Stockholm School of Economics
Master's Thesis in International Economics and Business

Jobless Growth in Sweden?

- a Descriptive Study

Abstract

The buzzword of the 21st century concerning business cycles is the notion of jobless growth. Sweden has experienced growth in GDP without an accompanying increase in employment, causing politicians and other debaters to dub the recent recovery as jobless. The purpose of this thesis is to examine the relationship between employment and GDP and selected macroeconomic variables for Sweden and make a cross-country comparison. Two models are developed on the basis of Okun's law. The first model is used to investigate the effect of GDP, population, cost of labour and past employment on total employment. The second model consists of employment-to-population and GDP per capita. This model is used to investigate if employment elasticity has changed over time, to explore the statistical causal relationship between GDP and employment and to make a forecast to compare with actual outcome. The employment elasticity w.r.t. GDP is about 0.7 percent for Sweden and does not change much over time. The relationship between employment and GDP is found to be strongly positive and this, together with the relatively constant employment elasticity over time, suggests that the previous situation in Sweden is due to a temporary discrepancy and not a fundamental change in the relationship.

KEYWORDS: jobless growth, business cycle, Okun's law, employment, GDP.

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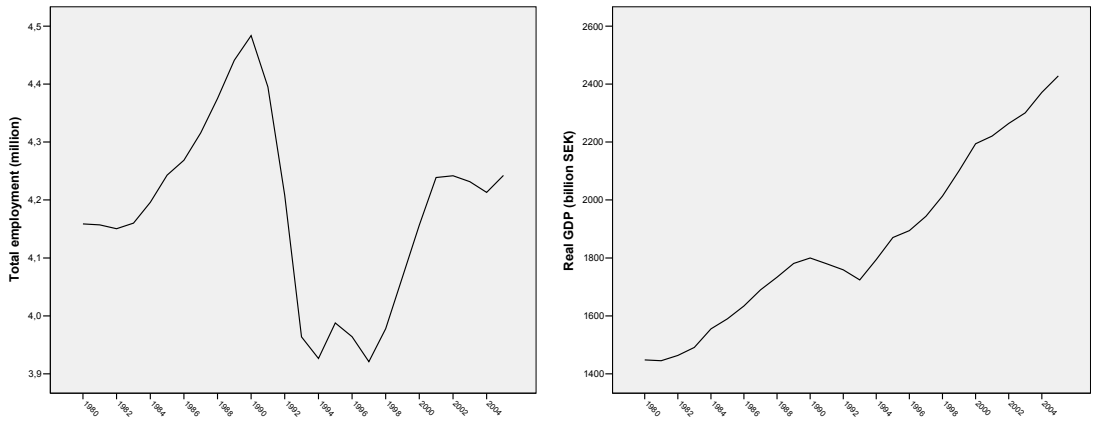
1 INTRODUCTION

After the economic downturn in the beginning of the 21st century, the Swedish economy has been in a state of recovery, with annual GDP growth of approximately 2 percent. In a typical recovery, the employment rate would be picking up as well as output, but this has not been the case. Concerns have been raised that Sweden may be experiencing jobless growth, a dilemma which is currently widely discussed.[1] The situation in Sweden has caused *Dagens Industri* (2006) to name Sweden world champion in jobless growth. However, little research has been done concerning the actual existence of this relatively new phenomenon of jobless growth, especially with focus on Sweden. Of the few international studies that have been performed, some advocate that it is just a lag and that employment soon will follow GDP. Others argue that there is a fundamental problem with the traditional relationship, suggesting a disconnection of GDP and employment over time. This thesis will describe how employment has been related to GDP during 1980-2004 and its sensitivity to population growth, growth in real labour cost and past employment growth, and thereafter try to assess whether Sweden is in fact experiencing jobless growth.

Figure 1-2. Total employment and GDP in Sweden 1980-2005.



Source: OECD Economic Outlook 2006.

[1] See for instance Moderaterna's Budgetmotion and Föreningssparbanken's conference 2006.

Previously, as output started to improve and the business cycle turned favourably, employment followed. When employment does not follow output in a recovery, the situation has been termed a jobless recovery[2]. Sweden and many other developed countries have suffered from lower and slower than normal increases in the employment rates during the most recent economic recoveries. Understanding the mechanisms behind the employment rate is a challenge and this thesis will examine its relationship with what has long been believed to be one of its main explaining factors; output growth.

The purpose of this thesis is to find the relationship between the level of employment and the variables GDP, cost of labour, population and previous employment level. The focus is on macroeconomic factors rather than micro level causes of a possible situation of jobless growth. The relationship will then be used to dissect the development of employment in Sweden 1980-2004. Furthermore, an international comparison of a sample of OECD countries will shed some light on if the Swedish situation is unique.

Several studies have looked at the relationship between economic growth and employment for specific countries and groups of countries. Okun's law suggests a relationship between output and unemployment and various versions of the Okun coefficient have been estimated. Studies have also been performed on the subject of jobless growth, both in general and with focus on specific countries. However, to our knowledge, no previous work has analysed the relationship between Swedish GDP and employment, with focus on 1980-2004, at an aggregate and purely descriptive level as this thesis. This is thus the contribution of this thesis.

Sweden is the focus of this thesis, although other countries are looked at as well. The analysis is done on a country, and not a sectoral, level. Furthermore, the data is from 1980 to 2004 at a yearly level. This particular time period is chosen because it is the period for which data could be found for most of the countries in the sample. The focal point is on the relationship between GDP and employment, which means that a number of possible explanatory variables are not included in the models.

[2] Or jobless growth, they are used as synonyms.

The rest of this thesis is organised as follows. The introduction is followed by a background section, where the developments of GDP and employment in Sweden and the OECD countries are presented. Additionally, previous research concerning the relationship between employment and growth is presented. In Section 3, business cycle theory and Okun's law are described. Theory covering employment elasticity as a measure is also studied. Next follow the regression models and analysis of the results in Section 4. In Section 5 the results are discussed before conclusions are reached in Section 6. References and appendices are found in Sections 7 and 8 respectively.

2 BACKGROUND

2.1 DEVELOPMENT OF GDP AND EMPLOYMENT IN SWEDEN

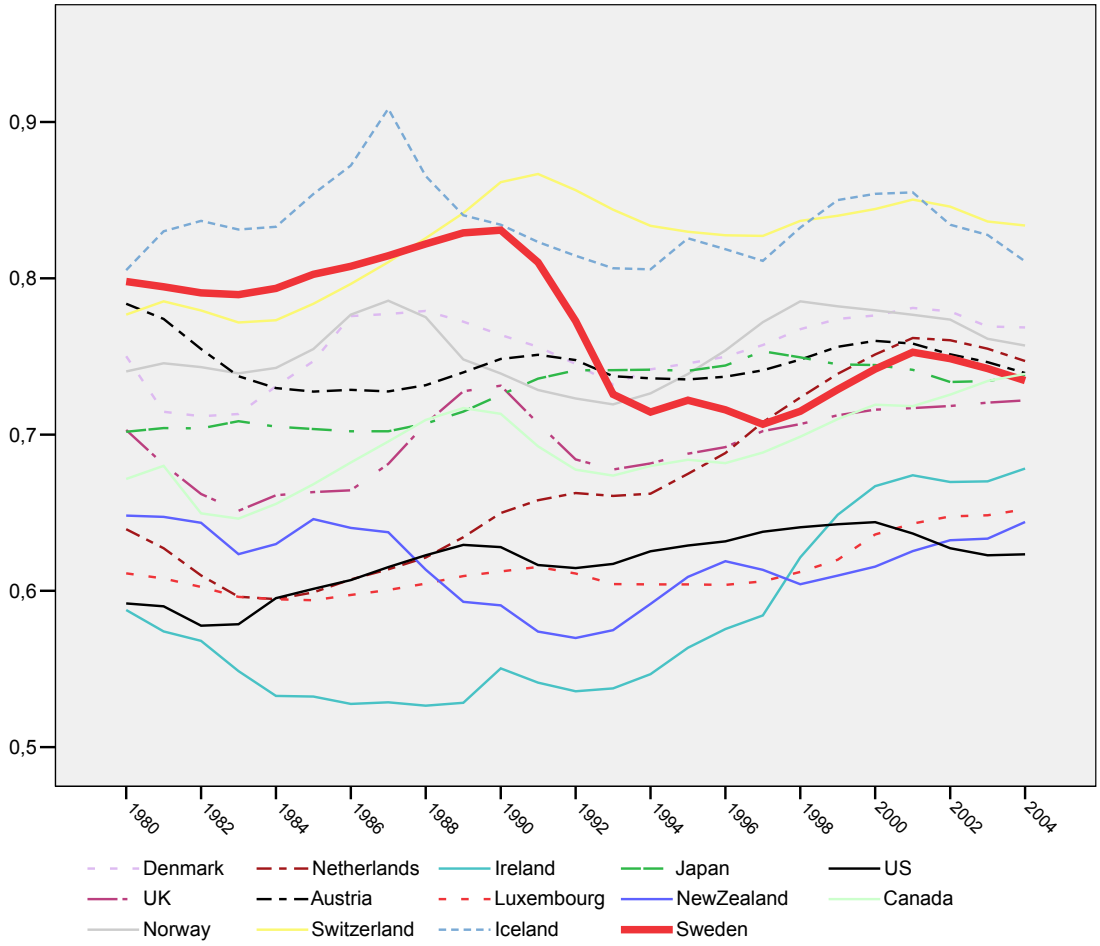
Real GDP growth has averaged 2.2 percent in the period 1991 to 2001. However since the year 2000, estimates of GDP indicate that economic activity in Sweden has increased. At the same time estimates of total employment have not improved, implying a situation of jobless growth.

