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Testing the Causal Nexus between Output and Unemployment: Swedish Data

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Abstract

In this paper we aim at testing for the Granger causality test between real GDP and unemployment in Sweden. We model a VAR (4) model on Swedish two macro-economic variables, namely, the gross domestic product (GDP) and unemployment (Un) for the period 1993:Q1 – 2011:Q2. Our main aim is to supporting further empirical evidence so as to identify the relationship between the GDP and unemployment in terms of females, males and total unemployment, with special reference to Sweden. A Granger causality test is used. The test shows that it is the GDP Granger that causes unemployment but not the other way around. An econometric model is deployed and developed on the basis of Okun's Law. Total unemployment, male unemployment and female unemployment coefficients of the relationship between the GDP and unemployment coefficients are diverted from Okun's coefficient and they are found to be approximately 8 per cent and statistically significant for Sweden. This stayed almost steady over time. This result also has important implications for determining macroeconomic policy.

Keywords: causality test between GDP and unemployment, Okun's Law, VAR model

1. Introduction

In econometrics, the variables included in the Vector Autoregressive (VAR) methodology have to be stationary before testing for causality in the Granger approach. Non-stationary variables used to be differenced (to make them stationary) before applying the causality test on the VAR modelling. An exception from this role can be achieved when the variables are non-stationary, integrated of the same order and cointegrated. In the case we can run the causality test on the cointegrated VAR model without the need of taking the differences of these variables. In this paper we apply the Johansens' (1988) tests for cointegration. Given the selected VAR models have shown to be cointegrated, have then focused on Granger causality in this research.

In this study we consider the Swedish economy during the period 1993:Q1 – 2011:Q2. The period of study covers a time of a major regulation and change in Swedish labour market policies, when the current financial crisis in industrialized countries and in Sweden led to a decline in GDP growth and an increase in the unemployment rate. Our evaluation is also an attempt to highlight the effects of a slowdown in growth on unemployment. The related empirical studies originally found that Okun's relationship between slow economic activity and the unemployment rate has various implications and is statistically significant during the business cycle.

Compared to the international labour market, the Swedish labour market was performing very well throughout the 1970s and 1980s. In the early 1960s, the female employment rate rose significantly, from 54% in 1965 to 82% in 1989 and 62.9% in 2011; total employment increased alongside with this particular increase in female participation Holmlund (2003). The economic downturns of the early 1990s, particularly in manufacturing, construction and the retail sectors, affected employment, which decreased from 83% to 73% between 1990 and 1993. Another change began in 1997 with a rise in GDP growth and employment. The employment rate was 75% in 2001, but since then dropped steadily each year to 73% in 2005 and to 65% in 2011, SCB (2006, 2011).

Typically, economic downturns correlate to an increase in unemployment. This negative relationship has been called "Okun's Law". Okun (1962) is known for its simplicity since it includes two domestic macro-economic variables. Furthermore, the relationship seems to have much empirical investigations. In reality, although Okun's Law is considered a statistical form of interrelation among two macro-economic variables, it may be subject to revision in an ever-evolving macro-economics. Thus questions remain: Is Okun's coefficient is dependable and steady relation? Is the Okun's finding helps to forecast future values of unemployment? We will also try to answer the following questions: Are there differences between the genders, or is there a policy of discrimination in the Swedish labour market? If there are no differences or they have equal opportunities, then the coefficients of estimations for the male and female unemployment rate can be the same. The calculation has been made using the Granger causality test between output and unemployment in Sweden; however, there have been many methods of formulating equations for Okun's hypothesis given in the literature. In almost all cases the variables involved in the model were traditionally included in a differentiated form. It is also well known that differentiating between macroeconomic variables damages the long term information in the variables. In order to avoid such a situation, we work with the variables at their own level. This means that if the variables are non-stationary and have a stochastic process, they must be first integrated with the same order and then cointegrated before processing in further analysis. In this paper we found our variables to be non-stationary and integrated of the first order. Based on these findings, we later focus on testing for causality between GDP and unemployment in Sweden. Given our data series of the Gross Domestic Product (GDP) and Unemployment (Un) from 1993:Q1 to 2011:Q2, we specify a VAR methodology with four lag lengths i.e., VAR (4) framework. By processing in this manner we test for the causality between these variables and at the same time keep the long-run relationship equilibrium between them.

In order to improve the validity of results, this study implements a different method, analysing more variables than previous studies. In addition, we adjust the research perspective, and use more variables for the labour market and thereby extend previous research. Whereas variables such as female and male unemployment have not been regarded as the important determinants in a relationship between the business cycle and employment function in existing quantitative studies of labour market in Scandinavian, they are highlighted in our study. Furthermore, former Scandinavian studies have not considered the Granger test to measure the long-run equilibrium relationship between real GDP and unemployment (female and male unemployment). Most of the previous international studies measured the relationship by total unemployment only. This study contributes to the literature on the macro-econometrics of the economics of the labour market by applying the Granger test method so as to examine the impact of GDP on unemployment rate, for the first time.

2. Previous Related Studies

Various former studies have estimated the relationship between unemployment and growth. Okun (1962) presented two empirical relationships for the rate of unemployment to output, which have become related with his study. These empirical relationships have been adopted as rule since then. However, both have been extended by later economists to include elements that Okun had omitted in his analysis.

Real GDP and employment usually move together. Okun documented that the US unemployment rate tended to fall by 1% point for every 3% point rise in real GDP. A large body of empirical studies noted that GDP fluctuations have considerable consequences on unemployment rates. These consequences are expected to be different in industrialized countries and in the USA. The Okun coefficient will be larger in industrialized countries and smaller in the USA, Canada and the United Kingdom Lee (2000). This result should be expected, because these countries have a much less regulated labour market and frequently lay workers off during economic downturns, while most other developed countries have stronger restrictions on laying off employees (Note 1).

