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Exchange Rate Regimes and Macroeconomic Stability: The Case of Sweden^{*}

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Abstract

In this paper I investigate the relevance of the exchange rate regime for macroeconomic stability. I simulate hypothetical macroeconomic developments under different hypothetical regimes in Sweden during the period 1974-1994. The main question is how stable output would have been if Sweden had had a floating exchange rate regime. Would it have been better with a floating exchange rate than the actual quasi-fixed regime? Also the development with an irrevocably fixed exchange rate is investigated. The results indicate that the central bank can stabilize much of the macroeconomic disturbances under a floating exchange rate, but still the volatility of the macroeconomic variables under the hypothetical floating exchange rate regime is about the same as under the actual quasi-fixed regime.

Keywords: Exchange rate regimes, macroeconomic stability, monetary policy.

JEL Classification: E52, F31, F41.

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1. Introduction

According to the classical model in international macro constructed by Robert Mundell and Marcus Fleming in the sixties, the central bank can pursue an active monetary policy under a floating exchange rate regime, in such a way that the exchange rate and the interest rate have a stabilizing effect on the economy. This principal argument is generally accepted, but the judgment of how important it in reality is, still remains an open question.

While it is obvious that the central bank can stabilize the economy under a floating exchange rate in the simple textbook model, the situation is more complex in practice (see e.g. Obstfeld and Rogoff (1996)). *First*, the central bank takes its decisions under imperfect information and monetary policy affects the economy with a lag. According to traditional macroeconomic theory, price and wage adjustments tend to stabilize the economy. This implies that the significance of the fact that the central bank can pursue an active monetary policy under a floating exchange rate regime depends on how quickly it can react, and how quickly the monetary policy affects the economy, as compared to how quickly wages and prices adapt. *Second*, stabilizing output is not the only target of the central bank; in fact an inflation target is often assigned as its most important target. *Third*, there may be some uncertainty about the monetary policy of the central bank, which in itself generates destabilizing exchange rate movements (overshooting).

This leads to several questions. Can we quantitatively say anything about the importance of the exchange rate for macroeconomic stability? What do we know empirically about the influence of the exchange rate on the economy? Is the basic proposition that the central bank can stabilize the economy under a floating exchange rate regime still valid, once we allow for reasonable lags in the implementation and effects of policy? ¹

¹A small, but growing part of the literature considers such questions. See, for instance, Svensson (2000), Clarida, Gali and Gertler (1998), (2001), Taylor (1999), Ghosh, Gulde, Ostry and Wolf (1997), Ball (1999), Batini and Haldane (1999), Gali and Monacelli (2002), Rotemberg and Woodford (1999) and Söderlind (2001).

To shed some light on these questions, I will construct a simple model assumed to be stable across exchange rate regimes, and then simulate the hypothetical macroeconomic development under alternative exchange rate regimes in Sweden in the period 1974-1994. In that period, Sweden had a quasi-fixed exchange rate regime, where the Swedish currency was tied to various currencies and baskets of currencies, with three devaluations in 1976-1977, two devaluations at the beginning of the 1980's and finally, the large depreciation in November 1992 leading to the float of the krona (see Figure 1).² This actual regime will be compared to two hypothetical regimes: *first* a floating exchange rate regime and *second*, an irrevocably fixed exchange rate. Under the floating exchange rate regime, I assume that we have an independent central bank carrying out a credible monetary policy. In the latter case, five different fixed exchange rate regimes are considered; I consider both the case when the Swedish krona is fixed to a weighted basket of currencies and the cases when it is fixed to four different currencies.

The exercise of comparing the macroeconomic development under alternative exchange rate regimes is interesting, because it provides answers to questions like:

- 1) How important is the exchange rate regime for macroeconomic stability, is the development about the same under the three regimes or does it substantially deviate between different exchange rate regimes?
- 2) What is quantitatively the central bank's possibility to stabilize the economy under a floating exchange rate regime?
- 3) Was the actual quasi-fixed exchange rate regime optimal from a stability point of view?

The results of my study indicate that under a floating exchange regime, the central bank can stabilize much of the macroeconomic shocks. Still, compared to the actual development, output volatility is only somewhat lower under the simulated floating exchange rate regime when the central bank has no information lags and is only interested in output stability. More precisely, under the simulated floating exchange rate regime, the central bank must pay a very high "price" in terms of volatility in exchange

²In this paper, a quasi-fixed exchange rate means a fixed exchange rate regime with a number of devaluations.

rate and prices to reach the same output stability as under the actual regime. This implies that the actual policy with a fixed exchange rate and a number of devaluations was quite successful from an output stability point of view; the devaluations were well timed in relation to the business cycle. As pointed out by Edin and Vredin (1993), Sweden tends to devalue when the economy goes into a recession. Finally, the outcomes under the hypothetical fixed exchange rate regimes are more volatile than under both the actual and the hypothetical floating exchange rate regime.

The rest of the paper is organized as follows. In the next section, I present the theoretical model. In section 3, I describe the data and estimate the model. The potential of monetary policy to stabilize output is examined in section 4. In section 5, sensitivity analyses are performed and the case with a fixed exchange rate regime is discussed in section 6. Finally, I discuss the results and draw some conclusions in sections 7 and 8.

2. The Model

The purpose of this paper is to investigate the hypothetical development under different exchange rate regimes, so I need a flexible model of the economy that works independently whether we have a fixed, a quasi fixed or a floating exchange rate. I consider a small open economy model, similar to those of Batini and Haldane (1999) and Svensson (2000). The model is quarterly and all variables (except the interest rate) are measured in logs as deviations from steady state. Aggregate demand for domestically produced goods in period t is given by:

$$y_t = \bar{b}q_{t-s} + \bar{t}y_{t|t-s} - \bar{g} \sum_{t=0}^{\infty} (r_{t+t-s|t-s} - \bar{r}) + \bar{h}_t. \quad (1)$$

Here, for any variable x , $x_{t|t-s}$ denotes the rational expectation of x_t conditional on all information available at time $t-s$.³ r_t is the short real interest rate and \bar{r} the natural (long-run mean) short interest rate. Thus, the aggregate demand depends on the sum of current and expected future deviations of the real interest rate from its mean. There is a

³Equation (1) is derived with some micro foundations presented in appendix A

decision/planning horizon of s periods, so that the interest rate affects the economy with a lag of s periods. The variable q_t is the real exchange rate, defined as

$$q_t = e_t + p_t^* - p_t, \quad (2)$$

where e_t is the exchange rate, p_t^* the foreign price level and p_t the domestic CPI price level. The real exchange rate affects the economy with a lag of s periods, since the market shares in the international market adjust slowly to changes in relative prices (see e.g. Gottfries (2002)). \hat{b} is a measure of how sensitive real output is to changes in the real exchange rate.

