower, 2007).

Since the unemployment rate is a nontrended variable, single-equation unemployment models have to use exogenous variables that do not display a

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31 See Karanassou, Sala and Snower (2007).

32 These adjustment costs are well documented in the literature. See, for example, Nickell (1978), Sargent (1978), Taylor (1979), Lindbeck and Snower (1987), and Layard and Bean (1989). For recent evidence on adjustment costs – particularly, dynamic models with flexible adjustment - see Masso and Heshmati (2003), Heshmati and Bhandari (2005), and Piekkola (2006) for the Estonian, Indian, and Finnish manufacturing, respectively.

trend. This is not the case when multi-equation labour market models are used - the only requirement is that each trended endogenous variable (e.g. employment, real wage, labour force) is balanced with the set of its explanatory variables. The CRT argues that growth drivers – capital stock, technical change, productivity or working-age population – matter for unemployment and can explain the performance of the labour market.[33]

In the context of multi-equation labour market models, changes in the unemployment rate are viewed as "chain reactions" of its responses to temporary and permanent labour market shocks. The unemployment responses work their way through a network of interacting lagged adjustment processes.

In other words, the CRT postulates that the evolution of unemployment is driven by the interplay of lagged adjustment processes and the spillover effects within the labour market system. Spillover effects arise when shocks to a specific equation feed through the labour market system. The label "shocks" refers to changes in the exogenous variables.

2.2.3.1 A formal representation of the CRT

We illustrate the workings of the CRT with the following modified version of the labour market systems presented in Karanassou, Sala and Snower (2007, 2009), which consists of labour supply, labour demand, and real wage equations:

$$l_t = \alpha_2 l_{t-1} + \beta_2 z_t, \tag{13}$$

$$n_t = \alpha_1 n_{t-1} + \beta_1 k_t - \gamma w_t, \tag{14}$$

$$w_t = \beta_3 x_t - \delta u_t \tag{15}$$

where l_t, n_t, and w_t denote the endogenous labour force, employment, and real wage, respectively; z_t is working-age population, k_t is real capital stock, and x_t represents a wage push factor (e.g. benefits); the autoregressive parameters are $0 < \alpha_1, \alpha_2 < 1$, and the β's, γ, and δ are positive constants. All variables are in logs and we ignore the error terms for ease of exposition. The unemployment rate (not in logs) is[34]

$$u_t = l_t - n_t. \tag{16}$$

We should note that when either γ or δ are zero in the model (13)-(15), labour market shocks do not spillover from labour supply to labour demand and vice versa. In other words, the influence of the exogenous variables (k_t and z_t) on

33 In Essay 3, we focus on the relationship between capital stock and unemployment and show that capital accumulation can explain the diverse unemployment experiences of the Nordic countries.

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

unemployment can be measured through individual analysis of the labour demand and supply equations. In particular, if unemployment does not influence wages $(\delta = 0)$, then labour demand and supply shocks do not spillover to wages. As a result, capital stock changes do not affect labour force, and changes in working-age population do not affect employment. If, on the other hand, $\gamma = 0$ shocks to wage setting do not affect employment and, consequently, do not spillover to unemployment. Thus the wage elasticity of demand provides the mechanism through which changes in the wage push factor x_t feed through to unemployment. This can be seen clearly in the reduced form unemployment rate equation (22) derived below.

Let us rewrite the labour supply and demand equations (13)-(14) as

$$(1-\alpha_2 B) l_t = \beta_2 z_t, \tag{17}$$
$$(1-\alpha_1 B) n_t = \beta_1 k_t - \gamma w_t, \tag{18}$$

where B is the backshift operator. Substitution of (15) into (18) gives

$$(1-\alpha_1 B) n_t = \beta_1 k_t - \gamma\beta_3 x_t + \gamma\delta u_t. \tag{19}$$

Multiplying both sides of (17) and (19) by $(1-\alpha_1 B)$ and $(1-\alpha_2 B)$, respectively, gives

$$(1-\alpha_1 B)(1-\alpha_2 B) l_t = \beta_2 (1-\alpha_1 B) z_t, \tag{20}$$
$$\begin{aligned}(1-\alpha_1 B)(1-\alpha_2 B) n_t = \beta_1 (1-\alpha_2 B) k_t + \gamma\beta_3 (1-\alpha_2 B) x_t \\ +\gamma\delta(1-\alpha_2 B) u_t.\end{aligned} \tag{21}$$

Finally, use the definition (16) and subtract (21) from (20) to obtain the *reduced form* unemployment rate equation:[35]

$$\begin{aligned}(1+\gamma\delta-\alpha_1 B)(1-\alpha_2 B) u_t = \beta_2 (1-\alpha_1 B) z_t - \beta_1 (1-\alpha_2 B) k_t \\ +\gamma\beta_3 (1-\alpha_2 B) x_t.\end{aligned} \tag{22}$$

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

Alternatively, the reduced form unemployment rate equation (22) can be written as

$$u_t = \phi_1 u_{t-1} - \phi_2 u_{t-2} - \theta_k k_t + \theta_z z_t + \theta_x x_t + \alpha_2 \theta_k k_{t-1} - \alpha_1 \theta_z z_{t-1} - \alpha_2 \theta_x x_{t-1}, \tag{23}$$

35 Note that (22) is dynamically stable since (i) products of polynomials in B which satisfy the stability conditions are stable, and (ii) linear combinations of dynamically stable polynomials in B are also stable.

where $\phi_1 = \frac{\alpha_1+\alpha_2(1+\gamma\delta)}{1+\gamma\delta}$, $\phi_2 = \frac{\alpha_1\alpha_2}{1+\gamma\delta}$, $\theta_k = \frac{\beta_1}{1+\gamma\delta}$, $\theta_z = \frac{\beta_2}{1+\gamma\delta}$, and $\theta_x = \frac{\gamma\beta_3}{1+\gamma\delta}$.

Parameterisations (22) and (23) of the reduced form unemployment rate equation show the following. First, the autoregressive parameters ϕ_1 and ϕ_2 embody the interactions of the employment and labour force adjustment processes (α_1 and α_2, respectively). Second, the short-run elasticities (θ_k, θ_x, and θ_z) are a function of the feedback mechanisms that give rise to the spillover effects in the labour market system. Third, the interplay of the lagged adjustment processes and the spillover effects can be captured by the induced lag structure of the exogenous variables.

In applied work, the NRU is defined as the equilibrium unemployment rate at which there is no tendency for this rate to change at any time t, given the permanent component values of the exogenous variables at that time. In this sense, it represents the unemployment that would be achieved once all the lagged adjustment processes have been completed in response to the permanent components of the exogenous variables.

Therefore, the NRU is computed by setting the backshift operator B equal to unity in the unemployment rate equation (22):

$$u_t^n = \frac{\beta_2(1-\alpha_1)\tilde{z}_t - \beta_1(1-\alpha_2)\tilde{k}_t + \gamma\beta_3(1-\alpha_2)\tilde{x}_t}{(1+\gamma\delta-\alpha_1)(1-\alpha_2)}, \tag{24}$$

where the $\sim$ above the variable denotes its permanent component. Naturally, the estimates of the NRU reflect the decision on which changes in the exogenous variables are permanent or temporary.

2.2.3.2 Long-run unemployment, NRU, and frictional growth

A salient feature of the CRT is that unemployment may substantially deviate from what is commonly perceived as its natural rate, even in the long-run. This was first pointed out by Karanassou and Snower (1997) and lies in sharp contrast with the conventional wisdom that the NRU is the attractor of the unemployment rate.

To elaborate this issue we use the labour market system (13)-(16) and make the plausible assumption that capital stock (k_t), the wage-push factor (x_t), and working-age population (z_t) are growing variables with growth rates that stabilise in the long-run. (Note that the growth rates of log variables are proxied by their first differences, $\Delta(\cdot)$, and recall that the superscript ^{LR} denotes the long-run value of the variable.)

Equation (16) implies that unemployment stabilises in the long-run, $\Delta u^{LR} = 0$, when

$$\Delta l^{LR} = \Delta n^{LR} = \lambda. \tag{25}$$

In other words, the restriction that the growth rate of employment is equal to the growth rate of labour force, say γ, ensures unemployment stability in the long-run.[36]

Let us substitute the wage equation (15) into the labour demand equation (14) and rewrite the resulting equation and the labour supply equation (13) as

$$l_t = \frac{\beta_2}{1-\alpha_2} z_t - \frac{\alpha_2}{(1-\alpha_2)} \Delta l_t, \tag{26}$$

$$n_t = \frac{\beta_1}{1-\alpha_1} k_t - \frac{\gamma\beta_3}{1-\alpha_1} x_t + \frac{\gamma\delta}{1-\alpha_1} u_t - \frac{\alpha_1}{(1-\alpha_1)} \Delta n_t \tag{27}$$

Substitution of the above equations into (16) and some algebraic manipulation yields the following expression for the unemployment rate:

$$u_t = \zeta\left(\frac{\beta_2}{1-\alpha_2} z_t - \frac{\beta_1}{1-\alpha_1} k_t + \frac{\gamma\beta_3}{1-\alpha_1} x_t \right) + \zeta\left(\frac{\alpha_1}{(1-\alpha_1)} \Delta n_t - \frac{\alpha_2}{(1-\alpha_2)} \Delta l_t \right), \tag{28}$$

where $\zeta = \frac{1-\alpha_1}{1-\alpha_1+\gamma\delta}$.

The long-run unemployment rate is obtained by imposing restriction (25) on parameterisation (28) of the reduced form unemployment rate equation:

$$u^{LR} = \zeta\left[\underbrace{\left(\frac{\beta_2}{1-\alpha_2} z^{LR} - \frac{\beta_1}{1-\alpha_1} k^{LR} + \frac{\gamma\beta_3}{1-\alpha_1} x^{LR} \right)}_{\text{natural rate of unemployment}} + \underbrace{\frac{(\alpha_1-\alpha_2)\lambda}{(1-\alpha_1)(1-\alpha_2)}}_{\text{frictional growth}} \right]. \tag{29}$$

Observe that the first term of (29) gives the NRU, whereas the second term of (29) captures *frictional growth*, i.e.,

$$\text{long-run unemployment rate} = \text{NRU} + \text{frictional growth},$$

where frictional growth arises from the interplay between the lagged adjustment processes and the growing exogenous variables.

The long-run value (u^{LR}) towards which the unemployment rate converges reduces to the NRU only when frictional growth is zero. This occurs when (i) the exogenous variables have zero growth rates in the long-run (so that $\lambda = 0$), or (ii) the labour demand and supply equations have identical dynamic structures (so that $\alpha_1 = \alpha_2$).

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36 The above restriction can also be expressed in terms of the long-run growth rates of the exogenous variables:

$$\frac{\beta_1}{1-\alpha_1}\Delta k^{LR} - \frac{\gamma\beta_3}{1-\alpha_1}\Delta x^{LR} = \frac{\beta_2}{1-\alpha_2}\Delta z^{LR} = \lambda.$$

Therefore, frictional growth implies that under quite plausible conditions (e.g. different labour demand and supply dynamics, and growing exogenous variables) the natural rate is not an attractor of the moving unemployment. In these circumstances, the relevance of the NRU in policy making is questionable.[37]

2.2.3.3 Lagged adjustment processes and their interactions

According to the CRT, actual labour market decisions depend on past labour market decisions because of adjustment costs. In other words, the presumption underlying CRT models is that current labour market activity depends on the past, and that the process of adjustment may take a long time to work itself out (Karanassou and Snower, 1998).

These lagged adjustment processes are well documented in the literature and refer, among others, to: (i) employment adjustments arising from labour turnover costs (hiring, training and firing costs); (ii) wage and price staggering, (iii) insider membership effects; (iv) long-term unemployment effects; and (v) labour force adjustments.[38]

By identifying the various lagged adjustment processes, the CRT can explore their interactions and quantify the potential complementarities/substitutabilities among them. For example, if the prolonged adjustments or lags are complementary with one another in propagating temporary and permanent labour market shocks, the joint influence of all the existing lags is greater than the sum of their individual influences. In this case, it will take unemployment much longer to recover in the aftermath of a recession than the period spanned by any particular lag.[39]

This dimension of the labour market is ignored by both the frictionless equilibrium view of unemployment and the hysteresis hypothesis. The former focuses attention on the long-run equilibrium unemployment rate once the adjustment processes have worked themselves out, which generally takes a few years. While in the latter approach, unemployment is assumed to have a unit root regardless of which the underlying adjustment processes are.[40]

2.2.3.4 Unemployment persistence and responsiveness

As noted, in CRT models current labour market activity depends on the past and the process of adjustment may take a long time to work itself out. That is, movements of unemployment are viewed as the outcome of the interplay between the lagged adjustment processes and the dynamic properties of the shocks. Shocks are not absorbed instantly and their effects are felt through time.

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37 In Essay 2, we show that the NRU only explains a small fraction of the variation in unemployment in Denmark, while frictional growth accounts for most of it.

38 See footnote 32.

39 Karanassou and Snower (1998, p. 836-837) develop lags complementarities analytically.

40 See Karanassou, Sala and Snower (2007).

According to the CRT, unemployment responds differently, through time, to a temporary shock than to a permanent one. For this reason, this approach analyses the after-effects of both temporary and permanent shocks.[41]

The concept that captures the after-effects of temporary shocks is "unemployment persistence", while the concept that captures the after-effects of permanent shocks is "imperfect unemployment responsiveness."[42] These two measures provide insights into the way unemployment moves through time.

To define unemployment persistence suppose a one-off temporary shock in an exogenous variable occurring at period t. Unemployment persistence, σ, is the sum of its responses for all periods $t+j$ in the aftermath of the shock $j \geq 1$:

$$\sigma \equiv \sum_{j=1}^{\infty} R_{t+j}, \tag{30}$$

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

If the unemployment model is static, then the shock is absorbed instantly and so persistence is zero $(\sigma = 0)$. If it is dynamically stable, like CRT models, then the effects of the shock gradually die out and persistence is a finite quantity. Finally, if unemployment displays hysteresis, then the temporary shock has a permanent effect and thus $\sigma = \infty$.[43]

Given that the temporary shock represents the change in a specific exogenous variable, then: (i) the immediate response, R_t, is the short-run elasticity of the unemployment rate with respect to that explanatory variable, and (ii) the sum of the immediate response, R_t, and persistence, σ, gives the long-run elasticity of the unemployment rate with respect to that explanatory variable. Thus, the long-run elasticity of the variable is:

$$\underbrace{R_t}_{\text{short-run elasticity}} + \underbrace{\sigma}_{\text{persistence}} = \underbrace{\sum_{j=0}^{\infty} R_{t+j}}_{\text{long-run elasticity}}. \tag{31}$$

On the other hand, unemployment responsiveness measures the cumulative unemployment effect of a permanent shock when unemployment does not adjust immediately to the new long-run equilibrium. In particular, suppose that the economy, in an initial long-run equilibrium, is perturbed by a unit permanent shock. The unemployment responsiveness is the sum of the

41 For an illustration of the unemployment dynamics, see Karanassou, Sala and Snower (2007, p. 169-178).

42 See Karanassou and Snower (1996, 1998) and Pivetta and Reis (2004).

43 In Section 5.5 of Essay 4, we show how the adjustment process of the unemployment rate to a temporary shock to capital stock may take a long time to work itself out, and measure the unemployment effects quantitatively.

differences through time between the actual unemployment rate and the new (post-shock) long-run equilibrium unemployment rate:

$$\rho \equiv \sum_{j=0}^{\infty}\left[R_{t+j}-1\right], \tag{32}$$

If unemployment responds instantaneously to the shock and jumps to its new long-run equilibrium, then $\rho = 0$, i.e., unemployment is *perfectly responsive*. If unemployment responds only gradually, so that the short-run unemployment effects of the shock are less than the long-run effect (undershooting), then unemployment is *under-responsive* and $\rho < 0$. Finally, unemployment can overshoot its long-run equilibrium, then unemployment is *over-responsive*, $\rho > 0$.

2.2.3.5 The short, medium, and long-run

As noted in previous paragraphs, in the frictionless equilibrium view of unemployment the short- and long-run states of the labour market are compartmentalised, while under the hysteresis hypothesis the long-run equilibrium is indistinguishable from the cyclical fluctuations. The view of the CRT is that the short- and long-run states of the labour market cannot be decomposed. On the contrary, the short- and long-run - or cyclical and structural unemployment - are imbedded in the concept of frictional growth (Karanassou, Sala and Snower, 2007).

Recall that movements in unemployment are driven by the interaction between labour market shocks and a network of lagged adjustment processes. In this context, the unemployment effects of a particular shock are extended through time, making the short- and long-run to be interrelated. Given that movements in unemployment are viewed as the cumulus of prolonged adjustments to a wave of labour market shocks and the adjustments can be very prolonged, it makes no sense to divide those movements into structural and cyclical. As pointed out by Karanassou and Snower (1998), the two components of unemployment are so interdependent that their interactions become more significant than their distinction.

In addition, only temporary shocks affect unemployment in both the frictionless equilibrium view and the hysteresis hypothesis. These approaches ignore the influence of permanent shocks. On the contrary, the CRT considers the role of temporary and permanent shocks on the trajectory of unemployment. These shocks affect a specific equation and then feed through the labour market system. The existence of lags, interacting with one another, prolongs the unemployment effects of the shock and, thus, unemployment responds differently, through time, to a temporary than to a permanent shock.

2.3 Discussion

The three major approaches to the macroeconomics of the labour market discussed in this paper provide distinct conceptions of the labour market. The main distinction comes from how they treat the short- and long-run states of the labour market. In the frictionless equilibrium view, unemployment is decomposed into two components, "structural" and "cyclical" unemployment. In other words, cyclical variations in unemployment are independent of structural variations. Under the hysteresis hypothesis, on the other hand, the long-run equilibrium is indistinguishable from the cyclical variations. That is, all cyclical variations are structural in the sense that all temporary shocks have permanent unemployment effects. Finally, the prolonged adjustment view shows how short, medium, and long runs are interrelated, merging with one another along an intertemporal continuum. In the CRT, cyclical unemployment variations can have prolonged after-effects. Second, while the CRT and NRU approaches offer structural representations of the labour market, models of hysteresis do not capture the structure of the labour market. Third, while models of hysteresis focus on the path dependency of unemployment, NRU and CRT models aim at identifying the driving forces of unemployment. However, in sharp contrast to NRU models, the CRT focuses on the determinants of the actual (instead of the natural) rate of unemployment, since it argues that the natural rate is not the main determinant of actual unemployment. Fourth, the CRT does not restrict explanatory variables to be stationary. In particular, it shows that the long-run unemployment rate depends on the size of capital stock. This implies that policies related to R&D activities, policies promoting innovations and productivity growth, or policies directly fostering investment and capital accumulation, can enhance the performance of the labour market.

Overall, the CRT should not be considered as an intermediate position between the frictionless equilibrium view and the hysteresis hypothesis since the prolonged adjustments cover a wide diversity of phenomena explaining the movements of employment and unemployment. Most important, the CRT gives them individual and explicit attention rather than placing them between the other two views. Thinking the prolonged adjustment view as the middle ground between the frictionless equilibrium view and the hysteresis hypothesis is, therefore, uninformative. In words of Karanassou, Sala and Snower "is like telling a painter that there are three groups of colors: white, black, and the range of tones in between. This is true, but uninformative, since the range of intermediate tones is where most of the action is." (2007, p. 178).

REFERENCES

Alogoskoufis, G. and A. Manning (1988), "On the persistence of unemployment", *Economic Policy*, 3 (2), pp. 427-469.

Belot, M. and J. van Ours (2004), "Does the recent success of some OECD countries in lowering their unemployment rates lie in the clever design of their labour market reforms?", *Oxford Economic Papers*, 56 (4), pp. 621-642.

Bianchi, M. and G. Zoega (1998), "Unemployment persistence: does the size of the shock matter?", *Journal of Applied Econometrics*, 13 (3), pp. 283-304.

Blanchard, O. and S. Fischer (1989), *Lectures on Macroeconomics*, The MIT Press, Cambridge MA.

Blanchard, O., W. Nordhaus and E. Phelps (1997), "The medium run", *Brookings Papers on Economic Activity*, 28 (2), pp. 89-158.

Blanchard, O. and L. Summers (1986), "Hysteresis and the European unemployment problem", pp. 15-77, *NBER Macroeconomics Annual*, 1, The MIT Press, Cambridge MA.

Blanchard, O. and L. Summers (1987), "Hysteresis in unemployment", *European Economic Review*, 31, 1/2, pp. 288-295.

Blanchard, O. and J. Wolfers (2000), "The role of shocks and institutions in the rise of European unemployment: the aggregate evidence", *The Economic Journal*, 110 (462), pp. C1-C33.

Cross, R. (1988), *Unemployment, hysteresis and the natural rate hypothesis*, Basil Blackwell, Oxford.

Fitoussi, J.P., D. Jestaz, E. Phelps and G. Zoega (2000), "Roots of recent recoveries: labor reforms or private sector forces", *Brooking Papers on Economic Activity*, 1:2000, pp. 292-304.

Friedman, M. (1968), "The role of monetary policy", *The American Economic Review*, 58 (1), pp. 1-17.

Gordon, R. J. (1982), "Inflation, flexible exchange rates, and the natural rate of unemployment", *NBER Working Paper*, W0708.

Gordon, R. J. (1997), "The time-varying NAIRU and its implications for economic policy", *Journal of Economic Perspectives*, 11 (1), pp. 11-32.

Gordon, R. J. (1998), "Foundations of the goldilocks economy: supply shocks and the time-varying NAIRU", *Brookings Papers on Economic Activity*, 2, pp. 297-333.

Heshmati A. and A.K. Bhandari (2005), "Labour use and its adjustment in Indian manufacturing industries, *IZA Discussion Paper*, 1596.

Hughes-Hallett, A.J. and L. Piscitelli (2002), "Testing for hysteresis against nonlinear alternatives", *Journal of Economic Dynamics and Control*, 27 (2), pp. 303-327.

Jaeger, A. and M. Parkinson (1994), "Some evidence on hysteresis in unemployment rates", *European Economic Review*, 38 (2), pp. 329-342.

Karanassou, M. and D.J. Snower (1996), "Explaining disparities in unemployment dynamics", in Baldassari, M., L. Paganetto and E. Phelps (eds.), *The 1990's slump: causes and cures,* Macmillan Press, London.

Karanassou, M. and D.J. Snower (1997), "Is the natural rate a reference point?", *European Economic Review*, 41 (3-5), pp. 559-569.

Karanassou, M. and D.J. Snower (1998), "How labor market flexibility affects unemployment: long-term implications of the chain reaction theory", *The Economic Journal*, 108 (448), pp. 832-849.

Karanassou, M. and D.J. Snower (2004), "Unemployment invariance", *German Economic Review*, 5 (3), pp. 297-317.

Karanassou, M., H. Sala and D.J. Snower (2003), "Unemployment in the European Union: a dynamic reappraisal", *Economic Modelling,* 20 (2), pp. 237-273.

Karanassou, M., H. Sala and D.J. Snower (2004), "Unemployment in the European Union: institutions, prices and growth", *CESifo Working Paper Series,* 1247.

Karanassou, M., H. Sala and D.J. Snower (2007), "The macroeconomics of the labor market: three fundamental views", *Portuguese Economic Journal*, 6 (3), pp. 151–180.

Karanassou, M., H. Sala and D.J. Snower (2009), "Phillips curves and unemployment dynamics: a critique and a holistic perspective", *Journal of Economic Surveys*, forthcoming.

Layard, R. and C. Bean (1989), "Why does unemployment persist?", *The Scandinavian Journal of Economics*, 91 (2), pp. 371-396.

Layard, R. and S. Nickell (1986), "Unemployment in Britain", *Economica*, New Series, 53 (210), Supplement: unemployment, pp. S121-S169.

Layard, R., S. Nickell, and R. Jackman (1991), *Unemployment: macroeconomic performance and the labour market*, Oxford University Press, Oxford.

Lindbeck, A., and D.J. Snower (1987), "Union activity, unemployment persistence, and wage-employment ratchets", *European Economic Review,* 31 (1-2), pp. 157-167.

Logeay, C. and S. Tober (2006), "Hysteresis and the NAIRU in the Euro area", *Scottish Journal of Political Economy*, 53 (4), pp. 409-429.

Lucas, R. E. Jr. (1972a), "Expectations and the neutrality of money", *Journal of Economic Theory*, 4 (2), pp. 103-124.

Lucas, R. E. Jr. (1972b), "Econometric testing of the natural rate hypothesis", in Eckstein, O. (ed.), *The econometrics of price determination*, Washington, D.C.: Board of Governors of the Federal Reserve System.

Lucas, R. E. Jr. (1973), "Some international evidence on output-inflation tradeoffs", *The American Economic Review*, 63 (3), pp. 326-334.

Masso J. and A. Heshmati (2003), "The optimality and overuse of labour in Estonian manufacturing enterprises", *IZA Discussion Paper*, 884.

Modigliani, F. and L. Papademos (1975), "Targets for monetary policy in the coming year", *Brookings Papers on Economic Activity*, 1, pp. 141-165.

Nickell, S. (1978), "Fixed costs, employment and labour demand over the cycle", *Economica*, 45 (180), pp. 329-345.

Nickell, S., L. Nunziata and W. Ochel (2005), "Unemployment in the OECD since the 1960s: what do we know?", *The Economic Journal*, 115 (500), pp. 1-27.

Phelps, E. (1967), "Phillips curves, expectations of inflation and optimal employment over time", *Economica*, 34 (135), pp. 254-281.

Phelps, E. (1968), "Money-wage dynamics and labour-market equilibrium", *Journal of Political Economy*, 76 (2), pp. 678-711.

Phelps, E. (1994), *Structural slumps: the modern equilibrium theory of unemployment, interest and assets*, Harvard University Press, Cambridge MA.

Phelps, E. (1995), "The origins and further development of the natural rate of unemployment", in Cross, R. (ed), *The natural rate of unemployment: reflections on 25 years of the hypothesis*, Cambridge University Press, Cambridge.

Phelps, E. and G. Zoega (1998), "Natural rate theory and OECD unemployment", *The Economic Journal*, 108 (448), pp. 782-801.

Phelps, E. and G. Zoega (2001), "Structural booms: productivity expectations and asset valuations", *Economic Policy,* 32 (16), pp. 85-126.

Piekkola, H. (2006), "Tax cuts and employment: evidence from Finnish linked employer-employee data", *ETLA Discussion Papers*, 1041.

Pivetta, F. and R. Reis (2004), "The persistence of inflation in the United States", *manuscript*, Harvard University.

Raurich, X., H. Sala and V. Sorolla (2006), "Unemployment, growth and fiscal policy: new insights on the hysteresis hypotheses", *Macroeconomic Dynamics*, 10 (3), pp. 285-316.

Røed, K. (1997), "Hysteresis in unemployment", *Journal of Economic Surveys*, 11 (4), pp. 389-418.

Sargent, T. (1978), "Estimation of dynamic labor demand schedules under rational expectations", *Journal of Political Economy*, 86 (6), pp. 1009-1044.

Staiger, D., J. Stock and M. Watson (1997a), "How precise are estimates of the NRU", pp. 195-246, in Romer, C. D. and D. H. Romer (eds.), *Reducing inflation: motivation and strategy*, Chicago University Press, Chicago.

Staiger, D., J. Stock and M. Watson (1997b), "The NAIRU, unemployment and monetary policy", *Journal of Economic Perspectives*, 11 (1), pp. 33-49.

Talyor, J. (1979), "Staggered wage setting in a macro model", *The American Economic Review*, 69 (2), pp. 108-113.

Vickrey, W. (1993), "Today's task for economists", *The American Economic Review*, 83 (1), pp. 1-10.

3 ESSAY 2: THE (IR)RELEVANCE OF THE NRU FOR POLICY MAKING: THE CASE OF DENMARK[44]

ABSTRACT. We reconsider the central role of the natural rate of unemployment (NRU) in forming policy decisions. We show that the unemployment rate does not gravitate towards the NRU due to frictional growth, a phenomenon that encapsulates the interplay between lagged adjustment processes and growth in dynamic labour market systems. We choose Denmark as the focal point of our empirical analysis and find that the NRU explains only 33% of the unemployment variation, while frictional growth accounts for the remaining 67%. Therefore, our theoretical and empirical findings raise doubts as to whether the NRU should play such a key instrumental role in policy making.

3.1 Introduction

The natural rate of unemployment (NRU) plays a pivotal role in the decisions of policy makers. The influential contributions of Friedman and Phelps at the end of the 1960s established that the Phillips curve is vertical in the long-run and marked the beginning of the "NRU era" in economic modelling. The term natural rate was coined by Friedman in 1968 and was described as a feature of the Walrasian market clearing general equilibrium. It is commonplace in the literature to regard the concepts of the natural rate and the non-accelerating inflation rate of unemployment (NAIRU) as approximately synonyms (Ball and Mankiw, 2002).[45]

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44 This paper was written with Marika Karanassou and Hector Sala and has been published in Scottish Journal of Political Economy (2008), 55 (3), pp. 369-392.

45 However, Tobin (1998) argues that the NRU and NAIRU are not synonymous. Karanassou, Sala, and Snower (2009) show that the NRU/NAIRU distinction becomes superfluous within their framework of "exogenous/endogenous" NRU models. It is important to note that our analysis does not hinge upon this issue, which is beyond the scope of the current paper.

On one hand, discussions about which labour market reforms are necessary draw heavily on the determinants of the NRU. On the other hand, the choice of contractionary or expansionary policy measures crucially depends on whether unemployment is below or above its natural rate. Proponents of the NRU paradigm assert that the natural rate is consistent with inflation stability and that unemployment gravitates towards it. This claim has major policy implications: when unemployment is perceived close to its natural rate any attempt to reduce it will only result in higher inflation.

This paper reassesses the role of the natural rate in policy making and argues that in the presence of *frictional growth* unemployment does not gravitate towards the NRU - instead, it can be described as chasing after a moving target. The phenomenon of frictional growth arises from the interplay between lagged adjustment processes and growth in multi-equation labour market models. Dynamic systems of equations that contain spillover effects and growing exogenous variables are an integral part of the chain reaction theory (CRT) of unemployment, a framework of analysis that gives rise to frictional growth. To illuminate the implications of frictional growth for the evolution of unemployment, we conduct our analysis in the context of a real labour market and thus abstract, without loss of generality, from Phillips curve effects and inflation dynamics issues.

Aside from the NRU viewpoint, another influential class of unemployment rate models is based on the hysteresis hypothesis.[46] Hysteresis, generally, describes a situation where temporary shocks have permanent effects on unemployment. In contrast, non-hysteretic behaviour characterises a model in which the rate of unemployment converges in the long-run to a value that does not depend on its initial conditions. The NRU hypothesis refers to this long-run value as the natural rate, estimates it as the steady-state unemployment rate in empirical models, and asserts that actual unemployment tracks its natural rate very well. Both the NRU and hysteresis hypotheses decompose unemployment into a "trend" component (natural rate) and a cyclical component, but while the NRU assumes that the two components evolve independently of each other, hysteresis postulates that cyclical variations of unemployment propagate to its natural rate (Jaeger and Parkinson, 1994). We should note that there is a plethora of definitions and interpretations of hysteresis in the labour market literature (Rφed, 1997, provides a comprehensive survey of the terminology surrounding hysteresis).

The concepts of hysteresis found in the literature are being tested with a variety of techniques (see, among others, León-Ledesma and McAdam, 2004). The interpretation of hysteresis as the presence of a unit root in unemployment rates is examined using individual and panel unit-root tests combined with endogenous structural break tests, and fractional integration techniques.[47]

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46 The term hysteresis was coined by Sir James Alfred Ewing, Scottish physicist and engineer, to describe the *history* dependence of physical systems. It derives from an ancient Greek word, [illegible], meaning "delayed."

47 When the order of fractional integration lies in the interval (0, 0.5), unemployment is

Jaeger and Parkinson (1994) argue that finding a unit root in unemployment is a necessary but not a sufficient condition for hysteresis. Interpreting hysteresis as the effects of cyclical variations on the natural rate, they apply the Kalman-filter technique to an unobserved components framework where the NRU is modelled as a random walk plus a term of lagged cyclical unemployment (a similar technique is also used by Logeay and Tober, 2006). Another interpretation of hysteresis is the existence of multiple equilibria in unemployment dynamics. Theoretical developments in multiple equilibria are given by Hughes-Hallett and Piscitelli (2002), and Raurich, Sala and Sorolla (2006). In this case, Markov-switching techniques are applied to identify the low- and high-unemployment rate regimes.[48]

How does the CRT framework relate to and differ from the NRU and hysteresis viewpoints? First, models of hysteresis do not capture the structure of the labour market – they are merely statistical representations of the unemployment rate process (Jaeger and Parkinson, 1994, p. 332). Unlike hysteresis, the CRT and NRU offer structural representations of the labour market. Second, while models of hysteresis focus on the path dependency of unemployment, NRU and CRT models aim at identifying the driving forces of unemployment. However, in sharp contrast to NRU models, the CRT focuses on the determinants of the actual (instead of the natural) rate of unemployment, because it argues that the natural rate is not an attractor of actual unemployment. The contribution of our work is to show that the CRT views the long-run unemployment rate as the sum of two components: steady-state unemployment (NRU) and frictional growth. Dynamic single-equation NRU models do not allow for frictional growth since (i) all the labour market adjustments are suppressed into the autoregressive coefficient(s) of the single unemployment rate equation, and (ii) the exogenous variables are stationary so that the right-hand side of this equation balances with the trendless unemployment rate.