Several studies after Okun have shown that aggregate economic activity does affect employment rate. Lee's (2000) empirical study found that the real effects of economic growth on employment are that the coefficients are considerably different across countries, possibly due to the rigid circumstances of the labour markets. Prachowny's (1993) empirical study provides additional evidence of the negative relationship between economic growth and unemployment in the U.S: this finding is considered further support for the view that Okun's law is help to forecast future value of unemployment.

In addition, Cuaresma's (2003) study also considers the reality of Okun's parameter with a higher value for contraction than for the recovery phase. Padalino and Vivarelli (1997) and Dökpe (2001), found a strong relationship between aggregate economic activity and employment for most of the main industrialized countries (G-7). Moosa (1997) used data for the US, Canada, Europe and Japan to assess the relationship between aggregate economic activity and employment by means of a (SUR) seemingly unrelated regressions. This study stressed that the responsiveness of employment to economic activity seemed to be greater in the U.S and Canada than in other industrialized countries and Japan by SUR technique proposed by Zellner (1962)'s Iterative (Note 2). Conversely, Piacentini and Pini's (1998) model fails to identify any real positive effect of aggregate economic activity on employment, Under this circumstance, real GDP might bear no relationship whatsoever to employment, thus unemployment might actually occur even with economic growth. Pianta et al. (1996) found evidence in the cases of 36 manufacturing sectors amongst the G-7 countries that employment does have to move positively together with economic growth, but have not show to have a significant effect on employment.

As the relationship between real GDP and unemployment is determined by factors such as technological change, laws, labour market politics and transitions, demand, welfare benefits, population change, global competition and privatization, it is believed that the Okun coefficient changes over time. Some economists showed that GDP fluctuations have considerable consequences on the unemployment rate. These consequences are expected to be different in industrialized countries and in the US Lee (2000). As it turns out, however, it now appears that Okun's Law might actually be quite a helpful instrument in making comparisons across countries and over time.

The main aim of this study is to supporting additional empirical study to measure the relationship between the GDP and unemployment. This relationship has been discussed in the empirical literature. There is a large number of literature on this topic have noted that such a relation appears to have weakened in early years, both in Sweden and in other industrialized countries. This study is important for Sweden and other industrialized countries for several reasons: firstly, Sweden provides an interesting context for this study due to their situation as domestic macro–economic in transitions, which had equalled the position of the more industrial European countries in the period under investigation. Secondly, it had followed new policies for openness and the labour market, and created more dependence on advance in information technology, moving towards increased internationalization of all economic activity, and profitability between national and international markets. Thus, an innovation of this study is consideration of the evolution of the relationship between the business cycle and unemployment during a country's transition to a new technological status. Additionally, the period of study covers three major recession phases in Sweden and the other industrialized countries, which contributed to slowing down aggregate economic growth. Thirdly, a large amount of literature on this topics focus on the US economy and G-7 countries, and to our knowledge, the Granger causality relation of real GDP and unemployment has not been examined for Sweden considering a variety of econometric specifications. We also apply the Johansen (1988) procedure for cointegration, which has not been used in any of the above mentioned studies; in spite of its general popularity. The paper contributes to the literature of macro-econometrics by studying the causality nexus between the business cycle and unemployment.

Most previous studies have used the ordinary last squared method (OLS), rolling OLS, seemingly unrelated regressions (SUR) and asymmetry dynamic model techniques to analyse the relationship between output and unemployment. In this paper we conduct the Granger causality test with the Johansen cointegration method.

We utilise this procedure since it treats the included variables endogenously and because it is robust to the normalisation factor. Moreover, it allows inclusion the variables in their own levels and hence keeping the long run relationship between them instead of what was traditionally done in the previous research (i.e., by taking the differences of the variables in order to make them stationary).

3. Data, Model Specification and Methodology

The causal relationship between real GDP and unemployment (Un) is investigated by using the quarterly data for two macroeconomic variables (real GDP and unemployment). The data as collected from the Organisation for Economic Co-operation and Development (OECD) database for the period of study 1993:Q1 to 2011:Q2. The output variable is real GDP measured in price, 2010. The calculations were performed using the statistical program package STATA Version 11.0.

Granger causality test, due to Granger (1969), implies that one variable precedes the other variable. In our study, when we test if GDP Granger causes Un is to see how much of the current values of Un is explained by past values of GDP, and vice versa. Note that the causality might have two directions simultaneously. This can be done by estimating the following VAR model and then apply the test:

$$Un_t = a_0 + \sum_{i=1}^{k} a_i Un_{t-i} + \sum_{i=1}^{k} b_i GDP_{t-i} + e_{1t} \tag{1}$$

$$GDP_t = c_0 + \sum_{i=1}^{k} c_i Un_{t-i} + \sum_{i=1}^{k} f_i GDP_{t-i} + e_{2t} \tag{2}$$

where e_{1t} and e_{2t} are assumed to be stochastic white noise error terms with means equal to zero and constant variances.

Note that the lag order of the VAR model will be selected according to the Schwarz (1978) information criteria (SIC). If all the values of b_i are simultaneously equal to zero, we can conclude that GDP does not cause Un. In the same manner, if all the values of c_i are simultaneously equal to zero, we can conclude that Un does not cause GDP.

Since these variables are usually non-stationary and have stochastic trends, before testing for Granger causality we have to check whether these variables are cointegrated (i.e., whether a long run relationship does exist among them). Note that before conducting the cointegration test, we apply the augmented Dickey-Fuller (1979 and 1981) ADF test in order to insure that the variables are non stationary and integrated of the same order. Results of these tests are summarized in (Tables A1, A2, A3 and A4). The results of the cointegration test are reported in Tables (B1, B2 and B3).