In an international comparison, the Swedish labour market was performing very well throughout the 1970's and the 1980's. Starting in the early 1960's, the female participation rate increased sharply, from 54 percent in 1965 to 82 percent in 1989, and total employment increased together with this increase in participation (Holmlund 2003). During the slump of the early 1990's the picture changed dramatically with a fall in employment from 83 percent to 73 percent between 1990 and 1993. A rebound began in 1997 with a rise in GDP growth and employment. In 2001 the employment rate was 75 percent, but since then it has been falling each year, to 73 percent in 2005 (SCB 2006).

2.2 Recent Developments in OECD Countries[3]

Total employment in the OECD area has increased gradually throughout the time period 1980-2004, however with rather different trends in the individual countries. The development of employment-to-population for a sample of OECD countries can be found in *Figure 3* below.

Figure 3. Employment-to-population for a sample of OECD countries, 1980-2004.



Source: OECD Economic Outlook 2006.

The total OECD area has experienced an average real GDP growth of 2.7 percent in the period 1991 to 2001. In 2002, real GDP growth averaged 1.7 percent whereas in 2003 it averaged 2.2 percent. For the last few years, the world economy has been in a state of recovery. The global recovery is led by the US, closely followed by Australia, Japan, New

[3] The trends presented in this section are from OECD Employment Outlook 2004.

Zealand and the UK. However, the Netherlands, Portugal and Switzerland have experienced negative growth.

Despite the high GDP growth experienced by most of the countries in the OECD area, labour market conditions have been slow to improve. Over the period 1991-2001, employment growth averaged 0.9 percent and in 2002 it averaged 0.1 percent. Employment growth remained sluggish in 2003, averaging 0.3 percent, and half of the OECD countries even experienced negative employment growth. By contrast, Australia, Canada, Greece, New Zealand and Spain experienced employment growth of more than 2 percent.

Population growth has averaged 0.9 percent in the OECD area in 1991-2001. In 2001, the population growth averaged 0.7 whereas in 2002 it averaged 0.5 percent. The working-age population in the OECD grew much slower in the early 1990's than it had done previously. The number of young people aged 15-24 peaked during the 1980's and nowadays both the population and the labour force in nearly all OECD countries are aging, a trend that is accelerating.

2.3 PREVIOUS RESEARCH

Various previous studies have investigated the relationship between employment and growth. There are essentially two strands of literature concerning the relationship between employment and growth. The first strand consists of those who believe that employment and growth do not have to move together and thus that jobless growth can occur. Pianta et al (1996) looked at 36 manufacturing sectors for the G-7 countries 1980-92 and found that the relationship between growth and employment, although positive, was not significant. Their results are consistent with the findings of Piacentini and Pini (1998).

The second strand constitutes those who believe that there exists a strong positive relationship between growth and employment. Several studies have shown that growth does affect employment. Lee (2000), for instance, argues that growth affects employment, that the coefficients are considerably different across the countries under investigation and that the results are likely consequences of labour market rigidities. Padalino and Vivarelli (1997)

show empirically that aggregate economic growth contributes to employment. Prachowny (1993) derives Okun coefficients and, using empirical evidence from the US, supports the view that the Okun equation is a useful proxy in macroeconomics. Döpke (2001) concludes that there exists a close link between employment and growth and that the employment intensity of growth has been larger in the 1990's than previously. This is supported by the results of Padalino and Vivarelli, who find a stronger employment response to growth for most of the G-7 countries in the 1990's. Further, Döpke finds evidence that the link between employment and growth appears to be asymmetric and that the impact of growth on employment differs at various phases of the business cycle. The results of Cuaresma (2003) also support the existence of a regime-dependent Okun's parameter with a higher absolute value for recessions than for expansions.

Moosa (1997) argues that employment is more responsive to economic growth in the US and Canada than in Europe and Japan, and explains his finding in terms of institutional differences that determine the flexibility of the labour markets in the different countries. Baker and Schmitt (1999) estimate Okun coefficients for a sample of OECD countries and stress the importance of foreign growth as a determinant of domestic employment. Furthermore, they argue that the good empirical performance of Okun's law suggests that macroeconomic forces play a greater role in the evolvement of unemployment, as opposed to microeconomic factors, than previously believed.

3 THEORY

3.1 BUSINESS CYCLE THEORY

In the short-run, macroeconomic variables like employment and GDP deviate from their long-run trend paths. These fluctuations are what economists call business cycles. There are two main schools with different views on the potential source and propagation of these economic fluctuations; the classical and the Keynesian. Classical economists believe that markets work perfectly, and that periods of unemployment cannot persist because wages will fall in order to get rid of the excess supply. Keynesians on the other hand believe that wages are not changed very easily, especially not downwards. Thus, excess demand and supply may persist for a while as the markets are assumed to be failing in coordination.

The real business cycle theory is a version of the classical view and was developed by Kydland and Prescott (1982). This theory assumes that there are large random fluctuations in the rate of technological change and that individuals change their amounts of labour supply and spending in response to these. In line with this reasoning, business cycles are the efficient responses of economies to different shocks, and changes in output are movements of the natural level of output rather than from it. Newer Keynesian perspectives have also been developed, but there is still no consensus on the source of business cycles.

Recent studies have focused on issues such as if business cycles are symmetric or not and on their potential causes. Artis et al (1997) show that business cycles in general are asymmetric, with more rapid declines in output during contractions than rises in expansions. Further, they find that few business cycles are confined to a single country and that there are strong associations between the phases of the business cycles across countries, particularly in two groups; one being the European core group (Germany, France, Italy, Belgium, Netherlands and Ireland) and the other consisting of the US and Canada. They conclude by advising macroeconomists to keep in mind that the turning points of business cycles can be the result of external factors, rather than only domestic events. More recently, McKay and Reis (2006) instead argue that the previously found asymmetry of the fluctuations in output does not apply, but that there exists an asymmetry in the fluctuations of employment. The contractions

are found to be briefer and more violent than the expansions. The authors show that employment tends to peak after output, and reach a trough approximately at the same time as output, after a sharp fall.

There is one fact about business cycles that has held historically and on which there has been consensus. This fact is that when economies have been in the recovery phase of a business cycle with growing GDP, employment has grown at the same time, or soon thereafter. However, lately this fact concerning the relationship has been questioned and the concern of jobless growth has been raised. Andolfatto and MacDonald (2005) show that a jobless recovery following a recession is exactly what neoclassical theory predicts, as the new technology affects various sectors of the economy differently and as sectoral adjustments in the labour market take time.

3.2 OKUN'S COEFFICIENT

Okun's law is one of the basic rules of thumb in economics. The fundamental inverse relationship between the unemployment rate and the growth of real output has been accepted by economists for many years. In 1962, Arthur Okun formalised this relationship into a statistical one, measuring the extent to which the unemployment rate is negatively related to real output growth. Okun's original estimate for the output-unemployment elasticity, based on US data, was -3, meaning that for every percentage point increase in unemployment, the real growth of output fell by approximately three percent (Izyumov & Vahaly 2002). However, later research has shown that the relationship varies depending on the time period and the region under consideration. Lee (2000) estimated the Okun coefficient for most OECD countries between 1955 and 1996 and found the Okun coefficients for European countries to be higher in general than for the US. A suggested explanation of this result was the more inflexible labour-markets associated with high unemployment in Europe. Izyumov & Vahaly found the Okun coefficient to be the highest for countries such as Japan, with labour-markets characterised by long-term, life-time employment contracts.

Okun pointed out that changes in the unemployment rate *per se* cannot account for the change in real output as the unemployment rate changes, but that there are intermediary factors, such

as labour force participation and productivity, linking the unemployment rate and the real output in the specified relationship. In a seminal paper from 1970, Okun specifies the relationship in the following way:

$$\Delta U_t = -\left(\frac{1}{k}\right)\Delta \ln GDP_t$$

where U is unemployment and k is the so called Okun coefficient.[4]

Following Lee and Döpke, a version of the Okun relation in forms of trend deviations is estimated as:

$$(U - U^*)_t = \alpha + \beta(GDP - GDP^*)_t + u_t$$

where the asterisk denotes the trend component of the time series under investigation. To measure the deviations from the trend of both the variables the Hodrick-Prescott filter[5] is used. The estimated employment elasticities in this thesis build on a modified version of the Okun coefficient, where employment rather than unemployment is used.

3.3 EMPLOYMENT ELASTICITY

The measure of employment elasticity used throughout this thesis is a widely used indicator for analyzing labour market trends and for examining how growth in economic output and growth in employment evolve together over time. A high employment elasticity indicates that growth in GDP leads to considerable job creation while an estimate closer to zero suggests a low correlation between economic growth and employment, that is jobless growth. The definition of employment elasticity is the percentage change in the deviation from trend in the number of employed persons in a country associated with a one percentage change in the deviation from trend of GDP.

[4] This section builds on Döpke (2001).

[5] See appendix 8.1 for more details on the Hodrick-Prescott filter.

Examining changes in GDP together with employment elasticities gives an idea as to whether growth in a country is occurring hand in hand with gains in employment. However, there exist some shortcomings with the employment elasticity as a measure and Islam and Nazara (2000) discuss a few of these. Firstly, the issue of the two-way relationship between employment and output is problematic. In a production function, labour and other factors of production generate GDP, and an increase in the growth of labour will, *ceteris paribus*, lead to an increase in the growth of GDP. The employment elasticity however ignores the output-creating effect of using labour. It only deals with the demand side of the relationship between labour and GDP, where GDP represents aggregate demand. Secondly, the employment elasticity is valid for a given technological state. As technology changes a given percentage of GDP growth can become more or less employment intensive. Furthermore, aggregate employment elasticity is sensitive to the time period investigated as well as to the method of measurement.