Thus, on one hand, the CRT argues that there may be a substantial disparity between the long-run and natural rates of unemployment (in this case the NRU ceases to be the attractor of actual unemployment). On the other hand, our limited knowledge of the long-run values of the growth rates of the exogenous variables implies that we do not have reliable estimates of the long-run unemployment rate. It is for these reasons that, unlike NRU models, CRT models do not attempt to determine the factors underlying the natural (or long-run) unemployment rate. Instead, the CRT focuses on the contributions of the exogenous variables to the evolution of unemployment, and emphasises the important role of the interactions between lags and growth in driving the

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covariance-stationary with long memory - it reverts to its mean at a much slower pace than that of an ARMA stochastic process. In this case, there is no evidence for hysteresis; the case of an order of fractional integration > 0.5 indicates hysteresis. See Caporale and Gil-Alana (2007) for an application with US data.

48 See, for example, Bianchi and Zoega (1998) and León-Ledesma and McAdam (2004) for an application of Markov-switching techniques to fifteen OECD countries and the CEECs (Central and Eastern European Countries), respectively.

unemployment rate. This has important implications for economic policy. For example, not taking into account the impact of frictional growth may lead to a misjudgement of the unemployment effects of labour market reforms.

Over the past 20 years the evolution of inflation and unemployment in most of the developed economies has put the NRU story under scrutiny. The relatively low and rather stable inflation rates imply that actual unemployment has been close to its natural rate. Therefore, given the rather high unemployment rates that persisted in the 1980s and the 1990s, the challenge for the NRU paradigm has been to identify the factors responsible for the rise in the natural rate. Blanchard (2006), in a journey through the decades, reviews the explanations offered to justify the NRU increases: high oil prices and slowdown in productivity in the 1970s, persistence mechanisms in the 1980s, labour market institutions in the 1990s. Blanchard (2006) is a narrative of what we have learned and what we still do not know. He bravely points out that 'One might have hoped that...we would now have an operational theory of unemployment. I do not think that we do' (p. 8). Blanchard scepticism is somehow echoed in Gordon's (1988) econometric critique of what he calls 'The Un-Natural Rate of Unemployment.'

Denmark is a particularly interesting case to study[49] as it appears to refute the NRU predictions. It is one of the successful economies in Europe having recovered, after experiencing serious unemployment problems, an unemployment rate close to full-employment levels that is half the European average. The Danish labour market is among the most flexible and dynamic ones across Europe, resembling more the Anglo-Saxon model than the continental European labour markets. At the same time, like the rest of the Nordic economies, Denmark has a well-developed welfare state system with a very low degree of income inequality.

Our empirical model of the Danish labour market reveals that actual unemployment does not evolve around its natural rate - the NRU can only explain one third of the variation in unemployment, while frictional growth accounts for the remaining two thirds. In a nutshell, our analytic and empirical findings question the prominent role of the NRU in policy modelling.

The remaining of the paper is structured as follows. In Section 3.2, we first discuss the standard methodologies to estimate the NRU, and illustrate the conventional wisdom with a simple graph. We then provide a formal definition of the NRU. In Section 3.3, we develop an analytic labour market model to explain the implications of the CRT of unemployment for the NRU. In Section 3.4, we present the multi-equation dynamic model estimated for the Danish economy. In Section 3.5, we compute the NRU and discuss its relevance for policy making. Section 3.6 concludes.

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[49] See the special report on Denmark's labour market "Flexicurity" in *The Economist*, 9 September 2006.

3.2 The natural rate of unemployment

3.2.1 The conventional wisdom

The standard unemployment rate models seek to explain movements in unemployment by distinguishing two components: (i) the so-called "business cycle," i.e. the high-frequency unemployment movements which are induced by the effects of temporary shocks disrupting equilibrium, and (ii) the so-called "trend" or NRU, i.e. the low-frequency movements of unemployment which arise from changes in the permanent components of its determinants.

This compartmentalisation implies that the unemployment rate evolves around the NRU from which it only temporarily deviates. In other words, the natural rate serves as an attractor for the moving unemployment rate. The structuralists and institutionalists are two prominent and influential groups within this tradition. Both groups estimate single-equation unemployment rate models to identify the driving forces of the natural rate.[50]

The structuralist perspective involves dynamic unemployment rate equations and asserts that the trajectory of unemployment is mainly determined by the structure of the economy, rather than by labour market lags (i.e. employment, real wage, and labour force adjustments).

This view was put forward by Phelps (1994) where the set of NRU determinants included (i) country-specific variables, such as real capital stock (normalised so that its trend is removed), real public debt, real government spending, tax rates, other institutional variables (replacement rate, duration of unemployment benefits), price mark-ups induced by exchange rates, and some demographic variable (e.g. the proportion of population between 20 and 24 years old), and (ii) world variables, such as the real interest rate and the real price of oil.

Subsequent works of the structuralist proponents - see, among others, Phelps and Zoega (1998, 2001) and Fitoussi *et al.* (2000) - also included the slowdown of productivity (witnessed since the mid-1970s), the share of social expenditures in gross domestic product (GDP), the educational composition of the labour force, and asset valuation in the determination of unemployment.

The idea that labour market institutions are the main driving force of unemployment has significantly influenced academics and policy makers since the OECD Jobs Study was published in 1994. In general, the institutionalists argue that wage-push factors (such as unemployment benefits, firing restrictions, minimum wages, union power, and the tax wedge) are responsible for the rise in unemployment, while active labour market policies can reduce it. It is worth noting how far apart the institutionalist story stands from the Keynesian viewpoint that capital accumulation, demand factors and

50 When the unemployment rate equations include the change in inflation on their right-hand side, they can be described as augmented Phillips curve models where the time-varying NRU changes are attributed to fundamentals.

unemployment persistence are the driving forces of unemployment (see Stockhammer, 2004).

Nickell (1997, 1998) uses cross-country regressions and finds that wage-push factors affect significantly the unemployment rate. Scarpetta (1996) and IMF (2003) estimate panel data regressions and stress the importance of labour market institutions and their interactions. Nickell, Nunziata and Ochel (2005) use a panel of 20 OECD countries over the 1961-1995 period and find that shifts in labour market institutions explain around 55% of the rise in European unemployment (excluding Greece, Luxembourg and Eastern Europe).

According to Blanchard (2006, p. 31) "Changes in institutions did not appear able, however, to explain the evolution of unemployment rates over time." This of course may be due to the inability of quantitative indices to describe effectively the multiple dimensions of labour market institutions. The lack of annual time-series data on institutional variables and the observation that institutions do not vary much through time, also led researchers to adopt 5-year averages in their estimations (see, e.g Blanchard and Wolfers, 2000).

However, we should note that cross-country regressions and 5-year data averages in panel estimation completely disregard the role played by labour market dynamics in the evolution of the unemployment rate. The dismissal of dynamics in the analysis of the unemployment problem is justified by the macroeconomic consensus that the long-run equilibrium of the unemployment rate (the NRU) and the short-run variations of actual unemployment around it are independent of one another.

Statistical filtering of the unemployment rate series is a popular technique to extract its "trend" component. In 1980, Hodrick and Prescott (1997) proposed their detrending method, commonly known as HP filtering. This is essentially a time-varying linear trend that changes smoothly over time. Although the univariate filters like the HP and band-pass (see Baxter and King, 1999) are used to decompose a series into its permanent and temporary components, they are unable to provide any insight on the driving forces of the "trend" component of the variable. This led to the development of multivariate HP filters, known as HPMV (see, e.g. Chagny and Lemoine, 2004). Furthermore, the Kalman filter is another statistical technique that has been extensively used in Phillips curve models to estimate the time-varying non-accelerating inflation rate of unemployment (TV-NAIRU).[51]

We illustrate the conventional wisdom with a simple example. Figure 1 plots the actual and natural rates of unemployment for Denmark over the 1973-2005 period. The NRU is computed by applying the HP filter to the actual unemployment rate series.[52] The plot below aims at mimicking Figure 18.2 in Phelps (1994) and Figure 1 in Phelps and Zoega (1996) for the world economy,

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51 Although the NRU and NAIRU are not synonymous, Karanassou, Sala, and Snower (2009) explain that the two concepts can be seen as the two sides of the same coin - the coin of the classical dichotomy. They also provide an overview of the various Phillips curve models and a discussion of their limitations.

52 Filtering the actual series is equivalent to filtering the fitted values when the estimated model fits the data well.

Figure 4 in Holden and Nymoen (2002) for the Nordic countries, Figure 2 in Batini and Greenslade (2006) for the United Kingdom, and Figure 2 in Blanchard (2006) for the EU15. These figures were obtained by using the conventional approaches described above and yield a similar picture: the NRU closely tracks the actual unemployment rate.[53] The NRU in Figure 1 reproduces this feature.

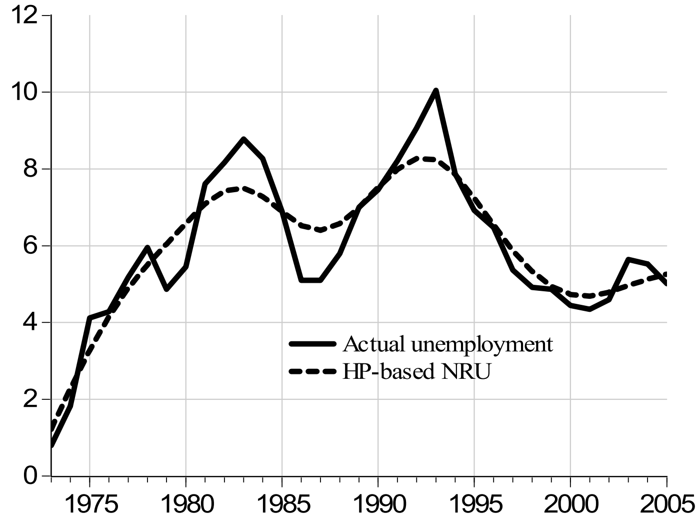

FIGURE 1 The NRU in Denmark according to the conventional view

Observe that unemployment varies more between business cycles (identified by the peaks in 1978, 1983, 1993 and 2003) than within them. According to the mainstream view the changes between cycles are accounted by the "trend" component of unemployment, whereas the variations within cycles are attributed to the effects of temporary shocks. In other words, Figure 1 conforms with the conventional wisdom that unemployment evolves around its natural rate and thus the NRU can explain the large swings of the unemployment rate. As we show in Section 3.3, any single-equation unemployment rate model can produce a picture similar to that in Figure 1 since it has zero frictional growth (no interacting labour market lags and trendless exogenous variables).

3.2.2 Formal definition

The NRU (u^n) is generally understood as the equilibrium value at which unemployment will stabilise in the long-run (see, e.g. Ball and Mankiw, 2002).

53 In particular, Phelps (1994) and Phelps and Zoega (1996) apply the structuralist theory to compute the NRU, Holden and Nymoen (2002) estimate the NAWRU (non-accelerating wage rate of unemployment), Batini and Greenslade (2006) use the Kalman filter to estimate the TV-NAIRU, and Blanchard (2006) constructs the NAIRU as $u^* = u + 0.5(\Delta\pi)$, where $\Delta\pi$ is a 3-year moving average of the change in inflation.

This definition is in line with the observation that the unemployment rate is trendless. When unemployment is modelled by a dynamic single equation, the natural rate is given by the steady-state unemployment rate.

For example, suppose that the unemployment rate is given by the following simple model:

$$u_t = \alpha u_{t-1} + \gamma x_t + \varepsilon_t, \tag{1}$$

where x_t is an exogenous variable, γ is a constant, ε_t is a strict white noise error term (i.e. independently, identically distributed with zero mean and constant variance), and the autoregressive coefficient α is < 1 in absolute value.

Let us consider the following normalisation of the above equation:

$$u_t = \frac{\gamma}{1-\alpha} x_t - \frac{\alpha}{1-\alpha} \Delta u_t + \frac{\varepsilon_t}{1-\alpha}, \tag{2}$$

where Δ denotes the difference operator.

We assume that in the long-run unemployment stabilises, so that $\Delta u_t = 0$ or $u_t = u_{t-1}$, and all shocks are absorbed, so that $\varepsilon_t = 0$. In this case the NRU is given by

$$u^n = \frac{\gamma}{1-\alpha} x^{LR}, \tag{3}$$

where the superscript x^{LR} denotes the long-run value of the variable. It is commonly assumed that the exogenous variable stabilises in the long-run, and so the natural rate is simply the steady-state of the unemployment model.

In applied work, the unknown long-run value of the exogenous variable is replaced by its permanent component.[54] We thus have the following definition.

Definition. The natural rate is the equilibrium unemployment rate at which there is no tendency for this rate to change at any time t, given the permanent component values of the exogenous variables at that time.

Note that the above definition applies to both single- and multi-equation models of the unemployment rate.

3.3 The chain reaction theory of unemployment

Like the structuralist and institutionalist theories, the CRT aims at identifying the economic factors responsible for the evolution of the unemployment rate. But unlike the structuralist and institutionalist theories, the CRT is an

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54 The permanent component of a series is usually obtained by filtering the series using the Hodrick-Prescott technique.

interactive dynamics approach: it applies *dynamic multi-equation systems with spillover effects* to the labour market to explain the time path of unemployment. (The CRT was developed by Karanassou and Snower in 1993. See, among others, Karanassou and Snower, 1998.)

Because the unemployment rate is a non-trended variable, single-equation unemployment models have to use exogenous variables that do not display a trend. This is not the case when multi-equation labour market models are used - the only requirement is that each trended endogenous variable (e.g. employment, real wage, and labour force) is balanced with the set of its explanatory variables.

In the context of multi-equation labour market models, changes in the unemployment rate are viewed as "chain reactions" of its responses to temporary and permanent labour market shocks. The unemployment responses work their way through a network of interacting lagged adjustment processes. These lagged adjustment processes are well documented in the literature and refer, among others, to: (i) employment adjustments arising from labour turnover costs (hiring, training, and firing costs), (ii) wage/price staggering, (iii) insider membership effects, (iv) long-term unemployment effects, and (v) labour force adjustments. By identifying the various lagged adjustment processes, the CRT can explore their interactions and quantify the potential complementarities/substitutabilities among them.

In other words, the CRT postulates that the evolution of unemployment is driven by the interplay of lagged adjustment processes and the spillover effects within the labour market system. Spillover effects arise when shocks to a specific equation feed through the labour market system. The label "shocks" refers to changes in the exogenous variables.

3.3.1 A simple CRT model

We illustrate the workings of the CRT with the following model of labour supply, labour demand, and real wage equations:

$$l_t = \alpha_2 l_{t-1} + \beta_2 z_t, \tag{4}$$
$$n_t = \alpha_1 n_{t-1} + \beta_1 k_t - \gamma w_t, \tag{5}$$
$$w_t = \beta_3 x_t - \delta u_t, \tag{6}$$

where l_t, n_t, and w_t denote the endogenous labour force, employment, and real wage, respectively; z_t is working-age population, k_t is real capital stock, and x_t represents a wage push factor (e.g. benefits); the autoregressive parameters are $0 < \alpha_1, \alpha_2 < 1$, and the β's, γ, and δ are positive constants. All variables are in logs and we ignore the error terms for ease of exposition. The unemployment rate (not in logs) is[55]

[55] Because labour force and employment are in logs, we can approximate the unemployment rate by their difference.

$$u_t = l_t - n_t. \tag{7}$$

We should note that when either γ or δ are zero in the toy model (4)-(6), labour market shocks do not spillover from labour supply to labour demand and vice versa. In other words, the influence of the exogenous variables (k_t and z_t) on unemployment can be measured through individual analysis of the labour demand and supply equations. In particular, if unemployment does not influence wages $(\delta = 0)$, then labour demand and supply shocks do not spillover to wages. As a result, capital stock changes do not affect labour force, and changes in working-age population do not affect employment. If, on the other hand, $\gamma = 0$ shocks to wage setting do not affect employment and, consequently, do not spillover to unemployment. Thus, the wage elasticity of demand provides the mechanism through which changes in the wage push factor x_t feed through to unemployment. This can be seen clearly in the reduced form unemployment rate equation (13) derived below.

Let us rewrite the labour supply and demand equations (4), (5) as

$$(1-\alpha_2 B)l_t = \beta_2 z_t, \tag{8}$$
$$(1-\alpha_1 B)n_t = \beta_1 k_t - \gamma w_t, \tag{9}$$

where B is the backshift operator. Substitution of (6) into (9) gives

$$(1-\alpha_1 B)n_t = \beta_1 k_t - \gamma\beta_3 x_t + \gamma\delta u_t. \tag{10}$$

Multiplying both sides of equations (8) and (10) by $(1-\alpha_1 B)$ and $(1-\alpha_2 B)$, respectively, gives

$$(1-\alpha_1 B)(1-\alpha_2 B)l_t = \beta_2(1-\alpha_1 B)z_t, \tag{11}$$
$$\begin{aligned}(1-\alpha_1 B)(1-\alpha_2 B)n_t = {} & \beta_1(1-\alpha_2 B)k_t - \gamma\beta_3(1-\alpha_2 B)x_t \\ & +\gamma\delta(1-\alpha_2 B)u_t.\end{aligned} \tag{12}$$

Finally, use the definition (7) and subtract equation (12) from equation (11) to obtain the *reduced form* unemployment rate equation:[56]

$$\begin{aligned}(1+\gamma\delta-\alpha_1 B)(1-\alpha_2 B)u_t = {} & \beta_2(1-\alpha_1 B)z_t - \beta_1(1-\alpha_2 B)k_t \\ & +\gamma\beta_3(1-\alpha_2 B)x_t.\end{aligned} \tag{13}$$

56 Note that (13) is dynamically stable because (i) products of polynomials in B, which satisfy the stability conditions are stable, and (ii) linear combinations of dynamically stable polynomials in B are also stable.

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

Alternatively, the reduced form unemployment rate equation (13) can be written as

$$u_t = \phi_1 u_{t-1} - \phi_2 u_{t-2} - \theta_k k_t + \theta_z z_t + \theta_x x_t + \alpha_2 \theta_k k_{t-1} - \alpha_1 \theta_z z_{t-1} - \alpha_2 \theta_x x_{t-1}, \qquad (14)$$

where $\phi_1 = \frac{\alpha_1 + \alpha_2(1+\gamma\delta)}{1+\gamma\delta}$, $\phi_2 = \frac{\alpha_1\alpha_2}{1+\gamma\delta}$, $\theta_k = \frac{\beta_1}{1+\gamma\delta}$, $\theta_z = \frac{\beta_2}{1+\gamma\delta}$, and $\theta_x = \frac{\gamma\beta_3}{1+\gamma\delta}$.

Parameterisations (13) and (14) of the reduced form unemployment rate equation show the following. First, the autoregressive parameters ϕ_1 and ϕ_2 embody the interactions of the employment and labour force adjustment processes (α_1 and α_2, respectively). Second, the short-run elasticities (θ_k, θ_x, and θ_z) are a function of the feedback mechanisms that give rise to the spillover effects in the labour market system. Third, the interplay of the lagged adjustment processes and the spillover effects can be captured by the induced lag structure of the exogenous variables.

In applied work, as we discussed in Section 3.2, the NRU is defined as the equilibrium unemployment rate at which there is no tendency for this rate to change at any time t, given the permanent component values of the exogenous variables at that time. In this sense, it represents the unemployment that would be achieved once all the lagged adjustment processes have been completed in response to the permanent components of the exogenous variables.

Therefore, the NRU is computed by setting the backshift operator B equal to unity in the unemployment rate equation (13):

$$u_t^n = \frac{\beta_2(1-\alpha_1)\tilde{z}_t - \beta_1(1-\alpha_2)\tilde{k}_t + \gamma\beta_3(1-\alpha_2)\tilde{x}_t}{(1+\gamma\delta-\alpha_1)(1-\alpha_2)}, \qquad (15)$$

where the $\sim$ above the variable denotes its permanent component. Naturally, the estimates of the NRU reflect the decision on which changes in the exogenous variables are permanent or temporary.

3.3.2 Long-run unemployment, NRU, and frictional growth

A salient feature of the CRT is that unemployment may substantially deviate from what is commonly perceived as its natural rate, even in the long-run. This was first pointed out by Karanassou and Snower (1997) and lies in sharp contrast with the conventional wisdom that the NRU is the attractor of the unemployment rate.

To elaborate this issue we use the labour market system (4)-(7) and make the plausible assumption that capital stock (k_t), the wage-push factor (x_t), and working-age population (z_t) are growing variables with growth rates that stabilise in the long-run. (Note that the growth rates of log variables are proxied by their first differences, $\Delta(\cdot)$, and recall that the superscript LR denotes the long-run value of the variable.)

Equation (7) implies that unemployment stabilises in the long-run, $\Delta u^{LR} = 0$, when

$$\Delta l^{LR} = \Delta n^{LR} = \lambda. \tag{16}$$

In other words, the restriction that the growth rate of employment is equal to the growth rate of labour force, say λ, ensures unemployment stability in the long-run.[57]

Let us substitute the wage equation (6) into the labour demand equation (5) and rewrite the resulting equation and the labour supply equation (4) as

$$l_t = \frac{\beta_2}{1-\alpha_2} z_t - \frac{\alpha_2}{(1-\alpha_2)} \Delta l_t, \tag{17}$$
$$n_t = \frac{\beta_1}{1-\alpha_1} k_t - \frac{\gamma\beta_3}{1-\alpha_1} x_t + \frac{\gamma\delta}{1-\alpha_1} u_t - \frac{\alpha_1}{(1-\alpha_1)} \Delta n_t. \tag{18}$$

Substitution of the above equations into equation (7) and some algebraic manipulation yields the following expression for the unemployment rate

$$u_t = \zeta\left(\frac{\beta_2}{1-\alpha_2} z_t - \frac{\beta_1}{1-\alpha_1} k_t + \frac{\gamma\beta_3}{1-\alpha_1} x_t\right) + \zeta\left(\frac{\alpha_1}{(1-\alpha_1)} \Delta n_t - \frac{\alpha_2}{(1-\alpha_2)} \Delta l_t\right), \tag{19}$$

where $\zeta = \frac{1-\alpha_1}{1-\alpha_1+\gamma\delta}$.

The long-run unemployment rate is obtained by imposing restriction (16) on parameterisation (19) of the reduced form unemployment rate equation

$$u^{LR} = \zeta\left[\underbrace{\left(\frac{\beta_2}{1-\alpha_2} z^{LR} - \frac{\beta_1}{1-\alpha_1} k^{LR} + \frac{\gamma\beta_3}{1-\alpha_1} x^{LR}\right)}_{\text{natural rate of unemployment}} + \underbrace{\frac{(\alpha_1-\alpha_2)\lambda}{(1-\alpha_1)(1-\alpha_2)}}_{\text{frictional growth}}\right]. \tag{20}$$

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57 The above restriction can also be expressed in terms of the long-run growth rates of the exogenous variables

$$\frac{\beta_1}{1-\alpha_1}\Delta k^{LR} - \frac{\gamma\beta_3}{1-\alpha_1}\Delta x^{LR} = \frac{\beta_2}{1-\alpha_2}\Delta z^{LR} = \lambda.$$

Observe that the first term of (20) gives the NRU, whereas the second term of (20) captures *frictional growth*, i.e.

$$\text{long - run unemployment rate} = \text{NRU} + \text{frictional growth},$$

where frictional growth arises from the interplay between the lagged adjustment processes and the growing exogenous variables.

The long-run value (u^{LR}) towards which the unemployment rate converges reduces to the NRU only when frictional growth is zero. This occurs when (i) the exogenous variables have zero growth rates in the long-run (so that $\lambda = 0$), or (ii) the labour demand and supply equations have identical dynamic structures (so that $\alpha_1 = \alpha_2$).

Therefore, frictional growth implies that under quite plausible conditions (e.g. different labour demand and supply dynamics, and growing exogenous variables) the natural rate is not an attractor of the moving unemployment. In these circumstances the relevance of the NRU in policy making is questionable.[58]

3.4 A dynamic structural model for Denmark

3.4.1 Data and estimation methodology

Our dataset is annual and covers the period 1973-2005. The OECD Economic Outlook is our main source. Table 1 presents the group of variables used in the estimated model.[59]

TABLE 1 Definitions of variables

n	employment (log)	k^n	capital stock per employee $(k-n)$
l	labour supply (log)	z	participation rate $\left(\frac{\text{labour force}}{\text{working-age population}}\right)$
w	real compensation per employee (log)	r	real long-term interest rate
u	unemployment rate $(l-n)$	g	public expenditures (as % of GDP)
k	real capital stock (log)		

Source: OECD, Economic Outlook.

58 We should also note that while the NRU is a charming idea, it is most often hard to agree on its value at any point in time. This issue has also been raised recently in *The Economist*, 30 September 2006, p. 108.

59 Our wider set of explanatory variables also included oil prices (source: IMF), financial wealth (source: Bloomberg), several public sector variables (such as direct and indirect taxes, the fiscal wedge, social security benefits and contributions), alternative measures of competitiveness, consumption, and real money balances. However, we were unable to find any influence of these variables on the Danish labour market.

The estimation methodology is the autoregressive distributed lag (ARDL) approach (also known as bounds testing approach). The ARDL was proposed by Pesaran (1997), Pesaran and Shin (1999), and Pesaran, Shin and Smith (2001) as an alternative procedure to the standard cointegration analysis. The advantage of the ARDL is that does not rely on whether the explanatory variables are integrated of order zero or one. The voluminous literature on all the different types of unit root tests proposed since the influential paper by Dickey and Fuller in *Econometrica* 1981, is a clear manifestation of the problems involved in correctly identifying the order of integration of a time series. The ARDL approach avoids these pre-testing problems, while it gives consistent estimates both in the short- and long-run. Thus, the ARDL provides us with an econometric tool to conduct our empirical analysis rigorously.

In line with the CRT, we estimate a structural vector autoregressive distributed lag model to analyse the trajectory of the unemployment rate[60]

$$\mathbf{A}_0\mathbf{y}_t = \sum_{i=1}^{2}\mathbf{A}_i\mathbf{y}_{t-i} + \sum_{i=0}^{2}\mathbf{D}_i\mathbf{x}_{t-i} + \mathbf{e}_t, \tag{21}$$

where $\mathbf{y}_t$ is a (3×1) vector of endogenous variables, $\mathbf{x}_t$ is a (4×1) vector of exogenous variables, the $\mathbf{A}_i$'s and $\mathbf{D}_i$'s are (3×3) and (4×4), respectively, coefficient matrices, and $\mathbf{e}_t$ is a (3×1) vector of strict white noise error terms.

Our labour market system (21) comprises labour demand, wage setting, and labour supply equations. Each equation is estimated following the ARDL approach and passes the standard misspecification and structural stability tests. To account for potential endogeneity and cross equation correlation we estimate the labour market model with 3SLS.[61]

3.4.2 Estimated equations

Using the estimated three-equation model (see Table 2 below) and the unemployment equation (7), we obtain the fitted values of unemployment. Figure 2 plots the actual and fitted values of the unemployment rate and shows that our estimation tracks the data reasonably well. We should emphasise that a good fit is much harder to obtain when dynamic multi-equation labour market models are being estimated instead of single unemployment rate equations. This is because of the numerous interactions of the endogenous variables that take place when we solve the model for the unemployment rate. Table 2 presents our estimated equations.

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60 The dynamic system equation (21) is stable if, for given values of the exogenous variables, all the roots of the determinantal equation $\left|\mathbf{A}_0 - \mathbf{A}_1B - \mathbf{A}_2B^2\right| = 0$ lie outside the unit circle. Note that the estimated equations given below satisfy this condition.

61 The OLS results do not differ substantially from the 3SLS ones and are available upon request. Table A1 in Appendix A presents diagnostic tests for the selected equations.

The labour demand equation is quite standard. Employment depends on capital stock, real wages, and public expenditures. Labour demand is more sensitive to changes in the real wage than to changes in capital stock (the long-run elasticities are - 1 and 0.6, respectively). Phelps (1994, ch. 17) popularised the inclusion of public expenditures in single-equation unemployment rate models, and its strong influence on the Danish economy comes as no surprise. The public sector is responsible for the production of the vast majority of services, it accounts for almost a third of total employment, and public consumption represents around 40% of total public expenditure (see Madsen, 1999). A 1 percentage point increase in the ratio of public expenditures to GDP will boost employment by 1.2%, in the long-run.

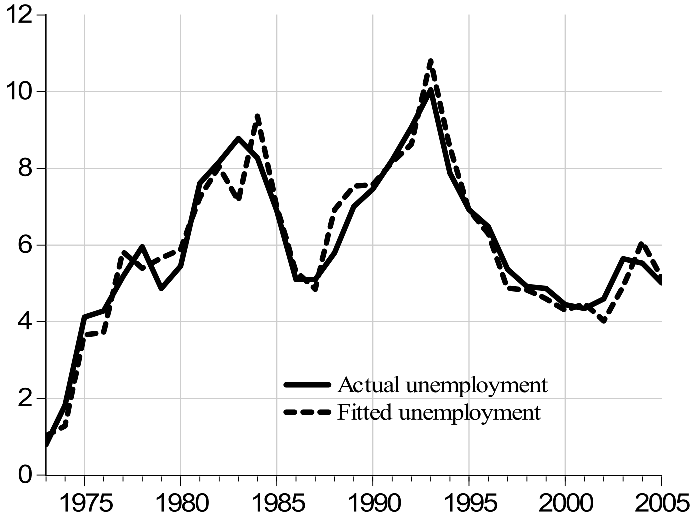

FIGURE 2 Unemployment rate: actual and fitted values

Furthermore, observe that the employment and wage equations display low persistence (the autoregressive coefficients are 0.18 and 0.32, respectively) indicating a quick speed of adjustment to economic disturbances. This reflects the high degree of flexibility, which characterises the Danish labour market (the employment protection legislation is among the less strict in the OECD countries).

Wage setting is influenced by unemployment, capital deepening $(k_t - n_t)$, and the interest rate. As expected, unemployment exerts downward pressure on the real wage with a semi-elasticity of - 0.60 in the short-run. In addition, if the unemployment rate goes up by 1 percentage point, wages fall by 0.9% in the long-run. The effect of capital deepening on wages is captured by a long-run coefficient of 0.46.[62] The impact of the interest rate on wages is positive (0.56 in the long-run).[63] However, since wages enter negatively in labour demand, the

62 Capital deepening is regarded as a good proxy for labour productivity. The advantage of using capital deepening instead of productivity in our model is that we avoid dealing with an additional endogenous variable in our estimation.

63 We regard the positive association of the real wage with the interest rate as a result of

relation between the interest rate and unemployment has the expected negative sign.

It is important to remark that neither tax variables nor social security benefits were found to influence the wage equation. This may be due to the emphasis of the Danish system on active labour market policies (ALMPs) - Denmark is the country with the highest GDP percentage of ALMPs expenditures. When this is coupled with loose employment protection legislation, standard labour market institutions (i.e., taxes and benefits) become less relevant to wage setting.

TABLE 2 Denmark, 3SLS, 1973-2005

Dependent variable: n_t			Dependent variable: w_t			Dependent variable: l_t		
	Coefficient	p-values		Coefficient	p-values		Coefficient	p-values
const	11.6	[0.000]	*const*	5.34	[0.000]	*const*	1.24	[0.000]
n_{t-1}	0.18	[0.000]	w_{t-1}	0.32	[0.000]	l_{t-1}	0.90	[0.000]
Δn_{t-1}	0.61	[0.000]	Δw_{t-1}	0.44	[0.001]	Δl_{t-1}	0.76	[0.000]
w_t	-0.58	[0.000]	u_t	-0.60	[0.000]	Δu_t	-0.04	[0.032]
w_{t-1}	-0.30	[0.052]	k_t^n	0.31	[0.000]	Δu_{t-1}	-0.04	[0.035]
k_t	0.48	[0.000]	r_t	0.38	[0.000]	w_t	0.02	[0.004]
Δk_t	1.78	[0.001]				Δw_t	-0.03	[0.035]
Δk_{t-1}	1.14	[0.083]				z_t	0.18	[0.000]
g_t	1.02	[0.001]				Δz_t	1.09	[0.000]
Δg_t	-0.89	[0.012]				Δz_{t-1}	-1.04	[0.000]
Δg_{t-1}	0.95	[0.003]						
s.e.		0.010			0.009			0.001

Note: Δ is the difference operator; *s.e.* is the standard error of the regression.

In contrast to labour demand and wage setting, inertia in labour supply decisions is large, with a persistence coefficient of 0.90. Labour supply is driven by the unemployment rate, real wage and participation rate.

In particular, it is the change rather than the level of unemployment that enters the labour force equation. This is commonly referred to as the discouraged workers' effect, here with a long-run coefficient of - 0.80. The wage incentive appears to activate labour supply with a long-run elasticity 0.20.

Finally, it is through the participation rate instead of the working-age population that we can capture demographic influences on the labour supply movements. Our understanding of this finding is that the participation rate also embodies the society's attitude towards the labour market. In this sense, it is

the procyclicality of the two variables. In booming times, a tight labour market puts upward pressure on wages, and the monetary authorities raise interest rates to control for inflation.

partly the social norms that induce participation rates to be among the highest in the Nordic countries and among the lowest in the Mediterranean ones.

3.5 The NRU in Denmark

Given the definition of the natural rate in Section 3.2, we compute the NRU along the lines of equation (15). That is, we set the lagged (period $t-i$) values of the endogenous variables equal to their period t values, and solve the labour market system by using only the permanent components of the exogenous variables. Recall that our model consists of the estimated equations given in Table 2, and the unemployment rate equation (7).

3.5.1 Permanent and temporary components of the exogenous variables

We estimate the kernel density functions of the determinants of unemployment to disentangle their permanent and temporary components and identify the number and longevity of the regimes embedded in each variable.[64] We should note that in this context, the term "permanent component" is not a universal concept - it only applies to our sample period.