Then the Johansen (1988) maximum likelihood estimator has been applied. The number of lags, *k*, has been defined as equal to 4 Using the SIC criteria the VAR (4) model is selected. This model has also shown to be well specified when applying a number of diagnostic tests. Results of these tests are summarized in tables (c1, c2 and c3). We then used the F-test for testing for Granger causality between the variables in the VAR (4) model. Our purpose is to investigate the causal relation between the GDP and Unemployment.

Numerous statistical diagnostic tests are carried out in our model selection procedure: Breusch (1978) and Godfrey (1978) commonly used autocorrelation test; White's (1980) test for heteroscedasticity was applied; Engle's (1981) LM test for autoregressive conditional heteroscedasticity ARCH; Ramsey's (1969) RESET test for omitted variables and functional misspecification. It is also of interest to use Jarque and Bera's (1987) test for non-normality. The cumulative sum of squares (CUSUMSQ) test for parameter stability Brown, Durbin, and Evans (1975) can be applied. The relevant results for tests are given in Tables' c1, c2 and c3. The main advantage of using such procedures, however, is that one can avoid less than adequate models, which could lead to extremely misleading results and inferences. The statistical results and diagnostic tests show that the coefficients estimated are corrected and all the diagnostic tests are accepted and significant. Results of these statistical and diagnostic tests are summarized in Tables (c1, c2 and c3).

4. Estimation Procedures for Significance and Granger Causality

In this paper we intend to study the causal relationship between the Swedish GDP and unemployment by performing a vector autoregressive (VAR) methodology that allows for causality testing in the Granger technique. Different tests are carried out for each method of study. First, we apply the ADF test in order to insure that the variables are non stationary and integrated of the same order. Accordingly, tests for cointegration have to be existed. Secondly, we determine the suitable lag lengths degree of the VAR framework by considering a number of VAR models using Schwarz (1978) model selection criteria. Thirdly, if the chosen model is shown to be tolerable, using a battery of diagnostic checking, we then test for cointegration between the variables in the VAR model using the Johansen's technique Salman and Shukur (2004). When we find enough evidence for cointegration, the next step is to test for Granger causality approach and make inferential statements.

5. Empirical Results

This section presents the results of applying the Granger causality test on the VAR (4) model in (1) and (2). The test has been applied on data for total (males and females) together, males only and females only. The results for the test can be found in Tables 1 and 3, respectively. In all cases, the test results indicate that during the period of study 1993:1 - 2011:2, there is a one directional causality effect from GDP to unemployment. We could not find any evidence or effects in the opposite direction. Looking at the p-values in the table, we can conclude that GDP significantly Granger -causes unemployment.

The strength of the causality from GDP to the total unemployment (TUn) is highly significant, while causality from TUn to GDP have appeared to be statistically non-significant (see Table 1). This might indicate that the nature of causality between these two variables is uni-directional and going from GDP to TUn but not the other way around. This might mean that any variation in past GDP can affect the unemployment negatively or render it unstable.

When using the same method to test for causality from GDP to the data for males and females unemployment, we obtained the results that GDP Granger causes unemployment, as summarized in Tables 2 and 3.

Table 1. Testing for causality in the Granger approach for Sweden using total data and applying VAR (4)

Null Hypothesis	P-value
TUn does not Granger Cause GDP	0.090
GDP does not Granger Cause Un	0.001

Note: This table is derived from Tables A1.

Table 2. Testing for causality in the Granger approach for Sweden using male data and applying VAR(4)

Null Hypothesis	P-value
MUn does not Granger Cause GDP	0.081
GDP does not Granger Cause Un	0.007

Note: This table is derived from Table A2.

Table 3. Testing for causality in the Granger approach for Sweden using female data and applying VAR (4)

Null Hypothesis	P-value
FUn does not Granger Cause GDP	0.083
GDP does not Granger Cause Un	0.001

Note: This table is derived from Table A3.

Sweden has experienced an unemployment recovery in the sense that unemployment has increased, even though GDP has reversed its negative path. The results presented in this study suggest a temporary lag, rather than a fundamental change in the relationship between GDP and unemployment. The regression results show that Sweden has total unemployment, male, and female unemployment coefficients with respect to the first lag of the GDP that are approximately -0.8% during the period of study 1993:1-2011:2. Results for these coefficients are summarized in Table 4.

Table 4. Estimates of coefficients for the relationship between GDP and unemployment*

Unemployment items	Coefficients	SE	T-Statistic	P-value
Total unemployment (t-1)	-0.076	0.017	-4.434	0.0000
Males unemployment	-0.084	0022	-3.799	0.0003
Females unemployment	-0.079	0.018	-4.478	0.0000

Note: * This table is derived from Tables B1 – B3.

This indicates a fairly strong negative and statistically significant relationship between GDP and all the items of unemployment. From the multivariable regression, it was concluded that the recent situation in the Swedish economy could be explained by lagged GDP, but only the first lag has shown to have a statistically significant effect on all Swedish unemployment items. It is also been shown that the unemployment coefficients with lagged two GDP, through lagged four GDP, have positive and not statistically significant effects on the Swedish unemployment items. However, these lags periods are existed in the model for the sake of specification since the model selection criterion and the diagnostic tests indicated the appropriateness of this number of lags.

6. Summary and Remarks

This section analyses the empirical results for the causal nexus between GDP and unemployment in Sweden from the 1993: Q1 to the 2011: Q2. The results show that only GDP Granger causes unemployment (total unemployment, male unemployment and female unemployment). It should be noticed that in all estimations the variables have been appeared to be both integrate of the first order I (1), and cointegrated. The VAR (4) model is recommended following model selection criterion and a battery of diagnostic tests, and was thus chosen for this study.