The parameter \mathbf{t} captures the effect of fiscal policy stabilization. If fiscal policy were fully flexible, it would be possible to minimize a loss function and find the optimal fiscal policy rule. Such flexibility in fiscal policy seems unrealistic, however, given fiscal policy decision lags, political negotiations etc. (see e.g. Alesina and Perotti (1995), and Ohlsson and Vredin (1996)). I therefore adopt the following reaction function for government expenditure:

$$g_t = \mathbf{t}y_{t-s} + \mathbf{h}_t^g, \quad (3)$$

where g_t is government expenditure (measured as deviations from the steady state), and \mathbf{h}_t^g is a vector of other variables influencing fiscal policy (e.g. elections and government ideology) that are assumed to be independent of the monetary policy regime. The parameter \mathbf{t} is a measure of how sensitive government expenditure is to changes in the output gap. Fiscal policy is assumed to be the same under different monetary policy regimes. Equation (3) may be considered as an active fiscal policy, where fiscal policy responds to the level of activity (represented by the output gap). Alternatively, equation (3) may be considered as a representation of a passive fiscal policy with automatic stabilization, where \mathbf{t} is the degree of automatic stabilization. \mathbf{t} in equation (1) is equal to $n_2\mathbf{t}$, where n_2 is the share of public demand in total aggregate demand.

The term $\hat{\mathbf{h}}_t$ is a vector of exogenous variables, for example, changes in foreign output, fiscal policy and domestic preference shocks that are independent of the

domestic monetary policy regime. Thus, $\hat{\mathbf{h}}_t$ captures everything affecting the output gap, except influences from monetary policy and fiscal policy stabilization.

I assume that the uncovered interest parity condition (UIP) holds, which implies that the real interest parity condition

$$r_t - r_t^* = q_{t+1|t} - q_t, \quad (4)$$

holds, where r_t^* is the foreign short real interest rate and $q_{t+1|t} - q_t$ is the expected relative change in the real exchange rate.⁴ Note that q_t and the sum of the current and expected future deviations of the real interest rate are closely related. By equation (4), we have (assuming $\lim_{t \rightarrow \infty} q_{t+t|t} = 0$),

$$\begin{aligned} \sum_{t=0}^{\infty} (r_{t+t|t} - \bar{r}) &= \left(\sum_{t=0}^{\infty} (r_{t+t|t}^* + q_{t+t+1|t} - q_{t+t|t} - \bar{r}) \right) \\ &= \sum_{t=0}^{\infty} (r_{t+t|t}^* - \bar{r}) - q_t. \end{aligned} \quad (5)$$

Hence, the only reason for the domestic sum of the current and expected future real interest rates to deviate from the foreign sum of the current and expected future real interest rates is that the real exchange rate deviates from the equilibrium level. Substituting in the new expression for the interest term (equation (5)) into the output equation, we get:

$$y_t = \mathbf{b}(e_{t-s} + p_{t-s}^* - p_{t-s}) + \mathbf{t}y_{t|t-s} + \mathbf{h}_t \quad (6)$$

where $\mathbf{h}_t = \mathbf{h}_t - \mathbf{g} \sum_{t=0}^{\infty} (r_{t+t-s|t-s}^* - \bar{r})$ and $\mathbf{b} = \hat{\mathbf{b}} + \mathbf{g}$. The parameter \mathbf{b} is a measure of

how sensitive the real output is to changes in the real exchange rate. Thus, the output gap consists of three parts: the real exchange rate q , the government's fiscal policy and

⁴For Sweden, there is some empirical support that uncovered interest parity holds (see Holden and Vikoren (1994)).

the exogenous variable \mathbf{h}_t , that is assumed to be independent of the monetary policy regime (due to the assumption of a “small open” economy, the foreign interest rate can be treated as exogenous to the domestic economy). \mathbf{h}_t is assumed to follow a stationary autoregressive process

$$\mathbf{h}_t = \mathbf{r}_1 \mathbf{h}_{t-1} + \mathbf{r}_2 \mathbf{h}_{t-2} + \mathbf{J}_t \quad (7)$$

where \mathbf{J}_t is white noise. This specification of the exogenous variables is chosen for simplicity; obviously we would get the same results if the different exogenous variables were explicitly introduced. \mathbf{h}_t is derived and discussed in further detail in appendix A.

Wages are set according to a standard wage equation (e.g. Blanchard and Katz (1999)), where wage setters in sector j set the wage according the following equation:

$$w_{jt} = dp_{t|t-k} + (1-d)w_{t|t-k} + \hat{b}y_{t+s|t-k} . \quad (8)$$

Here, for any variable x , $x_{t|t-k}$ denotes the wage setter's rational expectation of x_t conditional on the information available when the wage (w_t) is set. p_t denotes the CPI price level and w_t the aggregate wage level. Wages in period t also depend on the expected output gap, capturing tightness in the labor market.⁵ All wage setters have the same information, so aggregating over all wage setters implies that wage setters set the wage (w_t) such that:

$$w_t = p_{t|t-k} + by_{t+s|t-k} + \mathbf{e}_t , \quad (9)$$

where $b = \hat{b}/d$ and a zero-mean supply shock (cost-push shock), \mathbf{e}_t , has been added. Assuming monopolistic competition in the domestic economy, domestic prices are set as a mark-up on wages (i.e. $P_t^d = W_t$, where P_t^d is the price of domestically produced goods). Then, we get that the CPI price level is given by a weighted average of the prices of imported goods and the wage level:

⁵ Wages in period t depend on the expected output gap in period $t+s$, since wages affect output with a lag of s periods, i.e. the wage level in period t affects output (unemployment) in period $t+s$. Hence, wage setters have a tradeoff between high wages in period t and low output (unemployment) in period $t+s$.

$$p_t = aw_t + (1-a)(p_t^* + e_t), \quad (10)$$

where a is the elasticity of the CPI price level with respect to the domestic wage level.⁶ That is, I assume that there is no lag in the pass-through of imported costs to domestic prices of imported goods. Substituting the wage equation into the CPI equation, it is possible to express the aggregated supply equation (Phillips curve) in terms of CPI inflation:

$$\mathbf{p}_t = \mathbf{p}_{t|t-k} + by_{t+s|t-k} + \left(\frac{1-a}{a} \right) q_t + \mathbf{e}_t, \quad (11)$$

where the CPI inflation is defined as $\mathbf{p}_t = p_t - p_{t-1}$.⁷ Thus, the CPI inflation depends on the expected CPI inflation, the future output gap, the real exchange rate (q_t) and the cost-push shock (\mathbf{e}_t). According to equation (11), higher expected inflation, increased aggregated demand or a real exchange rate depreciation will imply higher inflation.

In this model, monetary policy affects the economy through several transmission channels. First, there is a conventional real interest rate channel, working through the output gap and then onto wages and prices. Second, a change in the interest rate also affects the exchange rate, which influences aggregate demand through the price of domestic goods in terms of foreign goods, thereby affecting wages and prices. A change in the exchange rate also has a direct effect on CPI inflation through the prices of imported goods. This is the quickest and most direct channel through which monetary policy affects inflation.

Under a floating exchange rate regime, the short nominal interest rate is the instrument of the central bank. When the central bank sets the interest rate, it directly affects the exchange rate, because of the interest parity condition. In the hypothetical floating exchange rate regime, I assume that the central bank is interested in both price

⁶The share of imported goods ($1-a$) in the CPI is exactly constant if the utility function over domestic and imported goods has a constant elasticity of substitution equal to unity (Cobb-Douglas utility function), as assumed in appendix A.