A time series with different regimes is characterised by a multimodal density of its frequency distribution, the number of modes corresponding to the number of regimes. In particular, a unimodal kernel density indicates that a unique regime exists with mean equal to the value of the mode. On the other hand, a variable with two regimes displays a bimodal kernel density with a "valley point" dividing the observations in the sample. The data points are grouped in the two regimes depending on whether they lie to the left or to the right of the "valley point." The kernel density analysis of the two-regime case can easily be extended to account for three or more regimes.

Naturally, when the time-series display one regime, this is taken to be permanent. For multimodal kernel densities, we distinguish between permanent and temporary regimes and identify them as follows: the variable starts in one regime (say, **A**) in the beginning of the sample, and then moves to another regime (say, **B**) at some later point in time. If the variable reverses to regime **A** before the end of the sample, then regime **B** is temporary and regime **A** is permanent. On the other hand, if the variable stays in regime **B** by the end of the sample then both regimes are permanent ones.

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64 Bianchi and Zoega (1998) use Kernel density functions to examine the regime-mean shifts of unemployment in 15 OECD countries. Raurich, Sala and Sorolla (2006) apply the Kernel density analysis to compare the relationship of unemployment and capital accumulation in the EU and the United States.

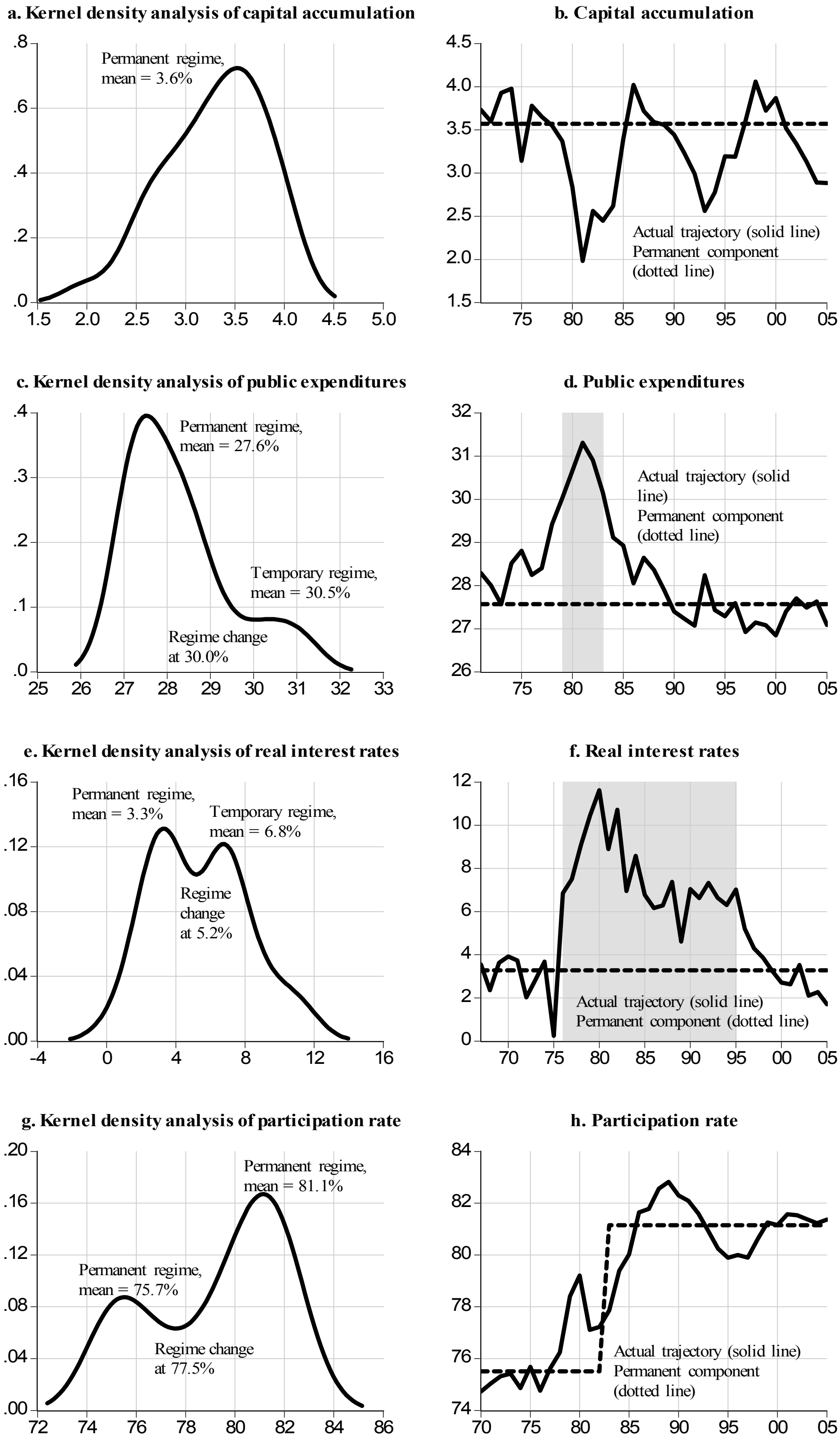

FIGURE 3 Actual and long-run values of the exogenous variables

The mean values of the identified permanent regimes give our estimates of the permanent components of the exogenous variables used in the computation of the NRU. It is important to note that the kernel density analysis can be carried out only when the time series is stationary. When the variable is growing (e.g. capital stock), the analysis is performed on its first difference from which we then recover the level of the variable.

The plots of the kernel density functions in the first column of Figure 3 reveal the number of regimes for each of the exogenous variables of the labour market model in Table 2. The plots in the second column of Figure 3 display the actual series (solid lines) and the mean values of their permanent regimes (dotted lines).

According to Figures 3a and b, the growth rate of capital stock has been in a single regime throughout the sample with mean 3.6%. In contrast, the bimodal kernel densities of public expenditures, interest rates, and participation rates reveal the existence of two regimes (see Figures 3c, e, and g).

Public expenditures and interest rates are characterised by one permanent and one (higher) temporary regime, the duration of which is indicated by the shaded areas in Figures 3d and f. The temporary regime of public expenditures refers to the expansionary fiscal policy during the economic downturn at the end of the 1970s and early 1980s, and is well documented in the literature.[65]

The temporary, albeit prolonged, regime of high interest rates was induced by the contractionary monetary policy response of the central bank to (i) the high inflation rates brought by the oil price shocks of the 1970s, and (ii) the rise in German interest rates by the Bundesbank to control inflation in the aftermath of the German unification. By the mid-1990s Denmark, like the rest of Europe, softened its monetary policy and has since then witnessed interest rate levels similar to the ones before the oil price crises.

On the other hand, the two regimes of the participation rates are both permanent (see Figure 3h). The "low" regime with mean 76% lasts until 1982 when the participation rate enters the high regime with mean 81%.

We should note that the above results are robust to the bandwidth value of the kernel density estimation (see Table B1 in Appendix B).

3.5.2 The (ir)relevance of the NRU

As we already explained, to compute the NRU we substitute the exogenous variables by their permanent trajectories (identified in the previous section), set the lags of the endogenous variables equal to their contemporaneous values, and solve the resulting labour market model for the unemployment rate. Figure 4 plots the NRU in Denmark vs. the actual unemployment rate series.

According to our analysis, the NRU in Denmark rose from values below 5% in the early 1970s to a peak of 6.3% in 1987 and 1988. The subsequent period was characterised by a slow but steady decline of the NRU reaching 4.1% in

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65 See Madsen (1999), Green-Pedersen and Lindbom (2005).

2005. In other words, the time path of the NRU has been rather flat since the 1970s, never exceeding 6% or falling below 4%.

Notwithstanding the different approaches, our results are in accordance with Holden and Nymoen (2002) and Nymoen and Rødseth (2003) who show that institutional or wage-pressure factors explain only a small fraction of the variation of unemployment in the Nordic countries. Our results are also in line with Henry, Karanassou and Snower (2000) who find that the NRU in the United Kingdom was reasonably stable around 4% over the 1964-1997 period with a mild peak in the mid-1980s.[66]

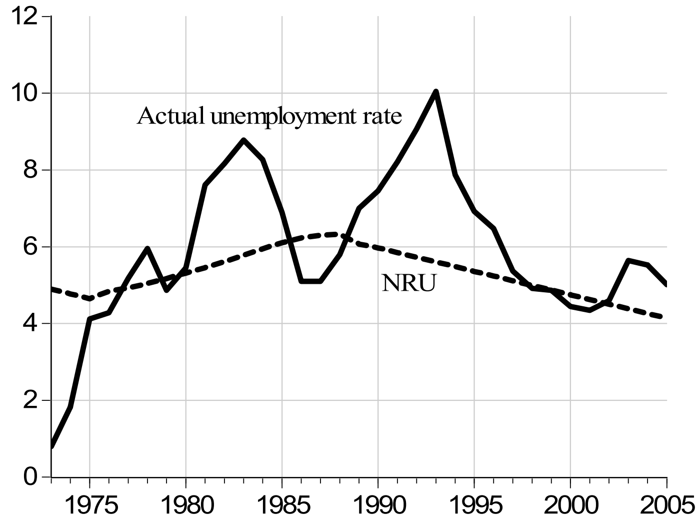

FIGURE 4 The NRU in Denmark according to the chain reaction theory

We should remark that Figure 4 above, and Figure 5 in Henry, Karanassou and Snower (2000), convey a very similar picture regarding the trajectory of the NRU in Denmark and the United Kingdom. This should come as no surprise since it is widely acknowledged that Denmark, unlike the other Nordic economies, shares some of the United Kingdom and United States features. First, its economic downturns follow closely those experienced by the Anglo-Saxon economies: the slump in the aftermath of the first and second oil price shocks, the recession of the early 1990s, and the slowdown of the early 2000s. Second, Denmark, the United Kingdom, and the United States, are the economies with the lowest level of employment protection. In sharp contrast, Sweden, Japan and Greece are at the other end of the employment protection spectrum.

Plougmann and Madsen (2005) point out that, although the Scandinavian Model (high tax rates, a comprehensive social security system, a universal insurance benefit system and low degrees of wage and income inequality) has not changed substantially, the natural rates of unemployment in Denmark and

66 The difference between our approach and the one in Henry, Karanassou, and Snower (2000) is that we use the kernel density function to extract the permanent components of the exogenous variables.

Sweden may have even decreased over the past decades. This offers support to the CRT perspective vs. the conventional belief that institutional variables (some of which are closely linked to the welfare state) are the main driving forces of the unemployment rate.

The viewpoint of the unemployment problem portrayed in Figure 4 is at odds with the conventional wisdom: the NRU does not account for the large increases in unemployment (3 percentage points in the early 1980s, and 5 percentage points in the early 1990s). In particular, we find that the NRU explains only 33% of the unemployment variation,[67] and so frictional growth accounts for the remaining 67%. We should note that these results are robust to the bandwidth value of the kernel density estimation (see Figure B1 in Appendix B).

3.6 Conclusions

Should the NRU dictate the decisions of policy makers? The theoretical and empirical models in this paper lead to a negative answer.

We first analysed a CRT model and showed that the unemployment rate does not gravitate towards the NRU. This is due to frictional growth, a phenomenon that encapsulates the interplay between lagged adjustment processes and growth in dynamic labour market systems.

We then chose Denmark as the focal point of our empirical analysis and found that the NRU is not the most important factor for explaining the movements of unemployment through time, because it can only explain one third of its variation. Our methodology differs from that of the conventional wisdom labour market models in two main respects: (i) we estimate a multi-equation (as opposed to a single-equation) dynamic labour market model that allows growing exogenous variables to interact with the persistence mechanism of the system, and (ii) we estimate the kernel density function of each exogenous variable to disentangle its trend and business-cycle components (as opposed to filtering the variables to extract their trend).

Our findings indicate that the NRU of single-equation unemployment rate estimations provides a rather incomplete picture of what really matters for the evolution of unemployment. We thus argue that future work should estimate CRT models, and measure the unemployment contributions of the "usual suspects" (e.g. wage-push factors) along with those of growing exogenous variables (such as capital stock) for a better understanding of the unemployment problem.

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67 This is the R^2 obtained by regressing the fitted values of our estimated model on the NRU.

REFERENCES

Ball, L, and G. Mankiw (2002), "The NAIRU in theory and practice", *Journal of Economic Perspectives*, 16 (4), pp. 115-136.

Batini, N. and J.V. Greenslade (2006), "Measuring the UK short-run NAIRU", *Oxford Economic Papers*, 58 (1), pp. 28-49.

Baxter, M. and R. King (1999), "Measuring business cycles approximate band-pass filters for economic time series", *The Review of Economics and Statistics*, 81 (4), pp. 575-593.

Bianchi, M. and G. Zoega (1998), "Unemployment persistence: does the size of the shock matter?", *Journal of Applied Econometrics*, 13 (3), pp. 283-304.

Blanchard, O. (2006), "European unemployment: the evolution of facts and ideas", *Economic Policy*, 21 (45), pp. 5-59.

Blanchard, O. and J. Wolfers (2000), "The role of shocks and institutions in the rise of European unemployment: the aggregate evidence", *The Economic Journal*, 110 (462), pp. C1-C33.

Caporale, G.M. and L.A. Gil-Alana (2007), "Nonlinearities and fractional integration in the US unemployment rate", *Oxford Bulletin of Economics and Statistics*, 69 (4), pp. 521-544.

Chagny, O. and M. Lemoine (2004), "An estimation of the Euro area potential output with a semi-structural multivariate Hodrick-Prescott filter", *Document de Travail*, 2004-14, OFCE, Paris.

Fitoussi, J.P., D. Jestaz, E.S. Phelps and G. Zoega (2000), "Roots of recent recoveries: labor reforms or private sector forces", *Brooking Papers on Economic Activity*, 1:2000, pp. 292-304.

Gordon, D. M. (1988), "The un-natural rate of unemployment: an econometric critique of the NAIRU hypothesis", *The American Economic Review Papers and Proceedings*, 78 (2), pp. 117-123.

Green-Pedersen, C. and A. Lindbom (2005), "Employment and unemployment in Denmark and Sweden: success or failure for the universal welfare model", pp. 65-85, in Becker, U. and H. Schwartz (eds.), *Employment "miracles" in critical comparison. The Dutch, Scandinavian, Swiss, Australian and Irish cases versus Germany and the USA*, Amsterdam University Press, Amsterdam.

Henry, B., M. Karanassou, and D.J. Snower (2000), "Adjustment dynamics and the natural rate: an account of UK unemployment", *Oxford Economic Papers*, 52 (1), pp. 178-203.

Hodrick, R.J. and E.C. Prescott (1997), "Postwar U.S. business cycles: an empirical investigation", *Journal of Money, Credit, and Banking*, 29 (1), pp. 1-16.

Holden, S. and R. Nymoen (2002), "Measuring structural unemployment: NAWRU estimates in the Nordic countries", *The Scandinavian Journal of Economics*, 104 (1), pp. 87-104.

Hughes-Hallett, A.J. and L. Piscitelli (2002), "Testing for hysteresis against nonlinear alternatives", *Journal of Economic Dynamics and Control*, 27 (2), pp. 303-327.

IMF (2003), "Unemployment and labor market institutions: why reforms pay off", *World Economic Outlook*, Chapter 4, pp. 129-150.

Jaeger, A. and M. Parkinson (1994), "Some evidence on hysteresis in unemployment rates", *European Economic Review*, 38 (2), p. 329-342.

Karanassou, M. and D.J. Snower (1997), "Is the natural rate a reference point?", *European Economic Review*, 41 (3-5), pp. 559-569.

Karanassou, M. and D.J. Snower (1998), "How labor market flexibility affects unemployment: long-term implications of the chain reaction theory", *The Economic Journal*, 108 (448), pp. 832-849.

Karanassou, M., H. Sala and D.J. Snower (2009), "Phillips curves and unemployment dynamics: a critique and a holistic perspective", *Journal of Economic Surveys*, forthcoming.

León-Ledesma, M. and P. McAdam (2004), "Unemployment, hysteresis and transition", *Scottish Journal of Political Economy*, 51 (3), pp. 377-401.

Logeay, C. and S. Tober (2006), "Hysteresis and the NAIRU in the Euro area", *Scottish Journal of Political Economy*, 53 (4), pp. 409-429.

Madsen, P.K. (1999), "Denmark: flexibility, security and labour market success", *ILO Employment and Training Papers*, 53.

Nickell, S. (1997), "Unemployment and labor market rigidities: Europe versus North America", *Journal of Economic Perspectives*, 11 (3), pp. 55-74.

Nickell, S. (1998), "Unemployment: questions and some answers", *The Economic Journal*, 108 (448), pp. 802-816.

Nickell, S., L. Nunziata and W. Ochel (2005), "Unemployment in the OECD since the 1960s: what do we know?", *The Economic Journal*, 115 (500), pp. 1-27.

Nymoen, R. and A. Rødseth (2003), "Explaining unemployment: some lessons from Nordic wage formation", *Labour Economics*, 10 (1), pp. 1-29.

OECD (1994), *The OECD jobs study*, Organisation for Economic Co-operation and Development, Paris.

Pesaran, M.H. (1997), "The role of economic theory in modelling the long-run", *The Economic Journal*, 107 (440), pp. 178-191.

Pesaran, M.H. and Y. Shin (1999), "An autoregressive distributed-lag modelling approach to cointegration analysis", pp. 371-413, in Strom, S. (ed), *Econometrics and economic theory in the twentieth century: the Ragnar Frisch Centennial Symposium*, Cambridge University Press, Cambridge.

Pesaran, M.H., Y. Shin and R.J. Smith (2001), "Bounds testing approaches to the analysis of level relationships", *Journal of Applied Econometrics*, 16 (3), pp. 289-326.

Phelps, E. (1994), *Structural slumps: the modern equilibrium theory of unemployment, interest and assets*, Harvard University Press, Cambridge MA.

Phelps, E. and G. Zoega (1996), "Do the main structural forces of the 1970s and 1980s account for the 1990s slump as well?", in M. Baldassari, L. Paganetto and E. Phelps (eds), *The 1990s slump: causes and cures*, MacMillan Press, London.

Phelps, E. and G. Zoega (1998), "Natural rate theory and OECD unemployment", *The Economic Journal*, 108 (448), pp. 782-801.

Phelps, E. and G. Zoega (2001), "Structural booms: productivity expectations and asset valuations", *Economic Policy,* 32 (16), pp. 85-126.

Plougmann, P. and P.K. Madsen (2005), "Labor market policy, flexibility and employment performance: Denmark and Sweden in the 1990s", in Howell, D.R. (ed.), *Fighting unemployment: the limits of free market orthodoxy*, Oxford University Press, Oxford.

Raurich, X., H. Sala and V. Sorolla (2006), "Unemployment, growth and fiscal policy: new insights on the hysteresis hypotheses", *Macroeconomic Dynamics*, 10 (3), pp. 285-316.

Rφed, K. (1997), "Hysteresis in unemployment", *Journal of Economic Surveys*, 11 (4), pp. 389-418.

Scarpetta, S. (1996), "Assessing the role of labour market policies and institutional settings on unemployment: a cross-country study", *OECD Economic Studies*, 26, pp. 43-98.

Silverman, B. (1986), *Density estimation for statistics and data analysis*, Chapman and Hall, London.

Stockhammer, E. (2004), "Explaining European unemployment: testing the NAIRU theory and a Keynesian approach", *International Review of Applied Economics*, 18 (1), pp. 3-23.

Tobin, J. (1998), "Supply constraints on employment and output: NAIRU versus natural rate", *Cowles Foundation Discussion Paper*, 1150.

Appendix A

Misspecification and structural stability tests

The estimated equations pass the standard misspecification tests for no serial correlation (SC), linearity (LIN), normality (NOR), heteroskedasticity (HET) and conditional heteroskedasticity (ARCH). The estimated parameters are structurally stable according to the CUSUM and CUSUM of squares (CUSUM^2) tests evaluated at the standard 5% critical value (Table A1).

TABLE A1 Tests

	Labour demand equation	Wage setting equation	Labour force equation
Misspecification tests:			
$SC[\chi^2(1)]$	0.60 [0.440]	1.88 [0.170]	0.03 [0.863]
$LIN[\chi^2(1)]$	0.60 [0.439]	0.12 [0.726]	0.03 [0.854]
$NOR[\chi^2(2)]$	0.53 [0.766]	1.81 [0.405]	1.09 [0.580]
$HET[\chi^2(1)]$	3.90 [0.048]	2.95 [0.086]	0.90 [0.343]
$ARCH[\chi^2(1)]$	0.00 [0.961]	0.00 [0.957]	1.61 [0.205]
Structural stability tests (5% significance):			
CUSUM	✓	✓	✓
CUSUM^2	✓	✓	✓

Note: p-values in squared brackets.

Appendix B

Kernel density analysis and robustness of the NRU estimation

B.1. The Kernel density analysis

A Kernel density function can be regarded as a sophisticated histogram. Both provide non-parametric density estimates of a distribution of a series, but the histogram is discrete while the Kernel density is continuous and requires some smoothing device of the histogram "boxes". The kernel density estimate of a series X at point x is estimated by

$$f(x) = \frac{1}{Nh}\sum_{i=1}^{N} K\left(\frac{x - X_i}{h}\right),$$

where N is the number of observations, $K()$ is a kernel function that integrates to 1 and h is the bandwidth (or smoothing parameter). The kernel function, K, is a weighting function that determines the shape of the bumps. We have used the Gaussian function so that $K = \left(1/\sqrt{2\pi}\right)^{-\frac{1}{2}v}$, where v is the argument of the Kernel function. Smoothing is done by putting less weight on observations that are further from the point being evaluated. The bandwidth, h, is what controls the smoothness of the density estimate so that the larger the bandwidth, the smoother the estimate. We use Silverman's (1986) method of bandwidth selection.

B.2. Robustness of the NRU estimation

To investigate the sensitivity of the NRU estimates provided in Figure 4 to variations in the bandwidth, we bracket the bandwidth and compute the permanent components of the exogenous variables by choosing smoothing parameters $0.5h$ and $1.5h$ (i.e., 50% smaller and 50% larger than the optimal one, h, chosen using Silverman's rule).

TABLE B1 Smoothing parameters and long-run values

	Smoothing parameter			Long-run values		
	$0.5h$	h	$1.5h$	$0.5h$	h	$1.5h$
Δk_t	0.1100	0.2200	0.3299	3.61	3.57	3.52
g_t	0.2394	0.4788	0.7183	27.35	27.5	27.65
r_t	0.5873	1.1746	1.7620	3.61	3.34	4.16
z_t	0.5812	1.1623	1.7435	r1: 75.25	r1: 75.53	r1: 75.77
				r2: 81.40	r2: 81.17	r2: 80.96

Note: 'r1' stands for regime 1, and 'r2' stands for regime 2.

Table B.1 shows the specific values of the smoothing parameter and the corresponding long-run values of the exogenous variables. These are used to compute the NRUs for h (as in Figure 4), for $0.5h$ and for $1.5h$, which are depicted in Figure B1.

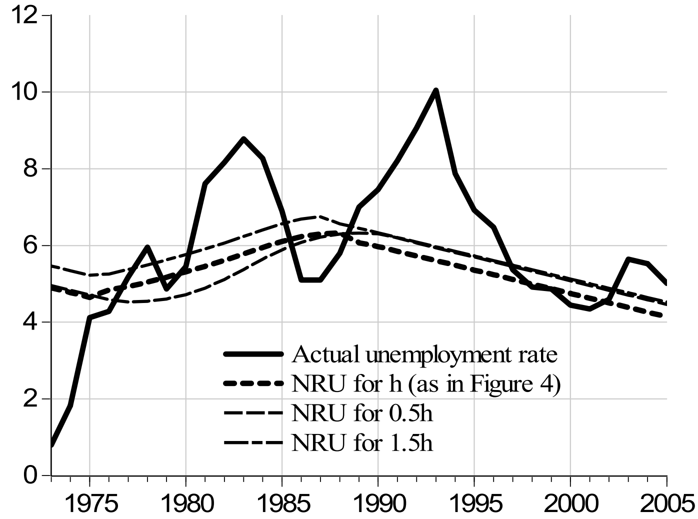

FIGURE B1 Robustness of the NRU estimates

Up to mid-1980s, the NRU computed with the optimal smoothing parameter, h, evolves between the ones for $0.5h$ and $1.5h$. Thereafter it falls underneath and remains between 0.3 and 0.4 percentage points below. The change that took place up to the mid-1980s in the relative values of the three NRUs estimated with different hs is due to the differences in (i) the magnitude of the permanent component of the interest rate, and (ii) the regime periods of the permanent components of the participation rate.

The above analysis and the similar trajectories for the NRU in Figure B1 show that our estimation of the natural rate is quite robust to the bandwidth value. This is due to the relative robustness of the estimates of the permanent components. Changes in the smoothing parameter affect mainly the Kernel density estimates of the temporary components, and not that much the values of the datapoints with the highest densities (i.e. the regime means or permanent components of the series).

4 ESSAY 3: CAPITAL ACCUMULATION AND UNEMPLOYMENT: NEW INSIGHTS ON THE NORDIC EXPERIENCE[68]

ABSTRACT. This paper takes a fresh look at the analysis of labour market dynamics and argues that capital accumulation plays a fundamental role in determining unemployment movements. This role has generally been examined by considering indirect transmission channels of the capital stock effects, i.e. using variables like interest rates or investment ratios in the NAIRU framework. Here we advocate a different approach. We directly estimate the effects of capital stock in the labour market by applying the chain reaction theory of unemployment, and we find that capital stock is a major determinant of unemployment in the Nordic countries. In particular, the different unemployment experiences of these economies derive from the temporary (albeit prolonged) negative shocks to capital stock growth in Denmark and Sweden, and the permanent downturn of capital stock growth in Finland. We are thus able to explain why the crisis of the early 1990s had a more acute impact in Finland than in its twin economy, Sweden.

4.1 Introduction

Interest in the capital-unemployment relationship has been revived in recent years.[69] In this paper we examine the proposition that the slowdown in the growth rate of capital is responsible for the rise in the unemployment rate. We argue that capital stock is a determinant of unemployment, both in the short-

68 This paper was written with Marika Karanassou and Hector Sala and has been published in Cambridge Journal of Economics (2008), 32 (6), pp. 977-1001. We are grateful to Jaakko Pehkonen for his valuable comments on earlier versions of this paper.

69 See, among others, Rowthorn (1999), Malley and Moutos (2001), Karanassou and Snower (2004), and Arestis, Baddeley and Sawyer (2007). We discuss this macro-labour literature in Section 4.2.

and the long-run, and show that capital accumulation can explain the diverse unemployment experiences of the Nordic countries.

These economies are normally grouped together due to their well developed welfare state system, low levels of income inequality and successful performance *vis-à-vis* continental Europe. Nevertheless, the unemployment trajectories of the three countries in Figures 1a, 1c, and 1e display significant disparities which are usually overlooked. While Sweden and Finland came out of the oil crises with hardly any damage, Denmark witnessed a substantial increase in its unemployment over the late 1970s and early 1980s. In contrast, although the 1990s crisis first hit Denmark, it did so less intensively than in Sweden and Finland. We should also note the remarkable similarity in shape, and disparity in magnitude, of the unemployment paths in these two economies.

The contribution of our work is a country-specific analysis of the Nordic economies where the evolution of capital accumulation accounts for the above heterogeneities. A bird's-eye view of the capital-unemployment relationship is depicted in Figures 1b, 1d, and 1f: the correlation between the rates of unemployment and capital stock growth is -0.67 in Denmark, -0.52 in Sweden, and -0.91 in Finland.

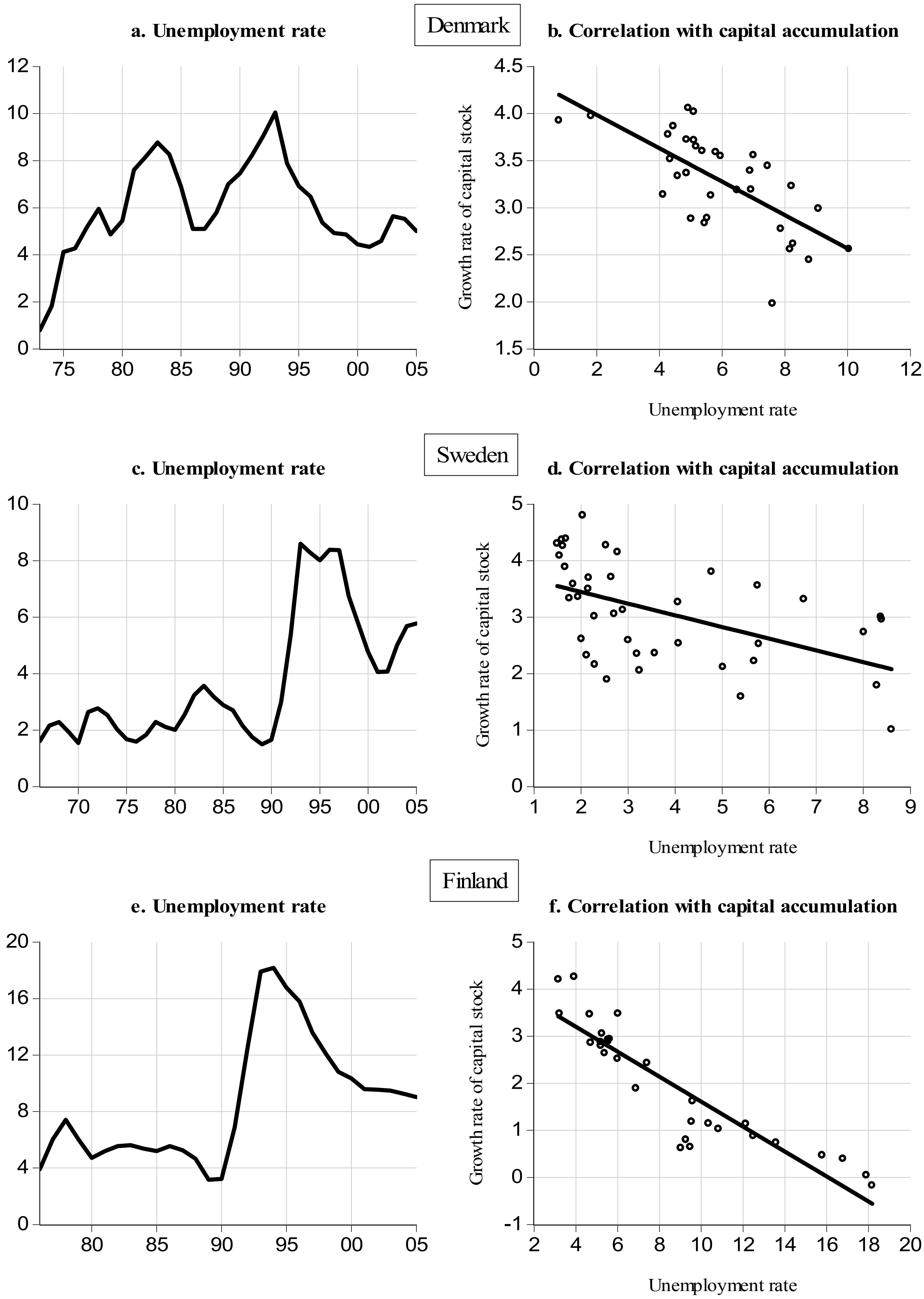

FIGURE 1 Unemployment and capital accumulation in the Nordic countries

To explain the unemployment hikes of the 1970s and early 1980s in Denmark, Green-Pedersen (2001) and Green-Pedersen and Lindbom (2005) point to interest rates as one of the main driving forces under the deteriorated international wage competitiveness and the decrease in the terms of trade that pushed unemployment upwards.

Fregert and Pehkonen (2009) provide a comparative review of some of the most influential studies analysing the Finnish and Swedish labour markets in the 1990s. Based on the combined evidence of the surveyed works and their own estimates they conclude that the main driving forces of the Finnish unemployment were the rise in interest rates, productivity shocks and tax changes. Productivity shocks and tax changes were also significant in Sweden, but with a smaller impact, while interest rates seem to have played no role.[70]

Honkapohja and Koskela (1999) attribute the unemployment problem in Finland to the financial crisis resulting from the pre-1992 overheating of the economy, the collapse of asset prices and the subsequent high indebtedness of firms and households, which were worsened with an interest rate rise to defend the exchange rate of the Markka. We believe that the Finnish financial crisis contributed to the permanent drop in the growth rate of capital stock that we identify in Section 4.4.[71] The fact that Denmark did not suffer a similar banking crisis is attributed by Edey and Hviding (1995) to a more prudential supervision of Danish banks and tighter capital standards.

This paper measures the unemployment effects of capital accumulation in the Nordic countries by applying the chain reaction theory (CRT) of unemployment.[72] The CRT uses a dynamic structural labour market model, with spillover effects, to evaluate the responses of unemployment to the realised changes in the exogenous variables. In this way, the CRT allows us to assess the role of capital stock on the evolution of unemployment via its influence on labour demand and wage setting. This is in stark contrast with the mainstream NAIRU approach, which does not accommodate any influence of capital accumulation on unemployment (see Layard, Nickell and Jackman, 1991, reprinted in 2005, hereafter referred as LNJ). In particular, LNJ argue that, on one hand, any productivity gains arising from capital accumulation are absorbed by the workers' bargaining power and, on the other, unemployment benefits block the possibility that efficiency gains are translated into employment ones.

There is a tendency in the literature to examine the influence of capital stock on unemployment by using single unemployment rate equations and proxy variables such as real interest rates, real balances or investment ratios. We believe there are two main problems with single-equation estimation of the unemployment rate. First, it is questionable as to whether the above proxies can

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70 Kiander and Pehkonen (1999) point to the rise in interest rates (caused by the high European interest rates, the speculative attacks against the fixed exchange rate of the Finnish Markka and faster than expected disinflation) as the main factor behind the Finnish unemployment increase in the early 1990s. For Sweden, Holmlund (2006) argues that the relationship between real interest rates and unemployment is difficult to assess quantitatively and the empirical evidence not conclusive.