Based on the Swedish data for real GDP and unemployment, this study shows existence of a statistically significant and a strong negative relationship that existed between real GDP and the items of unemployment (such as total unemployment, male and female unemployment). It has also been found that the Swedish unemployment coefficients are higher than Okun's coefficient as measured by previous studies, possibly due to the special circumstance of the Swedish economic system. More specifically, the changes in employment were less responsive to economic growth in Sweden, this is the cause high unemployment benefits and other social security also offer supplemental income payments for unemployed people who have little track record in the labour force. Additionally, Swedish small and micro firms employed more than 53 % of the total labour force, these firms move more quickly to bankruptcy than medium and large firms during the recession, therefore, these create greater unemployment. Moreover, possibly due to adopted heavy tax systems, new policies in the labour market, and more dependence on privatization, there is a move towards increased internationalization of all economic activity, advance in information technology and allowed increased competition between national and international markets (Note 3).

This study found that the real GDP has a statistically significant and a negative effect on total unemployment, male unemployment and female unemployment, estimating it at -0.076, -0.084 and -0.079 respectively. In this regard, the analysis shows that economic growth is a considerable source of volatility for total unemployment, male unemployment and female unemployment variables in this model. Overall, the present results are thus roughly consistent with the findings reported in the literature. In addition, the findings of this study showed that the estimations of the relationship between the real GDP and unemployment coefficients are the same or very close for both males and females. It suggests that either Swedish policymakers used the same policies for both genders of Swedish employees (male and female) or without any differences or discrimination during the recession or that they have equal employment opportunities. The results of this study have important implications for determining macroeconomic policy.

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Notes

Note 1. This study applied the Granger causality test to identify the relationship between the Swedish GDP with total unemployment, female unemployment and male unemployment for the period of study.

Note 2. Using different techniques, Lee (2000), Cuaresma (2003), Silvapulle & others (2004). Investigated asymmetry in Okun's Law.

Note 3. Okun Coefficients vary because the relationship of unemployment to aggregate economic activity governed by laws technology and demographical and society changes. Lee (2000). Another factor that can contribute to variation in the coefficient of unemployment is the hours worked per worker. During economic downturns, the hours of work fall in response to decline in growth. Therefore, firms lay off workers and cut back on overtime.

Appendix A

Table A1. Results of ADF test for unit root to the GDP

Null Hypothesis: GDP has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.911170	0.0539
Test critical values:	1% level	-2.593121	
	5% level	-1.944762	
	10% level	-1.614204	

Note: MacKinnon (1996) one-sided p-values.

Table A2. ADF test for Unit root total unemployment

Null Hypothesis: SWUNT has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.375121	0.0620
Test critical values:	1% level	-4.075340	
	5% level	-3.466248	
	10% level	-3.159780	

Note: MacKinnon (1996) one-sided p-values.

Table A3. Results of ADF test for unit root GDP and male unemployment

Null Hypothesis: SWUNM has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.286306	0.0758
Test critical values:	1% level	-4.073859	
	5% level	-3.465548	
	10% level	-3.159372	

Note: MacKinnon (1996) one-sided p-values.

Table A4. Results of ADF test for unit root GDP and female unemployment

Null Hypothesis: SWUNF has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.004368	0.1375
Test critical values:	1% level	-4.075340	
	5% level	-3.466248	
	10% level	-3.159780	

Note: MacKinnon (1996) one-sided p-values.

Appendix B

Table B1. The cointegration regression results for total unemployment

Sample(adjusted): 1993:1 2011:2
Included observations: 80 after adjusting endpoints
t-statistics in parentheses
Dependent Variables

Independent variables	GDP	TUn
GDP(t-1)	0.699678	-0.076309
	(5.99413)	(-4.43406)
GDP(t-2)	0.121202	0.038467
	(0.81024)	(1.74416)
GDP(t-3)	-0.004125	0.018089
	(-0.02711)	(0.80631)
GDP(t-4)	-0.282202	-0.001516
	(-2.34552)	(-0.08546)
TUn(t-1)	-0.339537	1.288171
	(-0.41538)	(10.6889)
TUn(t-2)	0.179097	-0.154083
	(0.13418)	(-0.78300)
TUn(t-3)	0.112342	-0.060805
	(0.08457)	(-0.31046)
TUn(t-4)	0.336124	-0.115455
	(0.41480)	(-0.96638)
Intercept	-0.874557	0.372134
	(-0.98596)	(2.84555)
R-squared	0.747097	0.980786
Adj. R-squared	0.718601	0.978621
Sum sq. resids	206.8354	4.496069
S.E. equation	1.706802	0.251644
F-statistic	26.21752	453.0223
Log likelihood	-151.5109	1.637844
Akaike AIC	4.012773	0.184054
Schwarz SC	4.280751	0.452032
Mean dependent	2.263750	7.256250
S.D. dependent	3.217525	1.721042
Determinant Residual Covariance		0.136907
Log Likelihood		-147.4920
Akaike Information Criteria		4.137299
Schwarz Criteria		4.673255

Table B2. The cointegration regression results for male unemployment

Sample(adjusted): 1993:1 2011:2		
Included observations: 80 after adjusting endpoints		
t-statistics in parentheses		
Dependent Variables		
Independent variables	GDP	MUn
GDP(t-1)	0.711753	-0.083771
	(5.90568)	(-3.79894)
GDP(t-2)	0.122635	0.035719
	(0.81880)	(1.30343)
GDP(t-3)	-0.046658	0.014767
	(-0.31181)	(0.53939)
GDP(t-4)	-0.279102	-0.003684
	(-2.37154)	(-0.17110)
MUn(t-1)	0.065619	1.316795
	(0.09585)	(10.5128)
MUn(t-2)	-0.577123	-0.201438
	(-0.50954)	(-0.97204)
MUn(t-3)	0.262779	-0.151494
	(0.23162)	(-0.72982)
MUn(t-4)	0.495478	-0.009713
	(0.72364)	(-0.07753)
Intercept	-0.609756	0.457259
	(-0.72270)	(2.96206)
R-squared	0.748009	0.977705
Adj. R-squared	0.719616	0.975193
Sum sq. resids	206.0892	6.899150
S.E. equation	1.703721	0.311723
F-statistic	26.34457	389.2009
Log likelihood	-151.3664	-15.48994
Akaike AIC	4.009159	0.612249
Schwarz SC	4.277137	0.880227
Mean dependent	2.263750	7.631250
S.D. dependent	3.217525	1.979170
Determinant Residual Covariance		0.197328
Log Likelihood		-162.1147
Akaike Information Criteria		4.502867
Schwarz Criteria		5.038823