⁷ $\mathbf{e}_t = \mathbf{e}_t - (p_{t-1} - p_{t-1|t-k})$

and output stability. Thus, under a floating exchange rate regime, it sets e_t to minimize the following loss function:⁸

$$\sum_{t=0}^{\infty} \mathbf{d}^t E_{t-m} \left(\frac{1}{2} (y_t)^2 + \frac{\mathbf{I}}{2} (p_t - p_t^n)^2 \right) \quad (12)$$

where \mathbf{d} is the discount factor and p^n the CPI price level target. The central bank minimizes the loss function, given its information in period $t-m$, where the size of m depends on the central bank's information/implementation lag. Finally, the tension between the two complementary goals embedded in the loss function is captured by the non-negative parameter \mathbf{I} . Substituting the equations for output, the CPI price level and wages in the loss function and solving the model, we get the following expressions for the CPI price level, the nominal exchange rate and the output gap

$$\begin{aligned} p_t &= p_t^n + (1-a)(p_t^* - p_{t|t-m}^*) \\ &+ (\mathbf{h}_{t+1|t-k} - \mathbf{h}_{t+1|t-m}) \left(\frac{\mathbf{dab}(1-a)}{\mathbf{d}(\mathbf{ab})^2 + \mathbf{I}(1-a)^2} \right) + (\mathbf{h}_{t+s|t-k} - \mathbf{h}_{t+s|t-s}) \left(\frac{\mathbf{dabt}(1-a)}{(1-t)(\mathbf{I}(1-a)^2 + (\mathbf{ab})^2)} \right) \\ &- \mathbf{h}_{t+s|t-k} \left(\frac{\mathbf{dab}(tb + (1-t)(1-a))}{\mathbf{I}(1-t)(1-a)((1-t)(1-a) + \mathbf{abb})} \right) \\ &+ \mathbf{e}_t \left(\frac{\mathbf{d}(\mathbf{ab})^2(1-t)}{\mathbf{I}((1-a)(1-t) + \mathbf{abb})(1-a)^2} \right) \end{aligned} \quad (13)$$

⁸The central bank sets the short nominal interest rate, (i_t) . Using that the interest parity condition (UIP) holds, it can be said that it “sets” the exchange rate, because according to UIP, $e_t = i_t^* - i_t + E_t(e_{t+1})$.

$$\begin{aligned}
e_t = & p_t^n - p_{t|t-m}^* - E_{t-k}(\mathbf{h}_{t+1}) \left(\frac{\mathbf{d}(\mathbf{ab})^2 b \mathbf{t} + ab(1-a)(1-\mathbf{t})(\mathbf{db} + \mathbf{lb})}{\mathbf{l}(1-a)(1-\mathbf{t})((1-a)(1-\mathbf{t}) + ab\mathbf{b})} \right) \\
& + (\mathbf{h}_{t+1|t-k} - \mathbf{h}_{t+1|t-s}) \left(\frac{\mathbf{dab}}{(1-\mathbf{t})(\mathbf{d}(\mathbf{ab})^2 + \mathbf{l}(1-a)^2)} \right) \\
& + (\mathbf{h}_{t+1|t-k} - \mathbf{h}_{t+1|t-m}) \left(\frac{\mathbf{dab}}{(\mathbf{d}(\mathbf{ab})^2 + \mathbf{l}(1-a)^2)} \right) \\
& + \mathbf{e}_t \left(\frac{\mathbf{d}(\mathbf{ab})^2 - \mathbf{l}(1-a)a(1-\mathbf{t})}{\mathbf{l}(1-a)((1-a)(1-\mathbf{t}) + ab\mathbf{b})} \right)
\end{aligned} \tag{14}$$

$$\begin{aligned}
y_t = & \frac{ab(p_{t-s}^* - p_{t-s|t-m-s}^*)}{(1-\mathbf{t})} + (\mathbf{h}_t - \mathbf{h}_{t|t-m-s}) \\
& + (\mathbf{h}_{t|t-m-s} - \mathbf{h}_{t|t-k-s}) \left(\frac{\mathbf{l}(1-a)^2}{(\mathbf{d}(\mathbf{ab})^2 + \mathbf{l}(1-a)^2)(1-\mathbf{t})} \right) \\
& + (\mathbf{h}_{t|t-s-s} - \mathbf{h}_{t|t-k-s}) \left(\frac{\mathbf{l}(1-a)^2 \mathbf{t}}{(\mathbf{d}(\mathbf{ab})^2 + \mathbf{l}(1-a)^2)(1-\mathbf{t})^2} \right) \\
& + \mathbf{h}_{t|t-k-s} \left(\frac{(1-\mathbf{t})(1-a) + ab\mathbf{b}\mathbf{t}}{(1-\mathbf{t})((1-\mathbf{t})(1-a) + ab\mathbf{b})} \right) \\
& - \mathbf{e}_{t-s} \left(\frac{ab(1-\mathbf{t})}{((1-a)(1-\mathbf{t}) + ab\mathbf{b})(1-\mathbf{t})} \right).
\end{aligned} \tag{15}$$

From equations (13)-(15), we can see that the stability of the economy not only depends on the actual demand and supply shocks, but also on the ability of the central bank, the government and the wage setters to forecast the demand shock. This implies that given

its own forecast, the wage setters' forecast and the government's forecast of the demand shock, the central bank sets the exchange rate to stabilize the price level and/or the output, depending on the value of I . From equation (15), we can see that the demand shock affects output in three different ways, depending on whether the shock is expected by the wage setters, the government, the central bank or completely unexpected. *First*, demand shocks expected by everybody have a direct effect on output, since the expected shocks are not completely compensated by changes in the real exchange rate or fiscal policy stabilization. According to equation (9), we can see that in the special case when the output gap does not affect the wage level ($b = 0$) and government expenditure is insensitive to changes in the output gap ($t = 0$) expected demand shocks will have complete penetration on output; in this case, wage setters set the wage such that the expected real exchange rate is constant. *Second*, the central bank will partly stabilize the output for demand shocks expected by the central bank itself, but unexpected by the wage setters depending on the value of I . *Third*, shocks that are unexpected by the wage setters, the government as well as the central bank will directly affect output.

3. Data and parameter values

3.1 Data description

The data set covers Sweden between 1973 Q1-1994 Q2. Data on domestic real GDP (y), foreign price (p^*), CPI price (p), domestic wages (hourly rates in manufacturing), government expenditure (g) and the exchange rate index (e) are collected from the OECD database Main Economic Indicator. The exchange rate index is constructed as a competition-weighted sum of exchange rate series for ten OECD countries. The foreign price index is also constructed as a competition-weighted sum of foreign price series for ten OECD countries. All variables are expressed in logs and detrended using a Hodrick-Prescott filter. Figure 1 illustrates the paths for the output gap, inflation, the real exchange rate and the nominal exchange rate. Appendix B provides more details on data sources and definitions for all variables.

Table 1: Model estimates (*t*-values in parentheses)

<p>Wage equation</p> $w_t = p_{t t-k} + 0.43 y_{t+s t-k}$ <p>(2.55)</p>
<p>CPI price equation</p> $p_t = 0.86 w_t + (1 - 0.86)(p_t^* + e_t)$ <p>(21.56)</p>
<p>Output equation and government reaction function</p> $y_t = 0.42(e_{t-s} + p_{t-s}^* - p_{t-s}) - 0.39*0.3y_{t t-s}$ <p>(3.14) (2.78)</p> $g_t = -0.39 y_{t t-s}$ <p>(2.78)</p>

Note: The CPI price equation (equation (10)) is estimated with OLS to get a measure of a , the wage equation is estimated with GMM to get a measure of b and the output equation (equation (6)) and the government reaction function (equation (3)) are estimated as a system using GMM to obtain a value of \mathbf{t} and \mathbf{b} .