71 Another factor responsible for this permanent drop is the phenomenon of 'capital shedding' (see Daveri and Silva, 2004).

72 See, for example, Karanassou and Snower (1998), and Karanassou, Sala and Snower (2009).

capture the effects of capital accumulation net of other influences. Quite often the influence of capital stock is hidden behind non-controversial accounts of the unemployment upturns due to rises in interest rates or financial crises.[73] Second, since the unemployment rate is a nontrended variable, single-equation models have to use exogenous variables that do not display a trend. This is not the case with multi-equation labour market models. As we show in Section 4.2, the only requirement is that each trended endogenous variable (e.g. employment, real wage, labour force) is balanced with the set of its explanatory variables.

In the context of our study of the "high unemployment" episodes in the Nordic countries, the benefit of the CRT modelling approach is that it enables us to evaluate the extent to which capital accumulation is responsible for their diverse unemployment upturns over the last decades. Specifically, we examine the rise in Danish unemployment in the aftermath of the oil price shocks and the substantial unemployment increases in the early 1990s in all three economies. To establish a link between these unemployment upturns and the evolution of capital stock, we first identify the downturns in the growth rate of capital stock using kernel density analysis, and then conduct dynamic simulations to measure the *contributions* of capital stock to unemployment movements. These contributions quantify the unemployment effects of capital accumulation.

In Denmark, we find that capital stock explains around 30% of the increase in unemployment in the aftermath of the oil price shocks and near 15% of the increase in the crisis of the early 1990s. In Sweden, capital accumulation contributes to 50% of the unemployment upsurge during the 1990s. Finally, the unemployment rate in Finland would have been 5 percentage points lower in the absence of the 1992 permanent drop in its capital stock growth rate.

The rest of the paper is structured as follows. Section 4.2 reviews and discusses the NAIRU, the aspirations gap and the CRT viewpoints on the capital-unemployment relationship. Section 4.3 presents the estimated equations for the Nordic economies. Section 4.4 associates the episodes of high unemployment in these countries with the slowdown in the growth rate of their capital stocks. Section 4.5 concludes.

4.2 The capital-unemployment relationship

The macro-labour literature in the 1990s was largely shaped by the NAIRU model and its focus on wage-push factors as main determinants of unemployment (see LNJ, 1991). Mainstream accounts have tended to deny the influence of capital formation on the European unemployment problem proposed by, among others, Drèze and Bean (1990). Nevertheless, the role of

73 For example, it is certainly true that a fall in interest rates (or a rise in real balances) may cause higher investment and, thereby, larger capital availability and new hirings, but it may also be capturing positive employment effects on account of the enhanced private consumption brought by this fall (rise). In this case it would be appropriate to include consumption as an explanatory variable in the estimation.

capital accumulation in the evolution of the unemployment rate has gradually regained the interest of macro-labour economists and the resulting literature is extensive and fast growing.

4.2.1 The NAIRU model

The finding that equilibrium unemployment is independent of capital stock is outlined in chapter 2 of LNJ (1991), where the microfoundations of the model are developed. It is a key result because it "helps to understand why, in the union context, unemployment is nontrended in the very long-run. If the production function is Cobb-Douglas (not a bad assumption) and benefit replacement rates are kept stable, then unemployment in the long run is independent of capital accumulation and technical progress" [p. 107].

In turn, the macroeconomic framework for analysing unemployment is provided in chapter 8. Their model comprises the following equilibrium price (P) and wage (W) setting equations (numbered 29 and 30 in p. 368):

$$P - W = a_0 - a_1 u - d(k - n) \tag{1}$$
$$W - P = b_0 - b_1 u + d(k - n) + x, \tag{2}$$

where the a's, the b's and d are all positive parameters, u is the unemployment rate, k denotes capital stock, n is employment, and x is a set of exogenous wage-push factors (all variables, except u, are in logs).[74] Adding up equations (1) and (2) yields the NAIRU (u^*)

$$u^* = \frac{a_0 + b_0 + x}{a_1 + b_1}. \tag{3}$$

Note that this is independent of growth drivers such as the capital stock or trend productivity (i.e., $k - n$). Two assumptions affecting the role of k and n give rise to the above framework: (i) the production function is $y - k = d(n - k) + \varepsilon$ (equation 17, in LNJ, p. 366), which restricts the elasticities of k and n;[75] and (ii) $(k - n)$ has exactly the same impact on price and wage setting. Relaxing these assumptions implies that, instead of (1) and (2), we have $P - W = a_0 - a_1 u - a_2 k + a_3 n$ and $W - P = b_0 - b_1 u + b_2 k - b_3 n + x$, which yield the following NAIRU:

$$u^* = \frac{a_0 + b_0 + z_w}{a_1 + b_1} + \frac{b_2 - a_2}{a_1 + b_1} k - \frac{b_3 - a_3}{a_1 + b_1} n. \tag{4}$$

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74 When there is full utilisation of resources, employment equals the labour force, which in LNJ's model is assumed to be constant. In that case, equations (1) and (2) may be expressed in terms of the ratio capital stock - (constant) labour force. This distinction is not significant for the purposes of our subsequent analysis.

75 Note that this is a Cobb-Douglas production function (in logs): $y = dn + (1 - d)k + \varepsilon$.

Observe that unless we impose some restrictions, growth drivers such as capital formation matter for the NAIRU. In particular, the restrictions needed to impose on equation (4) to obtain equation (3) are: (i) $(b_2 - a_2) = (b_3 - a_3) = g$, which implies that the NAIRU depends on the capital-employment ratio, instead of their individual levels; and (ii) $g = 0$, which means the NAIRU is independent of capital stock and employment. Karanassou and Snower (2004) call these restrictions the weak and strong unemployment invariance hypotheses, respectively, and reject them for the UK.

It is also important to note that, from the perspective of a labour demand equation, the capital-employment ratio can influence the NAIRU when the long-run elasticity of employment with respect to capital stock is unity. This of course indicates that the underlying production function is Cobb-Douglas (CD), which is one of the two central assumptions in the LNJ framework. (The other one is that unemployment benefits are set as a constant proportion of income and change in line with wages.)

In contrast to LNJ, Rowthorn (1999) uses a constant elasticity of substitution (CES) production function and shows that the capital-employment ratio affects unemployment when the elasticity of substitution between capital and employment is less than unity (he finds that this elasticity is typically between 0.6 and 0.8). More recently, Kapadia (2005) augments the standard CD production function by considering capacity constraints and shows that capital stock affects the equilibrium unemployment rate. This capital constrained function reduces to the standard CD when there is 'spare capacity'.

Furthermore, both Rowthorn (1999) and Kapadia (2005) endogenise investment and provide mechanisms whereby the interest rate can also affect the NAIRU. Indeed, several authors have claimed this is the case. Blanchard (2005) substantiates the role played by interest rates and argues that capital accumulation has influenced the evolution of European unemployment over the past three decades. Modigliani (2000) shows there is a strong negative correlation between investment and unemployment rates, which is dubbed the "Modigliani puzzle" in Blanchard (2000, p. 140). Also, from the perspective of the Structuralist theory, interest rates and capital accumulation are important determinants of unemployment in the OECD countries. However, since unemployment is nontrended in the long run, the influence of capital has to be empirically assessed by considering its trendless transformations, such as the ratio of capital to labour in efficiency units (Phelps, 1994), or the ratio of investment over GDP (Smith and Zoega, 2007).

Within the standard LNJ framework, Gordon (1997) and Malley and Moutos (2001) have also challenged the idea that upward shifts in the time path of capital stock lead to countervailing shifts in the wage setting curve so as to restore unemployment to its original long-run equilibrium. Gordon (1997) argues that the unemployment-productivity tradeoff (UPT) schedule shifts with movements in capital relative to a fixed level of employment, and finds that countries with the largest increases in unemployment had the largest slowdowns in the growth rate of capital per potential labour hour [p. 459].

However, the UPT schedule is flat in the long-run, implying no relationship between changes in productivity and changes in unemployment beyond the medium-term. In turn, Malley and Moutos (2001) augment the LNJ framework with a variant of the partial equilibrium models used in the strategic trade policy literature. In this context they show that, for twenty OECD countries, the unemployment rate is affected in the long-run when domestic and foreign capital stocks grow at unequal rates.

Finally, Stockhammer (2004) resorts to Keynesian arguments to augment the standard NAIRU model with capital accumulation, and finds that it is significantly related to the unemployment rate in the core European economies and the US. In contrast, he finds no robust support for the influence of wage-push factors on unemployment.

4.2.2 The 'aspirations gap' model

It is common to refer to the price equation (1) as the 'feasible real wage', and to the wage equation (2) as the 'target real wage'. This setup describes the conflicting claims of workers and firms, and is often called the 'battle of the mark-ups'. Rowthorn (1977 and 1995), acknowledging the role of this conflict, develops an alternative model based on the concept of *aspirations gap* (A).

This aspirations gap emerges from four different claims on output: from the state (via taxes, T), from foreign suppliers (via the import costs or the terms of trade, F), from workers (via the labour share, $\hat{W}$) and from firms (via the profit share, $\hat{\Pi}$). $\hat{W}$ and $\hat{\Pi}$ are target shares that workers and firms would receive if price expectations were realised. The extent to which these targets are accomplished depends on the aspirations gap, i.e., the relative strengths of workers and firms in this conflict. The main contribution of the aspirations gap model is the role played by capacity utilisation: "unemployment reduces the ability of workers to push up wages, while excess capacity limits the ability to firms to raise prices" (Rowthorn, 1995, p. 28).

The wage and profit shares depend also on taxes and import costs (or the terms of trade), so that $\hat{W} = \hat{W}(\underset{-}{U}, \underset{-}{T}, \underset{-}{F})$ and $\hat{\Pi} = \hat{\Pi}(\underset{+}{C}, \underset{-}{T}, \underset{-}{F})$, where U denotes unemployment and C is capacity utilisation. Symbols underneath the variables indicate the signs of the respective derivatives. In this context, the aspirations gap is defined as $A \equiv \hat{W} - \hat{\Pi}$, and the NAIRU is the equilibrium rate of unemployment that closes the aspirations gap, i.e., $A = 0$.

In other words, the gap between workers' and firms' aspirations is reduced not only by unemployment (as in the LNJ model) but by capital accumulation as well. The mechanism whereby capital accumulation reduces the conflict over income distribution between workers and firms is twofold. First, since capital stock raises excess capacity, it squeezes the firms' power to increase prices. Second, given that capital formation leads to a better trade performance, it increases the amount of resources available for domestic use.

Rowthorn (1995) estimates the impact of capital formation on manufacturing and services employment in ten OECD countries, and finds significant cumulative effects in the aftermath of the 1973 oil price shock. In turn, Arestis and Biefang-Frisancho (2000) and Arestis Baddeley and Sawyer (2007) extend Rowthorn's aspirations gap model, linearise $\hat{W}$ and $\hat{\Pi}$, and estimate the impact of capital on the NAIRU using an equation as follows:

$$u^* = c_0 - c_1 k + c_2 T + c_3 F + other\ terms, \qquad (5)$$

where 'other terms' refer to union power, real benefits, long-term unemployed, and nominal price inertia in Arestis and Biefang-Frisancho (2000); and to union power, replacement rate, wage gap and long-term unemployment in Arestis Baddeley and Sawyer (2007).[76] The first of these studies finds significant effects of capital accumulation on unemployment in Germany and the UK, while the latter, in turn, documents a robust negative relationship between capital accumulation and unemployment in nine EMU countries (including Germany). Note that both studies rely on integration/cointegration techniques and estimate error correction models.

4.2.3 The chain reaction theory

In line with Rowthorn's aspirations gap model, the CRT supports the claim that capital accumulation matters for unemployment. Yet, the CRT goes beyond this effect and argues that all growth drivers, such as technical change, productivity or working-age population, can explain the performance of the labour market.

To reconcile the effects of trended variables with the trendless path of the unemployment rate, the CRT uses a multi-equation labour market model where each trended left-hand side variable (e.g. employment, real wage, labour force) is balanced with the set of the trended regressors in the relevant equation. For expositional simplicity, consider the following stylised labour market model (all variables, except the unemployment rate, are in logs and error terms are ignored for simplicity).

First, labour demand is given by

$$n_t = \alpha_n + \alpha_1 n_{t-1} + \beta_1 k_t - \gamma_1 w_t, \qquad (6)$$

where w_t is the real wage, all parameters are positive, and $\alpha_1 < 1$. Note that if $\beta_1 = (1 - \alpha_1)$, i.e. the elasticity of substitution is one, the production function underlying (6) is the CD one assumed by LNJ.

[76] Studies which, plausibly, treat unemployment as stationary need to have stationary exogenous variables on the right-hand side of the equation. However, studies which find it to be I(1) need to make sure that the I(1) exogenous variables are cointegrated with unemployment. As we show below, the CRT does not encounter this issue since it does not estimate single unemployment rate models but, instead, uses multi-equation labour market systems to derive the dynamically stable reduced form unemployment equation.

In the absence of dynamic adjustments, i.e. when the market is in its long-run equilibrium, equation (6) can be interpreted as an inverted price equation along the lines of the LNJ model. This can be seen by defining $W-P=w$, normalising labour force so that $u=1-n$, and rewriting equation (1) in terms of n. We thus obtain $n=\alpha_n+\beta_1 k-\gamma_1 w$, where $\alpha_n=(a_1-a_0)/(a_1+d)$, $\beta_1=\gamma_1/(a_1+d)$, and $\gamma_1=1/(a_1+d)$.

Second, wage setting is

$$w_t=\alpha_w+\alpha_2 w_{t-1}+\beta_2 x_t-\gamma_2 u_t+\gamma_3(k_t-n_t), \qquad (7)$$

where all coefficients are positive, and the autoregressive parameter $\alpha_2<1$. Note that (7) can be regarded as the dynamic version of the LNJ wage setting equation (2), where the real wage depends negatively on the unemployment rate, and positively on the wage-push factors (x_t) and trend productivity (k_t-n_t). Note that if $\gamma_3=(1-\alpha_2)$, we have the LNJ restriction that real wages absorb any productivity gains.

Third, unlike the LNJ model, CRT models consider explicitly a labour supply equation. Without loss of generality, let the labour force depend only on demographic factors, such as working-age population (z_t), and abstract from any dynamic adjustments and other influences:

$$l_t=z_t. \qquad (8)$$

We should note that the labour market equations (6)-(8) are compatible with standard microeconomic foundations (in addition to LNJ, 1991, see Karanassou, Sala, and Snower, 2007). Furthermore, the autoregressive components of the equations, which we call "lagged adjustment processes", are well documented in the literature and refer, among others, to employment adjustments arising from labour turnover costs (hiring, training and firing costs), and real wage lags due to wage/price staggering.

Finally, since labour force and employment are in logs, the unemployment rate can be approximated by their difference:

$$u_t=l_t-n_t, \qquad (9)$$

In the context of the labour market model (6)-(9), we can make the following observations. First, if $\gamma_1=0$, or $\gamma_2=\gamma_3=0$, changes in capital stock (k_t) do not spillover in the labour market system, and so the unemployment effects of this variable can be adequately captured by the labour demand equation (6). In addition, if the wage elasticity of employment is zero $(\gamma_1=0)$, the wage-push factors (x_t) do not feed through labour demand, and thus do not influence unemployment. Second, if unemployment does not put downward pressure on wages $(\gamma_2=0)$, there are no working-age population (z_t) spillovers. In this case, the labour supply equation (8) can sufficiently measure the unemployment responses to changes in working-age population.

To sum-up, when spillover effects are present, the individual labour demand and supply equations cannot provide adequate measures of the sensitivities of unemployment to the exogenous variables. Instead, these are given by the univariate representation of unemployment, derived below, as it incorporates all the feedback mechanisms in the labour market model.

To derive unemployment as a function of its own lags and the exogenous variables (univariate representation), let us rewrite the demand (6) and wage (7) equations as

$$(1-\alpha_1 B)(1-\alpha_2 B)n_t = \beta_1(1-\alpha_2 B)k_t - \gamma_1(1-\alpha_2 B)w_t, \tag{10}$$
$$(1-\alpha_2 B)w_t = \beta_2 x_t - \gamma_2 u_t + \gamma_3(k_t - n_t), \tag{11}$$

respectively, where B is the backshift operator. Next, we substitute (11) into (10) to obtain the following labour demand:

$$[(1-\alpha_1 B)(1-\alpha_2 B) - \gamma_1\gamma_3]n_t = [\beta_1(1-\alpha_2 B) - \gamma_1\gamma_3]k_t - \gamma_1\beta_2 x_t + \gamma_1\gamma_2 u_t, \tag{12}$$

and rewrite the labour supply equation (8) as

$$[(1-\alpha_1 B)(1-\alpha_2 B) - \gamma_1\gamma_3]l_t = [(1-\alpha_1 B)(1-\alpha_2 B) - \gamma_1\gamma_3]z_t. \tag{13}$$

Finally, we subtract (12) from (13) to derive the univariate representation of unemployment:[77]

$$\begin{aligned}\left[(1-\alpha_1 B)(1-\alpha_2 B) + \gamma_1(\gamma_2 - \gamma_3)\right]u_t &= \left[\gamma_1\gamma_3 - \beta_1(1-\alpha_2 B)\right]k_t \\ &\quad + \gamma_1\beta_2 x_t + \left[(1-\alpha_1 B)(1-\alpha_2 B) - \gamma_1\gamma_3\right]z_t\end{aligned} \tag{14}$$

The above dynamic equation is also called the "reduced form" unemployment rate, since its parameters are not estimated directly, but are, instead, some nonlinear function of the parameters of the underlying labour market system (6)-(8).

Reparameterising (14), we have that:

$$u_t = \phi_1 u_{t-1} - \phi_2 u_{t-2} - \theta_0^k k_t + \theta_0^x x_t + \theta_0^z z_t + \theta_1^k k_{t-1} - \theta_1^z z_{t-1} + \theta_2^z z_{t-2}, \tag{15}$$

where $\phi_1 = \frac{\alpha_1+\alpha_2}{1+\gamma_1(\gamma_2-\gamma_3)}$, $\phi_2 = \frac{\alpha_1\alpha_2}{1+\gamma_1(\gamma_2-\gamma_3)}$, $\theta_0^k = \frac{\beta_1-\gamma_1\gamma_3}{1+\gamma_1(\gamma_2-\gamma_3)}$, $\theta_0^x = \frac{\gamma_1\beta_2}{1+\gamma_1(\gamma_2-\gamma_3)}$, $\theta_0^z = \frac{1-\gamma_1\gamma_3}{1+\gamma_1(\gamma_2-\gamma_3)}$, $\theta_1^k = \frac{\alpha_2\beta_1}{1+\gamma_1(\gamma_2-\gamma_3)}$, $\theta_1^z = \frac{\alpha_1+\alpha_2}{1+\gamma_1(\gamma_2-\gamma_3)}$ and $\theta_2^z = \frac{\alpha_1\alpha_2}{1+\gamma_1(\gamma_2-\gamma_3)}$.

77 Note that (12), (13), and (14) are dynamically stable since (i) products of polynomials in B which satisfy the stability conditions are stable, and (ii) linear combinations of dynamically stable polynomials in B are also stable.

The CRT views macroeconomic activity as the result of the interplay between lagged adjustment processes and spillover effects (i.e. changes in the exogenous variables, like capital stock) feeding through the labour market system. The univariate representation of the unemployment rate (15) displays the following key elements of the CRT. First, the autoregressive coefficients ϕ_1 and ϕ_2 represent the interactions of the employment adjustment (α_1) and wage-price staggering (α_2) processes. Second, the short-run coefficients $(\theta_0\text{'s})$ of the exogenous variables embody the feedback mechanisms built in the system, since they are a function of the short-run elasticities/slopes $(\beta\text{'s})$ of the individual equations (6)-(8) and the spillover effects (γ's). Third, the interplay of the employment adjustment and wage-price staggering effects, on the one hand, and the spillover effects, on the other, gives rise to the lagged terms of the exogenous variables. Using time-series jargon, we can refer to these lags as the moving-average terms of (15).

Finally, capital stock, a trended variable, features as a driving force of the unemployment rate, a stationary variable. This is a controversial and hotly debated result that we can justify as follows. Capital stock enters the system as a determinant of employment, which is a trended variable. This gives a balanced labour demand equation (6), since it is dynamically stable $(|\alpha_1| < 1)$, i.e. the trended employment and capital stock move together. Similarly, the trended labour force is driven by working-age population (also a trended variable), and the labour supply (8) is itself a balanced equation. Also note that, since (12) is dynamically stable,[78] labour demand remains balanced once the wage (7) has been substituted into (6).

Therefore, the "reduced" unemployment rate equation is itself balanced, since (by (9)) it is simply the difference between the dynamically stable labour supply and demand equations. Karanassou and Snower (2004) show that equilibrating mechanisms in the labour market and other markets jointly act to ensure that the unemployment rate is trendless in the long-run. These mechanisms can be expressed in the form of a restriction on the relationship between the long-run growth rates of capital stock and other growing exogenous variables,[79] and allow us to evaluate the influence of the level (as opposed to the ratio or the difference) of capital stock to the evolution of the unemployment rate.

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78 This is because the products of polynomials in B which satisfy the stability conditions are also stable.

79 Given the univariate representation (14) of the labour market model (6)-(9), it can be shown that the unemployment rate stabilises in the long-run if

$$[\beta_1(1-\alpha_2)-\gamma_1\gamma_3]g_k = [(1-\alpha_1)(1-\alpha_2)-\gamma_1\gamma_3]g_z + \gamma_1\beta_2 g_x,$$

where g_k, g_z, and g_x denote the long-run growth rates of capital stock, working-age population, and the wage-push factor, respectively. If x_t does not grow in the long-run, the above restriction simplifies to

$$g_k = \left[\frac{(1-\alpha_1)(1-\alpha_2)-\gamma_1\gamma_3}{\beta_1(1-\alpha_2)-\gamma_1\gamma_3}\right]g_z.$$

4.2.4 Upshot

Whereas the LNJ model (1)-(2) is ex-ante restricted so that capital stock does not influence unemployment (recall that the relevant restrictions are $b_2 = a_2$ and $b_3 = a_3$ in equation (4)), the aspirations gap and chain reaction theory models do not postulate that the underlying production function is CD and real wages absorb productivity gains. Therefore, both the aspirations gap and CRT models can test and evaluate the unemployment effects of capital accumulation. In the aspirations gap model (5), the relevant test is that unemployment and capital stock are cointegrated. In the context of the univariate unemployment rate representation (14) of the CRT model (6)-(9), the relevant test is that the long-run elasticity of unemployment with respect to capital stock $(\varepsilon_{u,k})$ is zero. This elasticity can be derived by setting the backshift operator equal to one in (14):

$$\varepsilon_{u,k} = \frac{\gamma_1\gamma_3 - \beta_1(1-\alpha_2)}{(1-\alpha_1)(1-\alpha_2)+\gamma_1(\gamma_2-\gamma_3)}.$$

Note that, capital accumulation does not affect unemployment when either of the following three restrictions apply: (i) $\gamma_1\gamma_3 = \beta_1(1-\alpha_2)$, or (ii) $\beta_1 = 0$ and $\gamma_1 = 0$ or $\gamma_3 = 0$, or (iii) $\alpha_2 = 1$ and $\gamma_1 = 0$ or $\gamma_3 = 0$. Clearly, if either (ii) or (iii) hold, then (i) holds as well. Also note that the counterpart of restriction (i) in the LNJ framework (equation (4)), is that $(b_2 - a_2) = (b_3 - a_3) = g = 0$. This is a very stringent condition which, as it will become clear in the next section, does not hold for any of the Nordic economies that we examine.

There are two main strands in the empirical NAIRU literature (see, among others, Stockhammer, 2004). The first one deals with the estimation of price and wage setting curves from which the NAIRU is derived (see chapter 9 in LNJ, 1991). The second one involves the estimation of single-equation reduced form unemployment models using time-series data (as in several studies of the Phelps' Structuralist perspective), or conducting cross-country analyses (Nickell, 1997, and Blanchard and Wolfers, 2000, among others). As explained above, a multi-equation system estimating the NAIRU embodies restrictions which prevent the influence of growing variables. On the other hand, since the unemployment rate is trendless, the regressors in the single-equation empirical NAIRU models are bound to be stationary and, thus, no role is assigned to the levels of growing variables such as capital stock.

With regard to the CRT viewpoint, empirical models have provided evidence for the important role of capital accumulation in the evolution of unemployment in Spain (Bande and Karanassou, 2009), in the UK (Henry, Karanassou and Snower, 2000), and in the EU (Karanassou, Sala and Snower, 2003). Furthermore, it has been shown that the NAIRU restrictions do not hold in the UK (Karanassou and Snower, 2004), and that the natural rate has low power in explaining actual unemployment in the UK (Henry, Karanassou and Snower, 2000) and Denmark (Karanassou, Sala and Salvador, 2008).

In a nutshell, the CRT labour market models differ from the conventional literature of the LNJ tradition in one main respect: they do not impose ex-ante restrictions on the capital-unemployment relationship.

4.3 Econometric analysis

The empirical models presented below are in line with the consensus view of the labour market, according to which (i) labour demand is negative along the real wage and shifts with changes in capital stock, (ii) rises in capital deepening (a proxy for productivity) increase real wages, and (iii) labour supply is positive along the real wage. In particular, the estimated labour market equations are extended versions of the stylised model (6)-(8). Although labour demand, wage setting, and labour supply share a common structure among the three countries in our dataset, they also have idiosyncratic terms that are identified by the general-to-specific element of our estimation procedure.

4.3.1 Data and methodology

The dataset is obtained from the OECD Economic Outlook and the sample period of our analysis is 1973-2005 for Denmark, 1976-2005 for Finland, and 1966-2005 for Sweden. Table 1 gives the definitions of the variables included in the selected equations.[80]

TABLE 1 Definitions of variables

n	employment (log)	r	real long-term interest rate
l	labour supply (log)	fd	exports-imports (% of GDP)
w	real compensation per employee (log)	τ^d	direct tax rates (% of GDP)
u	unemployment rate $(l-n)$	τ^i	indirect tax rates (% of GDP)
k	real capital stock (log)	g	public expenditures (as % of GDP)
k^n	capital stock per employee $(k-n)$	τ^w	fiscal wedge[81]
z	participation rate $\left(\frac{\text{labour force}}{\text{working-age population}}\right)$	o	real oil prices (log)

Source: OECD, Economic Outlook.

80 Note that we have experimented with a wider set of exogenous variables - social security benefits and contributions, measures of competitiveness, financial wealth, real money balances, and consumption - but these were found to have no explanatory power on the endogenous variables. For each equation we start from a common general specification, across countries, which after progressive filtering yields country-specific results. For example, in Denmark, the country with the largest share of public expenditures over GDP, we find that this variable has a strong effect. In turn, in Sweden and Finland, where tax reforms were implemented to stabilise government debt and reduce the budget deficit, tax variables are important.

81 The fiscal wedge is the sum of direct, indirect and payroll taxes as a ratio of total compensation of employees.

The estimation strategy involves the Autoregressive Distributed Lagged (ARDL) approach developed by Pesaran and Shin (1999) and Pesaran, Shin and Smith (2001). The justification of this choice can be summarised as follows. It has been shown that the ARDL yields consistent estimates both in the short- and long-run, and can be reliably used in small samples for hypothesis testing irrespective of whether the regressors are I(1) or I(0). Therefore, the ARDL offers an alternative to the popular cointegration/error-correction methodology that avoids the pretesting problem implicit in the standard cointegration techniques - the Johansen maximum likelihood, and the Phillips-Hansen semi-parametric, fully-modified OLS procedures. Furthermore, Pesaran and Shin (1999) argue that the Phillips-Hansen and ARDL approaches are directly comparable, and the estimator of the former is outperformed by the ARDL estimator, especially when the sample size is relatively small (as in our case).

Our dynamic labour market model comprises labour demand, wage setting, and labour supply equations:[82]

$$\mathbf{A}_0\mathbf{y}_t = \sum_{i=1}^{2}\mathbf{A}_i\mathbf{y}_{t-i} + \sum_{i=0}^{2}\mathbf{D}_i\mathbf{x}_{t-i} + \boldsymbol{\varepsilon}_t, \qquad (16)$$

where $\mathbf{y}_t$ is a (3×1) vector of endogenous variables (employment, real wage, and labour force), $\mathbf{x}_t$ is a (9×1) vector of exogenous variables, the $\mathbf{A}_i$'s and $\mathbf{D}_i$'s are (3×3) and (9×9), respectively, coefficient matrices, and $\boldsymbol{\varepsilon}_t$ is a (3×1) vector of strict white noise error terms.

Each equation of the labour market system (16) is estimated following the ARDL approach and the selected specifications pass a battery of diagnostic tests for serial correlation, linearity, normality, heteroskedasticity and autoregressive conditional heteroskedasticity, and structural stability. Finally, to account for potential endogeneity and cross equation correlation we estimate the labour market model for each country with 3SLS. These estimated equations, together with the definition (9), are then used to obtain the "reduced form" unemployment rate equation underlying the rest of our empirical analysis.

In what follows, we discuss our estimation results and provide an overall evaluation of the selected labour market models.[83]

4.3.2 Labour demand

Table 2 reports the 3SLS estimates of the employment equation for the three countries.

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82 The dynamic system (16) is stable if, for given values of the exogenous variables, all the roots of the determinantal equation $\left|\mathbf{A}_0 - \mathbf{A}_1B - \mathbf{A}_2B^2\right| = 0$ lie outside the unit circle. Note that the estimated equations given below satisfy this condition.

83 Although Tables 2-4 only give the 3SLS results, the OLS estimates together with the results on the misspecification tests are available upon request.

It is worth observing the different employment persistence across countries. Labour demand in Denmark displays the lowest persistence coefficient, 0.18, indicating a quick speed of adjustment to economic disturbances. This may reflect the high degree of flexibility which characterises the Danish labour market (the employment protection legislation is among the less strict in the OECD countries). In turn, the persistence coefficients in Sweden and Finland are substantially higher and amount to 0.66 and 0.64, respectively. Note that in Sweden the multiplicative dummies, n_{t-1}^{d1} and n_{t-1}^{d2}, take into account the significant decrease in employment persistence over 1991-2005.[84]

TABLE 2 Labour demand equations – Dependent variable: n_t

Denmark (1973-2005)			Sweden (1966-2005)			Finland (1976-2005)		
const	11.6	[0.000]	*const*	2.88	[0.046]	*const*	2.95	[0.004]
n_{t-1}	0.18	[0.000]	n_{t-1}	0.66	[0.000]	n_{t-1}	0.64	[0.000]
Δn_{t-1}	0.61	[0.000]	n_{t-1}^{d1}	-0.001	[0.140]	Δn_{t-1}	0.19	[0.046]
w_t	-0.58	[0.000]	n_{t-1}^{d2}	-0.003	[0.005]	w_t	0.71	[0.000]
w_{t-1}	-0.30	[0.052]	w_t	-0.78	[0.000]	w_{t-1}	-0.95	[0.000]
k_t	0.48	[0.000]	w_{t-1}	0.67	[0.000]	k_t	0.28	[0.001]
Δk_t	1.78	[0.001]	k_t	0.22	[0.002]	Δk_t	1.87	[0.001]
Δk_{t-1}	1.14	[0.083]	Δk_t	2.56	[0.000]	r_t	-0.34	[0.009]
g_t	1.02	[0.001]	τ_t^i	-1.08	[0.004]	fd_t	0.34	[0.007]
Δg_t	-0.89	[0.012]						
Δg_{t-1}	0.95	[0.003]						
R^2		0.981			0.935			0.971

Note: Δ denotes the difference operator; p-values in square brackets.

The effect of capital stock is significant in all three economies, with a long-run elasticity of 0.6 in Denmark (i.e. a 1% rise in k boosts employment by 0.6%), 0.7 in Sweden, and 0.8 in Finland. Note that all these values are in the range given by Rowthorn (1999).

Furthermore, employment in Denmark is very sensitive to wage variations; the long-run elasticity of almost negative unity comes as no surprise in such a flexible labour market. The long-run wage elasticities in Sweden and

84 We believe the decrease in persistence over that period is related to the boost in the active labour market programmes (ALMPs) - with increases in the volume of training programmes and expansion of subsidised employment and youth practice programmes - and the extension of the maximum permitted duration for probationary contracts from 6 to 12 months. Note that $n_{t-1}^{di} = di \times n_{t-1}$, for $i = 1, 2$, where the dummy $d1$ takes the value 1 over the period 1991-1994, zero otherwise, and the dummy $d2$ takes the value 1 over the period 1995-2005, zero otherwise.

Finland are -0.3 and -0.7, respectively. The latter is in line with Kiander and Pehkonen (1999) who show that wages affect the Finnish labour demand with an elasticity between -0.3 and -0.8, depending on the sample period.

Further to the above common determinants, we have also identified idiosyncratic influences: government expenditures in Denmark, indirect taxes in Sweden, and real interest rates and foreign demand in Finland.

The strong influence of government expenditures on the Danish economy relates to the fact that its public sector is responsible for the production of the vast majority of services and accounts for almost a third of total employment.[85] The role of interest rates in the Finnish unemployment rate has been extensively studied by Kiander and Pehkonen (1999), Honkapohja and Koskela (1999) and Fregert and Pehkonen (2009). In turn, the presence of foreign demand captures the important export-led recovery of the Finnish economy during the last decades, a phenomenon that Kiander and Pehkonen (1999) found significant in explaining the unemployment trajectory.