4 REGRESSION MODELS AND ANALYSIS

In this section, the regression models are presented together with their results. Two separate models are developed in order to determine the relationship between a cyclical change in GDP and a cyclical change in employment on the basis of Okun's law. The first regression model uses total numbers for all variables, whereas the second uses employment-to-population and GDP per capita. The first regression model is also extended into a multivariable regression model in order to incorporate the potential impacts of population, cost of labour and lagged employment on total employment. The second model is used to see whether the employment elasticity for Sweden has changed over time and for this purpose a regression is performed where the time period is divided into two parts, from 1980 to 1993 and from 1994 to 2004. Additionally, a Granger causality test is performed to investigate the statistical causality between employment-to-population and GDP per capita for Sweden. A forecasting model is thereafter developed in order to discern whether the recent situation in Sweden is abnormal or not. The developments in employment-to-population in 2002-05, for Sweden, are predicted by using the period 1980-2001. Finally, a closer look is taken on a specific sample of OECD countries.

4.1 SETTINGS

The data in the regressions are on a yearly basis for the period 1980-2004, except when forecasting and in *Figures 1*, *2* and *4*, when the year 2005 also is included for Sweden.[6] All data is taken from OECD Economic Outlook (2006) and is described as follows:

- *EMPL* is total employment.
- *GDP* is the real Gross Domestic Product. Real GDP is the number reached by valuing all the productive activity within the country, which is used as an indicator of the volume of the nation's output. Henceforth real GDP will be denoted simply GDP.
- *POPN* is the working-age population (ages 15-64).
- *WAGE* is the real wage and is a proxy for cost of labour. Real wages are defined as the goods and services which can be purchased with wages or are provided as wages.[7]

The series are all detrended using the Hodrick-Prescott filter, which makes the series stationary. The trend is denoted with a *. For instance, the annual deviation from the trend of total employment for country *i* in year *t,* with logged variables, is denoted $(\ln EMPL - \ln EMPL^*)_{it}$.

The two statistical measures of employment that are used throughout this thesis are total employment and employment-to-population. Total employment is the number of people currently employed in a country. The employment-to-population ratio is a measure of the extent to which the population is engaged in productive labour market activity and is defined as the proportion of a country´s working-age population (age 15-64) that are employed.

[6] Due to limited data availability for the year 2005, this year is not included in the regression models.

[7] The definitions are taken from OECD glossary of statistical terms (2006).

4.2 MODEL 1

4.2.1 Simple Regression

Firstly, a simple regression is made of the deviation from trend of total employment to the deviation from trend of GDP in order to determine the elasticity of employment with respect to GDP.

The regression estimated for country *i* in year *t*:

$$(\ln EMPL - \ln EMPL^*)_{it} = \alpha_{it} + \beta(\ln GDP - \ln GDP^*)_{it} + \varepsilon_{it} \quad (1)$$

Table 1. Cyclical percentage increase in employment due to a cyclical increase in GDP of one percent for selected OECD countries 1980-2004.

	GDP	R^2		*GDP*	R^2
Australia	0.83	0.59	Japan	0.28	0.43
	(5.72)***			(4.19)***	
Austria	0.70	0.72	Luxembourg	0.25	0.54
	(7.70)***			(5.19)***	
Belgium	0.84	0.84	Netherlands	0.84	0.82
	(11.11)***			(10.37)***	
Canada	0.69	0.78	New Zealand	0.80	0.64
	(9.00)***			(6.36)***	
Denmark	0.88	0.60	Norway	0.74	0.53
	(5.92)***			(5.10)***	
Finland	0.84	0.82	Portugal	0.34	0.45
	(10.32)***			(4.36)***	
France	0.79	0.88	Spain	1.49	0.94
	(12.72)***			(19.36)***	
Germany	0.87	0.64	Sweden	0.97	0.67
	(4.59)***			(6.82)***	
Iceland	0.51	0.53	Switzerland	0.68	0.63
	(5.09)***			(6.25)***	
Ireland	0.64	0.75	United Kingdom	0.99	0.64
	(8.24)***			(6.45)***	
Italy	0.56	0.26	United States	0.63	0.85
	(2.88)***			(11.50)***	

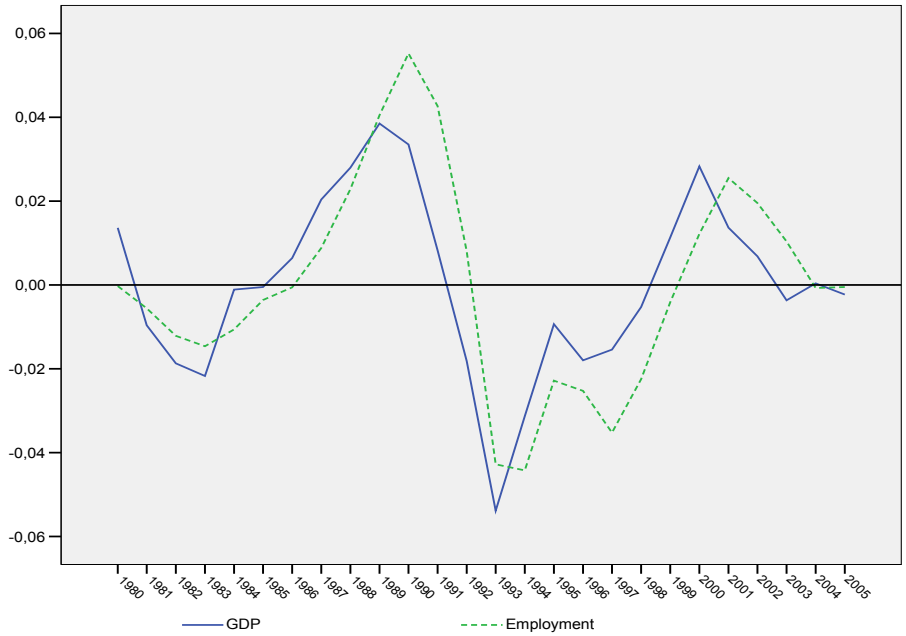
In brackets: t-values. *** denotes significance at the 1, 5, 10 percent level respectively. For Germany, the data is from 1990-2004.

The elasticities are predominantly in the range of 0.5-1.0, with a Swedish employment elasticity of 0.97. The coefficients are significant and the explanatory powers are, for most of the countries, quite high. The first conclusion that can be drawn from this regression is that employment has been more responsive to economic growth in Sweden than in most of the

included countries during this time period, since only Spain and the UK have higher estimated employment elasticities. For Sweden, a one percent increase in the deviation from trend of GDP should come hand in hand with a 0.97 percentage increase in the deviation from trend of total employment on average. This clearly suggests that GDP and employment are closely related and that a positive increase in the deviation from trend of GDP should be followed by an increase in total employment.

As can be seen in *Figure 4*, cyclical employment did not increase when GDP started to increase in around the year 2003. This lag can be noted already in the beginning of the recession, when cyclical employment started to decrease approximately a year after cyclical GDP started to fall. The significant and positive relationship between GDP and employment found above seems to support the strand of theory suggesting that the relationship between GDP and employment is normal and that the recent development just is a temporary deviation and that employment soon will pick up. It can actually be seen in the figure that employment reversed the negative path in 2005 and that both employment and GDP are growing with approximately their natural trends.

Figure 4. Percentage deviations from trend in Swedish GDP and total employment 1980-2005.



4.2.2 Multivariable Regression

In this section, a multivariable regression model is used to study whether the inclusion of other macroeconomic variables affects the strong relationship between GDP and employment that was found in the simple regression. The Okun equations have been criticised for neglecting important explanatory variables. Factor cost is one example of such a neglected variable and is believed to differ quite substantially between some countries. Thus, when making comparisons between countries, it is believed to be appropriate to include a variable for labour cost. Wages are used as a proxy for real labour cost and the β_3 coefficient in regression equation (2) is thus an estimation of the employment elasticity with respect to real labour cost.

Due to that strong positive autocorrelation is present between GDP and employment for Sweden (see appendix 8.2), a one-year lagged employment variable is included in the regression. Furthermore, it is likely that the level of past employment will have an effect on the level of today's employment. Sweden had a strong growth in total employment in the 1980's and it is reasonable that this will be a factor when explaining subsequent growth in employment. Furthermore, population growth affects total employment growth and is therefore included as an explanatory variable.

Multivariable regression equation estimated for country *i* in year *t*:

$$(\ln EMPL - \ln EMPL^*)_{it} = \alpha_{it} + \beta_1(\ln GDP - \ln GDP^*)_{it} + \beta_2(\ln POPN - \ln POPN^*)_{it} + \beta_3(\ln WAGE - \ln WAGE^*)_{it} + \beta_4(\ln EMPL - \ln EMPL^*)_{it-1} + \varepsilon_{it} \quad (2)$$

Table 2. Cyclical increase in employment in percentage due to a cyclical increase in GDP, population, wages and lagged employment of one percent for selected OECD countries 1980-2004.