3.2 Parameter values

In this section, I proceed by estimating the CPI price equation (10), the wage equation (9), the public demand equation (3) and the output equation (6) to get values of a, b, \mathbf{t} and \mathbf{b} . Before estimating these equations, I need to assign the length of the wage setters' wage contract (k) and the consumers' decision lag (s). Wage contracts are typically valid for 1 to 3 years. In the baseline case, I assume that wage setters set the wage one year ahead and that the consumer decision lag is two quarters, i.e. $k = 4$ and $s = 2$. Thus, wage setters can affect the price level with a four-quarter lag and output with a six-quarter lag. All variables in the estimated equations are treated as stationary, since before estimating equations (3), (6), (9) and (10), all variables are detrended with a HP-filter.

The CPI price equation is individually estimated by OLS to get a measure of the elasticity of the CPI price level with respect to the domestic wage level (the value of a). According to Table 1, the elasticity of the CPI price level with respect to the domestic wage level is equal to 0.86. The econometric procedure for estimating the wage equation is relatively straightforward (see e.g. Clarida, Gali and Gertler (1998) for a more detailed description of this procedure). Let Ω_{t-k} denote a vector of variables

observed at time $t-k$. Then, under rational expectations, equation (9) defines the set of orthogonality conditions

$$E[w_t - p_t - by_{t+s} | \Omega_{t-k}] = 0. \quad (16)$$

Given these conditions, we can estimate the model by using a generalized method of moments (GMM). In this case, the GMM estimator can be seen as a generalization of 2SLS/3SLS that takes account of moving average errors and heteroscedasticity, conditional on the instruments. The vector of instruments Ω_{t-k} includes lagged values of output, domestic and foreign prices, exchange rates and wages.

The output equation (equation (6)) and the government reaction function (equation (3)) are estimated as a system using generalized method of moments (GMM) to get a measure of how sensitive government expenditure is to changes in the output gap (the value of \mathbf{t}) and how sensitive real output is to changes in the real exchange rate (the value of \mathbf{b}). Equations (3) and (6) are estimated as a system since the parameter \mathbf{t} enters both equations. As discussed in section 2, the system will contain autoregressive (AR (2)) error specifications. I use instruments of output, domestic and foreign prices, exchange rates and wages dated $t-s$ or earlier. Furthermore, I assume that n_2 is equal to 0.3 (calculated as the average the share of government demand in total aggregate demand). According to Table 1, the empirical model works reasonably well. Government expenditure is negatively correlated with aggregated demand and a real depreciation stimulates aggregate demand.

The central bank's preference parameter between price and output stability, \mathbf{I} , can be chosen in different ways, depending on the purpose of the analysis. Finally, the discount factor (\mathbf{d}) is set to 0.96.

I calculate the actual path for \mathbf{h} using the residuals from equation (6) as:

$$\mathbf{h}_t = y_t - \mathbf{b}(e_{t-s} + p_{t-s}^* - p_{t-s}) - \mathbf{t}y_{t-s}. \quad (17)$$

Thus, \mathbf{h} is defined as the output gap purged from the effects of variations in the real exchange rate and fiscal policy stabilization. This implies that \mathbf{h} captures everything affecting the output gap, except influences from monetary policy and systematic fiscal

policy. The supply shock (cost-push shock) is analogously calculated as the residual from the wage equation:

$$\mathbf{e}_t = w_t - (p_{t|t-k} + by_{t+s|t-k}). \quad (18)$$

Figure 1 illustrates the path for the two structural disturbances (\mathbf{h} and \mathbf{e}). Thus, this paper studies how the Swedish economy would have performed if it had been subjected to the same structural disturbances (\mathbf{h} and \mathbf{e}) as those that have affected it in the past while, at the same time, the monetary policy conducted by the central bank had been different.

4. Maximal output stabilization without policy lags

In this section, I examine the potential of monetary policy to stabilize output if we take an optimistic view of how monetary policy is conducted.⁹ In order to maximize this potential, I *first* assume that the central bank has no information or data lag, thus $m = 0$.¹⁰ There is still a lag in the economy, since monetary policy affects the economy with a lag of two quarters. The wage contracts in Sweden are typically valid for 1 to 3 years. In the baseline case, I assume that wages are set one year ahead, i.e. $k = 4$. This implies that

$$\mathbf{h}_{t|t-m-s} = \mathbf{h}_{t|t-2},$$

$$\mathbf{h}_{t|t-k-s} = \mathbf{h}_{t|t-6}.$$

Second, since I want to highlight the potential for monetary policy to stabilize output, I initially focus on the case when $\mathbf{I} = 0.1$, thus the central bank is most interested in

⁹ The central bank is generally considered to put most weight on price stability (characterized by an explicit inflation target). But to get a more fair comparison between the actual and the hypothetical regime, I examine the potential of monetary policy to stabilize output, since the actual policy can be characterized as an “output stability target” during most of the period between 1974 and 1994.

¹⁰ I will later investigate how sensitive the results are to the assumption that there is no data lag.

output stability and puts very little weight on price stability. I assume that the central bank's price level target (p^n) is the same as the actual price level trend. The central bank's price level target (p^n) only affects the time trend for the domestic price level and the nominal exchange rate and not the stability properties for any of the variables.

Using the actual path for \mathbf{h} and \mathbf{e} , the central bank's, the government's and the wage setter's forecasts for \mathbf{h} , the path for p^n and p^* and the parameter values defined above for a, b, t, \mathbf{b} and \mathbf{d} , we have all the necessary information for calculating hypothetical output, CPI-prices and nominal exchange rates under a hypothetical floating exchange rate regime when the central bank is most interested in output stability (equations 13-15).¹¹ The actual and simulated macro series are shown in Figure 2, and the stability properties are reported in Table 2. Comparing the simulated regime with the actual regime, we can make three important observations: (i) the simulated

Table 2: Stabilization properties. Standard deviations in percent.

	<i>Actual</i>	<i>Simulated</i>	<i>Simulated/actual</i>
<i>Output gap</i>	2.85	2.42	0.85
<i>Exchange rate</i>	6.67	10.12	1.52
<i>CPI</i>	2.95	7.84	2.66
<i>h</i>	3.78		
<i>e</i>	3.60		

Note: All variables are evaluated after removing the time trend (approximated by a H-P filter).

CPI-price level and the nominal exchange rate are more volatile than the actual CPI-price level and the nominal exchange rate, (ii) the volatility of hypothetical output is only somewhat lower than actual output when the central bank has no data/information lag and is most interested in output stability,¹² (iii) the actual real exchange rate and the hypothetical real exchange rate almost coincide.

¹¹The central bank, the government and the wage setters form their expectations of \mathbf{h} and p^* according to the following forecast functions (see e.g. Enders (1995)): $x_{t|t-f} = a^1 x_{t-f} + a^2 x_{t-f-1}$, for x equal to \mathbf{h} or p^* .

According to table, 2 h is more volatile than actual output. In Figure 5, we can see that there is a negative correlation between the real exchange rate and the real output in the period 1974-1994. This is a pattern found by Edin and Vredin (1993); the probability of a devaluation increased when growth was low (declining industry production). Thus, the real exchange rate appeared to have had a stabilizing effect on output in this period, which implies that the actual policy with a fixed exchange rate and a number of devaluations was quite successful from a stability point of view. Comparing the volatility of the *simulated* output with h , we note that the variance of y is about 1.5 times smaller than that of h : It seems that under a floating exchange rate, the central bank could have used the exchange rate to stabilize output.