4.3.3 Wage setting

Table 3 below presents the 3SLS estimates of the real wage equation for the three countries.

Similarly to the labour demand, wage setting exhibits different degrees of persistence across countries. As expected, the quickest adjustment takes place in Denmark, where the inertia coefficient is 0.32, with Sweden, 0.62, and Finland, 0.80, displaying more sluggishness.

TABLE 3 Wage setting equations – Dependent variable: w_t

Denmark (1973-2005)			Sweden (1966-2005)			Finland (1976-2005)		
const	5.34	[0.000]	*const*	3.24	[0.000]	*const*	1.52	[0.037]
w_{t-1}	0.32	[0.000]	w_{t-1}	0.62	[0.000]	w_{t-1}	0.80	[0.000]
Δw_{t-1}	0.44	[0.001]	Δw_{t-1}	0.21	[0.046]	u_t	-0.59	[0.000]
u_t	-0.60	[0.000]	u_t	-0.67	[0.004]	k_t^n	0.22	[0.039]
k_t^n	0.31	[0.000]	k_t^n	0.31	[0.000]	τ_t^w	0.27	[0.008]
r_t	0.38	[0.000]	τ_t^d	0.63	[0.004]	o_t	0.02	[0.003]
			τ_{t-1}^d	-046	[0.056]			
			τ_t^i	-0.78	[0.003]			
R^2	0.995			0.995			0.995	

Note: Δ denotes the difference operator; p-values in square brackets.

85 See Karanassou, Sala and Salvador (2008) for a detailed analysis of the Danish labour market.

Furthermore, wages in all three countries are influenced by unemployment and capital deepening with the expected negative and positive signs, respectively. It is important to note that capital deepening (defined as the log of capital stock per employee) is a standard proxy of (the log of) labour productivity and several studies document its significance in the Nordic economies - Hansen and Warne (2001) in Denmark, Hjelm (2006) in Sweden, and Kiander and Pehkonen (1999) in Finland. In particular, the latter find that capital deepening is the most important factor in wage setting with a long-run elasticity close to unity. In our estimations, the long-run "productivity" elasticity of wage is close to unity in Sweden and Finland (0.82 and 1.10, respectively), while in Denmark it is only 0.46.

The absence of social security benefits and contributions from our estimations may appear striking, at first sight, given the important role usually assigned to these institutional variables. Note, however, that wage setting in Finland is influenced by the fiscal wedge, while wages in Sweden are affected by direct and indirect taxes. These results are consistent with other findings in the literature. Pehkonen (1999), and Kiander and Pehkonen (1999) outline the harmful employment effects of the steady growth in the fiscal wedge via the increasing wage pressure brought by the higher income and payroll taxes used to finance the Finnish pension and unemployment insurance systems. Regarding Sweden, the significance of taxes is also acknowledged by Forslund (1995), and Fregert and Pehkonen (2009), among others. We can thus argue that taxes and fiscal wedge capture the effect of wage push factors, such as benefits and contributions, in wage setting.

In Denmark, real interest rates contribute positively to real wages due to their downward pressure on prices.[86] Finally, the sensitivity of wages to oil prices, in Finland, signifies the exposure of this labour market to external shocks (see also Honkapohja and Koskela, 1999).

4.3.4 Labour supply

Table 4 below gives the 3SLS estimates of the labour force equation for the three countries.

In contrast with labour demand and wage setting, labour supply in Denmark features the highest persistence among the three economies. Note also that, while in Sweden and Finland stickiness in labour supply decisions does not differ substantially from that of labour demand and wage setting, in Denmark labour market flexibility is attained via quick labour demand and wage adjustments.

The role of wages and unemployment in labour supply decisions of the three countries is as expected. Wages exert an overall positive influence, while unemployment has a negative effect (in Denmark and Finland via a discouraged workers effect, in Sweden through the level of unemployment).

86 Note that the effect of interest rates on unemployment is the expected negative one, since wages enter negatively in labour demand.

TABLE 4 Labour supply equations – Dependent variable: l_t

Denmark (1973-2005)			Sweden (1966-2005)			Finland (1976-2005)		
const	1.24	[0.000]	*const*	4.55	[0.000]	*const*	3.76	[0.000]
l_{t-1}	0.90	[0.000]	l_{t-1}	0.64	[0.000]	l_{t-1}	0.70	[0.000]
Δl_{t-1}	0.76	[0.000]	Δl_{t-2}	-0.33	[0.000]	Δl_{t-1}	1.33	[0.000]
Δu_t	-0.04	[0.032]	u_t	-0.32	[0.000]	Δl_{t-2}	0.03	[0.053]
Δu_{t-1}	-0.04	[0.035]	w_t	0.08	[0.000]	Δu_t	-0.08	[0.000]
w_t	0.02	[0.004]	z_t	0.32	[0.000]	Δu_{t-1}	-0.01	[0.444]
Δw_t	-0.03	[0.035]				w_t	0.05	[0.000]
z_t	0.18	[0.000]				Δw_t	-0.03	[0.027]
Δz_t	1.09	[0.000]				z_t	0.42	[0.000]
Δz_{t-1}	-1.04	[0.000]				Δz_t	0.85	[0.000]
						Δz_{t-1}	-1.86	[0.000]
R^2		0.999			0.995			0.999

Note: Δ denotes the difference operator; p-values in square brackets.

Finally, it is through the participation rate instead of the working-age population that we can capture demographic influences on the labour supply movements. We explain this finding by recognising that the participation rate reflects both cultural - the society's attitude towards the labour market - and institutional features that have led the Nordic countries to have the highest (female and youth) participation rates in the OECD.

In particular, Denmark is the sole country where participation rates have stayed above 80% - the highest in the OECD countries - since the mid-1980s after the economy had recovered from the oil price crises. This is due to the system of Active Labour Market Policies characterising the Danish labour market that dates back to 1979. Its main objective is to promote labour market participation, thus avoiding labour shortages and ensuring the sustainability of public finances (see Andersen, 2006, and Plougmann and Madsen, 2005).

4.3.5 Evaluation of the models

We further evaluate our empirical models with two auxiliary diagnostics. First, we test whether the long-run relationships implied by our estimations (second column of Table 5) comprise cointegrating vectors within the Johansen framework. Once the maximal eigenvalue and trace statistics confirm that the variables involved in each equation are cointegrated, the Johansen's cointegrating vectors (third column of Table 5) are restricted to take the corresponding long-run values of our estimated equations. The last column of

Table 5 displays the LR tests following a $\chi^2(\cdot)$ distribution.[87] Observe that the restrictions cannot be rejected at conventional sizes of the test, indicating that the estimation methodology we followed conforms with the Johansen procedure.

TABLE 5 Testing the long-run relationships in the Johansen framework

	ARDL	Johansen	LR test
Labour demand equations	$(n \quad w \quad k)$	$(n \quad w \quad k)$	
Denmark	(1 1.20 -0.59)	(1 0.61 -0.38)	χ^2(2)=0.93[0.628]
Sweden	(1 0.32 -0.65)	(1 -0.26 -0.08)	χ^2(2)=4.34[0.114]
Finland	(1 0.67 -0.78)	(1 1.72 -1.97)	χ^2(2)=5.71[0.058]
Wage setting equations	$(w \quad k^n)$	$(w \quad k^n)$	
Denmark	(1 -0.46)	(1 -0.44)	χ^2(2)=2.25[0.324]
Sweden	(1 -0.82)	(1 -0.75)	χ^2(2)=5.89[0.053]
Finland	(1 -1.10)	(1 -1.13)	χ^2(2)=5.71[0.058]
Labour force equations	$(l \quad w)$	$(l \quad w)$	
Denmark	(1 -0.20)	(1 -0.19)	χ^2(1)=0.52[0.471]
Sweden	(1 -0.22)	(1 -0.20)	χ^2(1)=1.28[0.258]
Finland	(1 -0.17)	(1 -0.16)	χ^2(1)=2.46[0.117]

Note: p-values in square brackets; 5% critical values: χ^2(1) = 3.84; χ^2(2) = 5.99.

Second, we check the model's ability to replicate the actual facts. As Figure 2 shows, the estimated labour market models track actual unemployment very closely in all three countries - the only exception is the early part of the sample for Sweden. However, we do not find this discrepancy unsettling, since it is probably due to shocks affecting the foreign sector of the Swedish economy (e.g. devaluations) that dissipated by the late 1970s. In addition, the 1990s slump, which is the central focus of our analysis, is tracked very precisely.

87 It should be noted that the VAR model underlying the Johansen procedure contains all the variables in our labour market model, both the I(0) and I(1) variables. Naturally, the cointegration tests, only consider the I(1) variables in our models: n_t, w_t, l_t, and k_t (recall that $k_t^n = k_t - n_t$). This implies that we test two restrictions in the labour demand and wage setting equations and one in the labour supply equation. To conserve space, we do not report the results of the underlying unit root and cointegration tests. These are available upon request.

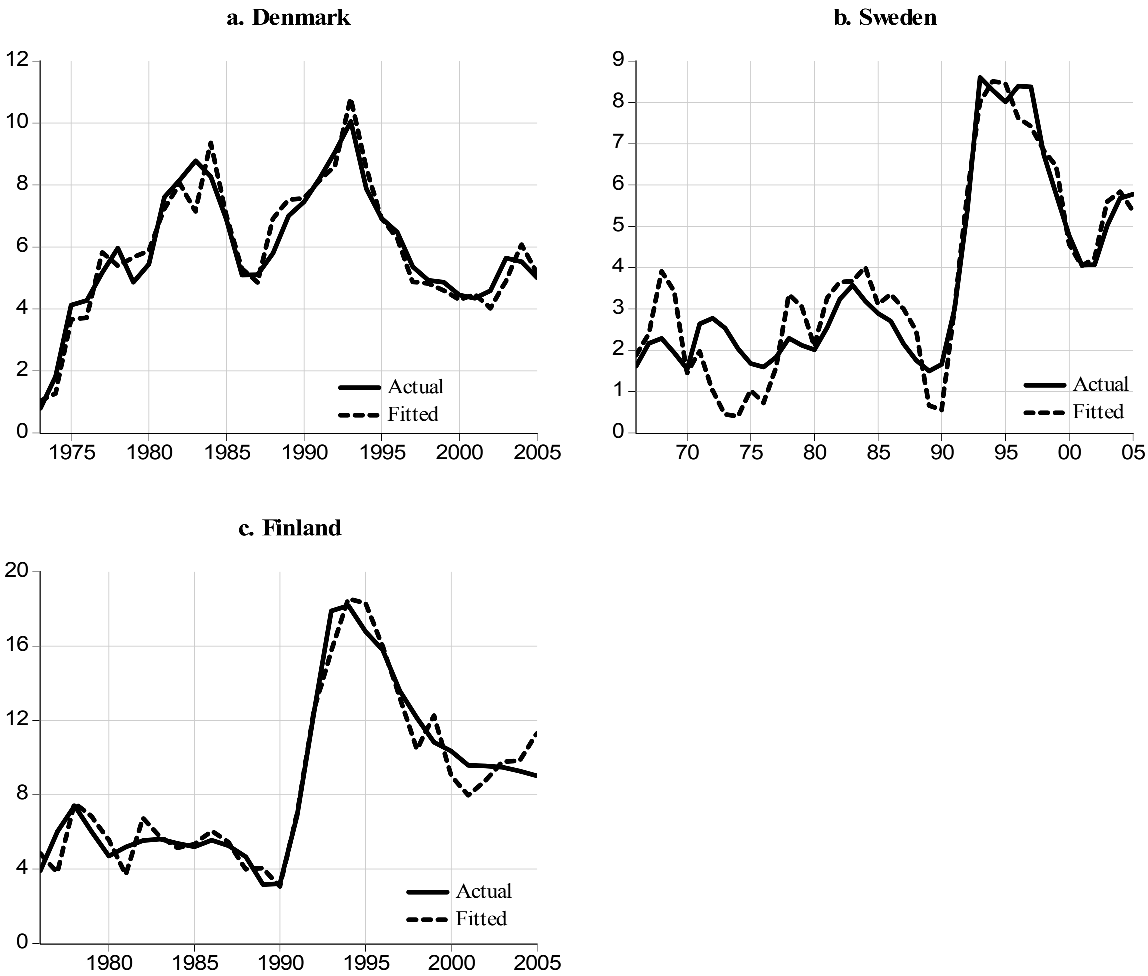

FIGURE 2 Unemployment rate: actual and fitted values

4.4 Contributions of capital accumulation to unemployment

The Nordic countries are generally treated as a relatively homogenous area which is compared with other groups such as the Continental European or the Anglo-Saxon economies. However, the plots in Figure 2 evidence the significant disparities in the unemployment trajectories of the three countries.

In the last decades Denmark has experienced two periods of rising unemployment, the first one in the aftermath of the oil price shocks with a rise of 8 percentage points (from 0.8% in 1973 to 8.8% in 1983), and the second one in the late 1980s and early 1990s with the unemployment rate doubling from 5.1% in 1987 to 10.0% in 1993.

In contrast, the Finnish and Swedish experiences are characterised by a long period of low unemployment lasting until the end of the 1980s, which was abruptly terminated in the early 1990s. For this, and other reasons, these two countries are sometimes referred to as the "twin economies," even though their unemployment trajectories display clear differences in terms of magnitudes. For example, the rate of unemployment in Sweden was on average 2.5-3 percentage points lower than that in Finland during the “full-employment” period. In the recession of the early 1990s, the Swedish unemployment rate never exceeded 8.6%, while the Finnish unemployment rate was pushed to a high of 18.2%. Finally, in the subsequent recovery, the difference between the two unemployment rates remained above 5 percentage points until 2003.

In what follows we argue that the evolution of capital stock accumulation can account for the disparities in the unemployment trajectories of the Nordic economies. In particular, we show that, feeding through the labour market system, the investment downturns give rise to the unemployment rate upturns and drive their intensity and longevity.

4.4.1 Identification of capital stock downturns

We identify the investment downturns by estimating the kernel density function of the capital stock growth rate.[88] This allows us to distinguish between the permanent and transitory components of the variable. Obviously, the term “permanent component” is not a universal concept - it only applies to our sample period. We should note that the kernel density analysis provides a simple and transparent way of determining the number and duration of investment slowdowns.

A stationary time series with different regimes is characterised by a multimodal density of its frequency distribution, the number of modes corresponding to the number of regimes. In particular, a unimodal kernel density indicates that a unique regime exists with mean equal to the value of the mode. On the other hand, a variable with two regimes displays a bimodal kernel density with a “valley point” dividing the observations in the sample. The data points are grouped in the two regimes depending on whether they lie to the left or to the right of the “valley point.” The kernel density analysis of the two-regime case can easily be extended to account for three or more regimes.

Naturally, when the variable is characterised by one regime, this is taken to be permanent. For multimodal kernel densities we distinguish between permanent and temporary regimes and identify them as follows. The variable starts in one regime (say, A) in the beginning of the sample, and then moves to another regime (say, B) at some later point in time. If the variable reverses to regime A before the end of the sample, then regime B is temporary and regime A is permanent. On the other hand, if the variable stays in regime B by the end of the sample then both regimes are permanent ones.

The plots of the kernel density functions in the first column of Figure 3 reveal the number of regimes for the capital stock growth rates of the Nordic

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88 Bianchi and Zoega (1998) use kernel density functions to examine the regime-mean shifts of unemployment in 15 OECD countries. Raurich, Sala and Sorolla (2006) apply the kernel density analysis to compare the relationship of unemployment and capital accumulation in the EU and the US.

economies. The plots in the second column of Figure 3 display the actual series (solid lines) and the mean values of their permanent regimes (dotted lines).

According to Figure 3a, the growth rate of capital stock in Denmark displays a single regime with mean 3.6%. Figure 3b shows that Denmark experienced two downturns in investment over the 1978-1985 and 1989-1997 periods with the growth rate of capital stock reaching a low of 2.0% in 1981 and 2.6% in 1993.

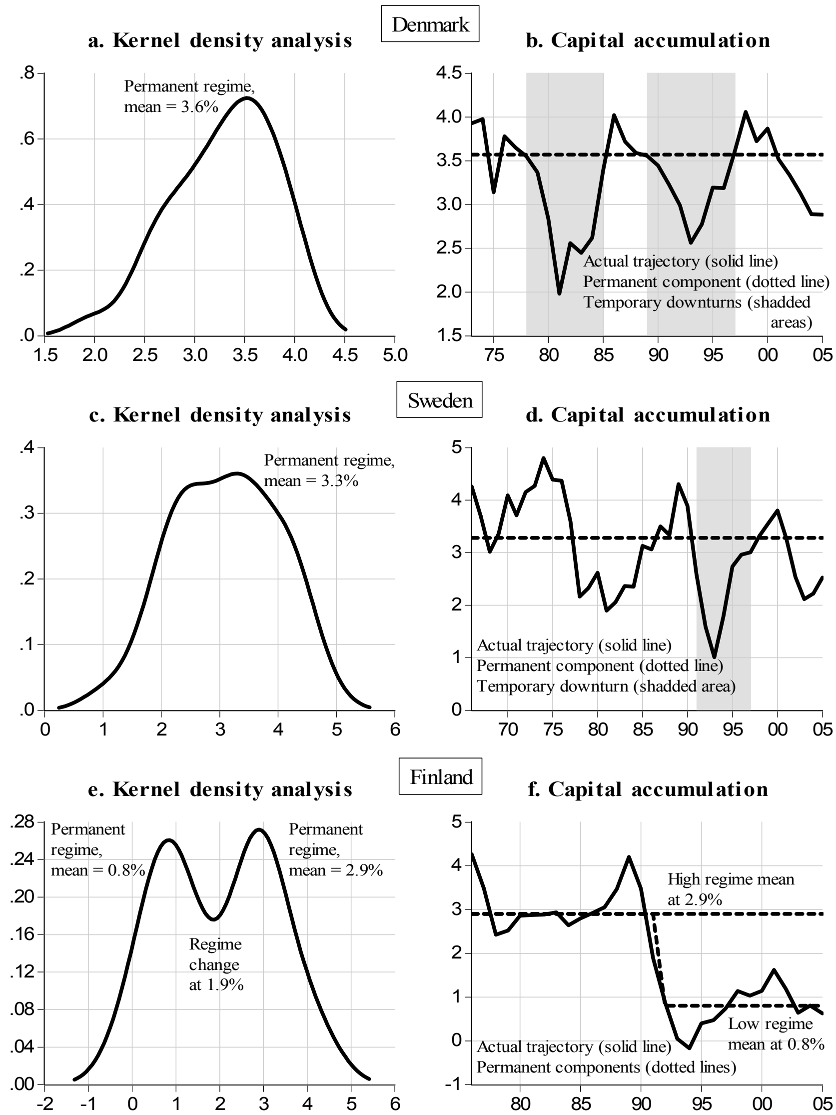

FIGURE 3 Capital accumulation in the Nordic countries

Figure 3c shows that the growth rate of capital stock in Sweden is also characterised by one regime with mean 3.3%. A temporary but prolonged downturn took place from 1991 to 1997 (see Figure 3d). In 1990 capital accumulation declined sharply from 3.9% to 1.0% in 1993; it slowly recovered afterwards to reach its structural level by 1998.

In contrast to Denmark and Sweden, capital accumulation in Finland displays two regimes (see Figure 3e-f). While the growth rate of capital stock fluctuates around 2.9% until 1991, it hovers around 0.8% 1992 onwards.[89] The slowdown in investment that persists after the 1992 structural break accompanies, strikingly well, the high unemployment era in Finland with rates between 9% and 18%. Thus, the kernel density analysis helps us to understand the extremely high negative correlation between the unemployment and capital stock growth rates documented in Figure 1f.

The permanent nature of the capital stock downturn in Finland is documented in the literature. Honkapohja and Koskela (1999) and Daveri and Silva (2004) distinguish a 'socialist period', lasting until 1990, characterised by strong regulation and inefficient usage of capital. Unlike any other OECD economy, this prompted a phenomenon of 'capital-shedding' like in most East and Central European Economies (recall that Finland, in contrast with Sweden and Denmark, had had strong links with the Soviet Union). This period was followed, after the early 1990s crisis, by an accelerated process of adoption of more efficient methods of production. Accelerated depreciation and substitution of obsolete capital characterise this process according to Böckerman and Maliranta (2007), using micro data, and Daveri and Silva (2004), using macro data. Moreover, Daveri and Silva (2004) explain how the well-known Finnish rise in labour productivity since mid-1990s was achieved despite the slowdown in capital accumulation. In particular, their "results show a clear link between information technology and Finland's outstanding productivity growth since 1995. But productivity growth accelerated in few industries. Indeed, productivity growth gains outside the Nokia industry and few IT-related service industries have been small, temporary or non-existent." (p. 122).

To evaluate the unemployment contributions of the above identified downturns in capital accumulation we simulate the estimated labour market model with a capital stock series that we construct by using the permanent component of capital accumulation (dotted line in Figures 3b, 3d, 3f), instead of the actual series (solid line in Figures 3b, 3d, 3f).

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89 We check the robustness of this result in two ways. First, we estimate a well-specified ARMA (2,1) that fits the data well:

$$\Delta k_t = \underset{[0.001]}{0.03} + \underset{[0.062]}{0.49}\,\Delta k_{t-1} - \underset{[0.025]}{0.65}\,\Delta k_{t-2} + \underset{[0.020]}{0.58}\left(\Delta k_{t-2} * d^{92}\right)$$
$$- \underset{[0.002]}{0.03}\,d^{92} + \hat{\varepsilon}_t + \underset{[0.001]}{0.72}\,\hat{\varepsilon}_{t-1}; \quad R^2 = 0.935;$$

where d^{92} is 1 1992-2005, 0 otherwise. Note that both the additive and multiplicative dummies are significant, confirming the two identified regimes. Second, we exclude the dummies from the above ARMA model and conduct the Chow breakpoint test and reject the null hypothesis of no structural breaks.

4.4.2 Denmark: the 'Anglo-Saxon' Nordic economy

In Denmark, we measure the unemployment effects of capital accumulation as follows. First, we simulate the Danish labour market model over the period of the first slowdown in the growth rate of capital stock, 1978-1985, using a capital stock series constructed by the 1978-1985 segment of the dotted line in Figure 3b. As shown Figure 4a, the persistent shock of the second half of the 1970s and first half of the 1980s accounts for a substantial part of the increase in Danish unemployment during this period. The unemployment rate would have been, on average, 2 percentage points lower: 5.0% instead of 7.0%. Therefore, almost 30% of unemployment in the 1978-1985 period can be explained by the decline in capital formation.

Second, we run an analogous simulation for the labour market model over the 1989-1997 capital accumulation slowdown. Figure 4b shows that, had the growth rate of capital stock remained at its structural path (dotted line in Figure 3b), unemployment would have been relatively stable (around 7%) in the early 1990s, reaching a maximum in 1993 of 7.5% instead of its actual 10% peak. In addition, the average rate of unemployment during the 1989-1997 period would have been 6.6%, one percentage point lower than its actual value.

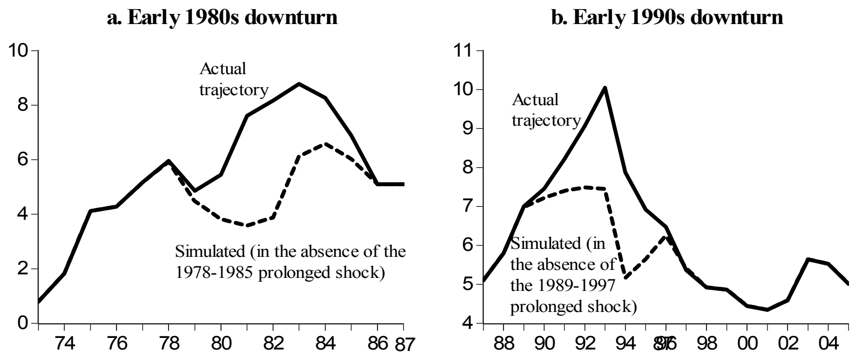

FIGURE 4 Unemployment effects of capital accumulation in Denmark

According to Honkapohja and Koskela (1999), and Koskela and Uusitalo (2006), among others, the second upturn in unemployment was prompted by the international recession and the 1989 German unification which raised interest rates all around Europe. Hence, real interest rates were a major contributor to the onset of this crisis. This meshes well with our own analysis since it is plausible to argue that the rise in interest rates is manifested in the investment slowdown after 1989.

4.4.3 The 'twin economies' and the 1990s slump

The message conveyed by the plots in Figure 1 is that the unemployment rate time paths of Sweden and Finland are rescaled versions of one another. Hence the reference to the two countries as the 'twin economies'. Below we argue that the much higher unemployment rates experienced by Finland after 1992 are due to the permanent decline in the growth rate of its capital stock occurring in 1992 (see Figures 3e-f). By contrast, in Sweden, the substantial slowdown in capital accumulation in 1991 has been reversed by 1997 (see Figures 3c-d).

In other words, the capital accumulation downturn in Sweden is transitory and we measure its effects on unemployment similarly to Denmark. We simulate the Swedish labour market model over the 1991-1997 period of the slowdown in investment, using a capital stock series constructed by the 1991-1997 segment of the dotted line in Figure 3d. Therefore, the dotted line in Figure 5a gives the time path that the unemployment rate would have followed had capital stock continued to grow at 3.2% from 1991 to 1997. Note that while actual unemployment sharply rises to a maximum of 8.6% in 1993 and then stabilises at values above 8%, the simulated series reaches its peak of 6.3% in 1998. Furthermore, the average unemployment rate would have been of 3.6% instead of 7.2%, and so the capital accumulation downturn accounts for 50% of the unemployment problem over the 1991-1997 period.

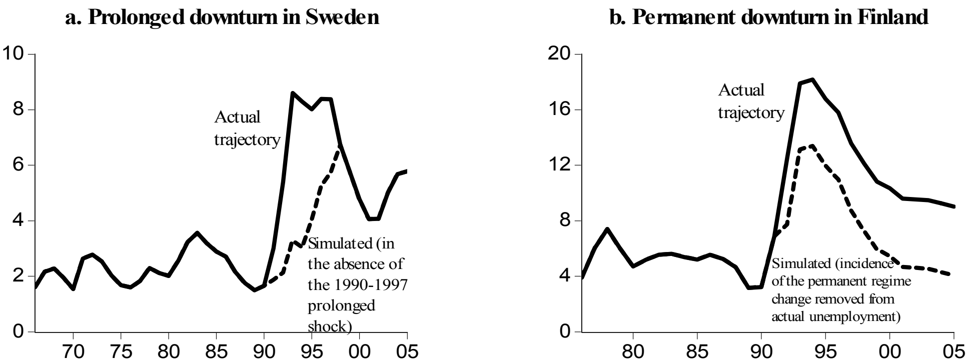

FIGURE 5 Unemployment effects of capital accumulation in Sweden and Finland

The kernel density analysis in Figures 3e-f shows that the 1992 structural break pushed the growth rate of capital stock in Finland from a high regime with mean 2.9% to a low regime with mean 0.8%. We evaluate the impact of the permanent decrease in capital accumulation after 1992 as follows.

We simulate the steady state of the Finnish labour market model under two scenarios 1992 onwards: (i) a capital stock growing at 2.9%, and (ii) a capital stock growing at 0.8%. The reason for simulating the steady-state of the model is that we want to measure the effect of the permanent shift in the growth rate of the capital stock net of the lagged adjustments present in the labour market. The difference between the two simulated time paths of the unemployment rate is around 5 percentage points and is our measure of the unemployment contribution of the permanent decline in capital accumulation after 1992. We subtract this contribution from the actual unemployment rate and plot the resulting series in Figure 5b (dotted line).

Figure 5b shows that had capital growth remained at its high regime mean, unemployment would have peaked at 13.4% in 1994 instead of the actual 18.2%. In turn, the actual subsequent fall to around 9% in 2005 would have ended up near 4.0%. This result has two important implications. First, the magnitudes of the Finnish unemployment trajectory would have been much closer to the Swedish ones. We have thus identified a crucial factor explaining the disparity in the intensity of the early 1990s crisis in the so-called twin economies. Second, in the absence of the permanent slowdown in investment after 1992, Finland would have recovered the full-employment levels that had historically characterised its labour market. Our analysis is consistent with the view of Honkapohja and Koskela (1999) that external shocks (the collapse of trade with the Soviet Union, the western recession and the rise in German interest rates) are not the main driving forces of the unemployment rate in Finland.

4.5 Conclusions

In this paper we showed that capital accumulation plays a significant role in explaining the diverse unemployment experiences of the Nordic countries.

Following the chain reaction theory (CRT) of unemployment, we estimated a dynamic labour market model with spillover effects that allows the interplay of the movements in capital stock and lagged adjustment processes to feed through to the unemployment rate. Using kernel density analysis, we identified the temporary and permanent slowdowns in capital accumulation and, focusing on the relatively high unemployment periods, we performed dynamic simulations and showed that the downturns in capital accumulation drive the intensity and longevity of the upturns in unemployment.

In particular, the unemployment swings in Denmark resemble those of the US, with peaks in the early 1980s and 1990s, hence the reference to it as the 'Anglo-Saxon' Nordic economy. We found that the persistent capital stock shocks of 1978-1985 and 1989-1997 account for approximately 30% and 15% of the rise in unemployment during these periods, respectively.

Finland and Sweden are labelled the 'twin economies' due to the similarity in their unemployment trajectories: they came out of the oil price shocks with no serious damage and faced unprecedented unemployment increases in the early 1990s. Nevertheless, the gap in the unemployment rates of the two countries in the aftermath of the 1990s crisis was substantial, reaching almost 10 percentage points. In Sweden, we found that the 1991-1997 slowdown in capital accumulation contributes to 50% of the unemployment increase during this period. Finland, unlike Denmark and Sweden, is characterised by a permanent drop in capital accumulation since 1992. Had capital accumulation remained at its high-regime mean, unemployment would have been 5 percentage points lower and the unemployment gap in the twin economies would have been substantially reduced 1992 onwards.

Our results shift the emphasis in the determinants of unemployment from wage-push factors to capital accumulation. Instead of following the conventional policy recipe attempting to reduce unemployment by suppressing wage-push factors (such as unemployment benefits, firing restrictions, minimum wages, union power, taxes), our analysis offers a way of explaining the unemployment problem by recognising the interaction of growth and dynamics in the labour market. The significant unemployment contributions of capital accumulation imply that policies related to R&D activities, policies promoting innovations and productivity growth, or policies directly fostering investment and capital accumulation, can enhance the performance of the labour market.

Given the relevance of the interactions between growth and labour market dynamics, the issue of capital stock endogeneity in a labour market system should be addressed in future work.

REFERENCES

Andersen, T. (2006), “From excess to shortage - recent developments in the Danish labour market”, pp. 75-102, in Werding, M. (ed), *Structural unemployment in Western Europe: reasons and remedies*, The MIT Press, Cambridge MA.

Arestis, P. and I. Biefang-Frisancho (2000), “Capital stock, unemployment and wages in the UK and Germany”, *Scottish Journal of Political Economy*, 47 (5), pp. 487-503.

Arestis, P., M. Baddeley and M. Sawyer (2007), “The relationship between capital stock, unemployment and wages in nine EMU countries”, *Bulletin of Economic Research*, 59 (2), pp. 125-148.

Bande, R. and M. Karanassou (2009), “Labour market flexibility and regional unemployment rate dynamics: Spain 1980-1995”, *Papers in Regional Science*, forthcoming (doi:10.1111/j.1435-5957.2008.00165.x).

Bianchi, M. and G. Zoega (1998), “Unemployment persistence: does the size of the shock matter?”, *Journal of Applied Econometrics*, 13 (3), pp. 283-304.

Blanchard, O. (2000), “The economics of unemployment: shocks, institutions and interactions”, Lionel Robbins Lectures.

Blanchard, O. (2005), “Monetary policy and unemployment”, in Semmler, W. (ed.), *Monetary policy and unemployment - US, Euro-area, and Japan*, Routledge, London.

Blanchard, O. and J. Wolfers (2000), “The role of shocks and institutions in the rise of European unemployment: the aggregate evidence”, *The Economic Journal*, 110 (462), pp. C1-C33.

Böckerman, P. and M. Maliranta (2007), “The micro-level dynamics of regional productivity growth: the source of divergence in Finland”, *Regional Science and Urban Economics*, 37 (2), pp. 165-182.

Daveri, F. and O. Silva (2004), “Not only Nokia: what Finland tells us about *new economy* growth”, *Economic Policy*, 19 (38), pp. 117-163.

Drèze, J. and Ch. Bean (1990), *Europe's unemployment problem*, The MIT Press, Cambridge MA.

Edey, M. and K. Hviding (1995), “An assessment of financial reform in OECD countries”, in *OECD Economics Studies, 25*, OECD Publishing.

Forslund, A. (1995), “Unemployment - is Sweden still different?”, *Swedish Economic Policy Review*, 2 (1), pp. 15-58.

Fregert, K. and J. Pehkonen (2009), “The crises of the 1990s and unemployment in Finland and Sweden”, in Jonung, L., J. Kiander and P. Vartia (eds.), *The crises of the 1990s in Finland and Sweden*, Edward Elgar. (forthcoming)

Gordon, R.J. (1997), “Is there a trade-off between unemployment and productivity growth?”, pp. 433-466, in Snower, D.J. and G. de la Dehesa (eds), *Unemployment policy: government options for the labour market*, Cambridge University Press, Cambridge.

Green-Pedersen, C. (2001), "Minority governments and party politics: the political and institutional background to the "Danish Miracle"", *Journal of Public Policy*, 21 (1), pp. 53-70.

Green-Pedersen, C. and A. Lindbom (2005), "Employment and unemployment in Denmark and Sweden: success or failure for the universal welfare model", pp. 65-85, in Becker, U. and H. Schwartz (eds.), *Employment "miracles" in critical comparison. The Dutch, Scandinavian, Swiss, Australian and Irish cases versus Germany and the USA*, Amsterdam University Press, Amsterdam.

