Inflation in a Small Open Economy: A Case Study of Sweden

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ABSTRACT

The paper attempts to identify the leading sources of inflation and their switching behavior following a change in the exchange rate regime in a small open economy like Sweden. Before regime changes the leading sources of inflation were real GDP, exchange rate, money supply and the foreign price respectively. In this period, the foreign impact-via devaluation and foreign price expressed in foreign currency-on domestic inflation was positive. After the regime changes, the sources are exchange rate, import prices, money supply and real GDP respectively. In this period, the foreign impact-via depreciation and foreign price expressed in foreign currency-on domestic inflation is negative. ECM has been used in the empirical study.

Keywords: inflation, exchange rate, ECM, cointegration, import prices

Introduction

Inflation is a major focus of economic policy and is regarded as one of the most important macroeconomic indicators. In fact, there is no single theory that can completely describe the inflation process (Hendry, 2001). Theories suggest many sources of inflation. Inflation might arise basically from three sources: excess demand for goods and services, excess money supply with respect to productive potential and imported inflation through foreign price and exchange rate (Surrey, 1989).

The paper attempts to identify the leading sources of inflation and their switching behavior following a change in the exchange rate regime in a small open economy like Sweden. Sweden had a fixed exchange rate

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regime before 1992-4. After that, it had adopted a flexible exchange rate with a statutory inflation target at about 2%. Thus, it is interesting to see the impact of fixed exchange rate regime and floating exchange rate regime on domestic price level. The foreign impact on Swedish inflation level might perform through two channels: exchange rate and international price level. Therefore, it would be also interesting to see that by which channel the foreign force affects the Swedish inflation. Error correction mechanism (ECM) has been used in the empirical study.

The impact of regime changes on Swedish economy can be observed by using the data for the period of 1975 -2005 (OECD database) and dividing them into two sub periods; the first sub period covers before 1992-4 and other sub period is the period after 1992-4.

The estimation results show that before adopting the flexible exchange rate, the foreign impact through devaluation and foreign price expressed in foreign currency on domestic inflation was positive. The study shows that devaluation had affected the domestic inflation positively while a change in foreign price in foreign currency had affected it negatively. As the relative strength of the devaluation was higher than that of the foreign price, the impact of foreign force on domestic inflation level was positive. However, import price pass-through to domestic price level was negative. This is somewhat a strange result. Because if the international price level increases, the domestic price level of a relatively open economy, with high import shares, might be increased. However, this is not a strong source of inflation in Sweden as it has the weakest predictive power.

However, after adopting the floating exchange rate, the foreign impact-via depreciation and foreign price expressed in foreign currency on domestic inflation is negative. The estimation results show that exchange rate pass-through is negative while foreign price pass-through is positive. As the relative strength of exchange rate pass-through is higher than that of foreign price pass-through, foreign impact on domestic inflation level is negative.

The study also shows that the leading sources of inflation in Sweden, before regime changes, were real GDP, exchange rate, money supply and the foreign price respectively. However, after regime changes, the leading sources of inflation in Sweden are the exchange rate, import prices, money supply and real GDP respectively

The derived short run inflation equation confirms that, before changing the monetary policy, real economic activity, nominal effective exchange rate and monetary growth affect inflation immediately, whereas the import price expressed in foreign price affects inflation after one quarter. However, the derived short run inflation equation confirms that, after adopting the flexible exchange rate, the impact of monetary growth and import price of goods and services expressed in foreign currency takes place immediately while the impact of real economic activity takes place after one quarter. However, in short run it shows no impact of nominal effective exchange rate.

The rest of the paper is organized as follows. Section 2 presents the empirical study with a discussion of results. Section 3 concludes with key findings.

Empirical Study

Theoretical Model

The study has been conducted by adopting the following model used by Bawumia and Otoo (2003):

$$\Delta p_t = \alpha m_t^s + \beta y_t + \delta e_t + \lambda p_t^f \qquad (3)$$

where,

$\Delta\ p_t$ = Inflation rate in period t,

m_t^s = log of money supply in time t,

y_t = log of GDP in time t,

e_t = Log of exchange rate in time t,

p_t^f = log of import prices of goods and services expressed in foreign currency,

It is expected that m_t^s , p_{t-1} , e_t and p_t^f affect p_t positively while y_t affects p_t negatively. The motivation of using the above equation is explained below.

Firstly, the quantity theory of money states that the central bank can manage the rate of inflation as it has control over money supply. If the central bank increases money supply rapidly, the price level will rise rapidly. If the central bank does not change money supply, the price level might be stable. Thus, there might be a positive relationship between money supply and inflation.

Secondly, money market equilibrium condition is,

$$M_t^{s} = M_t^{d}$$

Thus,

$$M_t / P_t = f(y_t, \pi_t^{e}) \qquad (4)$$

In equation (4), for given values of expected inflation (π_t^{e}) and M_t, a fall in income level reduces the demand for real money balances. This demand is accommodated by a rise in price level to re-establish the equilibrium. Therefore, income level might affect price level negatively.

Thirdly, monetary policy might affect inflation through expected inflation. For example, if monetary authority plans to ease monetary policy then consumers and businessmen might think that it might increase the future price level. Then they might demand higher wages and prices, which will eventually bring inflation in the future (FRB, Sanfransisco, 2006). However, if we take many lags in the long run, then both inflation (Δp_t) and lagged inflation (Δp_{t-1}) would have the same time series data. Thus in the long run, both inflation and lagged inflation would be the same.

Finally, if exchange rate depreciates or foreign price level increases, then domestic price level increases. Therefore, it is expected that money supply, exchange rate and foreign price level affect price level positively while income level affects it negatively. Thus, in the long run, the error correction for inflation (Δp_t) would be:

$$\Delta p_t = f(m_t^{s}, y_t, e_t, p_t^{f}) \qquad (5)$$

and ad hoc specified error-correction mechanism is :

$$\Delta p_t = \alpha m_t^s + \beta y_t + \delta e_t + \lambda p_t^f \qquad (6)$$

Thus it is interesting to see how those factors affect the domestic price level of a small open economy. An error correction model will be used to find those effects.