According to figure 2, the actual real exchange rate and the hypothetical real exchange rate almost coincide, but we can also see why the hypothetical regime has a somewhat lower output volatility. For example, during the second half of the 1980's, both regimes had a real appreciation that damped the boom, but the hypothetical regime had a larger dampening effect because it implied a faster real appreciation of the exchange rate.

In the next section, I will analyze how sensitive these results are to the assumptions about the central bank preference parameter I , and the central bank's information/data lag.

5. Sensitivity analysis

5.1 Trading output stability against price stability

Usually, the main goal of the central bank under a floating exchange rate regime is to maintain price stability and, without prejudice to this goal, the central bank should try to support the general economic policy to reach such goals as high sustainable growth and full employment. To reach these goals the central bank usually has targets (operational

¹²The somewhat strange result that under the hypothetical floating exchange rate regime, the central bank must pay a very high "price" to reach the same output stability as under the actual regime, will be further discussed in section 7.

goals) such as an inflation/price level target. For example, since 1993, Sweden has had an explicit inflation target of two percent per year.

So far, I have assumed that the central bank is most interested in output stability and puts very little weight on stabilizing the price level. However, in reality, the central bank should be interested in both output and price stability, so that the value of I be higher. Table 3 shows the standard deviations of output, exchange rate and CPI-price level for different values of I . I evaluate the performance under the following three regimes: strict price level targeting ($I = 10$), flexible price level targeting ($I = 1$) and output gap targeting ($I = 0.1$). From Table 3, we can see that the price stability is quite sensitive to changes in I . Figure 3 reports simulated series of output, the exchange rate, prices and the real exchange rate when the central bank has a flexible price level target ($I = 1$). Comparing Figures 2 and 3, we can see that an increasing I leads to a more stable pattern for prices and both nominal and real exchange rates, but at the cost of an increase in the standard deviation of detrended output.

Table 3: Standard deviation in output, nominal exchange rate and the CPI price level depending on the parameter I

I	Output gap	Exchange rate	CPI
0.1	2.42	10.12	7.84
1	3.26	5.01	1.85
10	3.48	4.42	0.23
Actual	2.85	6.67	2.95

5.2 Changing the inflation trend

Besides having a stabilizing effect on the real economy and prices, the central bank might also have an effect on the price level and hence, the trend path of the nominal exchange rate. For example, consider the case where the central bank had the flexible price level target ($I = 1$) that the price level should increase by two percent per year (i.e. $P_{t+1}^n = 1.02P_t^n$) during the period 1974-1994, instead of the actual quasi-fixed exchange rate regime. The actual and simulated macro series of this counterfactual experiment are

shown in Figure 4. Comparing Figures 3 and 4, we can see that the price level target does not affect the real economy (output and real exchange rate) or the stability properties of the nominal variables. The only thing that changes is the long-run time trend for the nominal exchange rate and the price level. In Figure 4, the simulated nominal exchange rate has a time trend reflecting a continuous appreciation of the Swedish krona because under the simulated regime, Sweden had a lower inflation rate than its foreign trade partners most of the time.

5.3 Information/implementation lags

So far, I have assumed that the central bank has no data /information lag but in reality, it takes at least three to four months before preliminary data become available and then, additional time to analyze the data and take policy decisions. In Table 4, the standard deviations of output, exchange rate and CPI-price level are reported when we have a one-year decision/information lag.¹³ According to Table 4 the volatility in the price level and the exchange rate is reduced but the volatility in output is increased when including an information lag. The reason for this is that the central bank makes smaller changes in the exchange rate in this case, since its ability to forecast h is substantially reduced.

Table 4: Standard deviation in the actual variables and the simulated variables when the central bank has an information lag of one year and $I = 0.1$.

	<i>Actual</i>	<i>Simulated</i>	<i>Simulated/actual</i>
<i>Output gap</i>	2.85	3.28	1.15
<i>Exchange rate</i>	6.67	7.27	1.09
<i>CPI</i>	2.95	7.19	2.44

¹³This implies that the central bank must make a forecast six quarters ahead, since the exchange rate affects the economy with a two-quarter lag.

6. An irrevocably fixed exchange rate

Suppose instead that Sweden had had a truly fixed exchange rate during the period 1974-1994. Five different fixed exchange rate regimes are considered, first that the Swedish krona is fixed in terms of a weighted basket of currencies and second, that the krona is tied to four different currencies. For this purpose, I modify the theoretical model so that the central bank cannot influence the economy and then, I calculate the hypothetical development under the five-fixed exchange rate regimes.

6.1 Theory

I will use the model described in section 2. The only modification in this case is that we have no domestic monetary policy, because the only task for the central bank under a fixed exchange rate regime is to keep the exchange rate fixed. Thus, only the wage setter and the government's fiscal policy can stabilize the economy. The output equation (6) will be exactly the same as before and I assume the wage setters set the wage in the same way as before (equation (9)). Solving the model in the case of a fixed exchange rate regime, we get the following expressions for the CPI price level, exchange rate and output:

$$p_t = a(e_{t|t-k} + p_{t|t-k}^*) + (1-a)(p_t^* + e_t) + \frac{a(1-t)\mathbf{e}_t + ab\mathbf{h}_{t+s|t-k}}{(1-a)(1-t) + ab\mathbf{b}} \quad (19)$$

$$e_t = e_t^* \quad (20)$$

$$y_t = \mathbf{h}_t + \frac{t}{1-t}\mathbf{h}_{t|t-s} + \frac{ab}{1-t}(p_{t-s}^* - p_{t-s|t-k-s}^*) + \frac{ab}{1-t}(e_{t-s} - e_{t-s|t-k-s}) \quad (21)$$

$$- \frac{ab}{((1-a)(1-t) + ab\mathbf{b})(1-t)}(b\mathbf{h}_{t|t-k-s} + (1-t)\mathbf{e}_{t-s}),$$

where e_t^* is the foreign exchange rate to which the Swedish krona is tied. From equation (21), it is easily seen that the macroeconomic stability depends on how

sensitive government expenditure is to changes in the output gap (the value of t) and the wage setter's ability to forecast the foreign price level, the exchange rate, the demand shock, the supply shock and the covariance between these variables.

6.2 Results

The paths for the foreign price level, h and e will be the same as before (see Figure 1). In the case when the krona is fixed to a single currency, the exchange rate index is constructed as previously with the only difference that in this case, the Swedish krona is tied to its host currency. The currency basket is constructed of ten different currencies where the weights are based on the shares of Swedish export to each country.

Using the wage setter's forecasts and the actual path for h, e , the foreign price level and the exchange rate, we have all the necessary information to calculate hypothetical output and prices under the fixed exchange rate regimes.¹⁴ Table 5 reports the standard deviation of the output gap and the CPI-prices for the five regimes. From that table, we can see that the stability of output and prices is quite insensitive to the choice of the currency to which the krona is fixed. Differences between different fixed exchange rate regimes are a combination of two effects: the output equation contains the term $\frac{ab}{1-t}(e_{t-s} - e_{t-s|t-k-s})$ and wage setters have difficulties in forecasting the movements of the exchange rate. Thus, the exchange rate affects the real economy, which implies that the covariance between h, e and the exchange rate is the main reason for differences between regimes.