Hansen, H. and A. Warne, (2001), "The cause of Danish unemployment: demand or supply shocks?", *Empirical Economics*, 26 (3), pp. 461-486.

Henry, B., M. Karanassou, and D.J. Snower (2000), "Adjustment dynamics and the natural rate: an account of UK unemployment", *Oxford Economic Papers*, 52 (1), pp. 178-203.

Hjelm, G. (2006), "Simultaneous determination of NAIRU, output gaps and structural budget balances: Swedish evidence", in Mazzi, G.L. and G. Savio (eds), *Growth and cycle in the Eurozone*, Palgrave, Mcmillan.

Holmlund, B. (2006), "The rise and fall of Swedish unemployment", pp. 103-132, in Werding, M. (ed.), *Structural unemployment in Western Europe: reasons and remedies*, The MIT Press, Cambridge MA.

Honkapohja, S. and E. Koskela (1999), "Finland's depression: a tale of bad luck and bad policies", *Economic Policy*, 14 (29), 400-436.

Kapadia, S. (2005), "The capital stock and equilibrium unemployment: a new theoretical perspective", Department of Economics, University of Oxford *Discussion Paper Series*, 181.

Karanassou, M. and D.J. Snower (1998), "How labor market flexibility affects unemployment: long-term implications of the chain reaction theory", *The Economic Journal*, 108 (448), pp. 832-849.

Karanassou, M. and D.J. Snower (2004), "Unemployment invariance", *German Economic Review*, 5 (3), pp. 297-317.

Karanassou, M., H. Sala and P.F. Salvador (2008), "The (ir)relevance of the NRU for policy making: the case of Denmark", *Scottish Journal of Political Economy*, 55 (3), pp. 369-392.

Karanassou, M., H. Sala and D.J. Snower (2003), "Unemployment in the European Union: a dynamic reappraisal", *Economic Modelling*, 20 (2), pp. 237-273.

Karanassou, M., H. Sala and D.J. Snower (2007), "The macroeconomics of the labor market: three fundamental views", *Portuguese Economic Journal*, 6 (3), pp. 151–180.

Karanassou, M., H. Sala and D.J. Snower (2009), "Phillips curves and unemployment dynamics: a critique and a holistic perspective", *Journal of Economic Surveys*, forthcoming.

Kiander, J. and J. Pehkonen (1999), "Finnish unemployment: observations and conjectures", *Finnish Economic Papers*, 12 (2), pp. 94-108.

Koskela, E. and R. Uusitalo (2006), "The unintended convergence: how Finnish unemployment reached the European level", pp. 159-185, in Werding, M.

(ed), *Structural unemployment in western Europe: reasons and remedies*, The MIT Press, Cambridge MA.

Layard, R., S. Nickell, and R. Jackman (1991), *Unemployment: macroeconomic performance and the labour market*, Oxford University Press, Oxford.

Malley, J. and T. Moutos (2001), "Capital accumulation and unemployment: a tale of two continents", *The Scandinavian Journal of Economics*, 103 (1), pp. 79-99.

Modigliani, F. (2000), "Europe's economic problems", prepared for testimony before the Monetary Committee of the European Parliament.

Nickell, S. (1997), "Unemployment and labor market rigidities: Europe versus North America", *Journal of Economic Perspectives*, 11 (3), pp. 55-74.

Pehkonen, J. (1999), "Wage formation in Finland, 1960-1994", *Finnish Economic Papers*, 12 (2), pp. 82-93.

Pesaran, M.H. and Y. Shin (1999), "An autoregressive distributed-lag modelling approach to cointegration analysis", pp. 371-413, in Strom, S. (ed), *Econometrics and economic theory in the twentieth century: the Ragnar Frisch Centennial Symposium*, Cambridge University Press, Cambridge.

Pesaran, M.H., Y. Shin and R.J. Smith (2001), "Bounds testing approaches to the analysis of level relationships", *Journal of Applied Econometrics*, 16 (3), pp. 289-326.

Phelps, E. (1994), *Structural slumps: the modern equilibrium theory of unemployment, interest and assets*, Harvard University Press, Cambridge MA.

Plougmann, P. and P.K. Madsen (2005), "Labor market policy, flexibility and employment performance: Denmark and Sweden in the 1990s", in Howell, D.R. (ed.), *Fighting unemployment: the limits of free market orthodoxy*, Oxford University Press, Oxford.

Raurich, X., H. Sala and V. Sorolla (2006), "Unemployment, growth and fiscal policy: new insights on the hysteresis hypotheses", *Macroeconomic Dynamics*, 10 (3), pp. 285-316.

Rowthorn, R. (1977), "Conflict, inflation and money", *Cambridge Journal of Economics*, 1 (3), pp. 215-239.

Rowthorn, R. (1995), "Capital formation and unemployment", *Oxford Review of Economic Policy*, 11 (1), pp. 26-39.

Rowthorn, R. (1999), "Unemployment, wage bargaining and capital-labour substitution", *Cambridge Journal of Economics*, 23 (4), pp. 413-425.

Smith, R. and G. Zoega (2007), "Global factors, unemployment adjustment and the natural rate", *Kiel Working Paper Collection No. 2*, 1367.

Stockhammer, E. (2004), "Explaining European unemployment: testing the NAIRU theory and a Keynesian approach", *International Review of Applied Economics*, 18 (1), pp. 3-23.

5 ESSAY 4: THE NORDIC EXPERIENCE REVISITED: EXPLAINING LABOUR MARKET BOOMS AND SLUMPS SINCE THE 1980s[90]

ABSTRACT. This paper provides an account of the unemployment performance of Denmark, Finland, and Sweden during their recent labour market booms and slumps. Our analysis yields three main findings. First, capital stock was the most important determinant of the unemployment trajectory in the three countries. This result appears in all periods considered: in the aftermath of the oil price shocks, in the slump of the early nineties and the boom of the late nineties, as well as in the stabilisation period of the early 2000s. Second, the role of the external sector on the unemployment trajectory was significant in Finland, its quantitative impact being one third of that of capital stock in the second and fourth periods, and half in the first and third periods. Third, temporary shocks to capital stock had a greater initial impact and were far more persistent in Finland. Nevertheless, the impact and persistence of the shocks were also significant in Denmark and Sweden. Our results illustrate the importance of non-standard labour market variables in examining unemployment trajectories. The findings call for a wider than usual perspective in trying to solve the unemployment problem.

5.1 Introduction

This paper analyses the unemployment trajectory in three Nordic countries - Denmark, Finland, and Sweden – since the 1980s. The analysis of the labour market of these countries is tempting, since these countries are usually grouped because of their well-developed welfare states, low levels of income inequality and successful performance as opposed to continental Europe. Nevertheless, the unemployment trajectories of the three countries display significant

90 Hector Sala has contributed on an earlier version of this paper. We are grateful to Jaakko Pehkonen for his valuable comments.

disparities. Finland and Sweden came out of the oil crises of the 1970s with hardly any damage, while Denmark witnessed large unemployment increases over the late 1970s and early 1980s. In contrast, the 1990s crisis hit Denmark less intensively than in Sweden and Finland. The unemployment trajectories of these two countries are of a special appeal since they were similar in the timing of the rise in unemployment from the trough in 1990 to the peak in 1994, but they differed in the size of the rise and in the unemployment evolution after the peak. In particular, Finnish unemployment steadily decreased after the peak in 1994, while Swedish unemployment remained constant between 1994 and 1997.

The purpose of this study is straightforward: to provide an account of the driving forces shaping unemployment in Denmark, Finland and Sweden over the last decades. We do this by utilising the empirical models of Karanassou, Sala and Salvador (2008b) to conduct new simulation exercises and further explore the determinants of unemployment. The analysis differs from theirs in three respects. First, we examine the unemployment effects of the whole set of explanatory variables, not only of changes in capital stock, on the Danish, Finnish, and Swedish unemployment trajectories. Second, we evaluate the impact of these exogenous variables in four different periods since 1980, instead of just focusing on the episodes of high unemployment. Third, we examine the process of adjustment of the unemployment rate to a temporary shock to capital stock.

The rest of the paper is structured as follows. Section 5.2 addresses methodological issues and explains the theoretical framework that encompasses our empirical analysis. Section 5.3 presents empirical labour market models for Denmark, Finland, and Sweden. Section 5.4 explains how the simulation exercise is performed and provides the accounts of unemployment performance. The analysis suggests that capital stock had an important role in the unemployment trajectory of the three countries, especially during the Finnish unemployment upturn in the 1990s. Fiscal policy also played an important role in Denmark and Sweden in the mid-1980s and in Finland during the first part of the 1990s, but its role was modest in the rest of the periods analysed. The external sector significantly influenced the Finnish unemployment trajectory. Finally, variations in participation rates also had an impact on Danish, Finnish, and Swedish labour markets. Section 5.5 examines the process of adjustment of the unemployment rate to a temporary shock to capital stock. The analysis shows that it takes several years before the shock is completely absorbed by the labour market. In particular, Finland experienced the greatest initial impact of the shock and the shock was far more persistent. Nevertheless, the impact and persistence of the shock were also significant in Denmark and Sweden. Section 5.6 concludes.

5.2 The chain reaction theory

The empirical analysis we undertake in the next sections follows the Chain Reaction Theory (CRT), or prolonged adjustment view, of unemployment.[91]

The terms "prolonged adjustment" refer to the existence of lags in labour market representations. These lags interact with one another and prolong the unemployment effects of a shock. In other words, current labour market activity depends on the past, and the process of adjustment may take a long time to work itself out. The dependence comes from the adjustment costs existing in the labour market: (i) employment adjustments arising from labour turnover costs (hiring, training and firing costs); (ii) wage and price staggering; (iii) insider membership effects; (iv) long-term unemployment effects; and (v) labour force adjustments, among others.[92]

The CRT provides structural representations of the labour market and estimates dynamic multi-equation systems with spillover effects. Spillover effects arise when shocks to a specific equation feed through the labour market system and "shocks" refer to changes in the exogenous variables. In this way, the CRT allows us to estimate individual labour demand, labour supply and wage setting curves to assess the role of different exogenous variables on the time path of unemployment. Exogenous variables also include growth drivers – e.g., capital stock, technical change, productivity or working-age population - because, according to the CRT, they help to explain the labour market performance (see Karanassou, Sala and Salvador, 2008b).[93]

In short, the CRT aims at identifying the economic factors responsible for the trajectory of unemployment. That is, it focuses on the contributions of each exogenous variable in shaping unemployment.

The CRT stresses the important role of the interplay between lagged adjustment processes and growth in driving the unemployment rate. On the one hand, the CRT identifies the various lagged adjustment processes to explore their interactions and quantifies the potential complementarities or substitutabilities among them. For example, if the prolonged adjustments, or lags, are complementary with one another in propagating temporary and permanent labour market shocks, the joint influence of all the existing lags is greater than the sum of their individual influences. In this case, it will take unemployment much longer to recover in the aftermath of a recession than the period spanned by any particular lag.[94] On the other hand, the CRT does not restrict explanatory variables to be stationary. Instead, the only requirement is

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91 See, among others, Karanassou and Snower (1996).

92 These adjustment costs are well documented in the literature. See, for example, Nickell (1978), Sargent (1978), Taylor (1979), Lindbeck and Snower (1987), Layard and Bean (1989), and more recently Masso and Heshmati (2003), Heshmati and Bhandari (2005), and Piekkola (2006).

93 The CRT allows us to assess the role of capital stock on the evolution of unemployment via its influence on labour demand and wage setting.

94 For an analytical development of lags complementarities, see Karanassou and Snower (1998, p. 836-837).

that each trended endogenous variable (for example, employment, real wage, and labour force) is balanced with the set of its explanatory variables. This is possible because the CRT relies on multi-equation labour market models. This interplay between the lagged adjustment processes and the growing exogenous variables causes "frictional growth."

As shown in Karanassou, Sala and Salvador (2008a, pp. 379-380), the presence of frictional growth in CRT models has the following implication: unemployment may substantially deviate from the natural rate of unemployment (NRU), even in the long-run. The CRT views unemployment in the long-run as two components:

$$\text{long - run unemployment rate} = \text{NRU} + \text{frictional growth},$$

The long-run value towards which the unemployment rate converges reduces to the NRU only when frictional growth is zero. This occurs when: (i) the exogenous variables have zero growth rates in the long-run, or (ii) the labour demand and supply equations have identical dynamic structures. Therefore, frictional growth implies that the NRU may not be an attractor of the moving unemployment. For example, Karanassou, Sala and Salvador (2008a) find that the NRU only explains one third of the unemployment variation in Denmark, while frictional growth accounts for the remaining two thirds. Henry, Karanassou and Snower (2000) find similar results. The NRU in the UK was reasonably stable over the 1964-1997 period and the major variations were because of frictional growth.

For a formal representation of the CRT refer to Karanassou, Sala and Salvador (2008a).

5.3 Multi-equation models

We now turn our attention to the estimated labour market models for Denmark, Finland and Sweden. In this section, we show the 3SLS estimates and the fitted values.[95] We should note, however, that all equations pass a series of misspecification tests (autocorrelation, heteroskedasticity, conditional heteroskedasticity, linearity and normality) and structural stability tests (cusum and cusum^2). Besides, the long-run relationship between the I(1) variables in each equation represents cointegrating vectors, which conforms with the Johansen procedure. Finally, the economic theory supports the signs of the variables. For an extended discussion on these issues, refer to Karanassou, Sala and Salvador (2008b).

95 To account for potential endogeneity and cross equation correlation, we estimated each labour market model with 3SLS. The OLS results do not differ substantially from the 3SLS ones.

5.3.1 Data

Our dataset is annual and the OECD Economic Outlook is our main source. Table 1 defines the variables effectively used.[96]

TABLE 1 Definitions of variables

n	employment (log)	r	real long-term interest rate
l	labour supply (log)	fd	exports-imports (% of GDP)
w	real compensation per employee (log)	τ^d	direct tax rates (% of GDP)
u	unemployment rate $(l-n)$	τ^i	indirect tax rates (% of GDP)
k	real capital stock (log)	g	public expenditures (as % of GDP)
k^n	capital stock per employee $(k-n)$	τ^w	fiscal wedge[97]
z	participation rate $\left(\frac{\text{labour force}}{\text{working-age population}}\right)$	o	real oil prices (log)

Source: OECD, Economic Outlook.

5.3.2 The Danish model

The Danish model runs from 1973 to 2005. According to our estimates, employment depends on capital stock, real wages, and public expenditures (see Table 2). Employment is much more sensitive to wage variations than to changes in capital stock. In particular, the long-run elasticity with respect to wages is close to unity and shows that a 1% rise in wages would reduce employment in a similar proportion. While the long-run elasticity with respect to capital stock is 0.6: a 1% rise in k would boost employment by 0.6%. Labour demand is also significantly strengthened by rises in public expenditures: a 1-percentage point increase in the ratio of public expenditures to GDP would boost employment by 1.2%, in the long-run.[98] Phelps (1994, chapter 17) popularised the use of public expenditures in single-equation unemployment rate models, and its strong influence on the Danish economy comes as no surprise. The public sector produces most services, accounts for almost one third of total employment, and public consumption represents around 40% of total public expenditure (see Madsen, 1999).

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96 We tried a wider set of supply-side and demand-side variables for all countries. What we present is the successful outcome of our full-analysis. More information is given in Karanassou, Sala and Salvador (2008b).

97 The fiscal wedge is the sum of direct, indirect and payroll taxes as a ratio of total compensation of employees.

98 The coefficients on variables defined as logs and variables defined as ratios cannot be compared. The former are interpreted in terms of elasticities and the latter in terms of semi-elasticities.

TABLE 2 Denmark, 3SLS, 1973-2005

Dependent variable: n_t			Dependent variable: w_t			Dependent variable: l_t		
	Coefficient	p-values		Coefficient	p-values		Coefficient	p-values
const	11.6	[0.000]	*const*	5.34	[0.000]	*const*	1.24	[0.000]
n_{t-1}	0.18	[0.000]	w_{t-1}	0.32	[0.000]	l_{t-1}	0.90	[0.000]
Δn_{t-1}	0.61	[0.000]	Δw_{t-1}	0.44	[0.001]	Δl_{t-1}	0.76	[0.000]
w_t	-0.58	[0.000]	u_t	-0.60	[0.000]	Δu_t	-0.04	[0.032]
w_{t-1}	-0.30	[0.052]	k_t^n	0.31	[0.000]	Δu_{t-1}	-0.04	[0.035]
k_t	0.48	[0.000]	r_t	0.38	[0.000]	w_t	0.02	[0.004]
Δk_t	1.78	[0.001]				Δw_t	-0.03	[0.035]
Δk_{t-1}	1.14	[0.083]				z_t	0.18	[0.000]
g_t	1.02	[0.001]				Δz_t	1.09	[0.000]
Δg_t	-0.89	[0.012]				Δz_{t-1}	-1.04	[0.000]
Δg_{t-1}	0.95	[0.003]						
s.e.		0.010			0.009			0.001

Note: Δ is the difference operator; *s.e.* is the standard error of the regression.

Our estimated wage setting equation shows that unemployment, capital deepening, and interest rates influence Danish wages. As expected, unemployment exerts downward pressure on the real wage. If the unemployment rate goes up by 1 percentage point, wages fall by 0.9% in the long-run. The effect of capital deepening on wages is captured by a long-run coefficient of 0.46.[99] Hansen and Warne (2001), document how significant this proxy is in the Danish economy. Holden and Nymoen (2002) and Nymoen and Rϕdseth (2003) also find a significant impact of productivity on Danish wage formation. The impact of the interest rate on wages is positive (0.56 in the long-run).[100] Nevertheless, since wages enter negatively in the labour demand, the relation between the interest rate and unemployment has the expected negative sign.

Notice that neither tax variables nor social security benefits influence the wage equation. This may be because of the emphasis of the Danish system on active labour market policies (ALMPs) - Denmark is the country with the highest GDP percentage of ALMPs expenditures. When this is coupled with loose employment protection legislation (EPL), standard labour market institutions (i.e., taxes and benefits) become less relevant to wage setting.

99 Capital deepening is regarded as a good proxy for labour productivity. The advantage of using capital deepening instead of productivity in our model is that we avoid dealing with an additional endogenous variable in our estimation.

100 We regard the positive association of the real wage with the interest rate as a result of the procyclicality of the two variables. In booming times, a tight labour market puts upward pressure on wages, and the monetary authorities raise interest rates to control for inflation.

Besides, the employment and wage equations display low persistence (the autoregressive coefficients are 0.18 and 0.32, respectively) suggesting a quick speed of adjustment to economic disturbances. This reflects the high degree of flexibility that characterises the Danish labour market (EPL is among the less strict in the OECD countries).

In contrast to labour demand and wage setting, inertia in labour supply decisions is large (the coefficient of persistence is 0.90). Labour supply is driven by the unemployment rate, real wage and participation rate. In particular, it is the change rather than the level of unemployment that enters the labour force equation. This is commonly referred to as the discouraged workers' effect, here with a long-run coefficient of -0.8.[101] The wage incentive activates labour supply with a long-run elasticity of 0.2. Finally, we capture demographic influences on the labour supply movements through the participation rate instead of the working-age population.[102] We explain this by recognising that the participation rate reflects both cultural - the society's attitude towards the labour market - and institutional features that have led the Nordic countries to have the highest (female and youth) participation rates in the OECD. In particular, Denmark is the sole country where participation rates have stayed above 80% since the mid-1980s when the economy recovered from the oil price crises. This is because of the system of ALMPs characterising the Danish labour market that dates from 1979. Its main objective is to promote labour market participation, thus avoiding labour shortages and ensuring the sustainability of public finances (see Andersen, 2006, and Plougmann and Madsen, 2005).

5.3.3 The Finnish model

The sample period of the Finnish model starts in 1976 because of lack of data on capital stock. As shown in Table 3, employment depends on capital stock, real wages, real interest rates and foreign demand. The long-run impacts of capital stock and real wages are, respectively, 0.8 and -0.7. Kiander and Pehkonen (1999) find that wages affect the Finnish labour demand with elasticities between -0.3 and -0.8, depending on the sample period. Notice, that Finnish employment is more sensitive to changes in capital stock than Danish employment, but it is much less sensitive to variations in wages.[103] Real interest rates exert a significant negative influence on the labour demand (in Denmark this influence is indirect, through wages), while foreign demand pushes it upwards. Both variables affect Finnish employment with a unit long-run elasticity. The role of interest rates in the Finnish unemployment trajectory has

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101 The negative association between the unemployment rate and the labour supply could be explained by higher reservation wages and search costs when the unemployment rate rises (see, for example, Piekkola, 2006). However, according to Haurin and Sridhar (2003), evidence on this relationship is mixed and scarce.

102 We expected working-age population to have a positive influence on the labour supply, but it was not significant in any of our models.

103 The lower wage elasticity in Finland may be reflecting the fact that part of the wage increases is explained by the upgrade of skill level and this upgrading process has been much more intense in Finland (see Piekkola, 2006).

been extensively studied by Kiander and Pehkonen (1999), Honkapohja and Koskela (1999) and Fregert and Pehkonen (2009). The latter study considers interest rates as one of the main driving forces of Finnish unemployment. The presence of foreign demand in Finland's employment equation captures the important export-led recovery of the Finnish economy during the last decades, a phenomenon that Kiander and Pehkonen (1999) find significant in explaining the unemployment trajectory.[104]

TABLE 3 Finland, 3SLS, 1976-2005

Dependent variable: n_t			Dependent variable: w_t			Dependent variable: l_t		
	Coefficient	p-values		Coefficient	p-values		Coefficient	p-values
const	2.95	[0.004]	*const*	1.52	[0.037]	*const*	3.76	[0.000]
n_{t-1}	0.64	[0.000]	w_{t-1}	0.80	[0.000]	l_{t-1}	0.70	[0.000]
Δn_{t-1}	0.19	[0.046]	u_t	-0.59	[0.000]	Δl_{t-1}	1.33	[0.000]
w_t	0.71	[0.000]	k_t^n	0.22	[0.039]	Δl_{t-2}	0.03	[0.053]
w_{t-1}	-0.95	[0.000]	τ_t^w	0.27	[0.008]	Δu_t	-0.08	[0.000]
k_t	0.28	[0.001]	o_t	0.02	[0.003]	Δu_{t-1}	-0.01	[0.444]
Δk_t	1.87	[0.001]				w_t	0.05	[0.000]
r_t	-0.34	[0.009]				Δw_t	-0.03	[0.027]
fd_t	0.34	[0.007]				z_t	0.42	[0.000]
						Δz_t	0.85	[0.000]
						Δz_{t-1}	-1.86	[0.000]
s.e.		0.011			0.012			0.001

Note: Δ is the difference operator; *s.e.* is the standard error of the regression.

Our wage setting equation shows that unemployment and capital deepening influence Finnish wages with the expected negative and positive signs, respectively. The long-run influence is much more intensive than in Denmark. In particular, the long-run elasticity of wages with respect to capital deepening is close to unity, while in Denmark is only 0.46. Kiander and Pehkonen (1999) find that capital deepening is the most important factor in Finnish wage setting with a long-run elasticity close to unity. This result is in accordance with Holden and Nymoen (2002) and Nymoen and Rϕdseth (2003). Wages in Finland are also sensitive to oil prices, which confirm this country as the most exposed to external shocks. This is consistent with Honkapohja and Koskela (1999) who stress that despite not being the main story, external shocks played a role in this economy. In addition, Kiander and Pehkonen (1999) find a significant impact of the terms of trade on Finnish unemployment.

104 Bergvall (2004) also shows the importance of demand shocks in Finland and Sweden, while terms of trade shocks are more important in Denmark.

Like in Denmark, the absence of social security benefits and contributions may appear striking given the important role usually assigned to these institutional variables. Note, however, that wage setting in Finland is influenced by the fiscal wedge. This result is consistent with other findings in the literature. Pehkonen (1999) and Kiander and Pehkonen (1999) outline the harmful employment effects of the steady growth in the fiscal wedge via the increasing wage pressure brought by the higher income and payroll taxes used to finance the Finnish pension and unemployment insurance systems. According to Kiander (2004), institutional reforms (or the absence of them) have played only a minor role in the upturn of Finnish unemployment in the early 1990s and in the Finnish employment revival in the late 1990s. Holden and Nymoen (2002) and Nymoen and Rϕdseth (2003) also show that Finnish wage setting behaviour is not much influenced by institutional or wage-pressure factors. Further, there is much more employment and wage sluggishness than in Denmark (inertia coefficients of 0.64 and 0.80, respectively).

Labour supply adjustment, reflected by a persistence coefficient of 0.70, is quicker than in Denmark. The structure of this equation is similar to the Danish one. There is a similar discouraged-worker's effect, however, less intensive than in Denmark (-0.3 vs. -0.8). Piekkola (2006) finds that the unemployment rate affects Finnish labour supply with an elasticity of -0.7. Real wages influence labour supply with a long-run coefficient of 0.17. Finally, in this country it is also through the participation rate that we capture demographic influences on the labour supply movements. Participation rates exert a weaker positive influence on the labour supply with a long-run elasticity of 0.13.

5.3.4 The Swedish model

In Sweden the sample period runs from 1966 to 2005 (see Table 4). The labour demand was not easy to estimate. The multiplicative dummies, n_{t-1}^{d1} and n_{t-1}^{d2}, take into account the significant decrease in employment persistence over 1991-2005.[105]

Swedish labour demand displays a coefficient of persistence of 0.66. Employment persistence is similar in Sweden and Finland and higher than in Denmark, which implies that the speed of adjustment to economic disturbances is much slower in the former two countries. Like in Finland and Denmark, our results show that Sweden's employment depends on capital stock and real

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105 We believe that the decrease in persistence over that period is related to the boost in the ALMPs - with increases in the volume of training programmes and expansion of subsidised employment and youth practice programmes - and the extension of the maximum permitted duration for probationary contracts from 6 to 12 months. Note that $n_{t-1}^{di} = di \times n_{t-1}$, for $i = 1, 2$, where the dummy $d1$ takes the value 1 over the period 1991-1994, zero otherwise, and the dummy $d2$ takes the value 1 over the period 1995-2005, zero otherwise. Is worth noting that we also considered these dummies in Finland - taking the value 1 over the periods 1992-1994 and 1995-2005, respectively - but they were not significant.

wages and on some country-specific variable: indirect taxes. The long-run elasticity of employment with respect to capital stock is 0.7: a 1% rise in k would boost employment by 0.7%. Notice that Swedish employment is as sensitive as Danish employment about the influence of capital stock. However, with a long-run impact of -0.3, Swedish employment is the least sensitive, of the three countries, to wage variations.

TABLE 4 Sweden, 3SLS, 1966-2005

Dependent variable: n_t			Dependent variable: w_t			Dependent variable: l_t		
	Coefficient	p-values		Coefficient	p-values		Coefficient	p-values
$const$	2.88	[0.046]	$const$	3.24	[0.000]	$const$	4.55	[0.000]
n_{t-1}	0.66	[0.000]	w_{t-1}	0.62	[0.000]	l_{t-1}	0.64	[0.000]
n_{t-1}^{d1}	-0.001	[0.140]	Δw_{t-1}	0.21	[0.046]	Δl_{t-2}	-0.33	[0.000]
n_{t-1}^{d2}	-0.003	[0.005]	u_t	-0.67	[0.004]	u_t	-0.32	[0.000]
w_t	-0.78	[0.000]	k_t^n	0.31	[0.000]	w_t	0.08	[0.000]
w_{t-1}	0.67	[0.000]	τ_t^d	0.63	[0.004]	z_t	0.32	[0.000]
k_t	0.22	[0.002]	τ_{t-1}^d	-046	[0.056]			
Δk_t	2.56	[0.000]	τ_t^i	-0.78	[0.003]			
τ_t^i	-1.08	[0.004]						
$s.e.$		0.016			0.016			0.005

Note: Δ is the difference operator; $s.e.$ is the standard error of the regression.

Our estimated wage setting equation also depends on unemployment and capital deepening, both significant and with the expected negative and positive sign, respectively. The long-run influence of wages with respect to capital deepening is close to unity. Hjelm (2006) finds also a similar result. According to Holden and Nymoen (2002) and Nymoen and Rϕdseth (2003), labour productivity has played an important role on Sweden's wage formation. Finally, fiscal policy is also important in Sweden's wage determination, with both direct and indirect taxes exerting an important influence. Forslund (1995) and Fregert and Pehkonen (2009), among others, recognise the significant role of taxes in Swedish wages. Thus, we can argue that taxes in Sweden - as well as the fiscal wedge in Finland - capture the effect of wage push factors, such as social security benefits and contributions, in wage setting. Further, the wage setting adjustments, 0.62, are quicker than in Finland though much slower than in Denmark.

Inertia in labour supply decisions is the same as in labour demand and wage setting decisions. Our labour supply is driven by the unemployment rate, real wage and participation rate. In contrast to Denmark and Finland where exists a significant discouraged-workers' effect, in Sweden is the level of unemployment what exerts the expected negative influence with a unit long-run elasticity. Labour supply in Sweden is as sensitive as its neighbouring countries' labour supply, on real wages. The long-run elasticity is 0.2. Finally, Swedish labour supply is much more sensitive to variations in participation rates than Finland's labour supply, but less sensitive than Danish labour supply in the long-run.

5.3.5 Fitted values

We use the estimated equations to show how our labour market models reproduce the unemployment trajectory (see Figure 1).

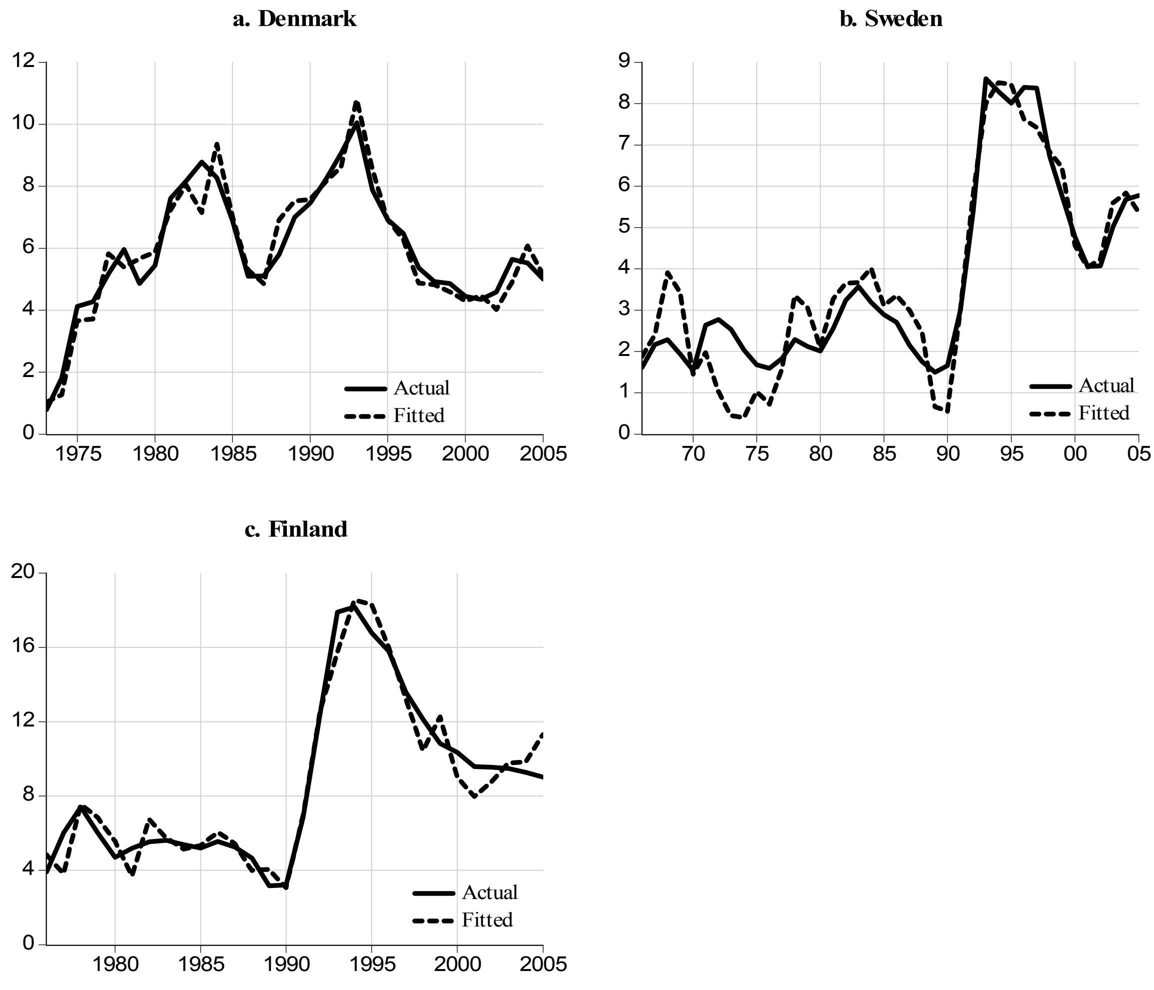

FIGURE 1 Unemployment rate: actual and fitted values

Our estimated models track unemployment well in Denmark and Finland. In Sweden there are some overestimation (at the end of the 1960s) and underestimation (in the 1970s) problems. However, the model tracks Swedish unemployment well since 1980 and onwards. We believe these problems are because of shocks (devaluations) affecting the foreign sector that spread by the late 1970s. It is important to remark that our models track the 1980s and early

1990s downturn in Denmark and the 1990s slump in Finland and Sweden accurately.