Econometric Model

Time series data in economics are usually non-stationary. In time series analysis it is generally assumed that time series data are stationary. One can convert non-stationary data to stationary by taking sufficient differences. However, in that case the long run information might be lost. One way of avoiding losing the long run information is cointegration. If economic variables are in the same order, cointegration set can be made (Engle & Granger, 1987). If z_t is I(1) and if x_t is I(1), there is a h such that z_t - h x_t = I(0). More generally, x_t is a p dimensional column vector of exogenous I (1) variables and z_t is described by the following Autoregressive Distributive Lag, ADL (k) process:

$$z_t = \alpha_1 z_{t-1} + \ldots + \alpha_k z_{t-k} + \beta_0' x_t + \ldots + \beta_k' x_{t-k} + \phi' D_t + \varepsilon_t , \qquad (7)$$

where parameters are p dimensional column vectors and D_t collects the deterministic terms. Then the corresponding error correction model is,

$$\Delta z_t = \sum_{i=1}^{k-1} \varsigma_i \Delta z_{t-i} + \sum_{i=0}^{k-1} \gamma_i' \Delta x - \alpha(z_{t-1} - h' x_{t-1}) + \phi' D_t + \varepsilon_t , \qquad (8)$$

where

$\varsigma_i = -\sum_{j=i+1}^{k} \alpha_j, \gamma_0 = \beta_0, \gamma_i = -\sum_{j=i+1}^{k} \beta_j \,(i = 1, \ldots, k-1), \alpha = 1 - \sum_{i=1}^{k} \alpha_i,$
$h = (1/\alpha) \sum_{i=0}^{k} \beta_i,$

and, $\sum_{i=1}^{k-1} \varsigma_i \Delta z_{t-i} + \sum_{i=0}^{k-1} \gamma_i' \Delta x$ is the short-run dynamics, D_t represents seasonal dummies, $\alpha(z_{t-1} - h' x_{t-1})$ is the error correction term which provides us static long run solution, given that the error correction model is stationary.

If the error correction model is I(0), then variables can be cointegrated and we can formulate the error correction model. In that case, regression analysis will be meaningful, and there will be no spurious regression and long run information will be retained. Let, $z_t = \Delta\ p_t$ and x_t = (m_t^s, y_t, e_t, p_t^f), Firstly, equation (6) will be regressed by equation (7) and, then, it will be regressed by error correction model (8)

Data Set

To estimate inflation equation, the quarterly data of Sweden, gathered from OECD, have been used. The time period of data is from 1975 Q-1 to 2005 Q-4.The price level is measured as consumer price index (CPI). M3 is used as a measurement of money supply as it captures the entire money supply in the whole economy (Lerner, 2004). It includes M2 plus large-denomination savings deposits and institutional money-market mutual fund. M3, a measure of inflation, gives us an idea about monetary growth and the big money in the institutions (Chapman, 2005). Income (y_t) is measured as GDP in market prices. The exchange rate (e_t) has been measured by the nominal effective exchange rate. It is a composite index of value of the domestic currency. Formally, the nominal effective exchange rate is the exchange rate of the domestic currency in relation to other currencies weighted by their share in the foreign trade of domestic country (OECD). Because of the unavailability of data for foreign prices expressed in foreign currency (p_t^f), Import prices of goods and services, local currency have been used as proxy variable. This proxy variable has been converted into foreign prices by using the nominal effective exchange rate. In this paper five series will be considered, they are, Δp_t = Inflation rate, (i.e. first difference of log of CPI), m_t^s = Log of money supply, y_t = Log of GDP, e_t =Log of nominal effective exchange rate, p_t^f = Log of import prices of good and services expressed in foreign currency(proxy variable).

The Dickey-Fuller (DF) and the Augmented Dickey – Fuller tests (ADF) have been used to test the level of integration. In the ADF test, the null hypothesis states that the time series variable has a unit root, this is, it is not stationary and the alternative hypothesis states that the time series variable does not have a unit root. However, if ADF rejects the null hypothesis but the beta Y_1 is over 0.80, the variable is considered non-stationary. Also graphs and correlogram test play an important role to see the stationary.

In practice, economic variables are (almost) never integrated of higher order than two. Consider a variable x. If the test of Δ x reveals that the null hypothesis is not rejected, Δ x is said to be integrated of order 1(or, Δ x is I (1)). That is, the first difference of Δ x is stationary. In other words, the second difference of x is stationary, that is, x is I (2). However, if the test of Δ x reveals that the null hypothesis is rejected, we have to find out whether x is I (1) or I (0). For example, if the stationary test of x reveals that null hypothesis is not rejected, x is I (1) that is, the first difference of x is stationary. However, if test of x by ADF reveals that null is rejected then x is I (0).The test of the unit root of each variable shows that all variables including inflation are integrated in the same order, that is, they are I (1) (Table 1). The details of stationary test have been mentioned in the appendix (Table1 to Table 3)

TABLE 1. The Time Series Property of the Variables[2]

Variables	Sample (1975-1 to 2005-4)	Sub-sample 1 (1975-1 to 1992-3)	Sub-sample-2 (1993-1 to 2005-4)
$\Delta\ p_t$	I(1)	I(1)	I(1)
y_t	I(1)	I(1)	I(1)
m_t^s	I(1)	I(1)	I(1)
e_t	I(1)	I(1)	I(1)
p_t^f	I(1)	I(1)	I(1)

Thus cointegration set can be built.