Table B3. The cointegration regression results for female unemployment

Sample(adjusted): 1993:1 2011:2

Included observations: 80 after adjusting endpoints

t-statistics in parentheses

Dependent Variables

Independent variables	GDP	FUn
GDP(t-1)	0.730644	-0.079437
	(6.46040)	(-4.47779)
GDP(t-2)	0.118881	0.057498
	(0.78019)	(2.40563)
GDP(t-3)	0.011641	0.001624
	(0.07372)	(0.06558)
GDP(t-4)	-0.251198	-0.001560
	(-2.07491)	(-0.08217)
FUn(t-1)	-0.546031	1.215346
	(-0.73038)	(10.3638)
FUn(t-2)	0.389734	-0.082276
	(0.32990)	(-0.44399)
FUn(t-3)	0.965979	-0.046736
	(0.83194)	(-0.25660)
FUn(t-4)	-0.517537	-0.126604
	(-0.71092)	(-1.10869)
Intercept	-1.003751	0.350044
	(-1.17353)	(2.60901)
R-squared	0.747745	0.974718
Adj. R-squared	0.719322	0.971869
Sum sq. resids	206.3053	5.076197
S.E. equation	1.704614	0.267387
F-statistic	26.30769	342.1591
Log likelihood	-151.4083	-3.216508
Akaike AIC	4.010207	0.305413
Schwarz SC	4.278185	0.573391
Mean dependent	2.263750	6.847500
S.D. dependent	3.217525	1.594212
Determinant Residual Covariance		0.162992
Log Likelihood		-154.4679
Akaike Information Criteria		4.311698
Schwarz Criteria		4.847654

Appendix C

Table C1. Johansen's test for cointegration results of diagnostic tests GDP and total unemployment VAR(4) model. Series GDPSW SWUNT

Lags interval: 1 to 4

	Likelihood	5 Percent	1 Percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CE(s)
0.174352	27.80947	15.41	20.04	None **
0.148224	12.67413	3.76	6.65	At most 1 **

Note: Johansen's test for cointegration shows that these variables are cointegrated

Granger CAUSALITY TEST

Pairwise Granger Causality Tests

Date: 10/16/11 Time: 22:01

Sample: 1993:1 2011:2

Lags: 4

Null Hypothesis:	Obs	F-Statistic	Probability
SWUNT does not Granger Cause GDPSW	80	2.10061	0.08972
GDPSW does not Granger Cause SWUNT		5.34247	0.00081

Note*:* This means that GDP causes unemployment but not the other way around. Now we check the adequacy of these two equations;

Single Equation regression of Unemployment on GDP

Dependent Variable: SWUNT (Unemployment)

Method: Least Squares

Date: 10/16/11 Time: 22:48

Sample(adjusted): 1993:1 2011:2

Included observations: 80 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.372134	0.130777	2.845553	0.0058
SWUNT(-1)	1.288171	0.120515	10.68885	0.0000
SWUNT(-2)	-0.154083	0.196786	-0.782998	0.4362
SWUNT(-3)	-0.060805	0.195850	-0.310464	0.7571
SWUNT(-4)	-0.115455	0.119471	-0.966382	0.3371
GDPSW(-1)	-0.076309	0.017210	-4.434061	0.0000
GDPSW(-2)	0.038467	0.022055	1.744158	0.0855
GDPSW(-3)	0.018089	0.022435	0.806314	0.4228
GDPSW(-4)	-0.001516	0.017739	-0.085459	0.9321
R-squared	0.980786	Mean dependent var		7.256250
Adjusted R-squared	0.978621	S.D. dependent var		1.721042
S.E. of regression	0.251644	Akaike info criterion		0.184054
Sum squared resid	4.496069	Schwarz criterion		0.452032
Log likelihood	1.637844	F-statistic		453.0223
Durbin-Watson stat	2.017627	Prob(F-statistic)		0.000000

Breusch-Godfrey Serial Correlation LM Test: 4 lags

F-statistic	1.595776	Probability	0.185631
Obs*R-squared	6.958665	Probability	0.138089

The results indicate no autocorrelation.

White Heteroskedasticity Test:

F-statistic	0.766385	Probability	0.715747
Obs*R-squared	13.03407	Probability	0.670265

ARCH Test:

F-statistic	2.784343	Probability	0.099251
Obs*R-squared	2.756970	Probability	0.096831

RESET test for misspecification

Ramsey RESET Test:

F-statistic	1.710377	Probability	0.157988
Log likelihood ratio	7.778271	Probability	0.100047

Tests for parameter stability that show stable parameters

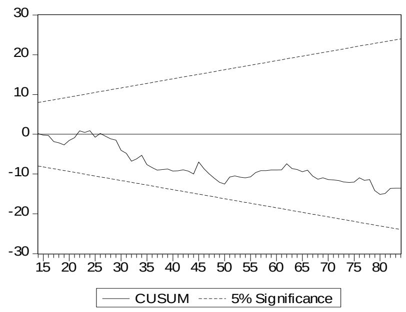

Figure 1.