5.4 The Nordic experience revisited

We use the estimated systems to perform a dynamic accounting exercise and examine how much of the unemployment variation in Denmark, Finland, and Sweden is attributable to the explanatory variables. The empirical results of Tables 2, 3, and 4 imply that in the case of Denmark we can evaluate the impact of capital stock, the real interest rate, public expenditures, and the participation rate. In Finland, we can evaluate the impact of capital stock, the real interest rate, the fiscal wedge, the participation rate, foreign demand and oil prices. For Sweden, the influence of capital stock, indirect and direct tax rates, and the participation rate in shaping the unemployment trajectory will be evaluated (see Appendix A).

Four periods that coincide with turning points in unemployment are considered: (i) the aftermath of the oil price shocks, (ii) the early nineties slump, (iii) the roaring nineties, and (iv) the end of the wild ride.

To provide a quantitative account of how each variable affects the unemployment rate we proceed as follows. First, we set all the explanatory variables simultaneously at a certain date to create a new (virtual) path of unemployment over a specific period. We then contrast the actual and simulated unemployment series, the difference between them being the dynamic contribution of all the exogenous variables. Next, we assess the impact of the exogenous variables individually by fixing one exogenous variable at a time and create a virtual path of unemployment for that particular variable.

This exercise provides insights of how the unemployment trajectory would have changed had a particular variable followed a different path and how much of the unemployment variation is attributable to each sector of the economy.

5.4.1 The aftermath of the oil price shocks

As explained above, we anchor the simulation periods to each country's unemployment turning points. Thus, the first turning point after the two oil shocks in Finland is 1980, when Finnish unemployment started a rising pattern that lasted until 1986. In the late 1980s, the Finnish economy recovered from the recession and unemployment rates declined to pre-crisis levels. This unemployment behaviour marks the second simulated period, which runs from 1986 to 1990. These two periods frame what we have called the aftermath of the oil price shocks.

Looking at the other two countries, their unemployment trajectories after the oil crises, and before the early 1990s slump, may be also split up in two periods. The first one coincides with a rising trajectory of unemployment that runs from 1979 to 1983 in Denmark and from 1980 to 1983 in Sweden. The second one, running respectively from 1983 to 1987 and from 1983 to 1989, coincides with a declining pattern of unemployment.

We now turn our attention to the dynamic accounting exercises. Denmark, Finland and Sweden enjoyed a favourable macroeconomic environment during the 1960s and mid-1970s. Unemployment did not exceed 2%. However, this situation ended with the two oil crises of the 1970s. Between the mid-1970s and early 1980s, unemployment rates went up, mostly in Denmark. As shown in Table 5 (first row) and Figure 2, Danish unemployment rate increased by 3.9 percentage points between 1979 and 1983. Had the macroeconomic conditions remained at their 1979 situation, unemployment would have placed 1.5 percentage points below in 1983 (third column of Table 5). In Sweden, unemployment rose 1.6 percentage points between 1980 and 1983; however, Swedish unemployment would have been 2.1 percentage points lower in 1983 had the macroeconomic conditions remained at their 1980 situation. In Finland, there was a mild increase of unemployment between 1980 and 1986 (0.7 percentage points). Nevertheless, there might have been a 4 percentage points drop in unemployment in 1986 if the macroeconomic conditions would have remained unchanged at the 1980 situation.

TABLE 5 Simulated unemployment changes attributable to each variable during the aftermath of the oil price shocks

	Δu	Δu^{sim}	Δu^{k}	Δu^{r}	Δu^{fd}	Δu^{fp}	Δu^{z}
Denmark, 1979-1983	3.9	-1.5	-2.2	1.0	-	0.7	-0.9
Finland, 1980-1986	0.7	-4.0	-0.3	-2.4	-1.4	0.5	-0.4
Sweden, 1980-1983	1.6	-2.1	-1.2	-	-	-0.8	-0.1
Denmark, 1983-1987	-3.7	2.2	4.7	0.6	-	-2.4	-0.8
Finland, 1986-1990	-2.3	0.1	5.1	-1.4	-2.4	0.1	-1.1
Sweden, 1983-1989	-2.1	2.6	5.0	-	-	-1.9	-0.4

Note: Δu = actual unemployment change; Δu^{sim} = simulated unemployment change with all the exogenous variables fixed; *fp* = fiscal policy refers to public expenditures in Denmark, the fiscal wedge in Finland, and to direct and indirect taxes in Sweden.

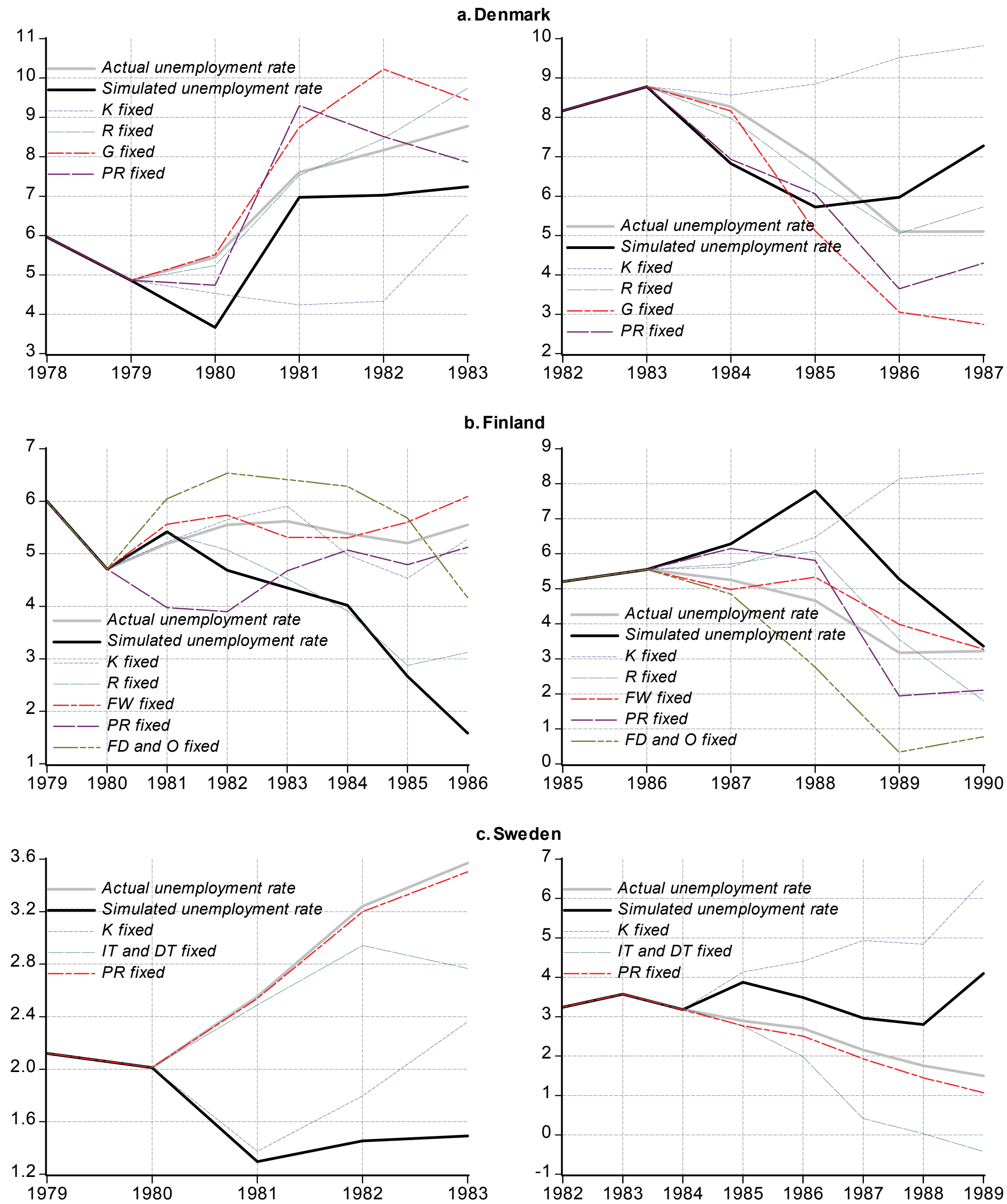

FIGURE 2 Simulated unemployment trajectories during the aftermath of the oil price shocks

What has caused this evolution of unemployment according to our results? In Denmark and Sweden, the role exerted by capital stock (with decelerating growth) was crucial. Had this variable remained at their original values, unemployment would have been lower: 6.6% and 2.4% respectively in Denmark and Sweden in 1983.[106] In Finland, interest rates (increasing several

106 These values appear from subtracting the -2.2 and -1.2 percentage points in the fourth column of Table 5 to the actual unemployment rates: 8.8% and 3.6% in Denmark and Sweden, respectively. For Denmark and Sweden, the actual rate corresponds to 1983.

percentage points) had a more important role. Had they remained unchanged, Finnish unemployment would have been 3.2% in 1986. In other words, the rising trajectory of unemployment during these years was mainly driven by the behaviour of capital accumulation and real interest rates.

Fiscal policy in Finland played a minor role compared to the role exerted by monetary policy (proxied by interest rates). Reforms in payroll, indirect and direct taxes hardly had an impact. In Denmark, increases in public expenditures helped to reduce Danish unemployment by almost 1 percentage point. Direct taxes remained unchanged in Sweden in the early 1980s, but indirect taxes increased by 2 percentage points, leading to almost 1 percentage point rise in unemployment.

Finally, variations in participation rates did not affect the Nordic labour markets notably along this period, although Danish unemployment rate would have been 1 percentage point lower in 1983, had the original values remained unchanged.

Our findings are in line with those of, for example, Kiander and Pehkonen (1999) and Honkapohja and Koskela (1999) who see in the raise of real interest rates the main driving force of Finnish and Swedish unemployment. Fiscal policy also had a role according to Blomqvist (1987) and Pehkonen (1989) - in particular, the rise in payroll, income, and consumption taxes. To explain the unemployment hikes of the 1970s and early 1980s in Denmark, Green-Pedersen (2001) and Green-Pedersen and Lindbom (2005) point to interest rates as one of the main driving forces under the deteriorated international wage competitiveness and the decrease in the terms of trade that pushed unemployment upwards.

After the economic downturn of the early 1980s, these economies started to recover in the second half of the decade. Danish unemployment dropped by 3.7 percentage points between 1983 and 1987. If the macroeconomic conditions had remained unchanged at the 1983 situation, unemployment would have been 2.2 percentage points higher in 1987. Swedish unemployment would have placed 2.6 percentage points above in 1989 instead of the decline of 2.1 percentage points. Finland’s unemployment rate would have remained unchanged, instead of decreasing 2.3 percentage points, between 1986 and 1990 if the 1986 macroeconomic condition would have prevailed.

Like the rising trajectory of unemployment in the early 1980s, we explain the unemployment decline attained by these countries in the latter part of this decade as mainly an outcome of capital accumulation. Had this variable remained at its original values, unemployment would have doubled in Denmark (10%) and more than doubled in Finland and Sweden (8.3% and 6.5%, respectively). Monetary policy also had an impact on Finnish unemployment.

Fiscal policy was much more influential, at least in Denmark and Sweden, and was the counterpart of the positive influence exerted by capital accumulation. The decrease in government expenditures in Denmark implied a rise in its unemployment rate of 2.4 percentage points while tax reforms in Sweden harmed its labour market by pushing unemployment up 1.9 percentage points.

Participation rates increased several points in Denmark and Sweden. Had this variable remained unchanged, unemployment in Denmark would have placed 1 percentage point below in 1987; however, their rises were innocuous to the Swedish labour market. It is worth mentioning the relevant influence of the external sector (foreign demand and oil prices) in Finland. Had international trade remained unchanged, unemployment would have been 2.4 percentage points lower in 1990.

Christensen and Topp (1997) and Andersen and Svarer (2007) recognise the important role exerted by monetary policy in Denmark. The former study also points to the significant tightening of fiscal policy in the early 1980s that helped interest rates to fall rapidly, leading to a sharp pick-up in domestic demand, declining unemployment and improving government finances.[107]

The mid-1980s economic upturn of the Finnish and Swedish economies has received much attention in the literature. Thus, we can mention the work of Jonung, Schuknecht, and Tujula (2006) according to which the boom in these economies between 1985 and 1989 was strongly driven by a financial liberalisation and the design of pro-cyclical monetary policies.[108] However, the boom overvalued their currencies leading to a weakened export performance and worsening their current accounts. Alexius and Holmlund (2008) point to an international upswing and expansionary domestic policies leading to an employment expansion in Sweden that lasted throughout the decade.

5.4.2 The early nineties slump

The boom experienced by Denmark in the mid-1980s, and by Finland and Sweden in the second part of the decade, ended in the early 1990s. Unemployment went up 15 percentage points in Finland between 1990 and 1994. In Sweden and Denmark unemployment rose, respectively, 7.1 and 4.9 percentage points between the late 1980s and 1993. As shown in Table 6, had the good macroeconomic conditions remained at the late 1980s situation, unemployment would have been 7.3 percentage points lower in Finland, 8.2 in Sweden, and 4.6 in Denmark (see also Figure 3).

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107 In words of Christensen and Topp (1997, p.8), "the Danish experience has been seen as a documentation of the possibility that a fiscal tightening can prove to be expansionary even in the short run."

108 See also Kiander (2004) and Holmlund (2006).

TABLE 6 Simulated unemployment changes attributable to each variable during the early nineties slump

	Δu	Δu^{sim}	Δu^{k}	Δu^{r}	Δu^{fd}	Δu^{fp}	Δu^{z}
Denmark, 1987-1993	4.9	-4.6	-3.0	-0.7	-	-1.0	0.1
Finland, 1990-1994	15.0	-7.3	-19.9	0.5	5.3	3.3	3.5
Sweden, 1989-1993	7.1	-8.2	-8.4	-	-	-0.6	0.8

Note: Δu = actual unemployment change; Δu^{sim} = simulated unemployment change with all the exogenous variables fixed; fp = fiscal policy refers to public expenditures in Denmark, the fiscal wedge in Finland, and to direct and indirect taxes in Sweden.

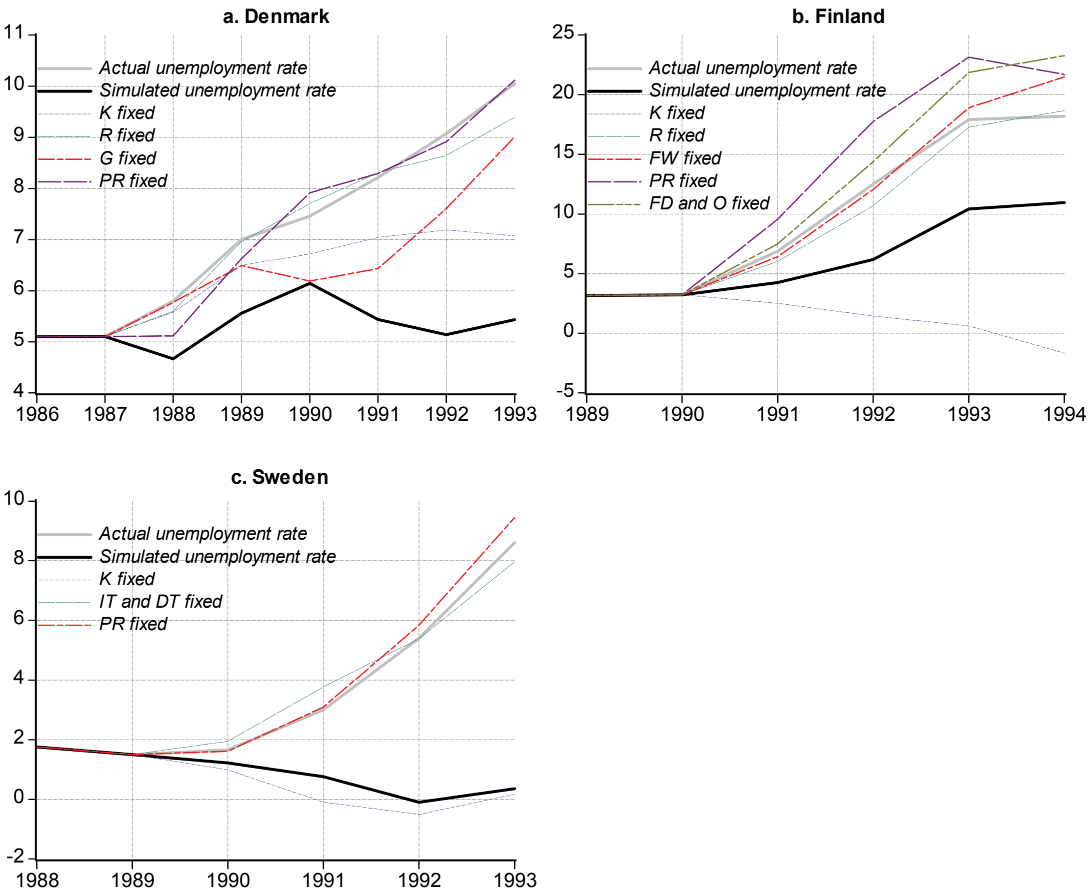

FIGURE 3 Simulated unemployment trajectories during the early nineties slump

Our results show, once again, that capital stock played a central role on the Nordic labour markets. The impact was more acute in Finland. The 2 percentage points decrease in capital accumulation likely accounted for the different unemployment experience of this economy in the early 1990s downturn.[109] Finnish external sector was the counterpart to the negative

109 The different trajectory of the Finnish capital stock could be attributed, among other things, to a more severe financial crisis in Finland; a strong regulation and inefficient usage of capital; a more rapid internationalisation of Finnish firms since the mid-1990s; foreign investment concentrating in less capital-intensive sectors; and a lower

influence exerted by capital accumulation. When the government allowed the currency to float in 1992 it depreciated immediately, strengthening competitiveness and triggering exports. Monetary policy had a modest impact on unemployment in Finland and Denmark.

Cuts in Danish public expenditures and a more tighten fiscal policy in Sweden played a role in their labour markets though minor. However, had the fiscal wedge remained at its original level in Finland, unemployment would have been 3.3 percentage points higher in 1994. Variations in participation rates also had a significant impact on the Finnish labour market, whereas they had only a minor and non-existent role in Sweden and Denmark, respectively.

Our results coincide with those of Kiander (2004) and Honkapohja *et al.* (2009) who remark that macroeconomic factors such as changes in monetary policy and exchange rates, and pro-cyclical fiscal policy led to the Finnish unemployment upturn. Honkapohja and Koskela (1999) also document that interest rate rises jointly with the collapse of asset prices and high indebtedness of firms and households led Finnish unemployment to soar. Turner *et al.* (2001) point to the various shocks experienced by Finland in the early 1990s (the burst of an asset price bubble, a sharp terms-of-trade fall, and the collapse of trade with the ex-Soviet Union) as responsible for the unemployment upturn (see also Conesa, Kehoe and Ruhl, 2007).[110]

Koskela and Uusitalo (2006) and Holmlund (2006) address the central role of interest rates in the Finnish and Swedish crises.[111] According to Fregert and Pehkonen (2009) own estimates and evidence coming from their surveyed works, the main driving forces of Finnish and Swedish unemployment were the rise in interest rates, productivity shocks and tax changes. However, they had a smaller impact in Sweden. Alexius and Holmlund (2008) show that Swedish unemployment rose because of two main policy failures - a too lax fiscal policy to combat rising inflation between 1985 and 1989, and a less than optimal time for financial deregulation and tax reform. Berg and Gröttheim (1997) find in the international recession of the early 1990s, the reformed tax system, and abolished investment allowances the main driving forces of the Swedish unemployment increase. Although Denmark experienced similar macroeconomic developments, it did not suffer a similar banking crisis, which Edey and Hviding (1995) attribute to a more prudential supervision of Danish banks and tighter capital standards.

share of ICT industries in the market - with ICT investments in Finland concentrating on communication equipment, while in Denmark and Sweden ICT investments growing quite rapidly in all sectors. See, among others, Honkapohja and Koskela (1999); Jalava (2002); Daveri and Silva (2004); Dahlman, Routti and Ylä-Anttila (2006); Sauramo (2008); and Honkaphoja *et al*. (2009).

110 Piekkola and Haaparanta (2006) argue that tight monetary policy and high interest rates imposed financial constraints on firms and this contributed to explain between one third and half of the unemployment during the early 1990s (see also Honkapohja *et al.*, 2009).

111 See, among others, Kiander and Pehkonen (1999).

5.4.3 The roaring nineties

After the deep recession of the early 1990s, all Nordic countries experienced a strong recovery. The growth rates of output, productivity, and employment were faster in Finland. This prompted a steady decline in unemployment: from its pick in the early 1990s, it experienced a fast lessening up to 2001. Finnish unemployment fell by 8.6 percentage points, from 18.2% in 1994 to 9.6% in 2001. Swedish unemployment went down by 4.5 percentage points, from 8.6% in 1993 to 4.1% in 2001. Danish unemployment fell almost 6 percentage points, from 10.0% in 1993 to 4.3% in 2001. The quasi-halving of these rates is the central expression of the roaring nineties in the Nordic countries.

Unemployment in Denmark would have been 2.9 percentage points higher in 2001 had the macroeconomic conditions remained at their 1993 situation (see Table 7 and Figure 4). Under the same assumptions, the analysis for Finland reveals a simulated unemployment rate 11.2 percentage points higher than the value achieved in 2001 (around 21% instead of near 10%). In Sweden, the unemployment path would have been upwards and gained 10.2 more percentage points than the actual 4% had the economic context remained as it was in 1993.

TABLE 7 Simulated unemployment changes attributable to each variable during the roaring nineties

	Δu	Δu^{sim}	Δu^{k}	Δu^{r}	✌u^{fd}	Δu^{fp}	✌u^{z}
Denmark, 1993-2001	-5.7	2.9	2.6	1.6	-	-1.3	-0.1
Finland, 1994-2001	-8.6	11.2	6.8	2.4	3.8	1.2	-3.0
Sweden, 1993-2001	-4.5	10.2	9.4	-	-	0.6	0.3

Note: Δu = actual unemployment change; Δu^{sim} = simulated unemployment change with all the exogenous variables fixed; *fp* = fiscal policy refers to public expenditures in Denmark, the fiscal wedge in Finland, and to direct and indirect taxes in Sweden.

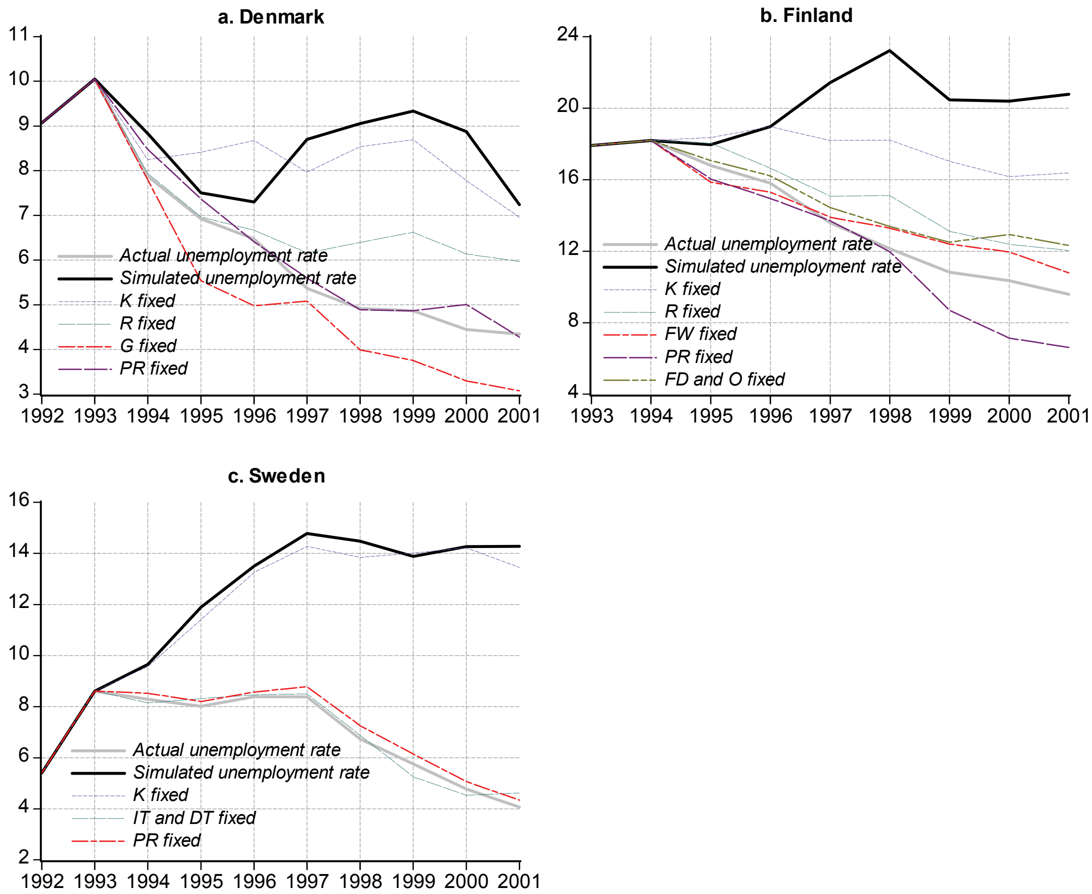

FIGURE 4 Simulated unemployment trajectories during the roaring nineties

According to our analysis, the main feature of these years in all countries was the positive influence exerted by capital stock (with growth speeding up) and interest rates (falling several percentage points). Had these variables remained at their original values, Danish unemployment in 2001 would have placed at 6.9% and 5.9%, respectively. In Finland, these rates would have been 16.4% and 12.0%, respectively. Had capital stock remained unchanged in Sweden, its unemployment rate would have increased to 13.4% in 2001. The sharp fall of Finnish unemployment was also an outcome of the continued improvement of the international trade that started in 1990 and prevented Finnish unemployment from going up 3.8 percentage points in 2001.

Public intervention did also influence the labour market performance, but mildly in response to, sometimes, large changes. The drop in government expenditures in Denmark harmed its labour market by increasing its unemployment rate 1.3 percentage points. Finnish government cut the fiscal wedge by several percentage points. Nevertheless, had it remained unchanged, unemployment would have been 1.2 percentage points higher in 2001. Changes in direct and indirect taxes in Sweden hardly had a positive impact on unemployment.

Our results are in line with other empirical evidence. For example, Fregert and Pehkonen (2009) evaluate the influence of institutional changes affecting the replacement rate, ALMPs, EPL and wage bargaining, but also the tax wedge. They do not find large effects on the Finnish and Swedish unemployment trajectories during these years but, on the contrary, claim that interest rates and the closing output gap contributed to reduce Finnish unemployment. This closing is likely to be related to the acceleration in capital that took place those years.

Kiander (2004), points out that the revival in Finnish employment towards the end of the 1990s took place without any deep labour market reforms. In turn, the breakthrough of information and communication technologies (ICT) improving competitiveness and increasing exports rapidly, and macroeconomic factors (changes in monetary policy and pro-cyclical fiscal policy) accounted for most of the Finnish unemployment decrease.[112] Honkaphoja *et al*. (2009) attribute the successful recovery to better economic policies, success in the information technology revolution, and successful internationalisation of the Finnish society. However, had this recovery been more labour-intensive instead, Finnish unemployment would have decreased more and faster (see Kiander, 2004).

According to Holmlund (2006), restrictive monetary and fiscal policies in Sweden in the mid-1990s contributed to the weak employment performance, leading unemployment to remain high until 1997. However, they allowed for the fiscal consolidation and credible low inflation achieved in the late 1990s. When the government met these goals, tax and expenditure policies became more expansionary and monetary policy supported the expansion with which unemployment rates declined. Berg and Gröttheim (1997) also show that high unemployment in Sweden up to 1997 was mainly the outcome of tight monetary policy between 1994 and 1995. However, the ease of monetary policy during 1996 helped to reduce unemployment.

Finally, changes in participation rates in response to economic activity were slow. In Sweden and Denmark participation rates started to increase again only at the end of the 1990s, but their rises were innocuous to the labour market. On the contrary, in Finland they started to move up as soon as in 1994 and had a significant impact. Without their rise of 3 percentage points, unemployment would have been 3.0 percentage points lower in 2001. This was, therefore, a relevant counterpart of the positive influence exerted by the rapid capital stock growth, lower interest rates, and strengthened international trade.

5.4.4 The end of the wild ride

The strong expansionary period experienced by the Nordic economies in the second half of the 1990s ended in 2001. Since then, economic and capital stock growth decelerated and unemployment stopped its falling path: it increased in Denmark and Sweden and gradually stabilised in Finland. In 2005, these rates were close to, respectively, 5%, 6% and 9%.

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112 See also Koski and Ylä-Anttila (2006).

According to our analysis, the end of the wild ride would have occurred anyway in Denmark, but not in Finland and Sweden. In the first case, unemployment would have gone from 4.3% to 3.5%; that is 1.5 percentage points below the actual 5%. On the contrary, the other two countries still had room for further improvement. Had the conditions of 2001 remained, Finnish unemployment would have gone further down by 4.8 percentage points (instead of the 0.6 points decrease) gaining a rate of 4.2% in 2005, a similar value than before the early 1990s slump. In Sweden, the decline would have achieved 3.2 percentage points, instead of the 1.7 percentage points increase. This would have driven unemployment rate to its full employment level of the early 1990s slump (see Table 8 and Figure 5).

TABLE 8 Simulated unemployment changes attributable to each variable during the end of the wild ride

	Δu	Δu^{sim}	Δu^{k}	Δu^{r}	✌u^{fd}☐	Δu^{fp}	✌u^{z}
Denmark, 2001-2005	0.7	-1.5	-2.0	0.5	-	0.1	-0.1
Finland, 2001-2005	-0.6	-4.8	-5.4	-0.3	1.4	-0.3	-0.3
Sweden, 2001-2005	1.7	-3.2	-2.9	-	-	-0.5	0.1

Note: Δu = actual unemployment change; Δu^{sim} = simulated unemployment change with all the exogenous variables fixed; *fp* = fiscal policy refers to public expenditures in Denmark, the fiscal wedge in Finland, and to direct and indirect taxes in Sweden.

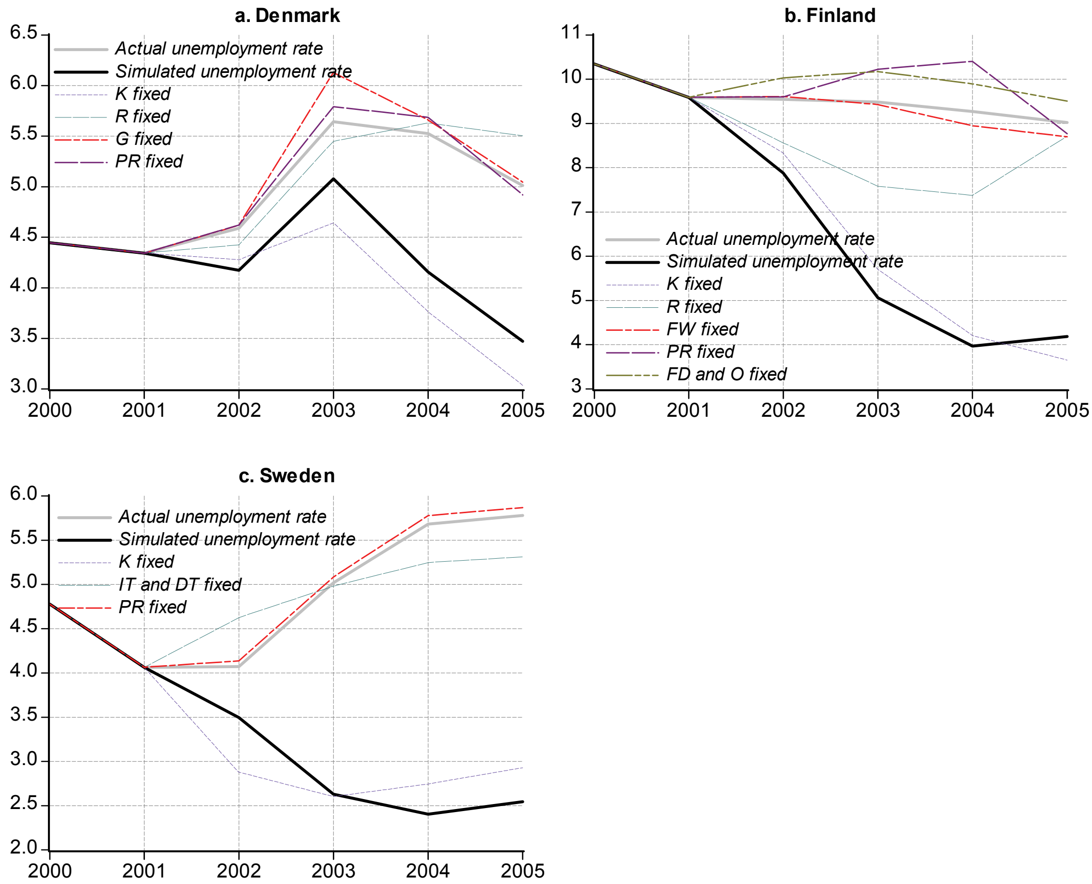

FIGURE 5 Simulated unemployment trajectories during the end of the wild ride

Our results indicate that the effects of capital accumulation have driven most of these changes. Had capital stock remained unchanged at its 2001 situation, Finnish unemployment would have placed at 3.6% in 2005, 5.4 percentage points below the actual figure of 9%. In Sweden and Denmark, the fall would have been 2.9 and 2.0 percentage points, respectively.

Fiscal policy and variations in participation rates did not affect much the Nordic labour markets in this period. Public expenditures in Denmark, the fiscal wedge in Finland, and direct and indirect taxes in Sweden did not change notably. Had these variables remained at their original values, unemployment would have changed less than half percentage point in all three countries.