The only case that substantially deviates from the other fixed exchange rate arrangement is when the krona is fixed to the U.S. dollar. In this case, the real exchange rate clearly had a destabilizing effect on the economy. For example, in the latter part of the 1970's, Sweden began a recession and, at the same time, there was an appreciation in the exchange rate, leading to a loss in the competitiveness of Swedish industry that made the recession even worse. The depreciation of the U.S. dollar during the second half of the 1980's also increased the overheating of the economy at the end of the 1980's.

¹⁴The forecast for e and p^* is estimated in the same way as the forecast for h .

Table 5: Standard deviation in the output gap and CPI-prices under different regimes.

<i>Exchange rate regime:</i>	<i>Output gap</i>	<i>CPI</i>
<i>Fixed to a basket of currencies</i>	<i>3.01</i>	<i>3.09</i>
<i>Fixed to the German mark</i>	<i>3.14</i>	<i>3.94</i>
<i>Fixed to the British pound</i>	<i>3.23</i>	<i>4.54</i>
<i>Fixed to the French franc</i>	<i>3.11</i>	<i>3.35</i>
<i>Fixed to the U.S. dollar</i>	<i>3.89</i>	<i>4.74</i>
<i>Floating exchange rate:</i> ($m=0, \mathbf{I} = 0.1$)	<i>2.42</i>	<i>7.84</i>
<i>Floating exchange rate:</i> ($m=4, \mathbf{I} = 0.1$)	<i>3.28</i>	<i>7.19</i>
<i>Floating exchange rate:</i> ($m=0, \mathbf{I} = 1$)	<i>3.26</i>	<i>1.85</i>
<i>Floating exchange rate:</i> ($m=4, \mathbf{I} = 1$)	<i>3.31</i>	<i>2.29</i>
<i>Actual</i>	<i>2.85</i>	<i>2.95</i>

Comparing the hypothetical floating exchange rate regime (when $m = 0$ and $\mathbf{I} = 0.1$) to the simulated fixed exchange rate regime: It seems that the central bank makes a good job in stabilizing output, because output volatility is about 1.3 times higher if the exchange rate is fixed to the currency basket or to any of the European currencies and more than 1.6 times higher if the exchange rate is fixed to the U.S. dollar, as compared to the volatility under the simulated floating exchange rate regime. However, the CPI-prices are substantially more volatile under the simulated floating exchange rate regime.

If we instead compare a more realistic case when the central bank has an one-year information lag and \mathbf{I} is equal to one, the output gap volatility is about the same under the simulated fixed and floating exchange rate regimes. However, in this case, prices are more volatile under fixed regimes than under the simulated floating exchange rate regime.

7. Why such low output volatility under the actual exchange rate regime?

Comparing the actual exchange rate regime with the hypothetical floating or fixed exchange rate regime, the actual regime seems successful from a stability point of view. More precisely, under the hypothetical floating exchange rate regime, the central bank must pay a very high “price” in terms of volatility in the exchange rate and prices to reach the same output stability as under the actual regime.

To understand how this apparently successful exchange rate policy came about, it is useful to briefly review what factors shaped the policy responses in this period.¹⁵ The macroeconomic development in the Bretton Woods period (1946-1971) was calm, where the cyclical swings in the economy were fairly small. With this experience, the established approach toward macroeconomic shocks became one where these could and should be dealt with by a fixed exchange rate and a countercyclical fiscal policy. Thus, when the world economy was hit by the first oil price shock in 1973-1974, OPEC I, the Swedish reaction was determined by the belief that the expected international downturn can be avoided by an expansionary fiscal policy.

The policy resulted in a growing budget deficit, an increased tax burden, a deficit in the current account and a serious “cost crisis”. With a fixed exchange rate, this led to a dramatic loss of competitiveness of Swedish exports and an increase in relative prices. Competition was partially restored when Sweden left the “currency snake” and devaluated three times in 1976-1977.

The next major macroeconomic shock had its origins in the second oil price shock of 1979-1980, OPEC II. Compared to the first OPEC crisis, in this case the fiscal policy was tightened and the value of the krona was changed at an earlier stage. In September 1981, the krona was devalued by 9 per cent. After winning the 1982 elections, the new social democratic government carried out a large devaluation of 16 percent in October 1982. The devaluation of 1982, planned in the years of opposition, can be described as an offensive devaluation with the aim to “kick-start” the Swedish economy. From Figure 5, we can see that the devaluation was successful from a stability point of view,

¹⁵See, for instance, Jonung (1999), SOU 1996:158.

because it made Swedish industry very competitive and thus, damped the recession at the beginning of the 1980's. After the devaluations in 1981 and 1982, Swedish prices and wages increased more than abroad and with a fixed exchange rate, this led to a real appreciation that damped the boom in the second half of the 1980's. Around 1991, the boom turned into a deep international recession. Basically, this was a financial crisis due to a rapid rise in the real interest rate caused by a set of impulses; the international increase in the real interest rate due to the German reunification, "the tax reform of the century" (which made household borrowing more expensive) and a decline in Swedish inflation.

This time, there was no "kick-start", because the government stabilization policy was rigidly committed to maintaining the fixed exchange rate for the krona. However, when countries such as Great Britain and Italy abandoned the fixed exchange rate in the autumn of 1992, the defense of the Swedish krona became impossible, leading up to the float of the krona in November 1992. The subsequent depreciation made Swedish industry very competitive, which helped the Swedish economy recover from the recession at the beginning of the 1990's.

In summary, the actual exchange rate policy appears successful from an output stability point of view, because we devalued at the beginning of each recession, and a fixed exchange rate and high inflation implied a real appreciation during booms.

8. Conclusions

In this paper, I have studied how Swedish output, inflation and exchange rates would have evolved in 1974-1994 if the Swedish Riksbank had pursued a different monetary policy. In that period, Sweden had a quasi-fixed exchange rate regime, where the currency was tied to various currencies and baskets of currencies, with three devaluations in 1976-1977, two devaluations at the beginning of the 1980's and finally, the large depreciation in November 1992 leading to the float of the krona. This actual regime is compared to two simulated monetary policy regimes: *first*, a floating exchange rate regime and *second*, an irrevocably fixed exchange rate. Under the floating exchange rate regime, I assume that we have an independent central bank carrying out a credible monetary policy. In the latter case, five different fixed exchange rate regimes are

considered; I consider both the case when the Swedish krona is fixed to a weighted basket of currencies and the cases when it is fixed to four different currencies.

The results show that the choice of exchange rate regime does influence macroeconomic stability. More precisely, output volatility under the actual exchange rate regime is about the same as under the hypothetical floating exchange rate regime, but output is substantially more volatile under the hypothetical fixed exchange rate regimes.¹⁶ Somewhat surprisingly, output volatility is only somewhat lower under the hypothetical floating exchange rate regime when the central bank has no information lags and is only interested in output stability than under the actual quasi-fixed exchange rate regime in Sweden during the period 1974-1994. This implies that the actual policy with a fixed exchange rate and a number of devaluations was quite successful from an output stability point of view; devaluations were well timed in relation to the business cycle. According to Figure 2, the actual and the hypothetical real exchange rates almost coincide. Hence, the actual exchange rate regime was more like an optimal floating or “managed” exchange rate than a fixed exchange rate regime. Finally, the real exchange rate had a stabilizing effect on output under the hypothetical floating exchange rate regime, which indicates that the central bank’s monetary policy had a stabilizing effect on output.