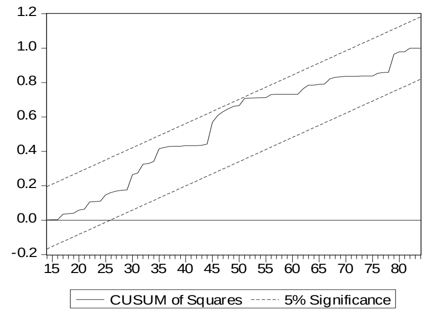

Figure 2.

Single Equation regression of GDP on Unemployment

Dependent Variable: GDPSW (Swedish GDP)
Method: Least Squares
Date: 10/16/11 Time: 22:52
Sample(adjusted): 1993:1 2011:2
Included observations: 80 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.874557	0.887010	-0.985961	0.3275
SWUNT(-1)	-0.339537	0.817407	-0.415384	0.6791
SWUNT(-2)	0.179097	1.334723	0.134183	0.8936
SWUNT(-3)	0.112342	1.328375	0.084571	0.9328
SWUNT(-4)	0.336124	0.810325	0.414802	0.6795
GDPSW(-1)	0.699678	0.116727	5.994130	0.0000
GDPSW(-2)	0.121202	0.149589	0.810235	0.4205
GDPSW(-3)	-0.004125	0.152166	-0.027112	0.9784
GDPSW(-4)	-0.282202	0.120315	-2.345524	0.0218
R-squared	0.747097	Mean dependent var		2.263750
Adjusted R-squared	0.718601	S.D. dependent var		3.217525
S.E. of regression	1.706802	Akaike info criterion		4.012773
Sum squared resid	206.8354	Schwarz criterion		4.280751
Log likelihood	-151.5109	F-statistic		26.21752
Durbin-Watson stat	1.911781	Prob(F-statistic)		0.000000
Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	1.073418	Probability	0.376662	
Obs*R-squared	4.818010	Probability	0.306486	
White Heteroskedasticity Test:				
F-statistic	1.186083	Probability	0.303717	
Obs*R-squared	18.51958	Probability	0.294361	
ARCH Test:				
F-statistic	6.114025	Probability	0.015616	
Obs*R-squared	5.811390	Probability	0.015923	
Ramsey RESET Test:				
F-statistic	1.071543	Probability	0.377577	
Log likelihood ratio	4.960779	Probability	0.291345	

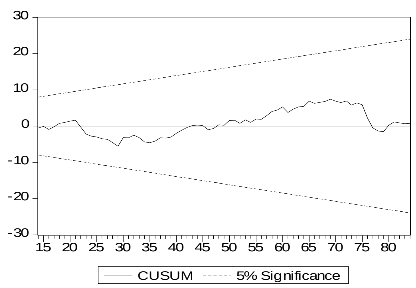

Figure 3.

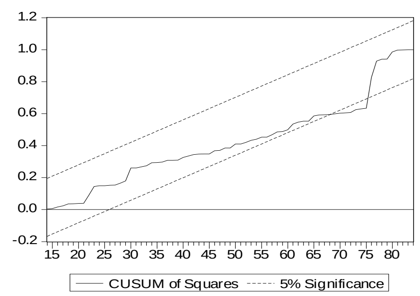

Figure 4.

Table C2. Johansen's test for cointegration results of diagnostic tests GDP and male unemployment VAR(4) model. Series GDPSW SWUNM

Lags interval: 1 to 4

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.190247	29.02685	15.41	20.04	None **
0.144785	12.35583	3.76	6.65	At most 1 **

Note: Johansen's test for cointegration shows that these variables are cointegrated

Pairwise Granger Causality Tests

Date: 10/16/11 Time: 22:21

Sample: 1993:1 2011:2

Lags: 4

Null Hypothesis:	Obs	F-Statistic	Probability
SWUNM does not Granger Cause GDPSW	80	2.17248	0.08081
GDPSW does not Granger Cause SWUNM		3.84429	0.00695

Single Equation regression of Unemployment on GDP

Dependent Variable: SWUNM

Method: Least Squares

Date: 10/16/11 Time: 22:55

Sample(adjusted): 1993:1 2011:2

Included observations: 80 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.457259	0.154372	2.962062	0.0042
2. SWUNM(-1)	1.316795	0.125257	10.51278	0.0000
SWUNM(-2)	-0.201438	0.207232	-0.972042	0.3343
SWUNM(-3)	-0.151494	0.207576	-0.729824	0.4679
SWUNM(-4)	-0.009713	0.125277	-0.077534	0.9384
1.GDPSW(-1)	-0.083771	0.022051	-3.798936	0.0003
GDPSW(-2)	0.035719	0.027404	1.303435	0.1966
GDPSW(-3)	0.014767	0.027378	0.539387	0.5913
GDPSW(-4)	-0.003684	0.021533	-0.171097	0.8646
R-squared	0.977705	Mean dependent var		7.631250
Adjusted R-squared	0.975193	S.D. dependent var		1.979170
S.E. of regression	0.311723	Akaike info criterion		0.612249
Sum squared resid	6.899150	Schwarz criterion		0.880227
Log likelihood	-15.48994	F-statistic		389.2009
Durbin-Watson stat	2.008343	Prob(F-statistic)		0.000000
Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	2.483113	Probability	0.051899	
Obs*R-squared	10.32849	Probability	0.035243	
White Heteroskedasticity Test:				
F-statistic	0.808586	Probability	0.670873	
Obs*R-squared	13.62952	Probability	0.626292	
ARCH Test:				
F-statistic	1.823159	Probability	0.180893	
Obs*R-squared	1.827249	Probability	0.176453	
Ramsey RESET Test:				
F-statistic	1.150586	Probability	0.340567	
Log likelihood ratio	5.314817	Probability	0.256493	

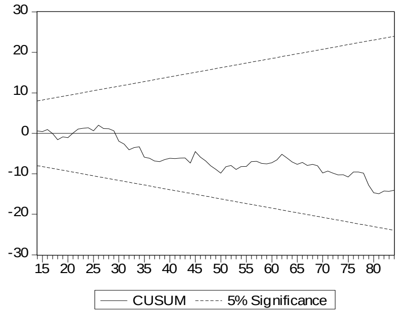

Figure 5.