[2] In sample for period 1975-1 to 2005-4, (a) y_t is trend stationary (b) beta Y_1 value of p_t^f is close to 1 which reveals that null is not rejected. That is, it is I(1) (see table 1 in the appendix)

In Sub-sample 2, ADF test of m_t^s reveals that it is I (2) (see table 2 in the appendix). But from correlogram test it is clear that it is stationary (see Figure 5 in the appendix). So for practical reason it can be considered as I(1)

Results and Discussions

After doing the lag structure analysis by using the PCGive computer software, equation (7) was estimated by OLS where $z_t = \Delta\ p_t$ and $x_t = (m_t^s, y_t, e_t, p_t^f)$. In the lag structure analysis, the null-hypothesis (a model with a lagged term is a sub model of the general model) is tested. If diagnostic checking shows the existence of normality and non-existence of AR and ARCH problem, cointregration can be tested by using the static long run solution. If the error term is I (0), then the system is said to be cointegrated. Thus, cointegration between the variables can be found and, then, error correction model can be formulated. Thus, ECM in equation (8), can be estimated by taking the first difference of all variables. The parsimonious form of the model can be determined by dropping out the variables that appear to be insignificant. At each stage, the diagnostic test has been performed. By this way the parsimonious form of ECM has been achieved.

Analysis for the Period of 1975-1 to 2005-4

From analysis of lag structure, it turns out that 2 lags are needed. The hypothesis testing of insignificant of lag showing that P value for lag 3 is 0.5581. The remaining lags are significant. The lag structure analysis does not always give the correct answer. It is an F-test, which sometimes goes wrong. In this case, it concluded the third lag is not needed, when in fact it is needed. It can help in determining the number of lags, but sometimes it gives the inappropriate answer. This we found out by getting the misleading information in case of money supply. Regressing the ADL (k=3) (equation 7) by OLS, where $z_t = \Delta\ p_t$ and $x_t = (m_t^s, y_t, e_t, p_t^f)$, yields no problem of AR, and ARCH and normality has also been accepted (see table 5, model 7 in the Appendix). Dummy variable for the period 1992-4 has been used as D. The static long run solution is,

$$\Delta p_t = -0.619 + \underset{(1.19)}{0.021} y_t + \underset{(0.09)}{0.004} m^s{}_t + \underset{(1.22)}{0.062} e_t + \underset{(0.23)}{0.006} p^f{}_t - \underset{(0.944)}{0.0003} T$$

Where $\Delta\ p_t$ = Inflation rate in period t, y_t = log of GDP in time t, m_t^s = log of money supply in time t, e_t = Log of exchange rate in time t,

$p_t^{\,f}$ = log import prices of goods and services expressed in foreign currency and T = trend variable. Here, significance level is less informative as variables are I(1).

As the error correction term in equation (8) is found trend- stationary (See Appendix, table 4, Fig 6), error correction model can be built as there is a valid cointegration relationship. By taking the first difference of all variables in equation (8), where $z_t = \Delta\ p_t$ and $x_t =$ $(m_t^{\,s}, y_t, e_t, p_t^{\,f})$:

$$\Delta^2 p_t = -0.011 - \underset{(6.15)}{0.524}\Delta^2 p_{t-1} - \underset{(2.69)}{0.239}\Delta^2 p_{t-2} + \underset{(4.53)}{0.22}\Delta y_t + \underset{(1.97)}{0.10}\Delta y_{t-1} + \underset{(0.49)}{0.026}\Delta y_{t-2} + \underset{(0.60)}{0.015}\Delta m_t^s +$$

$$\underset{(2.77)}{0.07}\Delta m_{t-1}^s - \underset{(1.00)}{0.025}\Delta m_{t-2}^s + \underset{(2.64)}{0.12}\Delta e_t - \underset{(1.21)}{0.05}\Delta e_{t-1} + \underset{(3.36)}{0.15}\Delta e_{t-2} + \underset{(3.62)}{0.093}\Delta p_t^f + \underset{(0.11)}{0.002}\Delta p_{t-1}^f$$

$$+\underset{(1.99)}{0.05}\Delta p_{t-2}^f - \underset{(4.18)}{0.21}ecm_{t-1} + 0.014D$$

AR=0.14 ARCH=0.73 Chi square Normality= 0.24

In this model, there is no AR, ARCH problem and normality is also accepted. The above equation can be reduced by imposing zero restrictions on variables that appear to be insignificant:

$$\Delta^2 p_t = -0.010 - \underset{(6.5)}{0.53}\Delta^2 p_{t-1} - \underset{(3.16)}{0.24}\Delta^2 p_{t-2} + \underset{(4.86)}{0.23}\Delta y_t + \underset{(2.04)}{0.09}\Delta y_{t-1} + 0.06\Delta m_{t-1}^s - \underset{(0.95)}{0.02}\Delta m_{t-2}^s$$

$$(2.77)$$

$$+\underset{(2.74)}{0.13}\Delta e_t - \underset{(2.47)}{0.06}\Delta e_{t-1} + \underset{(3.62)}{0.16}\Delta e_{t-2} + \underset{(3.85)}{0.09}\Delta p_t^f + \underset{(2.19)}{0.05}\Delta p_{t-2}^f - \underset{(4.84)}{0.19}ecm_{t-1} + 0.14D$$

From the test of model reduction, it is clear that the null hypothesis (equation (i+1) is a sub model of equation (i)) is not rejected. So, the reduced model is a sub model of the original model.

Thus, from the estimated model it can be said that short run changes in GDP, money supply, lagged inflation, exchange rate and import prices have significant effect on inflation. These results show that short run changes in variables on the right hand side have significant effect on the inflation rate and that about 0.19 of the discrepancy between the actual and the long-run, or equilibrium, the value of inflation is eliminated or corrected each quarter.

However, there was chaos in the Swedish economy at the end of 1992, especially in 1992-4.The Swedish Krona was pegged at fixed foreign exchange rate before 1992-4. A floating exchange rate was adopted on 19 November 1992 and the Krona depreciated by 20%. The market interest rate also fell. Monetary policy also changed with the floating exchange rate. In 1993, the Riksbank defined its monetary policy objective and introduced an inflation targeting regime. Its objective is to maintain a stable price level – maintaining the inflation rate with the tolerance of more or less than 1%. (Svante Öberg, 2006). Thus, we may observe the impact of the policy change on Swedish economy by dividing the periods into two sub periods; one is before 1992-4 and the other is after 1992-4.