¹⁶Ghosh, Gulde, Ostry and Wolf (1997) also reported that the exchange rate regime has an effect on macroeconomic stability. But Flood and Rose (1995) reported that the volatility of macroeconomic variables does not change a great deal across exchange rate regimes.

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Appendix A: Derivation of the aggregate demand equation

The aggregate demand equation used in the main text will be derived with some micro foundations in this appendix. It is a variant of the derivation used by Svensson (1998) and McCallum and Nelson (1999). Assume that domestic consumers have an additively separable CES utility function of aggregate real consumption with intertemporal elasticity of substitution s . Under the assumption that real consumption is predetermined for s quarters, intertemporal optimization will imply the first-order condition

$$c_t = c_{t+1|t-s} - s(r_{t|t-s} - \bar{r}), \quad (\text{A.1})$$

where c_t denotes the deviation from the trend of aggregate real consumption and $r_t - \bar{r}$ is the real interest rate deviation from a long-run mean interest rate. Let aggregate consumption be a Cobb-Douglas function of consumption of domestic and foreign goods (that is, assuming a constant elasticity of substitution equal to unity). Then, it follows that the consumer's decision problem can be written as:

$$\begin{aligned} \max \quad & E_{t-s} (C_t^d)^a (C_t^*)^{1-a} \\ \text{s.t.} \quad & E_{t-s} (P_t C_t) \geq E_{t-s} (P_t^d C_t^d + P_t^* C_t^*), \end{aligned} \quad (\text{A.2})$$

where C_t^d and C_t^* denote the consumption of domestic and foreign goods, respectively and P_t^* is the foreign price level measured in domestic currency. The CPI price level is defined as $P_t = (P_t^d)^a (P_t^*)^{1-a}$. Assuming monopolistic competition in the domestic economy, domestic prices are set as a mark-up on wages, i.e. $P_t^d = W_t$ (see e.g. Leitemo (2000)). Solving that problem, we get that domestic demand for domestically produced goods is given by

$$\begin{aligned} c_t^d &= c_{t|t-s} - (w_{t|t-s} - p_{t|t-s}) \\ &= c_{t|t-s} + \left(\frac{1-a}{a} \right) q_{t|t-s}, \end{aligned} \quad (\text{A.3})$$

where $(w - p)$ has been rewritten as the real exchange rate q using equations (9) and (10). Next, let us assume that changes in relative prices affect the consumption with a lag of s quarters, because the consumption basket adjusts slowly to changes in relative prices. Then, after substituting (A.3) into the first-order condition (A.1), we get that

$$c_t^d = c_{t+1|t-s}^d - s(r_{t-s} - \bar{r}) - \left(\frac{1-a}{a} \right) (q_{t-s+1|t-s} - q_{t-s}). \quad (\text{A.4})$$

Assume $\lim_{t \rightarrow \infty} c_{t+1|t-s}^d = 0$ ¹⁷, $\lim_{t \rightarrow \infty} q_{t+1|t-s} = 0$ then

$$\begin{aligned} c_t^d &= c_{t+1|t-s}^d - s \sum_{\tau=0}^{\infty} (r_{t+\tau-s|t-s} - \bar{r}) - \left(\frac{1-a}{a} \right) \sum_{\tau=0}^{\infty} (q_{t+\tau-s+1|t-s} - q_{t+\tau-s|t-s}) + \mathbf{h}_t^d \\ &= -s \sum_{\tau=0}^{\infty} (r_{t+\tau-s|t-s} - \bar{r}) + \left(\frac{1-a}{a} \right) q_{t-s} + \mathbf{h}_t^d, \end{aligned} \quad (\text{A.5})$$

where a zero-mean demand shock, \mathbf{h}_t^d , has been added (\mathbf{h}_t^d can be seen as a preference shock).

Let the foreign demand for home goods (measured as deviations from the trend), be

$$c_t^{*d} = dy_t^* + f^* q_{t-s} + \mathbf{J}_t^*, \quad (\text{A.6})$$

where f^* is a measure of how sensitive foreign demand for home goods is to changes in the real exchange rate, y_t^* is the foreign output gap and \mathbf{J}_t^* a demand shock. The foreign demand for home goods can be decomposed into two components: $f^* q_{t-s}$ that depends on domestic monetary policy and $\mathbf{h}_t^* = dy_t^* + \mathbf{J}_t^*$ that is independent of domestic monetary policy.

¹⁷This assumption presumes that net foreign assets are stationary. Thus, I avoid the problem that a small open economy with infinitely lived consumers, who can borrow at an exogenous world interest rate, normally has non-stationary net foreign assets

Thus,

$$c_t^{*d} = f^* q_{t-s} + \mathbf{h}_t^*, \quad (\text{A.7})$$

Public demand for domestically produced goods is defined as

$$g_t = \mathbf{t} y_{t|t-s} + \mathbf{h}_t^g, \quad (\text{A.8})$$

where g_t is government expenditure (measured as deviations from the steady state), and \mathbf{h}_t^g is a vector of other variables influencing fiscal policy (e.g. elections and government ideology) that is assumed to be independent of the monetary policy regime. Parameter \mathbf{t} is a measure of how sensitive government expenditure is to changes in the output gap. Total real aggregate demand for domestically produced goods is defined as

$$y_t = n_1 c_t^d + n_2 g_t + n_3 c_t^{*d}, \quad (\text{A.9})$$

n_1 is the share of private domestic demand, n_2 the share of public demand and n_3 the share of foreign demand in total aggregate demand. Substitution of (A.5), (A.7) and (A.8) into the output gap equation (A.9) results in

$$y_t = \hat{\mathbf{b}} q_{t-s} + \mathbf{t} y_{t|t-s} - \mathbf{g} \sum_{j=0}^{\infty} (r_{t+j-s|t-s} - \bar{r}) + \mathbf{h}_t, \quad (\text{A.10})$$

where $\mathbf{g} = n_1 \mathbf{s}$, $\mathbf{h}_t = (n_1 \mathbf{h}_t^h + n_2 \mathbf{h}_t^g + n_3 \mathbf{h}_t^*)$, $\hat{\mathbf{b}} = \left(n_3 f^* + n_1 \left(\frac{1-a}{a} \right) \right)$ and $\mathbf{t} = n_2 \mathbf{t}$.

Expression (A.10) is equivalent to equation (1) in the main text.

Appendix B: Data Sources and Definitions

The data set covers Sweden in the period 1973 Q1-1994 Q2. The data are seasonally adjusted and all variables are expressed in logs. All data are collected from the OECD database Main Economic Indicator.

Output (y): real GDP

Domestic price level (p): domestic CPI-price level

Domestic wages (w): wage rates (hourly rates in manufacturing)

Government expenditure (g): total government expenditure

Exchange rate (e): the exchange rate index is constructed as a competition-weighted sum of exchange rate series for ten OECD countries.