	GDP	*POPN*	*WAGE*	*LAGEMPL*	R^2
Australia	0.62	0.19	0.18	0.33	0.86
	(5.75)***	(0.21)	(1.45)	(2.64)**	
Austria	0.36	-0.65	0.07	0.46	0.87
	(3.36)***	(-2.89)***	(1.00)	(3.32)***	
Belgium	0.60	0.19	-0.10	0.40	0.90
	(6.78)***	(0.45)	(-2.22)**	(3.94)***	
Canada	0.61	-0.48	-0.13	0.56	0.93
	(6.61)***	(-0.43)	(-1.38)	(4.31)***	
Denmark	0.65	-2.08	0.20	0.34	0.92
	(7.19)***	(-1.60)	(3.11)***	(4.38)***	
Finland	0.47	1.03	0.23	0.20	0.96
	(5.27)***	(1.54)	(2.03)*	(1.57)	
France	0.69	0.06	0.00	0.17	0.89
	(7.27)***	(0.14)	(0.05)	(1.49)	
Germany	0.72	-0.34	-0.06	0.32	0.85
	(4.12)***	(-0.45)	(-0.46)	(1.79)	
Ireland	0.50	0.03	0.16	0.09	0.80
	(4.48)**	(0.08)	(1.28)	(0.52)	
Italy	0.43	-0.04	0.20	0.54	0.86
	(4.08)***	(-0.09)	(2.41)**	(4.21)***	
Japan	0.14	-0.07	0.19	0.21	0.92
	(3.21)***	(-0.31)	(3.61)***	(1.46)	
Luxembourg	0.21	2.11	-0.14	0.52	0.92
	(6.81)***	(4.39)***	(-2.51)**	(5.12)***	
Netherlands	0.65	0.50	0.01	0.41	0.93
	(9.86)***	(0.99)	(0.16)	(4.20)***	
Norway	0.43	-1.16	0.27	0.34	0.96
	(5.90)***	(-1.36)	(3.25)***	(3.12)***	
Portugal	0.70	0.72	-0.27	0.60	0.96
	(2.85)**	(0.49)	(-1.28)	(5.14)***	
Spain	1.36	0.45	-0.04	0.15	0.95
	(10.53)***	(1.40)	(-0.43)	(1.68)	
Sweden	0.75	1.08	0.10	0.45	0.97
	(8.49)***	(2.07)*	(1.52)	(6.12)***	
Switzerland	0.53	0.14	0.02	0.54	0.95
	(4.67)***	(0.26)	(0.20)	(3.15)***	
UK	0.79	0.02	0.02	0.52	0.93
	(9.10)***	(0.05)	(0.23)	(4.16)***	
USA	0.56	0.20	-0.02	0.29	0.92
	(7.40)***	(0.65)	(-0.28)	(3.44)***	

In brackets: t-values. ***, **, * denotes significance at the 1, 5, 10 percent level respectively. The data for Germany is for 1991-2004, Luxembourg for 1985-2004, Switzerland for 1990-2004 and Portugal for 1995-2004. Iceland and New Zealand are excluded due to that data is lacking.

The GDP coefficients are naturally smaller than those found in the simple regression but they are still highly significant. Obviously, the exclusion of the other variables in the simple regression did cause a positive bias of the estimated elasticity. The GDP coefficients are now mostly found in the range of 0.3-0.8. Sweden has a GDP coefficient of 0.75, which means that a one percentage increase in the deviation from trend of GDP is followed by an increase in the

deviation from trend of employment by 0.75 percent on average, given that the other variables are held constant. Concerning the other variables, only lagged employment of 0.45 percent is found to be significant at the one percent level for Sweden. The regression suggests that a one percentage increase in past employment from trend should affect today's deviation from trend of employment by 0.45 percent, ceteris paribus. Similar to the results in Seyfried (2005), the multivariable model incorporating lagged employment suggests that past employment growth itself can play an important part in explaining employment growth. For instance, periods of poor employment growth may be followed by further periods of poor employment growth. Hence, it could be natural for employment growth to lag behind economic growth in the beginning of a recovery. This may help explain the sluggish employment growth of recent recoveries to some extent.

Looking at the results for the other countries, for most of them, neither the population nor the wage coefficients are significant. However, the lagged employment coefficient is significant at the one percent level for a majority of the countries. It is also quite influential since the range of the coefficients is from 0.29 for the US to 0.60 for Portugal. This suggests that it is in fact GDP and past employment that are the two main explaining factors of employment of the ones included. Persistence in employment growth generally seems to be important, suggesting that GDP has to increase for a while before employment picks up. Again, the high Swedish employment elasticity of 0.75 together with the significant variable of lagged employment suggests that it is in fact only a transitory lag that Sweden was experiencing in the last recovery.

4.3 MODEL 2

The second regression model consists of the variables employment-to-population, lagged employment-to-population and GDP per capita and is developed in order to investigate whether the results support or differ from the results from model 1. The variable of lagged employment-to-population is included since lagged employment was the only other variable that, except for GDP, was highly significant for most of the countries above. Employment-to-population and GDP per capita are commonly used variables in this field of study and is therefore from now on used for comparative reasons.

The following model is estimated for country *i* in year *t*:

$$\left(\ln\frac{EMPL}{POPN}-\ln\frac{EMPL}{POPN}^{*}\right)_{it}=\alpha_{it}+\beta_1\left(\ln\frac{GDP}{POPN}-\ln\frac{GDP}{POPN}^{*}\right)_{it}+\beta_2\left(\ln\frac{EMPL}{POPN}-\ln\frac{EMPL}{POPN}^{*}\right)_{it-1}+\varepsilon_{it} \quad (3)$$

Table 3. Cyclical increase in employment-to-population in percentage due to a cyclical increase in GDP per capita of one percent for selected OECD countries 1980-2004.

	$\frac{GDP}{POPN}$	$\frac{LAGEMPL}{POPN}$	R^2		$\frac{GDP}{POPN}$	$\frac{LAGEMPL}{POPN}$	R^2
Australia	0.66	0.51	0.80	Japan	0.25	0.75	0.85
	(6.75)***	(5.33)***			(6.71)***	(9.02)***	
Austria	0.58	0.34	0.85	Luxembourg	0.17	0.55	0.84
	(5.87)***	(3.27)***			(5.27)***	(5.86)***	
Belgium	0.66	0.25	0.89	Netherlands	0.64	0.38	0.92
	(7.70)***	(2.89)***			(9.74)***	(5.73)***	
Canada	0.57	0.39	0.93	New Zealand	0.57	0.42	0.70
	(11.01)***	(6.09)***			(4.08)***	(3.07)***	
Denmark	0.74	0.51	0.86	Norway	0.56	0.64	0.93
	(8.13)***	(6.63)***			(9.52)***	(10.56)***	
Finland	0.62	0.43	0.96	Portugal	0.31	0.47	0.75
	(12.66)***	(8.00)***			(5.18)***	(4.16)***	
France	0.68	0.19	0.90	Spain	1.28	0.17	0.93
	(8.64)***	(2.06)*			(10.01)***	(2.11)**	
Germany	0.71	0.31	0.83	Sweden	0.71	0.56	0.96
	(4.78)***	(2.58)**			(13.24)***	(12.02)***	
Iceland	0.41	0.24	0.58	Switzerland	0.49	0.55	0.95
	(3.22)***	(1.29)			(10.85)***	(10.02)***	
Ireland	0.55	0.16	0.78	UK	0.81	0.54	0.92
	(5.73)***	(1.17)			(10.42)***	(9.44)***	
Italy	0.45	0.71	0.81	USA	0.54	0.28	0.92
	(4.40)***	(7.33)***			(11.84)***	(4.34)***	

In brackets: t-values. ***, **, * denotes significance at the 1, 5, 10 percent level respectively. For Germany, the data is for 1990-2004.

As can be seen, the coefficients are very similar to those obtained in the multivariable regression of model 1. The coefficients are, for the most part, statistically significant at the one percent level and the regressions have high explanatory powers as can be seen by the high R^2. The elasticity of employment for Sweden is estimated to be 0.71 and in the previous multivariable model it was found to be 0.75. Therefore it can be concluded that the Swedish employment elasticity is about 0.7. This is quite high compared to the other countries in the sample and suggests that the correlation between GDP and employment should be even higher for Sweden than for the rest of the countries. It can be seen in *Figure 4* that there is a close correlation between employment and GDP in the years 1980-2002, but that employment indeed failed to increase when GDP started to increase in 2003. In 2005, however, it can be seen that employment reversed its negative path and turned upwards.

4.3.1 Evolvement of Employment Elasticity

The employment elasticity was found to be about 0.7 for Sweden in the period 1980-2004. This is higher than for most of the countries in the sample and it is interesting to investigate whether this is a recent development or whether the employment elasticities have been roughly the same during the sample period. Therefore two regressions are performed where the employment elasticities during two time periods of 1980-93 and 1994-2004 are estimated using equation (3). This specific partitioning of the time periods is chosen due to that 1993 is the year when the recovery after the recession in the early 1990's started.

Table 4. Results from regression (3) when divided into two time periods.

Country	1980-93	$\frac{GDP}{POPN}$	$\frac{LAGEMPL}{POPN}$	R^2	1994-2004	$\frac{GDP}{POPN}$	$\frac{LAGEMPL}{POPN}$	R^2
Australia		0.75	0.58	0.93		-0.03	0.26	0.21
		(8.38)***	(6.45)***			(-0.14)	(1.45)	
Austria		0.63	0.29	0.82		0.53	0.44	0.92
		(3.43)***	(1.71)			(5.99)***	(3.47)***	
Belgium		0.69	0.17	0.93		0.69	0.41	0.86
		(6.55)***	(1.59)			(4.38)***	(2.65)**	
Canada		0.63	0.40	0.97		0.27	0.47	0.83
		(12.14)***	(6.15)***			(2.50)**	(2.91)**	
Denmark		0.86	0.49	0.89		0.43	0.54	0.90
		(6.60)***	(4.65)***			(3.81)***	(5.67)***	
Finland		0.63	0.45	0.96		0.53	0.47	0.95
		(10.88)***	(4.99)***			(3.39)***	(4.01)***	
France		0.66	0.05	0.90		0.80	0.28	0.97
		(6.15)***	(0.39)			(9.58)***	(3.31)**	
Iceland		0.48	0.11	0.64		0.27	0.42	0.49
		(2.84)**	(0.44)			(1.20)	(1.44)	
Ireland		0.46	0.18	0.74		0.71	0.01	0.83
		(4.26)***	(1.06)			(3.68)***	(0.03)	
Italy		0.50	0.44	0.79		0.53	0.96	0.90
		(4.22)***	(2.81)**			(2.91)**	(7.71)***	
Japan		0.21	0.81	0.90		0.42	0.64	0.87
		(5.13)***	(8.19)***			(6.01)***	(5.23)***	
Luxembourg		0.21	0.22	0.85		0.21	0.78	0.94
		(4.07)***	(1.22)			(6.55)***	(9.01)***	
Netherlands		0.68	0.39	0.93		0.63	0.32	0.91
		(6.99)***	(5.36)***			(5.76)***	(1.99)*	
New Zealand		0.51	0.45	0.72		0.90	0.39	0.64
		(2.58)**	(2.10)*			(3.02)**	(2.56)**	
Norway		0.61	0.72	0.94		0.56	0.52	0.97
		(7.02)***	(8.02)***			(9.18)***	(9.10)***	
Portugal		0.29	0.40	0.69		0.37	0.58	0.92
		(3.17)***	(2.18)*			(6.37)***	(5.71)***	
Spain		1.49	0.00	0.97		0.88	0.45	0.92
		(12.80)***	(0.04)			(3.72)***	(3.03)**	
Sweden		0.72	0.58	0.97		0.70	0.54	0.95
		(11.48)***	(8.00)***			(5.39)***	(5.99)***	
Switzerland		0.52	0.57	0.96		0.43	0.41	0.92
		(8.55)***	(8.14)***			(6.82)***	(3.94)***	
UK		0.84	0.56	0.93		0.30	0.63	0.91
		(8.03)***	(6.98)***			(1.65)	(5.69)***	
USA		0.56	0.31	0.96		0.45	0.26	0.86
		(12.04)***	(4.64)***			(4.23)***	(1.63)	

In brackets: t-values. ***, **, * denotes significance at the 1, 5, 10 percent level respectively. Germany is excluded due to that data is missing.