Analysis for the Period of 1975-1 to 1992-3

All the variables are I (1) (Table 1). Lag structure analysis does not give any indication that how many lags would be necessary. Thus, we started the test by taking 3, 4, 5 lags and in every case they show the same relation between the variables. This is true for both sub-samples.

Regressing the ADL (k=4) (equation 7) by OLS, where $z_t = \Delta\, p_t$ and $x_t = (m_t^{\,s}, y_t, e_t, p_t^{\,f})$ yield no problem of AR., ARCH and normality has been accepted (See Appendix, Table 6, model 7). The static long run solution is,

$$\Delta p_t = -2.27 + \underset{(0.95)}{0.097 y_t} + \underset{(1.02)}{0.050 m^s{}_t} + \underset{(1.21)}{0.0832 e_t} - \underset{(0.46)}{0.018 p^f{}_t} - \underset{(1.03)}{0.0025T}$$

From the above equation, it is clear that all the variables except income level and proxy variable influence inflation level according to the theory. Here, significance level is less informative as variables are I(1).

The error correction term in equation (8) has been found stationary (Table 4 in the appendix). Error correction model can be built, as there is a valid cointegration relationship, by taking the first difference of all variables, and then the equation (8), where $z_t = \Delta\ p_t$ and $x_t = (m_t^{\,s}, y_t, e_t, p_t^{\,f})$ is:

$$\Delta^2 p_t = -0.007 - \underset{(4.71)}{0.69\Delta^2 p_{t-1}} - \underset{(1.97)}{0.33\Delta^2 p_{t-2}} + \underset{(0.44)}{0.065\Delta^2 p_{t-3}} + \underset{(3.66)}{0.27\Delta y_t} + \underset{(1.84)}{0.169\Delta y_{t-1}} - \underset{(1.63)}{0.15\Delta y_{t-2}}$$

$$- \underset{(1.58)}{0.13\Delta y_{t-3}} - \underset{(1.13)}{0.05\Delta m_t^s} + \underset{(0.208)}{0.01\Delta m_{t-1}^s} + \underset{(0.57)}{0.028\Delta m_{t-2}^s} - \underset{(1.45)}{0.06\Delta m_{t-3}^s} + \underset{(1.64)}{0.13\Delta e_t} + \underset{(0.78)}{0.07\Delta e_{t-1}} + \underset{(0.99)}{0.09\Delta e_{t-2}}$$

$$+ \underset{(1.06)}{0.09\Delta e_{t-3}} + \underset{(2.10)}{0.09\Delta p_t^f} + \underset{(1.37)}{0.062\Delta p_{t-1}^f} - \underset{(0.14)}{0.007\Delta p_{t-2}^f} + \underset{(0.92)}{0.04\Delta p_{t-3}^f} - \underset{(1.06)}{0.03ecm_{t-1}}$$

AR=0.49 ARCH=0.65 Chi square Normality= 0.45

In this model, there is no AR, ARCH problem and Normality is also accepted. The above equation can be reduced by imposing zero restrictions on variables that appear to be insignificant. The reduced model is,

$$\Delta^2 p_t = -0.008 - \underset{(5.15)}{0.69\Delta^2 p_{t-1}} - \underset{(2.64)}{0.34\Delta^2 p_{t-2}} + \underset{(3.77)}{0.25\Delta y_t} + \underset{(2.34)}{0.19\Delta y_{t-1}} - \underset{(1.09)}{0.88\Delta y_{t-2}} - \underset{(1.34)}{0.09\Delta y_{t-3}}$$

$$- \underset{(1.70)}{0.66\Delta m_t^s} - \underset{(1.47)}{0.036\Delta m_{t-3}^s} + \underset{(1.87)}{0.14\Delta e_t} - \underset{(1.08)}{0.05\Delta e_{t-3}} + \underset{(2.38)}{0.09\Delta p_{t-1}^f} + \underset{(1.25)}{0.02\Delta p_{t-1}^f} - \underset{(1.40)}{0.36ecm_{t-1}}$$

The test of model reduction ensures that the reduced model is a sub model of the original model. These results show that short run changes in variables on the right hand side have a significant effect on the inflation rate and that about 0.36 of the discrepancy between the actual and the long run, or equilibrium, the value of inflation is eliminated or corrected each quarter. Finally, see the results for period 1993-1 to 2005-4.

Analysis for the Period of 1993-1 to 2005-4

All the variables are I (1) as in table 1. Regression of model (7), where $z_t = \Delta\, p_t$ and $x_t = (m_t^{\;s}, y_t, e_t, p_t^{\;f})$, by taking 3 lags, shows that there is no AR problem and normality has also been accepted (Table 7,model 7 in the appendix).

The following static long run solution has been found:

$$\Delta p_t = 1.07 + \underset{(0.48)}{0.0187\, y_t} + \underset{(2.47)}{0.07 m^s{}_t} - \underset{(0.75)}{0.26 e_t} + \underset{(0.77)}{0.17\, p^f{}_t} - \underset{(2.15)}{0.001T}$$

From the above equation, it is clear that all the variables except exchange rate and income level influence inflation level according to the theory. Here, significance level is less informative as variables are I (1).