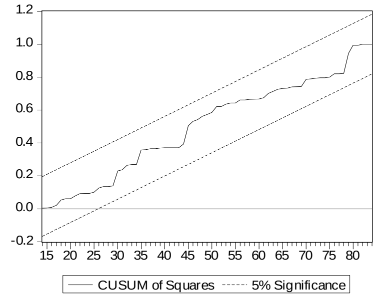

Figure 6.

Single Equation regression of GDP on Unemployment

Dependent Variable: GDPSW

Method: Least Squares

Date: 10/16/11 Time: 22:58

Sample(adjusted): 1993:1 2011:2

Included observations: 80 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.609756	0.843719	-0.722700	0.4722
SWUNM(-1)	0.065619	0.684590	0.095851	0.9239
SWUNM(-2)	-0.577123	1.132626	-0.509545	0.6120
SWUNM(-3)	0.262779	1.134507	0.231624	0.8175
SWUNM(-4)	0.495478	0.684702	0.723640	0.4717
GDPSW(-1)	0.711753	0.120520	5.905682	0.0000
GDPSW(-2)	0.122635	0.149774	0.818798	0.4156
GDPSW(-3)	-0.046658	0.149635	-0.311810	0.7561
GDPSW(-4)	-0.279102	0.117688	-2.371538	0.0204
R-squared	0.748009	Mean dependent var		2.263750
Adjusted R-squared	0.719616	S.D. dependent var		3.217525
S.E. of regression	1.703721	Akaike info criterion		4.009159
Sum squared resid	206.0892	Schwarz criterion		4.277137
Log likelihood	-151.3664	F-statistic		26.34457
Durbin-Watson stat	1.900164	Prob(F-statistic)		0.000000

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	2.365223	Probability	0.128574
Obs*R-squared	2.614762	Probability	0.105873

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.991559	Probability	0.418310
Obs*R-squared	4.471126	Probability	0.345985

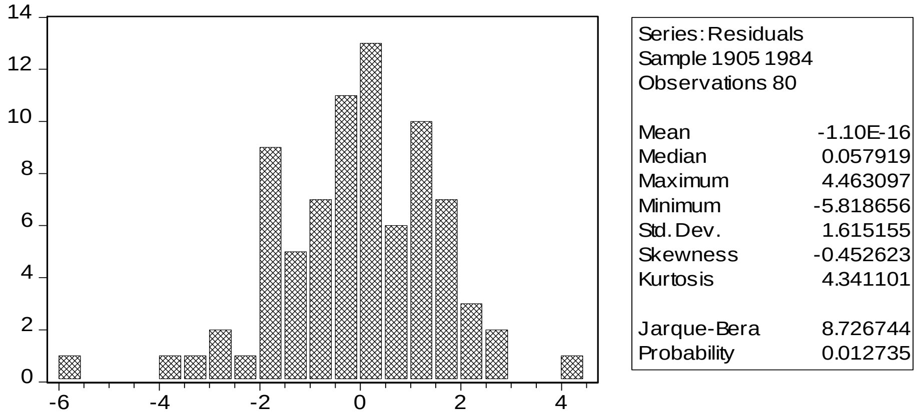

Figure 7.

White Heteroskedasticity Test:			
F-statistic	0.977010	Probability	0.491726
Obs*R-squared	15.90409	Probability	0.459675

ARCH Test:			
F-statistic	4.767382	Probability	0.032050
Obs*R-squared	4.606032	Probability	0.031860

Ramsey RESET Test:			
F-statistic	1.220334	Probability	0.310504
Log likelihood ratio	5.625921	Probability	0.228881

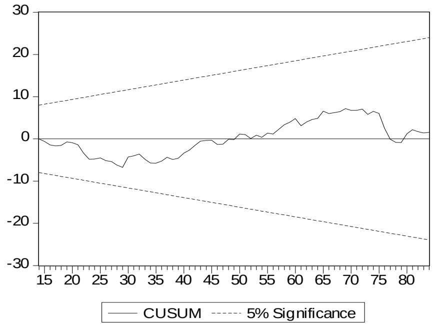

Figure 8.

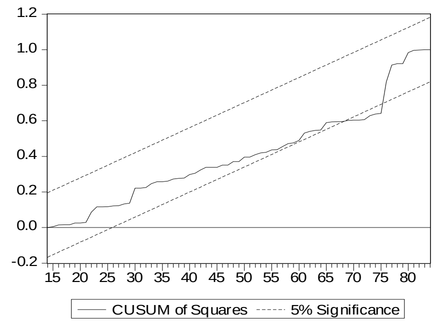

Figure 9.

Table C3. Johansen's test for cointegration results of diagnostic tests GDP and female unemployment VAR(4) model

Cointegration tests. Series GDPSW SWUNF

Lags interval: 1 to 4

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.174233	24.56101	15.41	20.04	None **
0.112597	9.437009	3.76	6.65	At most 1 **

Note: Johansen's test for cointegration shows that these variables are cointegrated.