It can be seen that the second time period still shows a strong and positive correlation between the deviation from trend of GDP per capita and the deviation from trend of employment-to-population. For Sweden, the relationship has only decreased marginally, from 0.72 percent to 0.70 percent, and this supports the conclusion that changes in GDP per capita

still come very much hand in hand with changes in employment-to-population. The suggestion that the lagging responsiveness of employment to GDP growth has been more pronounced in the last couple of years is not disputed by the results but rather supports them since the relationship has weakened to some extent. Looking at the coefficient of GDP per capita for the rest of the sample shows that the majority has experienced a weakened relationship (11 out of 17). Thus Sweden follows the trend in that GDP per capita has a somewhat smaller impact on employment-to-population than previously has been the case. However, when looking at the coefficient of lagged employment, Sweden has experienced a weakened relationship whereas the majority of the other countries have seen a strengthening of the relationship (11 out of 17). Consequently, Sweden has not followed the general trend in the sense that for the majority of the countries, previous employment-to-population has become more important in affecting today's employment-to-population. An interesting result is the fact that Iceland and the UK, where the GDP per capita in the first time period was highly significant, have lost all significance of this variable. In Iceland this change can possibly to some extent be explained by the greater influence from the lagged employment-variable, but very little so in the UK.

4.3.2 Granger causality

The question of causality is central when examining the relationship between GDP and employment. In order to investigate if changes from the trend in GDP per capita happen before changes from the trend in employment-to-population and therefore can be used for prediction, a Granger causality test is performed. According to Granger, GDP per capita causes employment-to-population if the past values of GDP per capita can be used to predict employment-to-population more accurately than simply using the past values of employment-to-population. If that is the case, then GDP per capita is said to "Granger-cause" employment-to-population. The Granger causality test will now be performed on Swedish data.

Firstly, the number of lags to be included in the Granger causality test needs to be determined and this is done by using the Akaike Information Criteria (AIC) (see Appendix 8.3). It was found that the number of lags that should be included is four for GDP per capita and two for employment-to-population. The following equations are used when testing for Granger causality:

Restricted equation:

$$\left(\ln\frac{EMPL}{POPN}-\ln\frac{EMPL}{POPN}^{*}\right)_t=\beta_1\left(\ln\frac{EMPL}{POPN}-\ln\frac{EMPL}{POPN}^{*}\right)_{t-1}+\beta_2\left(\ln\frac{EMPL}{POPN}-\ln\frac{EMPL}{POPN}^{*}\right)_{t-2}+u_t$$

Unrestricted equation:

$$\left(\ln\frac{EMPL}{POPN}-\ln\frac{EMPL}{POPN}^{*}\right)_t=\beta_1\left(\ln\frac{EMPL}{POPN}-\ln\frac{EMPL}{POPN}^{*}\right)_{t-1}+\beta_2\left(\ln\frac{EMPL}{POPN}-\ln\frac{EMPL}{POPN}^{*}\right)_{t-2}+$$
$$\beta_3\left(\ln\frac{GDP}{POPN}-\ln\frac{GDP}{POPN}^{*}\right)_{t-1}+\beta_4\left(\ln\frac{GDP}{POPN}-\ln\frac{GDP}{POPN}^{*}\right)_{t-2}+\beta_5\left(\ln\frac{GDP}{POPN}-\ln\frac{GDP}{POPN}^{*}\right)_{t-3}+$$
$$\beta_6\left(\ln\frac{GDP}{POPN}-\ln\frac{GDP}{POPN}^{*}\right)_{t-4}+u_t$$

The hypothesis tested:

H_0 = lagged GDP per capita variables do not belong in the regression.

H_1 = lagged GDP per capita variables do belong in the regression.

The F-test is used to test for Granger causality:

$$F=\frac{(RSS_R-RSS_{UR})/m}{RSS_{UR}/(n-k)}$$

If the computed F value exceeds the critical F value at the chosen level of significance, the null hypothesis can be rejected and it can be concluded that GDP per capita Granger-causes employment-to-population. The critical value is 3.5219 at the five percent level for *m*=2 and *n-k*=19 df. $F_{crit} < F_{obs} = 7.7951$ and therefore the null hypothesis can be rejected and GDP per capita thus Granger-causes employment-to-population.

The Granger causality test is used in a similar fashion as above to test whether employment-to-population Granger-causes GDP per capita. In that case, $F_{crit} = 3.5219 > F_{obs} = 2.3330$ with *m*=4 and *n-k*=19 and the null hypothesis that the lagged variable of employment-to-population does not belong in the regression cannot be rejected. Employment-to-population can therefore not be said to Granger-cause GDP per capita.

Table 5. F-test whether GDP per capita Granger-causes employment-to-population and vice versa.

	RSS_R	RSS_{UR}	m	$n-k$	F
GDP → EMPL	0.00193723	0.00106410	2	19	7.795112
EMPL → GDP	0.00325705	0.00218423	4	19	2.333023

Forecasting employment-to-population using GDP per capita can therefore be done and it can be concluded that, for Sweden, changes from the trend in GDP per capita happen before changes from the trend in employment-to-population.

4.3.3 Forecasting

The Granger causality test showed that GDP per capita can be used to forecast employment-to-population. In order to determine whether the situation in Sweden in 2002-05 has been abnormal in an international perspective, a projection of the employment-to-population ratio can therefore be done using GDP per capita. The deviation from the trend for the employment-to-population ratio is, for Sweden, forecasted for the years 2002-05 on the basis of the sample data from 1980-2001. For the sample of OECD countries, the forecasting is done for 2002-04 in the basis of data from 1980-2001. The following equation for individual prediction is used:

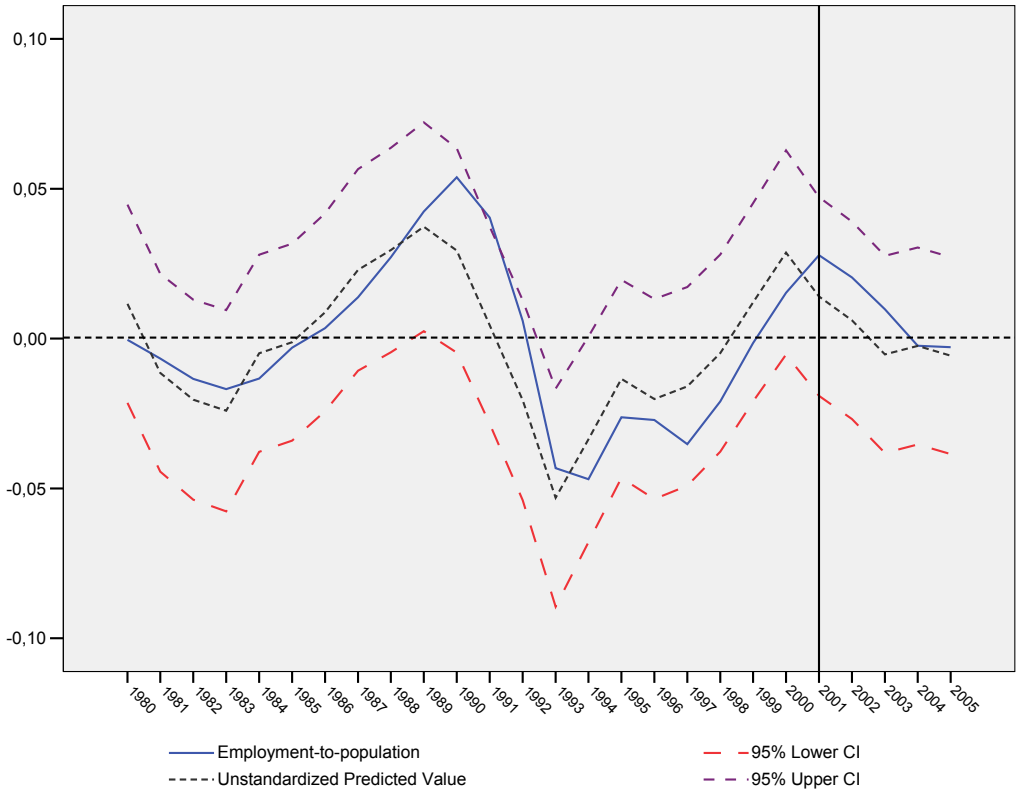
$$\left(\ln\frac{EMPL}{POPN}-\ln\frac{EMPL}{POPN}^{*}\right)_t=\hat{\beta}_1+\hat{\beta}_2\left(\ln\frac{GDP}{POPN}-\ln\frac{GDP}{POPN}^{*}\right)_t$$

On the basis of the sample data, the following sample regression for Sweden was obtained:

$$\left(\ln\frac{EMPL}{POPN}-\ln\frac{EMPL}{POPN}^{*}\right)_t=-0.002+0.937\left(\ln\frac{GDP}{POPN}-\ln\frac{GDP}{POPN}^{*}\right)_t$$

To get the predicted values of the employment-to-population ratio the model is applied to GDP per capita data for the years 2002-05.