The error correction term in equation (8) has been found stationary (Table 4 in the appendix). Error correction model can be built, as there is a valid cointegration relationship, by taking the first difference of all variables, and then equation (8), where $z_t = \Delta p_t$ and $x_t = (m_t^s, y_t, e_t, p_t^f)$. This model contains no problem of AR, ARCH. Normality has also been accepted:

$$\Delta^2 p_t = 0.32 + \underset{(1.32)}{0.21\Delta^2 p_{t-1}} + \underset{(0.62)}{0.065\Delta^2 p_{t-2}} - \underset{(0.23)}{0.015\Delta y_t} + \underset{(1.12)}{0.075\Delta y_{t-1}} - \underset{(1.02)}{0.06\Delta y_{t-2}}$$

$$+ \underset{(1.93)}{0.08\Delta m_t^s} - \underset{(2.94)}{0.18\Delta m_{t-1}^s} + \underset{(1.90)}{0.88\Delta m_{t-2}^s} + \underset{(0.55)}{0.02\Delta e_t} - \underset{(0.42)}{0.02\Delta e_{t-1}} - \underset{(0.23)}{0.014\Delta e_{t-2}} + \underset{(1.41)}{0.04\Delta p_t^f}$$

$$- \underset{(1.49)}{0.05\Delta p_{t-1}^f} + \underset{(0.07)}{0.002\Delta p_{t-2}^f} - \underset{(4.89)}{1.30 ecm_{t-1}}$$

AR=0.31 ARCH=0.97 Chi square Normality= 0.11

The reduced model is,

$$\Delta^2 p_t = 0.190 + \underset{(1.36)}{0.12\Delta^2 p_{t-1}} + \underset{(1.31)}{0.066\Delta y_{t-1}} - \underset{(1.46)}{0.068\Delta y_{t-2}} + \underset{(2.29)}{0.84\Delta m_t^s} - \underset{(3.75)}{0.17\Delta m_{t-1}^s} + \underset{(2.12)}{0.07\Delta m_{t-2}^s}$$

$$+ \underset{(2.32)}{0.02\Delta p_t^f} - \underset{(2.29)}{0.02\Delta p_{t-1}^f} - \underset{(6.16)}{1.16 ecm_{t-1}}$$

The test of model reduction shows that the reduced model is a sub model of the original model.

The results show that the short run changes in variables on the right hand side have significant effect on the inflation rate and that about 1.16 of the discrepancy between the actual and the long-run value of inflation is eliminated or corrected each quarter.

By using the error correction mechanism for estimating the leading sources of inflation in Sweden and to see the impact of regime change, a static long run equilibrium relationship have been found between inflation, money supply, real GDP, exchange rate and import price for each sample period. This is consistent with other studies (Bawmia and Otoo, 2003; Zavkiev, 2005; Brower and Ericsson, 1995) where ECM is used to estimate the inflation process for different countries. Those studies contain different variables but a long run equilibrium solution has been found in each case.

The derived short run inflation equation, for the period of 1975-1 to 2005-4, confirms that the impact of real economic activity, depreciation and price of imported goods and services on inflation take place immediately while the impact of money supply takes place after one quarter. The derived static long run solution (1975-1 to 2005-4) show that there is an equilibrium long run relationship between the money supply, the exchange rate, the real economic activity and the import prices of goods and services. According to theory, the results reveal that inflation in Sweden is positively related to money supply, exchange rate, and import prices of goods and services.

The estimation results show that during the fixed exchange rate regime, the foreign impact –via devaluation and the foreign price expressed in foreign currency-on domestic price inflation was positive. The exchange rate had a positive impact while the foreign price had a negative impact on domestic price level. As the relative strength of the exchange rate was stronger than that of the international price, the foreign impact on Swedish inflation was positive.

However, after adopting the floating exchange rate, the foreign impact on Swedish inflation level is negative. The study shows that exchange rate pass-through is negative while foreign price pass-through is positive. As the relative strength of exchange rate pass-through is higher than that of foreign price pass-through on domestic inflation level, the foreign impact on domestic inflation is negative. However, McCarthy (2000) analyzes the impact of exchange rate and import prices on domestic PPI and on CPI in selected industrialized countries like United States, Japan, Germany, France, United Kingdom, Belgium, Netherlands, Sweden, and Switzerland. He finds that exchange rate has a moderate impact on domestic price inflation, but import price has a stronger effect on inflation.

It has been mentioned earlier that exchange rate pass-through is negative after adopting flexible exchange rate policy. The interference of the central bank via interest rate to maintain a low inflation rate might be an explanation for this. The study of Gagnon and Ihrig (2004) finds that exchange rate pass through to domestic price level generally declined in many countries including Sweden since the 1990s. They argue that the role of central bank plays an important role in this case as the central bank intended to maintain a low inflation level or tight monetary policy from the 1990s.

The study also confirms that the price of imported goods and services plays an important role to determine the domestic price level as the import price has the second highest predictive power for explaining the inflation in Sweden. Thus if the import price is lower, domestic price level will be lower. This is consistent with the report of Riksbank (2005). It reports that low imported inflation is one of the causes for a low inflation regime in Sweden.

The estimating results indicate the leading indicators for inflation in Sweden. However, before the change in the exchange rate policy, real GDP was the strongest indicator of inflation in Sweden. Exchange rate, money supply and import price were the second, third and fourth strongest indicator respectively. After change in policy, the long run exchange rate elasticity of prices is 0.26 which shows that exchange rate has the highest predictive power of inflation in Sweden. The import price elasticity of prices is the second highest among all explanatory variables (0.17). Money supply and real GDP have some predictive power on inflation. Thus, the results contradict with the findings of Baumgartner, Ramaswamy and Zettergren (1997). They find narrow money is the strongest indicator and broad money is a stronger indicator of inflation in Sweden. They also find that exchange rate has no predictive power for inflation in Sweden. However, the result shows that the exchange rate is one of the important indicators of inflation in Sweden.

However, the study shows that inflation is positively related to real economic activity, for the whole sample and for two sub-sample also, which violets the theory. This is consistent with the inflation report of Riksbank (2005, 1). It reports that lower GDP is one of the domestic factors for lower inflation in Sweden. The output gap (Actual GDP-Potential GDP) in Swedish economy might be negative which put the downward pressure on inflation. Thus, it reveals that there is a positive relationship between inflation and GDP. Thus, the output gap might have an explanatory power for the lower inflation in Sweden. However, the study did not measure the marginal cost based NKPC or the output gap based NKPC like Holmberg (2006), Gali and Gertler (1999) to get a comparative result. They find that marginal cost based NKPC has better explanatory power to explain the inflation in Sweden.