Monetary policy in Finland and Denmark hardly had an impact in the early 2000s. Finally, the external sector influenced Finnish unemployment positively. Had foreign demand and oil prices remained unchanged, Finnish unemployment would have increased 1.4 percentage points in 2005.

Many works attribute the early 2000s' slump to the slowdown in the world economy that took place in 2001. Zhou (2007) and Andersen and Svarer (2007) point out that not only the international crisis, but also a more tightened fiscal policy to avoid overheating in the late 1990s worsened the Danish labour market. The latter study also points to labour force shortages.[113] According to Kiander (2004) and Honkaphoja *et al.* (2009), growth in Finland and Sweden slowed down after the burst of the ICT bubble in 2001, leading employment to remain almost constant. However, Finnish unemployment did not increase because exports and imports growth revived after the sluggish development between 2001 and 2003 (see Kiander, Romppanen and Kröger, 2006). Giavazzi and Mishkin (2006) also point to tighten monetary policy in Sweden –- interest rates rose twice in the spring of 2002 – as responsible for part of the unemployment increase.

5.5 Unemployment effects of temporary shocks to capital stock

According to Section 5.4 results, capital stock has played the most important role on the unemployment trajectories of Denmark, Finland, and Sweden since the 1980s. In addition, Karanassou, Sala and Salvador (2008b) show that the evolution of capital stock has accounted for the disparities in the unemployment trajectories of the three countries. In particular, temporary slowdowns in capital accumulation in Denmark and Sweden and permanent slowdowns in capital accumulation in Finland have driven the intensity and longevity of the upturns in unemployment.

In what follows, we further evaluate the role of capital stock on the unemployment trajectory of the Nordic countries by examining the responses through time of the unemployment rate to a unit one-period shock to capital stock. That is, we examine the process of adjustment of the unemployment rate to that temporary shock.[114]

Recall the presumption underlying CRT models: current labour market activity depends on the past, and the process of adjustment may take a long time to work itself out. That is, movements of unemployment are viewed as the outcome of the interplay between the dynamic properties of the shocks and the lagged adjustment processes. These shocks, temporaries or permanents, affect a specific equation and then feed through the labour market system. The existence of lags, interacting with one another, prolongs the unemployment effects of the shock. In other words, these shocks are not absorbed instantly and their effects are felt through time.[115]

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113 See also Danmarks Nationalbank's Monetary Report (2002).

114 Given that the purpose of this exercise is to show how this process may take a long time, we only illustrate it by considering the impact of a temporary shock to capital stock. Nevertheless, this exercise could also be performed by supposing a temporary or permanent shock to any of the exogenous variables contained in the three estimated systems. The analysis of permanent shocks on the unemployment trajectory is beyond the scope of this paper.

115 For an illustration of the unemployment dynamics, see Karanassou, Sala and Snower (2007, p. 169-178).

The concept that captures the after-effects of temporary labour market shocks is "unemployment persistence."[116] The impulse response function (IRF) of unemployment describes the responses of unemployment through time to a specific temporary shock (impulse). To define unemployment persistence suppose a one-off temporary shock in an exogenous variable occurring at period t. Unemployment persistence, σ, is the sum of its responses for all periods $t+j$ in the aftermath of the shock $j \geq 1$: $\sigma \equiv \sum_{j=1}^{\infty} R_{t+j}$, where the series R_{t+j}, $j \geq 0$ is the IRF of unemployment.[117] If the unemployment model (i) is static, then the shock is absorbed instantly and so $\sigma = 0$, (ii) is dynamically stable, like CRT models, then the effects of the shock gradually die out and persistence is a finite quantity, and (iii) displays hysteresis, then the temporary shock has a permanent effect and thus $\sigma = \infty$.

Given that the temporary shock represents the change in a specific exogenous variable, then: (i) the immediate response, R_t, is the short-run elasticity of the unemployment rate with respect to that explanatory variable, and (ii) the sum of the immediate response, R_t, and persistence, σ, gives the long-run elasticity of the unemployment rate with respect to that explanatory variable. Thus, the long-run elasticity of the variable is:

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

Next, we use the estimated labour market models of Section 5.3 to show how temporary shocks to capital stock may have prolonged after-effects. Suppose that the shock occurs at period $t = 0$, and lasts just a year. Figure 6 shows the responses through time of the unemployment rate to the temporary shock to capital stock in Denmark, Finland, and Sweden. The generated IRFs have been normalised so the immediate impact of the shock is unity.

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116 When the shock is permanent, the concept of relevance is "imperfect unemployment responsiveness." The two measures, unemployment persistence and imperfect unemployment responsiveness, provide insights into the way unemployment moves through time (see Karanassou and Snower, 1996, 1998).

117 See Karanassou and Snower (1996, 1998), Pivetta and Reis (2004), and Bande and Karanassou (2009).

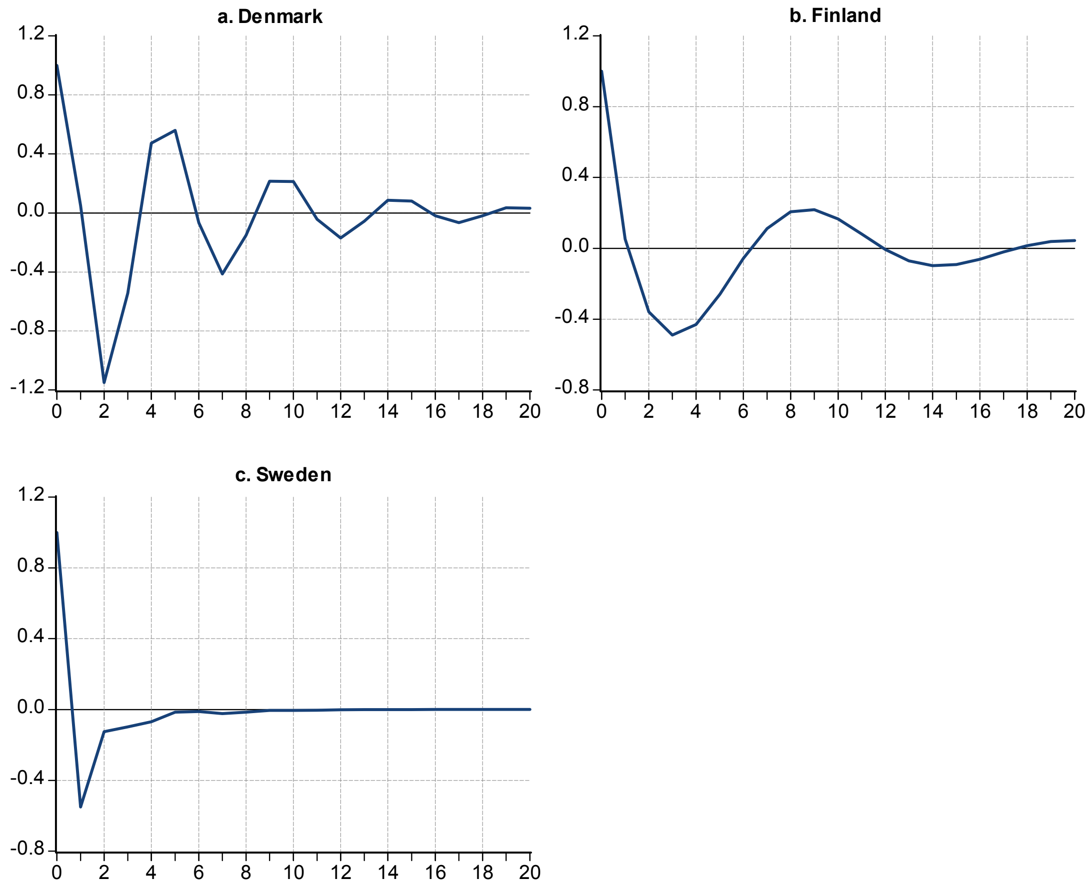

FIGURE 6 Impulse response function of unemployment to a temporary sock to capital stock

As shown in Figure 6, the unemployment effects of a temporary shock to capital stock start decreasing once the shock has been initiated. When unemployment falls below the level before the shock it then oscillates around this level in Denmark and Finland, and moves towards this level without oscillating in Sweden.[118] Our results also show that it takes several years before the one-period shocks are completely absorbed by the labour market. In particular, 20% of the initial impact of the shock is still felt by the market after 8 years in Denmark and Finland.

Henry, Karanassou, and Snower (2000) find similar results for the UK. According to this study, 10% of the initial unemployment effect to temporary shocks in the labour demand, wage setting, and labour force equations is still felt after 4, 12 and 10 years, respectively. Karanassou, Sala and Snower (2004) examine unemployment persistence in response to different temporary shocks for a panel of EU countries. In particular, they evaluate the impact of temporary shocks to competitiveness, social security benefits, and real interest rates. In all three cases, it takes several years – roughly 20 - before the one-period shocks are completely absorbed by the labour market. Bande and Karanassou (2009)

118 Given that the unemployment models are dynamically stable, the effects of the shock gradually die out and persistence is a finite quantity.

analyse the responses through time of the unemployment rate to a unit one-period labour demand, wage setting and labour supply shocks in two Spanish regions. They show that 20% of the initial impact of the shock is still felt by the market after 2, 5 and 3 years, respectively.

Let us now examine unemployment persistence from a quantitative perspective. Recall that the temporary shock represents the change in a specific exogenous variable - capital stock in our case. Unemployment persistence, σ, is the sum of all the after-effects of the shock. The total effect, τ, of the shock on unemployment is the sum of: (i) the initial unemployment response, R_0, or short-run elasticity of unemployment with respect to capital stock, and (ii) the persistence measure: $\tau \equiv \sum_{t=0}^{\infty} R_t = R_0 + \sigma$.

Note that the initial response captures both the direct and indirect effects of the shock on unemployment. The direct effect is the size of the shock, whereas the indirect effects are due to spillovers. In other words, when there are no spillover effects in the labour market system, the initial unemployment response is equal to the size of the shock, $R_0 = 1$.

According to our results, the initial impact of the shock is greater in Finland than in Denmark and Sweden (see first row of Table 9). In the latter two countries, the short-run elasticity is of a similar size. In addition, the shock is far more persistent in Finland, followed by Denmark and finally Sweden. After the initial impact, the overall future decrease in Finnish unemployment is 2.75 percentage points. While the unemployment decrease in Denmark and Sweden is, respectively, 1.70 and 1.50. As a result, the total effect of the shock on unemployment is similar for Denmark and Finland and lower than in Sweden.

TABLE 9 Persistence of shocks

	Denmark	Sweden	Finland
short-run elasticity R_0 (initial response)	1.73	1.63	2.76
persistence σ (sum of future responses)	-1.70	-1.50	-2.75
long-run elasticity τ (short-run elasticity + persistence)	0.03	0.13	0.01

Karanassou and Snower (2000) examine the persistence of shocks in Germany, the UK, and the US from a quantitative perspective. The study focuses on unemployment persistence associated to temporary shocks in the labour demand equation. The results yield quite different inter-country comparisons due to the different labour market lag structures of the three countries. Karanassou, Sala and Snower (2004) and Bande and Karanassou (2009) calculate measures of persistence associated to temporary shocks. These measures depend on the specific equation on which the shocks impact and from where they then feed through the labour market system.

The analysis in Figure 6 and Table 9 provides insights of how temporary labour market shocks - more precisely a temporary shock to capital stock - may have prolonged effects on unemployment, after they have worked their way through the network of interacting lagged adjustment processes.

5.6 Conclusions

In this paper we conducted dynamic simulations to provide an account of the labour market performance of three Nordic countries since the 1980s. In particular, we examined how much of the Danish, Finnish, and Swedish unemployment variation was attributable to different explanatory variables in four periods of interest.

Our results illustrate the importance of non-standard labour market variables in examining unemployment trajectories. According to our simulation results, capital stock was the most important determinant of the unemployment trajectory. It impeded a fall in unemployment in Denmark and Sweden of 2.2 and 1.2 percentage points, respectively, in the early 1980s; and avoided a rise in unemployment of roughly 5 percentage points in the three countries in the late 1980s. In the early 1990s, it contributed significantly to the 4.9, 15, and 7.1 percentage points increase in the Danish, Finnish, and Swedish unemployment rates, respectively. It avoided a rise in unemployment in Denmark, Finland, and Sweden of 2.6, 6.8, and 9.4 percentage points, respectively, in the late 1990s. In the early 2000s, it impeded a 2, 5.4, and 2.9 percentage points fall in the Danish, Finnish, and Swedish unemployment rates, respectively. The other main determinant of Finland’s unemployment was the external sector, its quantitative impact varying from one third to a half of that of capital stock, depending on the period analysed. Fiscal policy and participation rates also had a significant role, particularly in Finland. Their impact, approximately 20% of that of capital stock, was strongest in the early 1990s. We further evaluated the major role of capital stock in the unemployment trajectories of Denmark, Finland, and Sweden by examining the process of adjustment of the unemployment rate to a temporary shock to capital stock. This exercise reveals that Finland experienced the greatest initial impact of the shock and the shock was far more persistent. Nevertheless, the impact and persistence of the shock were also significant in Denmark and Sweden.

REFERENCES

Alexius, A. and B. Holmlund (2008), "Monetary policy and Swedish unemployment fluctuations", *Economics: The Open-Access, Open-Assessment E-Journal*, 2, 2008-4.

Andersen, T. (2006), "From excess to shortage - recent developments in the Danish labour market", pp. 75-102, in Werding, M. (ed), *Structural unemployment in Western Europe: reasons and remedies*, The MIT Press, Cambridge MA.

Andersen, T. and M. Svarer (2007), "Flexicurity - labour market performance in Denmark", *CESifo Economic Studies*, 53 (3), pp. 389-429.

Bande, R. and M. Karanassou (2009), "Labour market flexibility and regional unemployment rate dynamics: Spain 1980-1995", *Papers in Regional Science*, forthcoming (doi:10.1111/j.1435-5957.2008.00165.x).

Berg, C. and R. Gröttheim (1997), "Monetary policy in Sweden since 1992", pp. 140-182, in *Monetary policy in the Nordic countries: experiences since 1992*, *BIS Policy Papers*, 2.

Bergvall, A. (2004), "What determines real exchange rates? The Nordic countries", *The Scandinavian Journal of Economics*, 106 (2), pp. 315-337.

Blomqvist, H. C. (1987), "The causes of unemployment in Finland 1970-1982: some empirical evidence", *Applied Economics*, 19 (5), 687-694.

Christensen, A. M. and J. Topp (1997), "Monetary policy in Denmark since 1992", pp. 5-23, in *Monetary policy in the Nordic countries: experiences since 1992*, *BIS Policy Papers*, 2.

Conesa, J.C., T. Kehoe and K. Ruhl (2007), "Modeling great depressions: the depression in Finland in the 1990s", *Quarterly Review*, Nov, pp. 16-44.

Dahlman, C., J. Routti and P. Ylä-Anttila (2006), *Finland as a knowledge economy. Elements of success and lessons learned*, World Bank, Washington DC.

Danmarks Nationalbank (2002), *Monetary review*, 4th Quarter 2002. http://www.nationalbanken.dk/C1256BE9004F6416/side/Monetary_Review_4_Quarter_2002.

Daveri, F. and O. Silva (2004), "Not only Nokia: what Finland tells us about *new economy* growth", *Economic Policy*, 19 (38), pp. 117-163.

Edey, M. and K. Hviding (1995), "An assessment of financial reform in OECD countries", in *OECD Economics Studies, 25*, OECD Publishing.

Forslund, A. (1995), "Unemployment - is Sweden still different?", *Swedish Economic Policy Review*, 2 (1), pp. 15-58.

Fregert, K. and J. Pehkonen (2009), "The crises of the 1990s and unemployment in Finland and Sweden", in Jonung, L., J. Kiander and P. Vartia (eds.), *The crises of the 1990s in Finland and Sweden*, Edward Elgar. (forthcoming)

Giavazzi, F. and F. Mishkin (2006), "An evaluation of Swedish monetary policy between 1995 and 2005", Report from the Swedish Parliament, 2006/07: RFR1, Stockholm, The Committee on Finance.

Green-Pedersen, C. (2001), "Minority governments and party politics: the political and institutional background to the "Danish Miracle"", *Journal of Public Policy*, 21 (1), pp. 53-70.

Green-Pedersen, C. and A. Lindbom (2005), "Employment and unemployment in Denmark and Sweden: success or failure for the universal welfare model", pp. 65-85, in Becker, U. and H. Schwartz (eds.), *Employment "miracles" in critical comparison. The Dutch, Scandinavian, Swiss, Australian and Irish cases versus Germany and the USA*, Amsterdam University Press, Amsterdam.

Hansen, H. and A. Warne (2001), "The cause of Danish unemployment: demand or supply shocks?", *Empirical Economics*, 26 (3), pp. 461-486.

Haurin, D.R. and K.S. Sridhar (2003), "The impact of local unemployment rates on reservation wages and the duration of search for a job", *Applied Economics*, 35 (13), pp. 1469-1476.

Henry, B., M. Karanassou, and D.J. Snower (2000), "Adjustment dynamics and the natural rate: an account of UK unemployment", *Oxford Economic Papers*, 52 (1), pp. 178-203.

Heshmati A. and A.K. Bhandari (2005), "Labour use and its adjustment in Indian manufacturing industries, *IZA Discussion Paper*, 1596.

Hjelm, G. (2006), "Simultaneous determination of NAIRU, output gaps and structural budget balances: Swedish evidence", in Mazzi, G.L. and G. Savio (eds), *Growth and cycle in the Eurozone*, Palgrave, Mcmillan.

Holden, S. and R. Nymoen (2002), "Measuring structural unemployment: NAWRU estimates in the Nordic countries", *The Scandinavian Journal of Economics*, 104 (1), pp. 87-104.

Holmlund, B. (2006), "The rise and fall of Swedish unemployment", pp. 103-132, in Werding, M. (ed), *Structural unemployment in western Europe: reasons and remedies*, The MIT Press, Cambridge MA.

Honkapohja, S. and E. Koskela (1999), "Finland's depression: a tale of bad luck and bad policies", *Economic Policy*, 14 (29), 400-436.

Honkapohja, S., E. Koskela, W. Leibfritz and R. Uusitalo (2009), *Economic prosperity recaptured: the Finnish path from crisis to rapid growth*, The MIT Press, Cambridge MA.

Jalava, J. (2002), "Accounting for growth and productivity: Finnish multi-factor productivity 1975–99", *Finnish Economic Papers*, 15 (2), pp. 76-86.

Jonung, L., L. Schuknecht and M. Tujula (2006), "The boom-bust cycle in Finland and Sweden 1984-1995 in an international perspective", *CFS Working Paper*, 2006/13.

Karanassou, M. and D.J. Snower (1996), "Explaining disparities in unemployment dynamics", in Baldassari M., L. Paganetto and E. Phelps (eds.), *The 1990's slump: causes and cures*, Macmillan Press, London.

Karanassou, M. and D.J. Snower (1998), "How labor market flexibility affects unemployment: long-term implications of the chain reaction theory", *The Economic Journal*, 108 (448), pp. 832-849.

Karanassou, M. and D.J. Snower (2000), "Characteristics of unemployment dynamics: the chain reaction approach", *IZA Discussion Paper*, 127.

Karanassou, M., H. Sala and P.F. Salvador (2008a), "The (ir)relevance of the NRU for policy making: the case of Denmark", *Scottish Journal of Political Economy*, 55 (3), pp. 369-392.

Karanassou, M., H. Sala and P.F. Salvador (2008b), "Capital accumulation and unemployment: new insights on the Nordic experience", *Cambridge Journal of Economics*, 32 (6), pp. 977-1001.

Karanassou, M., H. Sala and D.J. Snower (2004), "Unemployment in the European Union: institutions, prices and growth", *CESifo Working Paper Series,* 1247.

Karanassou, M., H. Sala and D.J. Snower (2007), "The macroeconomics of the labor market: three fundamental views", *Portuguese Economic Journal*, 6 (3), pp. 151–180.

Kiander, J. (2004), "The evolution of the Finnish model in the 1990s: from depression to high-tech boom", *VATT Discussion Papers*, 344.

Kiander, J. and J. Pehkonen (1999), "Finnish unemployment: observations and conjectures", *Finnish Economic Papers*, 12 (2), pp. 94-108.

Kiander, J., A. Romppanen and O. Kröger (2006), *Finnish economy - structural indicators 2006*, Oy Nord Print Ab, Helsinki.

Koskela, E. and R. Uusitalo (2006), "The unintended convergence: how Finnish unemployment reached the European level", pp. 159-185, in Werding, M. (ed), *Structural unemployment in western Europe: reasons and remedies*, The MIT Press, Cambridge MA.

Koski, H. and P. Ylä-Anttila (2006), "Structural changes in the Finnish economy: from agriculture to high-tech", in Dahlman, C., J. Routti and P. Ylä-Anttila (eds.): *Finland as a knowledge economy. Elements of success and lessons learned,* World Bank, Washington DC.

Layard, R. and C. Bean (1989), "Why does unemployment persist?", *The Scandinavian Journal of Economics*, 91 (2), pp. 371-396.

Lindbeck, A., and D.J. Snower (1987), "Union activity, unemployment persistence, and wage-employment ratchets", *European Economic Review*, 31 (1-2), pp. 157-167.

Madsen, P.K. (1999), "Denmark: flexibility, security and labour market success", *ILO Employment and Training Papers*, 53.

Masso J. and A. Heshmati (2003), "The optimality and overuse of labour in Estonian manufacturing enterprises", *IZA Discussion Paper*, 884.

Nickell, S. (1978), "Fixed costs, employment and labour demand over the cycle", *Economica*, 45 (180), pp. 329-345.

Nymoen, R. and A. Rødseth (2003), "Explaining unemployment: some lessons from Nordic wage formation", *Labour Economics*, 10 (1), pp. 1-29.

Pehkonen, J. (1989), "The causes of unemployment in Finland 1970-82: some further empirical evidence", *Applied Economics*, 21 (6), 723-739.

Pehkonen, J. (1999), "Wage formation in Finland, 1960-1994", *Finnish Economic Papers*, 12 (2), pp. 82-93.

Phelps, E. (1994), *Structural slumps: the modern equilibrium theory of unemployment, interest and assets*, Harvard University Press, Cambridge MA.

Piekkola, H. (2006), "Tax cuts and employment: evidence from Finnish linked employer-employee data", *ETLA Discussion Papers*, 1041.

Piekkola, H. and P. Haaparanta (2006), "Liquidity constraints faced by firms and employment", *Applied Economics Quarterly*, 52 (1), pp. 55-74.

Pivetta, F. and R. Reis (2004), "The persistence of inflation in the United States", mimeo, Harvard University.

Plougmann, P. and P.K. Madsen (2005), "Labor market policy, flexibility and employment performance: Denmark and Sweden in the 1990s", in Howell, D.R. (ed.), *Fighting unemployment: the limits of free market orthodoxy*, Oxford University Press, Oxford.

Sargent, T. (1978), "Estimation of dynamic labor demand schedules under rational expectations", *Journal of Political Economy*, 86 (6), pp. 1009-1044.

Sauramo, P. (2008), "Does outward foreign direct investment reduce domestic investment? Macro-evidence from Finland, *Labour Institute for Economic Research discussion papers*, 239.

Talyor, J. (1979), "Staggered wage setting in a macro model", *The American Economic Review*, 69 (2), pp. 108-113.

Turner, D., L. Boone, C. Giorno, M. Meacci, D. Rae and P. Richardson (2001), "Estimating the structural rate of unemployment for the OECD countries", *OECD Economic Studies*, 33, pp. 171-216.

Zhou, J. (2007), "Danish for all? Balancing flexibility with security: the flexicurity model", *IMF Working Paper*, 07/36.

Appendix A

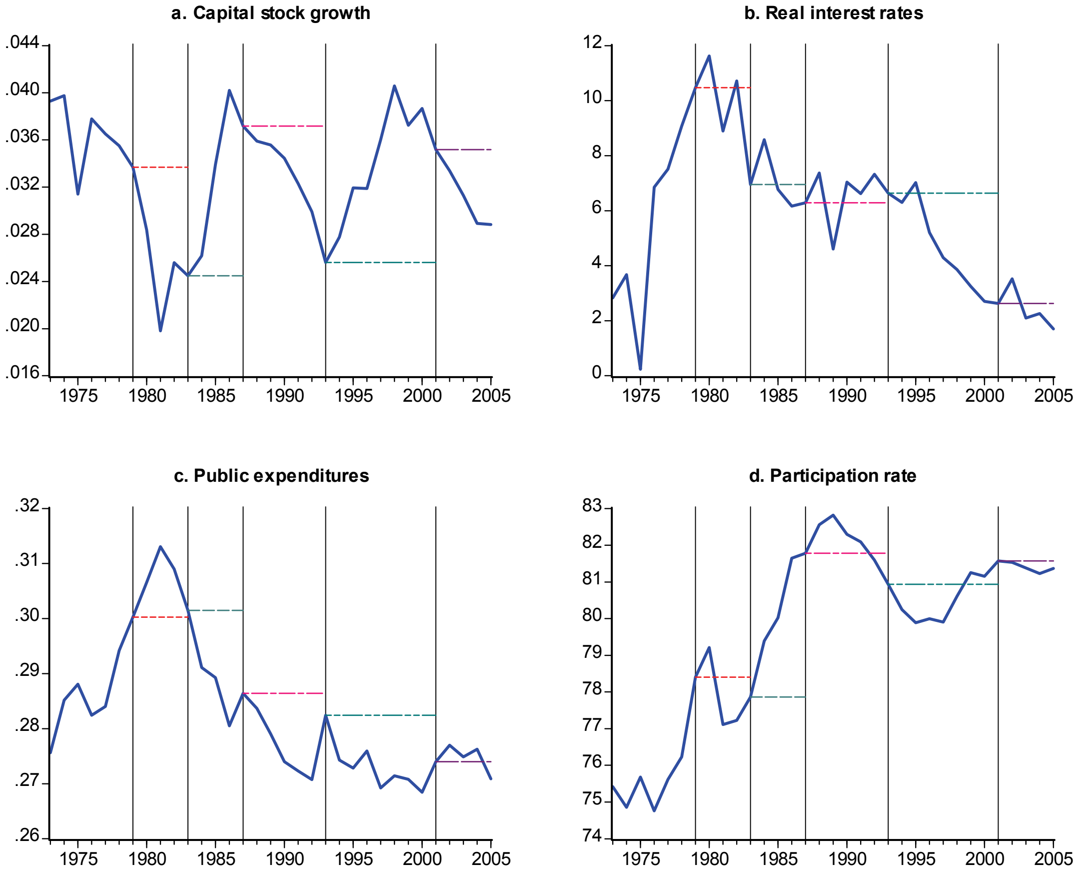

FIGURE A1 Actual and simulated values of the exogenous variables in Denmark

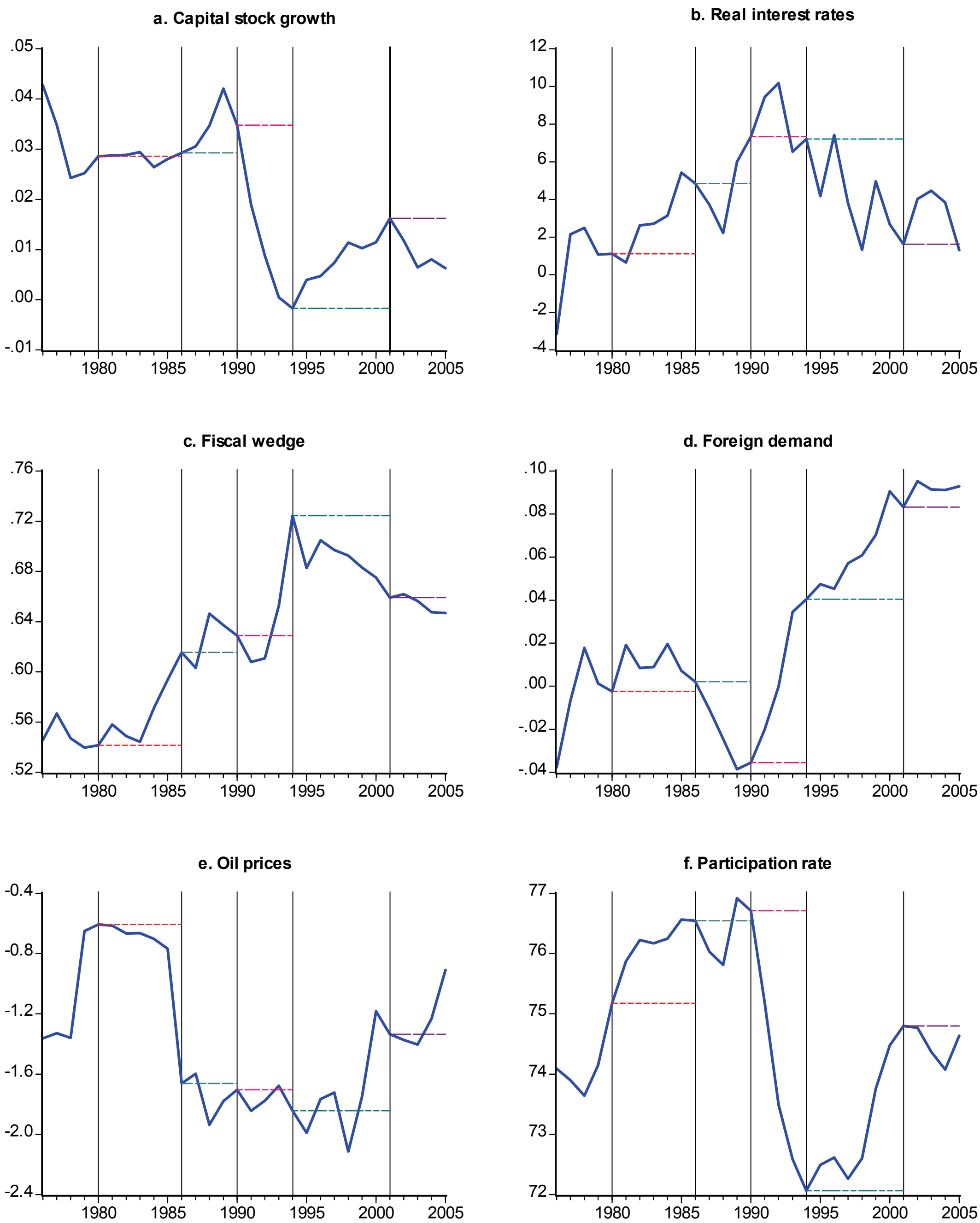

FIGURE A2 Actual and simulated values of the exogenous variables in Finland

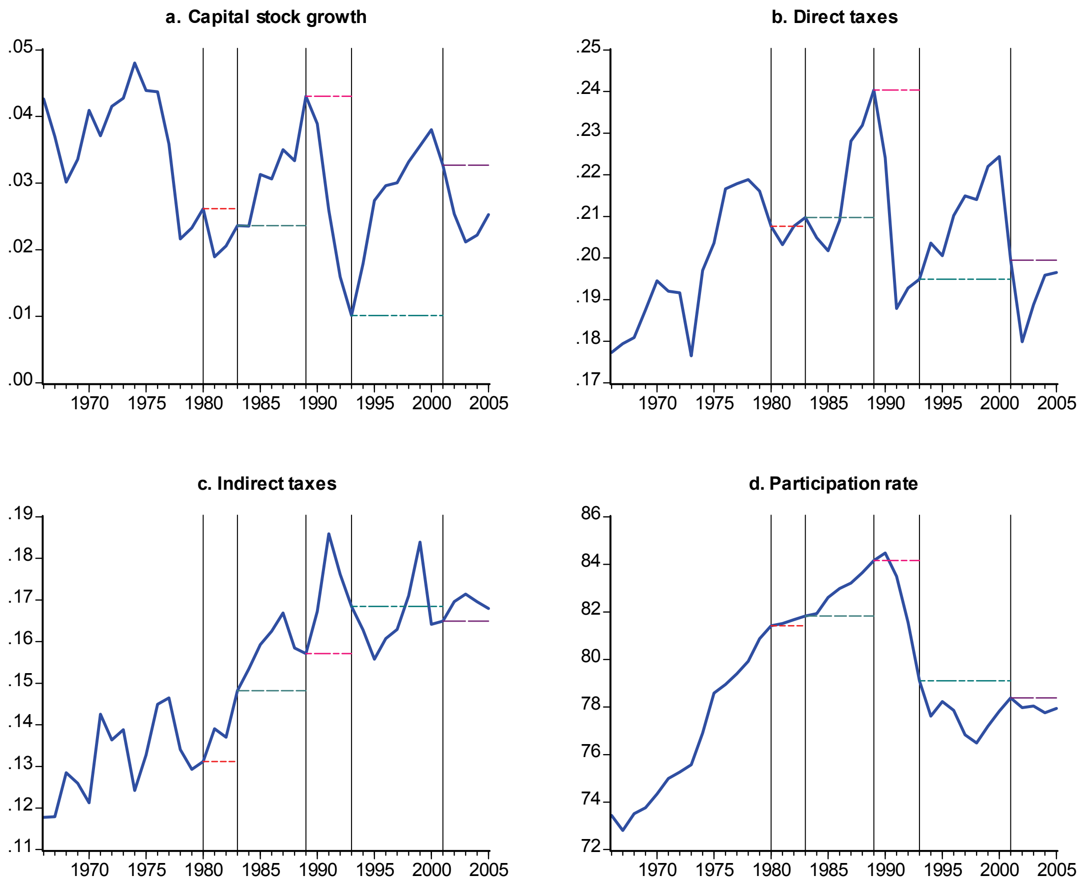

FIGURE A3 Actual and simulated values of the exogenous variables in Sweden