Figure 5. Forecasting of Sweden's employment rate 2002-05 using data 1980-2001.



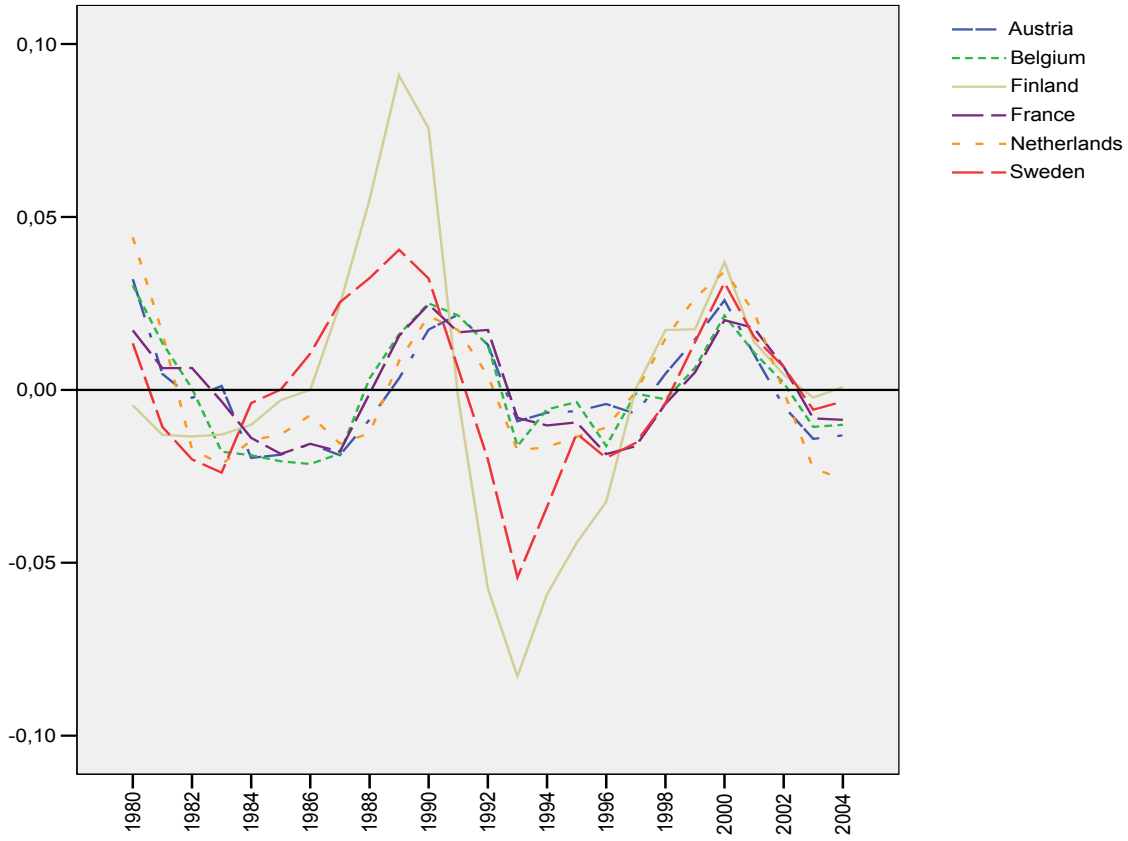
As can be seen in *Figure 5*, Sweden's employment rate is following the same path as the predicted employment rate, although with a lag of about a year. Furthermore, the actual outcome is within the confidence interval and thus any difference between the employment rate and the predicted value can be seen as a statistically normal fluctuation. This supports the notion that the previous situation in Sweden of growth in GDP without a subsequent increase in employment is normal. It should though be kept in mind that the Hodrick-Prescott filter has been criticised for that it is not as good in estimating the trend in the end periods as when looking at historical trends (Kaiser & Maravall 1999). The results should thus not be interpreted too strictly.

Looking at the forecasting figures of the other countries in the sample, the situation is roughly the same for Austria, Belgium, France, Finland and the Netherlands (see Appendix 8.3). That is the actual employment rate lags behind the predicted employment rate for the most part, at least in the last 10 years, and is following roughly the same cycle as Sweden. A closer look is therefore taken on these countries.

4.3.4 A Closer Look at a Sample of Countries

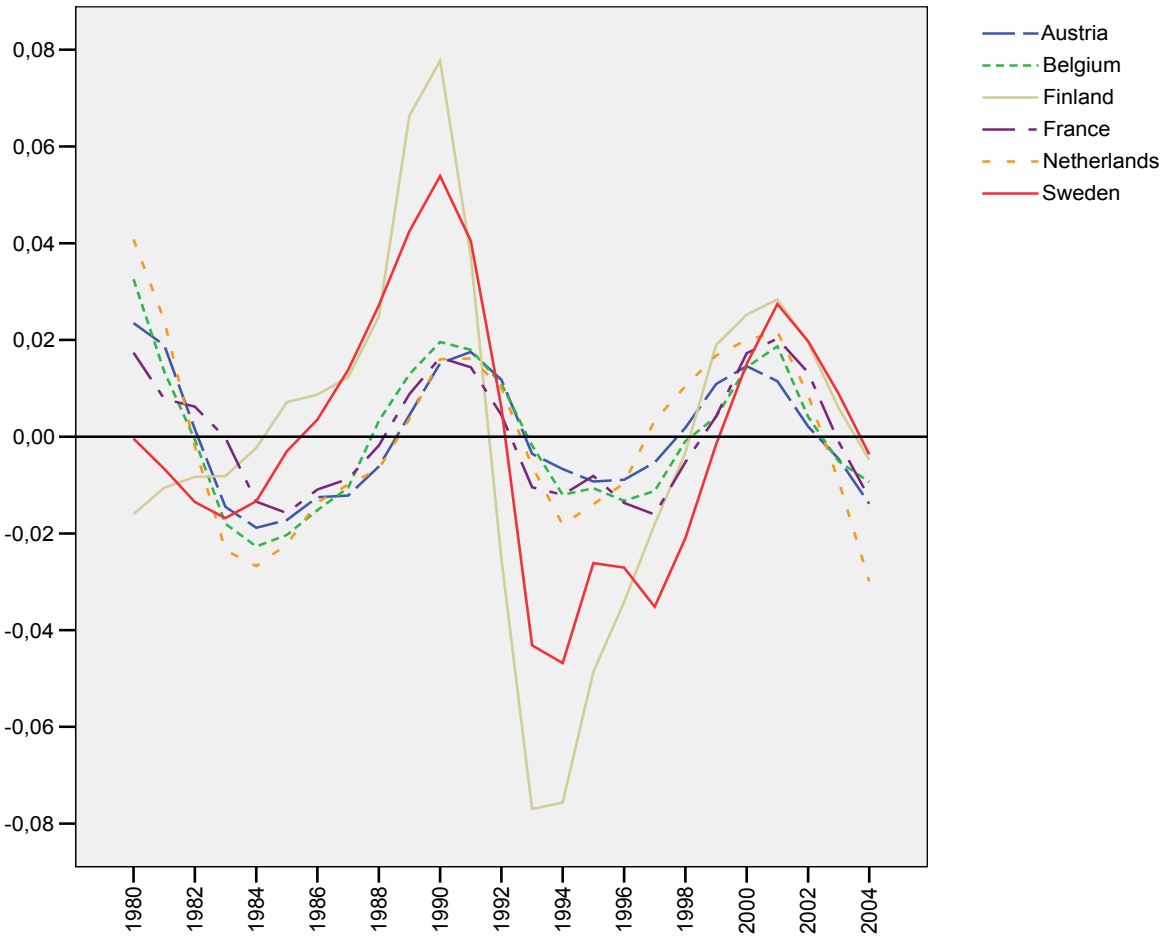
Looking at the results of regression model 2 for Austria, Belgium, Finland, France and the Netherlands it is apparent that the employment elasticities are around 0.65. This is quite high and means that the correlation is high between GDP per capita and employment-to-population. To determine whether GDP has developed roughly the same for the sample of countries, GDP per capita is plotted against time in *Figure 6*. It is evident that they follow more or less the same business cycle. For 2002 and onwards, the countries are reversing the negative trend paths for their GDP per capita, except the Netherlands.

Figure 6. GDP per capita 1980-2004 for a sample of countries.



Looking instead at employment-to-population over time in *Figure 7*, the deviations from trend are again quite similar to Sweden. They are all below the trend and continuing the negative path since a few years back. This suggests that Sweden's situation is rather similar to at least these countries in Europe.

Figure 7. Employment-to-population 1980-2004 for a sample of countries.



It can be discussed why these countries show a similar pattern as Sweden and a suggestion for further research could be to look in detail into the economic conditions of the countries. For the scope of this thesis it is enough to conclude that the Swedish situation of economic growth and slow unemployment recovery should not be treated as a unique case and preferably not be studied in isolation.

5 DISCUSSION

The results of the regressions are rather intuitive and not extreme in any sense. However a few things must be kept in mind when interpreting the results. Firstly, the regression models may overestimate the employment elasticities due to omitted variable bias. It is possible that the inclusion of variables such as exchange rates and labour productivity could have explanatory power. However, the purpose of this thesis is not to obtain an exact estimate of employment elasticity but instead to investigate the relationship between GDP and employment. Secondly, the regression results are sensitive to the time period used. Furthermore the notion of jobless growth was first heard of in the beginning of the 1990's and it is the interest of this study to investigate the validity of this claim and looking at data from more than 25 years back will not add anything to this study.