Conclusions

The estimation in this study suggests that after adopting the flexible exchange rate policy, the foreign impact on Swedish inflation is negative as the impact of negative exchange rate pass through is stronger than that of positive import price pass-through. Before policy change, the result was just opposite, as the impact of positive exchange rate pass through was stronger than that of negative import price pass-through. Exchange rate pass-through in Sweden is negative; import price pass-through is positive. Moreover, because of stronger negative exchange rate pass-through, the foreign impact on Swedish inflation is negative. Before policy change, inflation was positively affected by the exchange rate and negatively affected by the foreign price expressed in foreign currency. As the effect of devaluation was stronger than that of the foreign price, the foreign impact on Swedish inflation was positive.

The study also suggests that after regime changes, the exchange rate is the strongest leading source of inflation in Sweden, the import price contains the second highest predictive information on the targeted measure of inflation in Sweden. Real GDP and money supply have some predictive power. Before policy change, real GDP was the strongest indicator whereas the exchange rate had the second highest predictive power.

However, there are some limitations of the study. The model does not include all variables affecting inflation in Sweden. They are interest rates, credit aggregate, implied forward rates, marginal cost, CBI etc. So, the findings may not be conclusive. Nevertheless, it has important policy implications. It gives the signal to policy maker how they should react to the fundamentals of price stability. The growth rate of money supply and the growth of real economic activity are inflationary. The exchange rate pass through is very low and even negative, thus, it is very low inflationary. Import price growth is inflationary. Thus, import from low-cost countries would be helpful to stabilize the price level. Therefore, monetary authority should consider those fundamentals in their policy making. Further research is needed to investigate the policy impact on Swedish inflation by using the alternative models such as the mark-up model, monetary model or Phillips curve model.

AUTHOR NOTES

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APPENDICES

TABLE 1. Unit root test of variables, sample period: 1975-1 to 2005-4]

Variables	D-lag	t-adf	beta Y_1
$\Delta\ p_t$	3	-1.721	0.86308
$\Delta\ m_t^s$	6	-4.921*	-0.33901
m_t^s	6	-2.621	0.98762
$\Delta\ y_t$ (with trend)	2	-5.157*	0.02678
y_t	3	-1.194	0.98745
$\Delta\ e_t$	1	-7.410*	0.14082
e_t	1	-2.559	0.94771
$\Delta\ p_t^f$	1	-7.178*	0.14447
p_t^f	0	-2.908*	0.97097

TABLE 2. Unit root test of variables, sample period: 1975-1 to 1992-3

Variables	D-lag	t-adf	beta Y_1
$\Delta\ p_t$	5	-2.729	0.49
$\Delta\ m_t^s$	3	-1.949	0.35
$\Delta\ y_t$	1	-4.72**	-0.032
y_t	1	-2.61	0.98
$\Delta\ e_t$	0	-6.2*	0.22
e_t	4	-2.31	0.93
$\Delta\ p_t^f$	0	-6.946**	0.177
p_t^f	0	-6.086	0.95

'*' and '**' denote 5% and 1% level of significance respectively.

TABLE 3. Unit root test of variables, sample period: 1993-1 to 2005-4

Variables	D-lag	t-adf	beta Y_1
$\Delta\ p_t$	4	-2.855	0.24
$\Delta\ m_t^s$	5	-4.76	0.96
m_t^s	6	-8.301	0.99
$\Delta\ y_t$	1	-5.46**	-0.35
y_t	2	-0.80	0.99
$\Delta\ e_t$	4	-7.37**	0.20
e_t	1	-2.80	0.76
$\Delta\ p_t^f$	0	-5.76**	0.13
p_t^f	0	-1.036	0.91

TABLE 4. Unit root test ECM

Sample period	Lag	t-adf	Be t a Y_1	Results
1975-1 to 2005-4	5	-4.740**	0.22978	I(0)
1975-1 to 1992-3	5	-4.730**	-0.15	I(0)
1993-1 to 2005-4	5	-4.50**	-1.09	I(0)