Pairwise Granger Causality Tests

Date: 10/16/11 Time: 22:40

Sample: 1993:1 2011:2

Lags: 4

Null Hypothesis:	Obs	F-Statistic	Probability
SWUNF does not Granger Cause GDPSW	80	2.15162	0.08330
GDPSW does not Granger Cause SWUNF		5.28517	0.00088

Single Equation regression of Unemployment on GDP

Dependent Variable: SWUNF

Method: Least Squares

Date: 10/16/11 Time: 22:42

Sample(adjusted): 1993:1 2011:2

Included observations: 80 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.350044	0.134167	2.609011	0.0111
SWUNF(-1)	1.215346	0.117268	10.36381	0.0000
SWUNF(-2)	-0.082276	0.185312	-0.443989	0.6584
SWUNF(-3)	-0.046736	0.182134	-0.256600	0.7982
SWUNF(-4)	-0.126604	0.114192	-1.108693	0.2713
GDPSW(-1)	-0.079437	0.017740	-4.477785	0.0000
GDPSW(-2)	0.057498	0.023902	2.405626	0.0188
GDPSW(-3)	0.001624	0.024769	0.065581	0.9479
GDPSW(-4)	-0.001560	0.018990	-0.082168	0.9347
R-squared	0.974718	Mean dependent var		6.847500
Adjusted R-squared	0.971869	S.D. dependent var		1.594212
S.E. of regression	0.267387	Akaike info criterion		0.305413
Sum squared resid	5.076197	Schwarz criterion		0.573391
Log likelihood	-3.216508	F-statistic		342.1591
Durbin-Watson stat	2.011162	Prob(F-statistic)		0.000000

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.127933	Probability	0.721661
Obs*R-squared	0.145942	Probability	0.702444

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.763870	Probability	0.552492
Obs*R-squared	3.489211	Probability	0.479521

White Heteroskedasticity Test:			
F-statistic	0.913998	Probability	0.557433
Obs*R-squared	15.07160	Probability	0.519401
ARCH Test:			
F-statistic	0.126084	Probability	0.723498
Obs*R-squared	0.129148	Probability	0.719317
Ramsey RESET Test:			
F-statistic	0.437374	Probability	0.781146
Log likelihood ratio	2.062145	Probability	0.724330

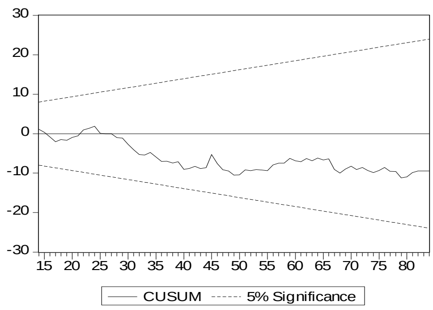

Figure 10.

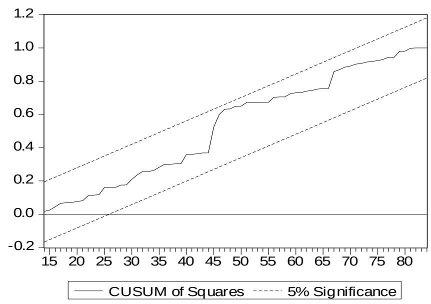

Figure 11.

Single Equation regression of GDP on Unemployment

Dependent Variable: GDPSW
Method: Least Squares
Date: 10/16/11 Time: 22:45
Sample(adjusted): 1993:1 2011:2
Included observations: 80 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.003751	0.855327	-1.173529	0.2445
SWUNF(-1)	-0.546031	0.747596	-0.730383	0.4676
SWUNF(-2)	0.389734	1.181378	0.329898	0.7424
SWUNF(-3)	0.965979	1.161119	0.831938	0.4082
SWUNF(-4)	-0.517537	0.727982	-0.710920	0.4795
GDPSW(-1)	0.730644	0.113096	6.460399	0.0000
GDPSW(-2)	0.118881	0.152375	0.780192	0.4379
GDPSW(-3)	0.011641	0.157906	0.073720	0.9414
GDPSW(-4)	-0.251198	0.121064	-2.074912	0.0416
R-squared	0.747745	Mean dependent var		2.263750
Adjusted R-squared	0.719322	S.D. dependent var		3.217525
S.E. of regression	1.704614	Akaike info criterion		4.010207
Sum squared resid	206.3053	Schwarz criterion		4.278185
Log likelihood	-151.4083	F-statistic		26.30769
Durbin-Watson stat	1.907445	Prob(F-statistic)		0.000000
Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	1.625030	Probability	0.206607	
Obs*R-squared	1.815042	Probability	0.177905	
Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	1.183255	Probability	0.326190	
Obs*R-squared	5.278484	Probability	0.259898	
White Heteroskedasticity Test:				
F-statistic	1.415529	Probability		0.163750
Obs*R-squared	21.15481	Probability		0.172636
ARCH Test:				
F-statistic	6.527494	Probability	0.012594	
Obs*R-squared	6.173680	Probability	0.012966	
Ramsey RESET Test:				
F-statistic	0.919027	Probability	0.458154	
Log likelihood ratio	4.273196	Probability	0.370294	

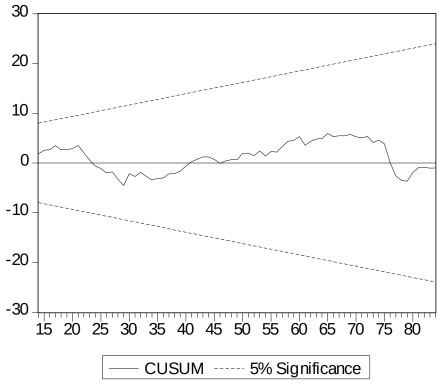

Figure 12.

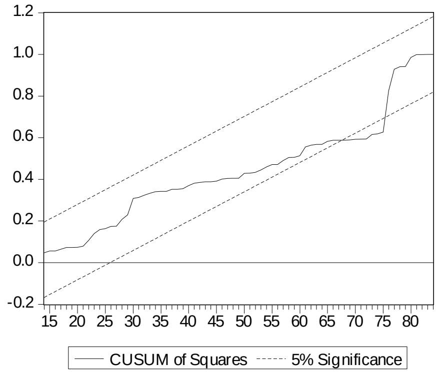

Figure 13.