Interesting to note is that the employment elasticities estimated in the regression models vary quite markedly between countries. One suggested explanation to the varying employment elasticities could be the differing labour market institutions. The results from regression equation (3) as found in *Table 3*, show that Portugal has an employment elasticity w.r.t. GDP per capita of 0.31 whereas Spain has an elasticity of 1.28. These are neighboring countries and the big difference is quite puzzling. It can though be noted that the explanatory power of the model is much lower for Portugal ($R^2 = 0.75$) than for Spain ($R^2 = 0.93$). There might be a variable with more impact on the development of employment in Portugal than in Spain, which has not been included in this regression.

When it was investigated whether the employment elasticity in different countries has changed over time, it was found that the majority of the countries, including Sweden, have experienced a somewhat weakened relationship. One possible explanation could be that the globalization process has meant that the employment elasticities are more sensitive to international factors than before and less so to the domestic changes in GDP.

An issue that is problematic regarding the relationship between GDP and employment is the question of causality, since the causality may run from GDP to employment, from employment to GDP, or in both directions. The related literature on the topic is not extensive and the issue remains unsolved in this thesis. A Granger causality test was, however, performed in order to test for statistical causality. The test showed that GDP per capita Granger-causes employment-to-population but not the other way around. From this it cannot be concluded that GDP growth in fact causes employment growth, but only that increases in GDP happen before increases in employment.

The forecast of the Swedish employment rate for the year 2001-05, using data from 1980-2000, showed that the actual employment rate continuously lagged behind the predicted employment rate by about a year. This suggests that what Sweden was experiencing of GDP growth and no employment growth could be due to a lag and in any case that the situation has not been abnormal. Looking at a sample of other countries showed a similar, if not as pronounced, lag. Furthermore, their developments of GDP and employment have been roughly alike to Sweden's. This suggests that the countries are following more or less the same business cycle and an analysis of Sweden's developments should preferably not be done in isolation.

6 CONCLUSION

Sweden has experienced a jobless recovery in the sense that even though GDP per capita has reversed its negative path, employment-to-population has failed to follow. The results presented in this thesis suggest a temporary lag, rather than a fundamental change in the relationship between GDP per capita and employment-to-population. The regression results show that Sweden has an employment elasticity with respect to GDP per capita of approximately 0.7 percent during 1980-2004. This indicates a fairly strong positive relationship between GDP growth and employment growth. From the multivariable regression, it was concluded that the recent situation in Sweden cannot be explained by a change from the trend in population or cost of labour. It is only GDP and lagged employment that have statistically significant effects on Swedish employment. It has also been shown that the employment elasticities with respect to GDP per capita and previous employment have not changed much in Sweden from 1980-93 to 1994-2004. For the majority of the countries in the sample, the relationship between GDP per capita and employment-to-population was found to be weaker in the second time period. Previous employment-to-population, however, had become more important in explaining present employment-to-population for the main part of the countries in the sample, though not for Sweden.

The Granger causality test showed that GDP per capita Granger-causes employment-to-population, and the first variable was thus used to forecast the latter. The forecasts illustrated that the actual employment-to-population rate has followed the prediction with a lag of about a year. Comparing the development of GDP per capita and employment-to-population between countries, hinted that the situation of a lagging employment-to-population is by no means unique for Sweden. A closer look at Austria, Belgium, Finland, France and the Netherlands revealed a similar pattern.

In conclusion, the main findings of this thesis imply that the Swedish situation of disconnected employment growth to GDP growth in the 21st century is due to a temporary discrepancy rather than a fundamental change in the relationship. The situation is by no means abnormal or unique for Sweden as found when making comparisons with other OECD countries. Moreover, the relationship between employment and GDP was found to be strongly positive and the employment elasticity was found to be relatively constant over time.

The contribution of this thesis has been an aggregate and purely descriptive analysis of the relationship between Swedish GDP and employment. With focus on the years 1980-2004, it has been found that the situation in Sweden is by no means exceptional and thus the label world champion of jobless growth is not deserved.

Suggested future research is to look closer at the possible causes or explanations of the lag between GDP per capita and employment-to-population. A complementary micro level study could be of interest as this thesis is solely focusing on the aggregate macro level. Furthermore, the situation in other countries could be looked at more in-depth and differences and similarities with Sweden could then perhaps shed some light on the causes of the previous development of high GDP growth without job creation. Another suggestion for further research is to look more closely into the causal relationship between employment and GDP.

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8 APPENDICES

8.1 THE HODRICK-PRESCOTT FILTER

The standard practice when considering business cycles is to discard long term trends, thereby keeping only the fluctuations around the trend. The reason for this is that otherwise the variables may be highly correlated since most macroeconomic series have common trends. For instance, the trend is removed from the GDP data in order to isolate and analyse the deviation from the normal GDP growth component. The Hodrick-Prescott filter is a popular method for removing a trend from a time series and it allows for trends that are not a straight line (Cogley 2006).

Hodrick-Prescott assumes that the original series (y_t) is composed of a nonstationary trend component (τ_t) and a stationary cyclical component (c_t):

$$y_t = \tau_t + c_t \ , \ t = 1,2,...,T$$

The HP filter identifies the trend and the cycle by minimizing the variance of the cycle subject to a penalty for variation in the second difference of the trend,

$$\min_{\{\tau_t\}_{t=1}^{T}} \left[\sum_{t=1}^{T} (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} (\nabla^2 \tau_{t+1})^2 \right],$$

where λ is the penalty parameter (Hyeongwoo 2004). The smoothness of the trend depends on the penalty parameter; the larger the penalty parameter the smoother is the solution series. To avoid the creation of spurious correlations between the variables investigated, the same parameter value is used for all variables in this thesis. For annual data there exists no consensus on which number to choose. Here the original recommendation for annual data series by Hodrick and Prescott is followed and a penalty parameter of 100 is chosen (Ash et al 2002). The logarithms of the series are used since this result in that the cyclical components are expressed as percentage deviations.

Criticism of the HP filter is most profound to the arbitrariness of the choice of the penalty parameter. The regressions in this thesis have also been run with a penalty parameter of 10

and the results were quite similar. This supports the robustness of the results and suggests that for this thesis, the choice of the penalty parameter is not decisive in determining the magnitude of the results. Another criticism is the one previously mentioned in the thesis, and that is that the HP filter is a poor method in removing trends from the end points of the observations and therefore is not optimal when making forecasts.

8.2 TEST FOR AUTOCORRELATION[8]

Autocorrelation occurs when a series of data has observations that are not independent of one another. The multivariable regression series are tested for autocorrelation. For this purpose, the Durbin-Watson d-statistics is used, which tests the first order autocorrelation in the residuals of the regression equation. The test compares the residual for time period *t* with the residual from time period *t-1* and develops a statistic that measures the significance of the correlation. The d-statistics is obtained by the following equation:

$$d = \frac{\sum_{t=1}^{n} (\hat{u}_t - \hat{u}_{t-1})^2}{\sum_{t=1}^{n} \hat{u}_t^2}$$

The statistic is used to test for both positive and negative correlation in the residuals. The Durbin-Watson *d* statistic can be used to estimate the first-order autocorrelation coefficient ρ. The relationship used is,

$$\hat{\rho} \approx 1 - \frac{d}{2} = 1 - \frac{0.916}{2} = 0.542$$

The following hypothesis is tested at the 5% level:

$H_0 : \rho \leq 0$; no positive autocorrelation.

$H_1 : \rho > 0$; positive autocorrelation.

Using n = 25 and k = 3, the critical limits $d_L = 1.123$ and $d_U = 1.654$ are obtained. The null hypothesis of no positive autocorrelation cannot be rejected if $d_{obs} > 1.654$. If $d_{obs} < 1.123$ the

[8] The following section is based on Edlund (1997).

null hypothesis can be rejected. If $1.29 < d_{obs} < 1.45$ nothing can be concluded. In the case of Sweden, $\rho = 0.542 < d_L = 1.123$ and the null hypothesis of no positive autocorrelation can therefore be rejected. Thus there is a problem of positive autocorrelation and to deal with this, the dependent variable is included as a lag in the regression model.

8.3 AKAIKE INFORMATION CRITERIA

The AIC is calculated using the following formula:

$$\ln AIC = \left(\frac{2k}{n}\right) + \ln\left(\frac{RSS}{n}\right)$$

Where n is the number of observations, k is the number of regressors and RSS is the residual sum of squares.

Table 6. The Akaike Information Criteria for employment-to-population.

p	RSS	$\left(\frac{2k}{n}\right)$	$\ln\left(\frac{RSS}{n}\right)$	$\ln AIC$
1	0.00589978	0.1667	-8.3109	-8.1442
2	0.00266961	0.2609	-9.0613	-8.8004
3	0.00249839	0.3636	-9.0831	-8.7195
4	0.00193723	0.4762	-9.2910	-8.8148
5	0.00188592	0.6	-9.2691	-8.6691
6	0.00177598	0.7368	-9.2778	-8.5410
7	0.00176593	0.8889	-9.2294	-8.3406

The lowest value of AIC is preferred and therefore the lag length chosen for employment-to-population is four lags. As can be seen in *Table 7*, for GDP per capita, the lowest value of AIC occurs when lag length 2 is chosen.

Table 7. The Akaike Information Criteria for GDP per capita.

p	RSS	$\left(\frac{2k}{n}\right)$	$\ln\left(\frac{RSS}{n}\right)$	$\ln AIC$
1	0.00545521	0.1667	-8.3892	-8.2226
2	0.00325705	0.2609	-8.8624	-8.6016
3	0.00318671	0.3636	-8.8398	-8.4762
4	0.00307984	0.4762	-8.8274	-8.3512
5	0.00269463	0.6	-8.9122	-8.3122
6	0.00201228	0.7368	-9.1529	-8.4161
7	0.00169808	0.8889	-9.2686	-8.3797

8.4 FORECASTING FIGURES

Figure 8. Forecasting of Austria's employment rate 2002-04 using data 1980-2001.