TABLE 5. Test Diagnostics

Test	Model (7)
AR	0.26
ARCH	0.37
Chi square Normality	0.13

TABLE 6. Test Diagnostics

Test	Model (7)
AR	0.89
ARCH	0.16
Chi square Normality	0.83

TABLE 7. Test Diagnostics

Test	Model (7)
AR	0.40
ARCH	0.99
Chi square Normality	0.06

FIGURE 1. Inflation rate in Sweden, 1975-1 to 2005-4

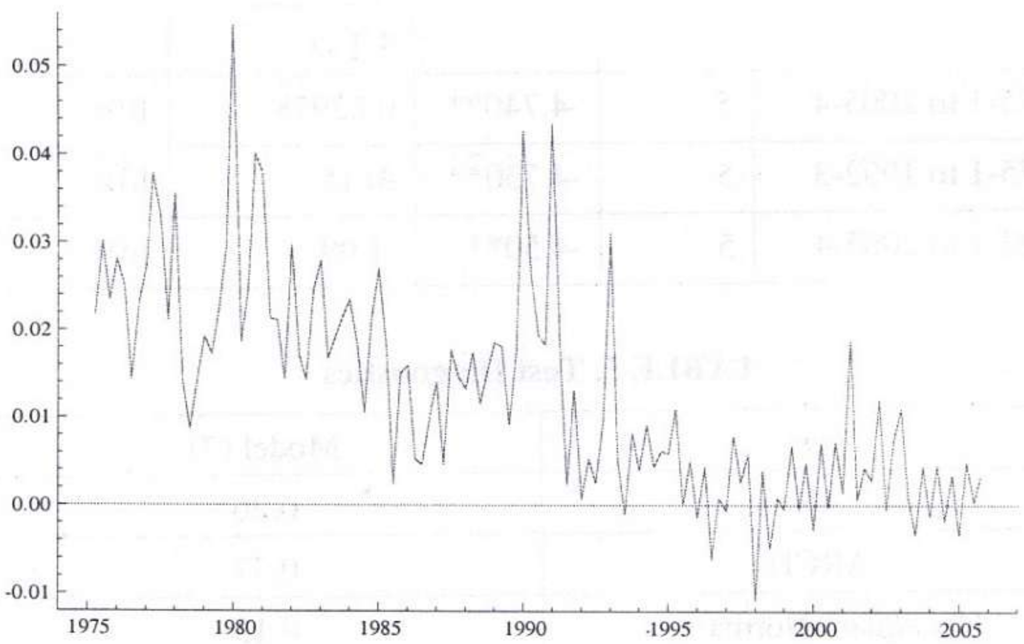

FIGURE 2. First difference of money supply Δm_t^s (upper) and money supply m_t^s (SEK millions) (lower) in Sweden, 1975-1 to 2005-4

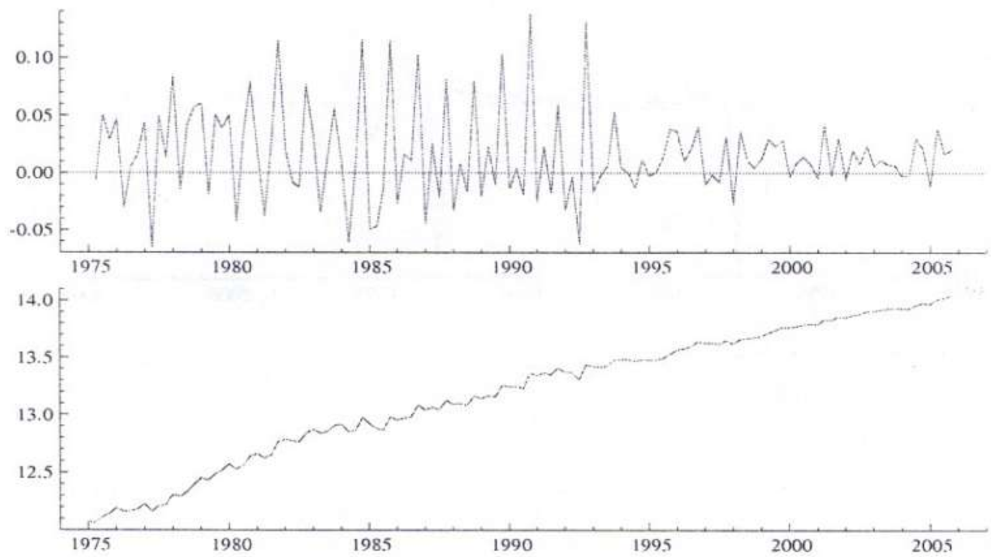

FIGURE 3. First difference of log of GDP (upper) and log of GDP (millions of SEK) (lower) in Sweden, 1975-1 to 2005-4

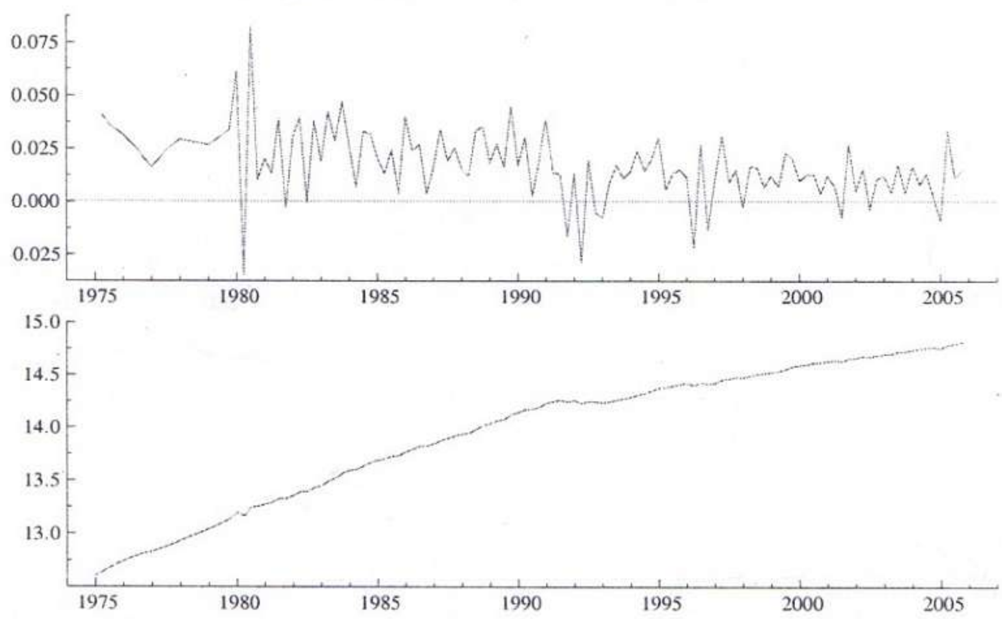

FIGURE 4. First difference of nominal effective exchange rate (upper) and nominal effective exchange rate (SEK/USD) (Lower) in Sweden, 1975-1 to 2005-4