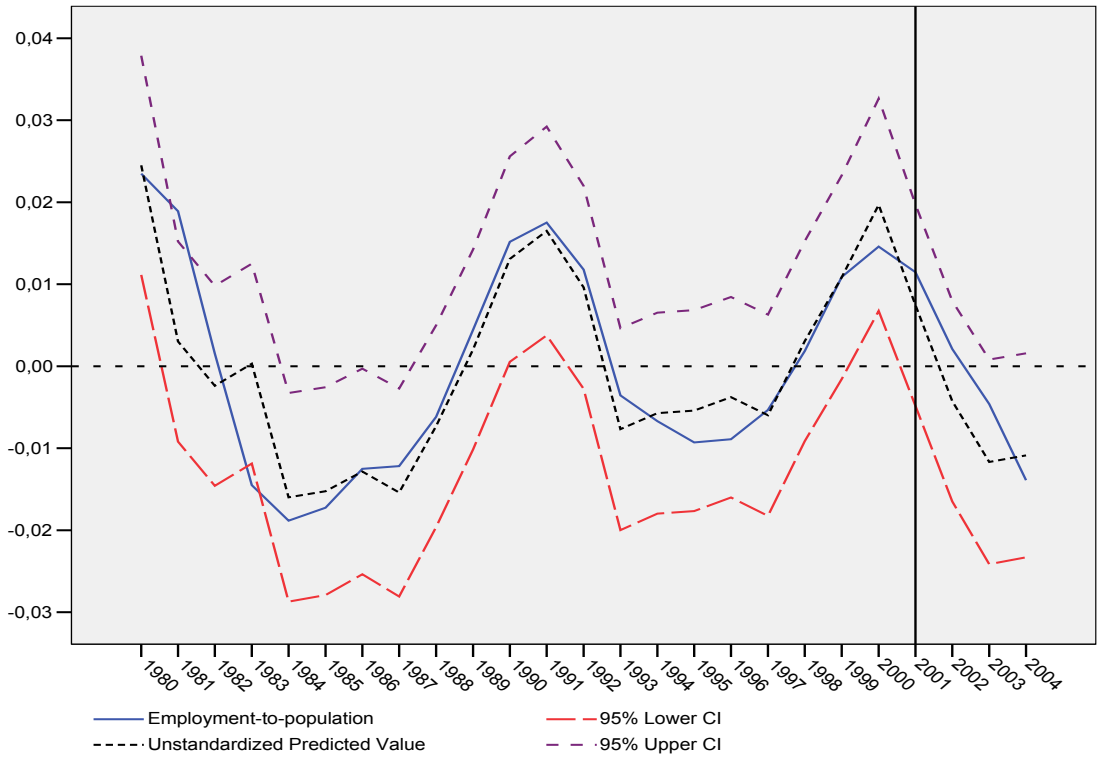

Figure 9. Forecasting of Belgium's employment rate 2002-04 using data 1980-2001.

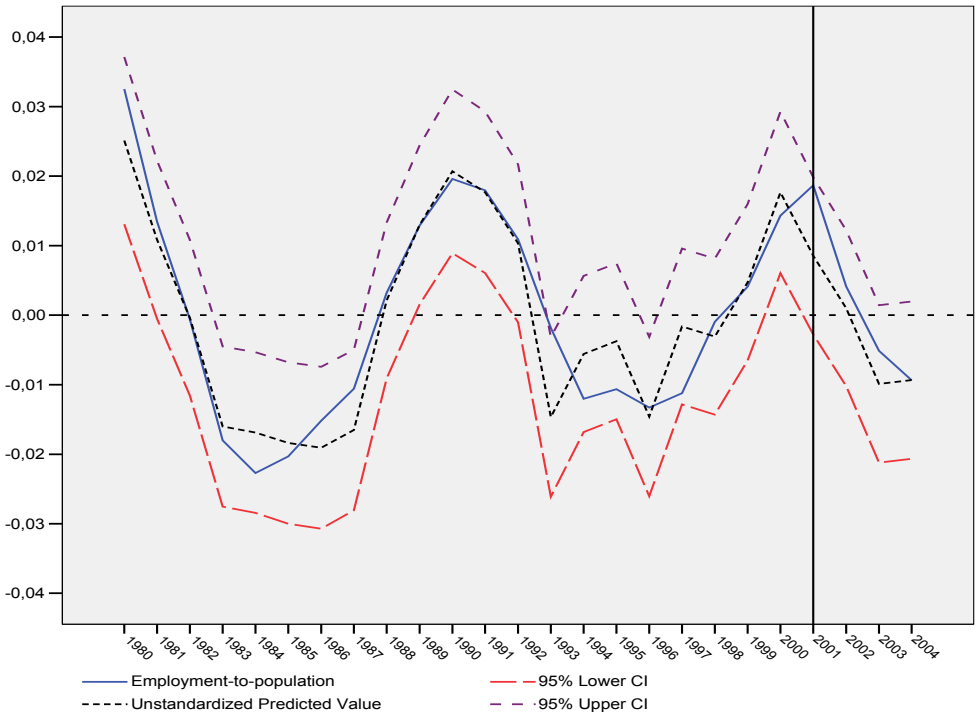

Figure 10. Forecasting of Finland's employment rate 2002-04 using data 1980-2001.

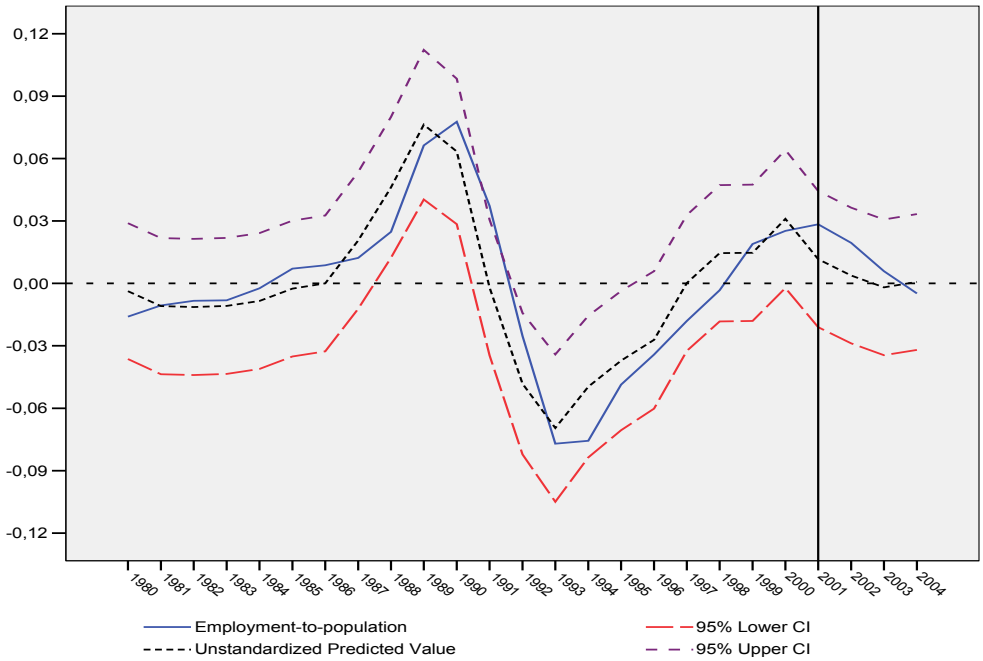

Figure 11. Forecasting of France's employment rate 2002-04 using data 1980-2001.

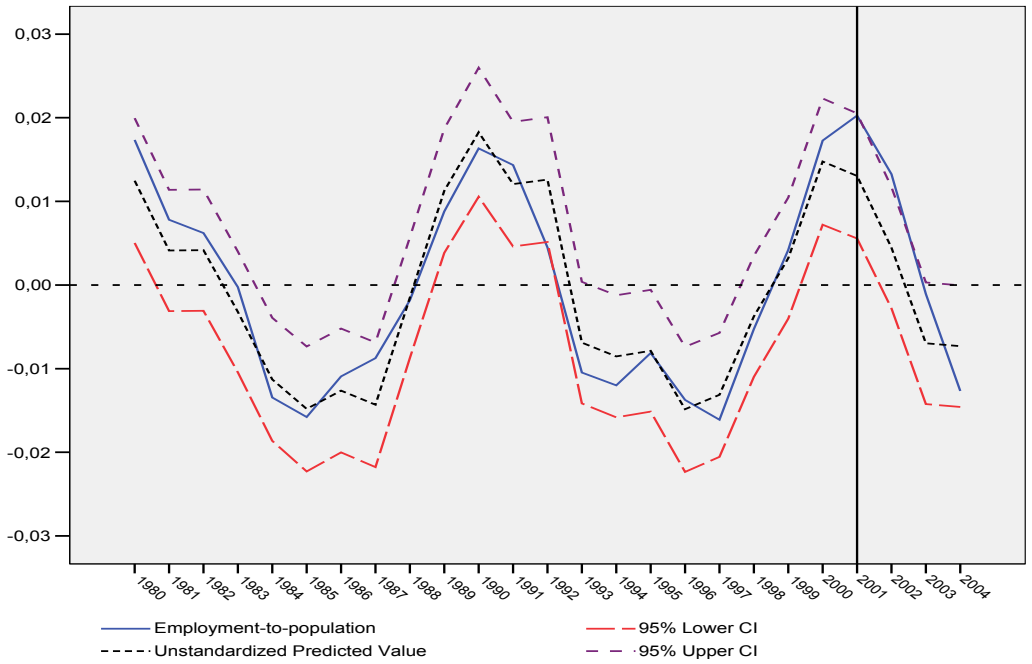

Figure 12. Forecasting of Netherland's employment rate 2002-04 using data 1980-2001.