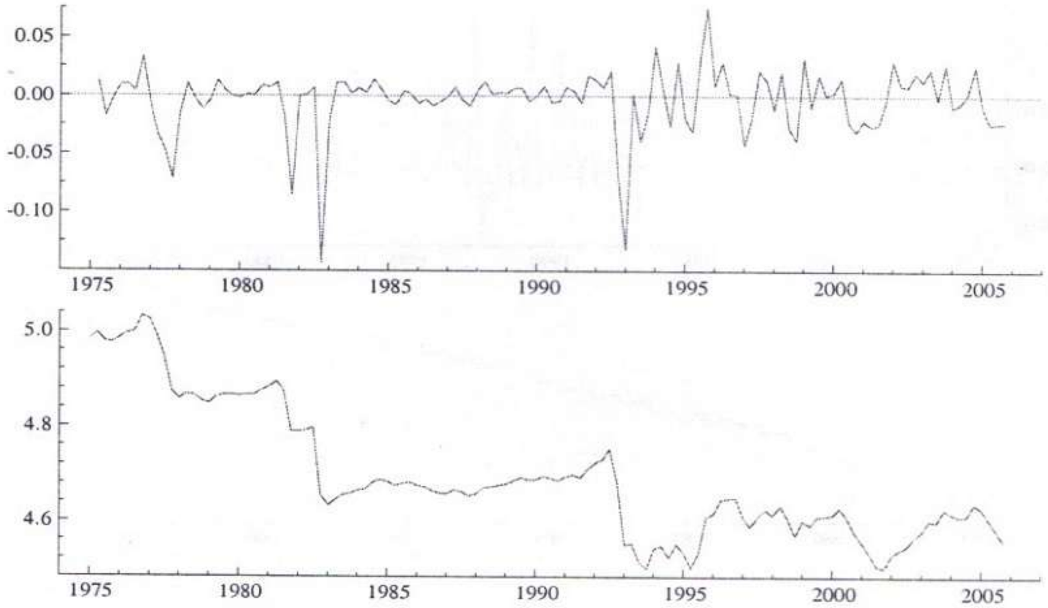

FIGURE 5. First difference of p_t^f (upper) and p_t^f (Millions in USD) (lower) in Sweden, 1975-1 to 2005-4

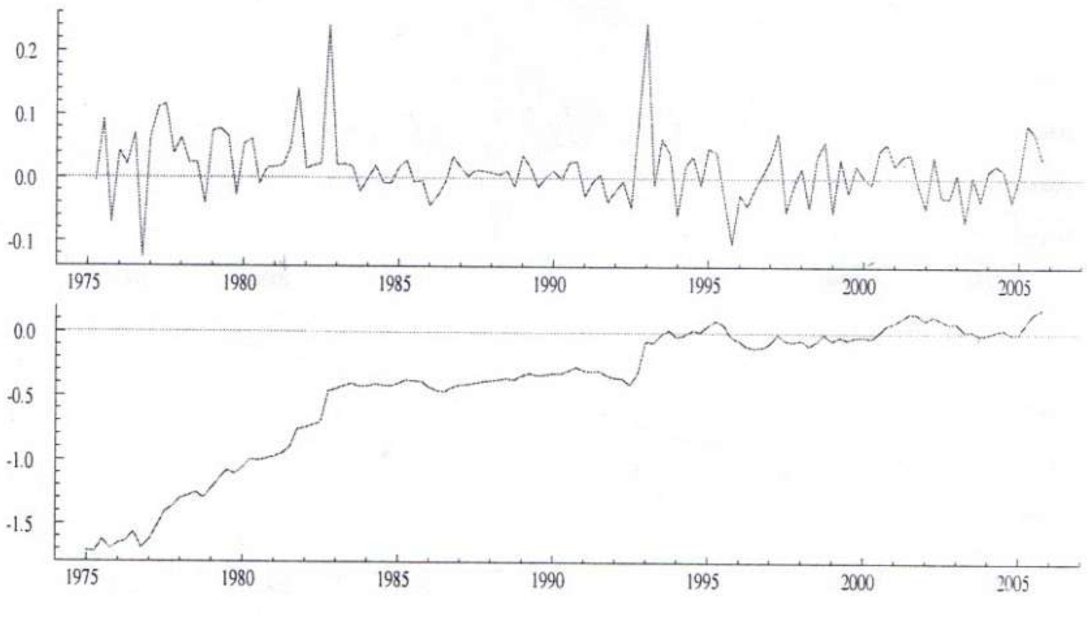

FIGURE 5. Correlogram test of money supply in Sweden from 1975-1 to 1992-3

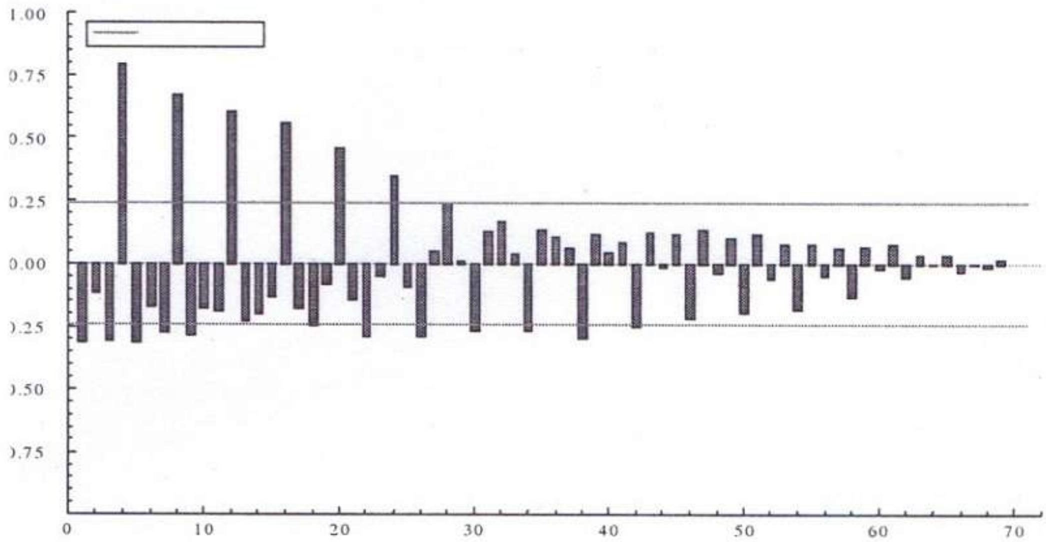

FIGURE 6. Error Correction Model (ECM)