Foreign price level (p*): the foreign CPI-price index is constructed using the same methodology and trade weights as in the exchange rate index

Appendix C: Figures

Figure 1

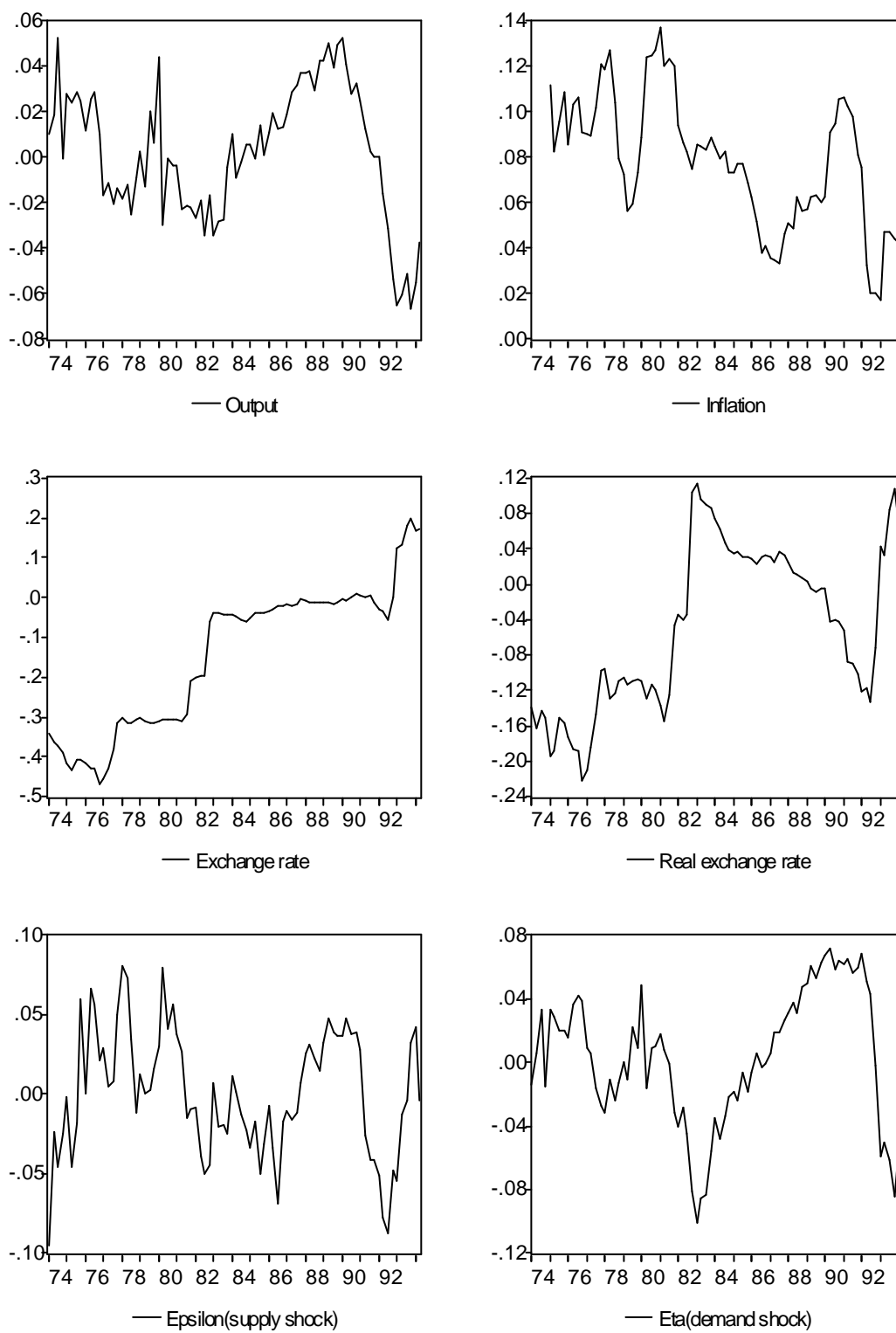


Figure 2: Actual and simulated output, inflation, real exchange rate and nominal exchange rate when the central bank is most interested in output stability.

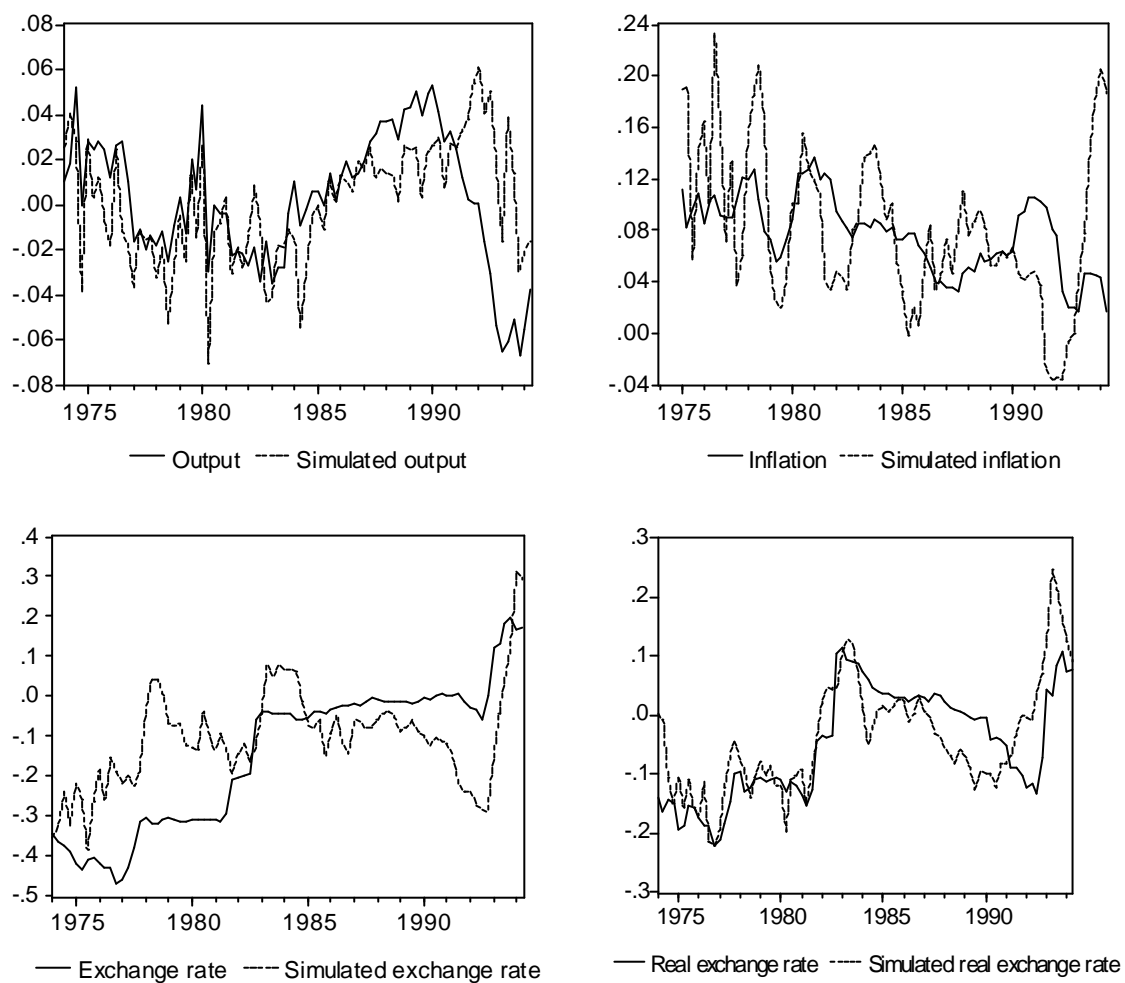


Figure 3: Actual and simulated output, inflation, real exchange rate and nominal exchange rate under a flexible price level target.

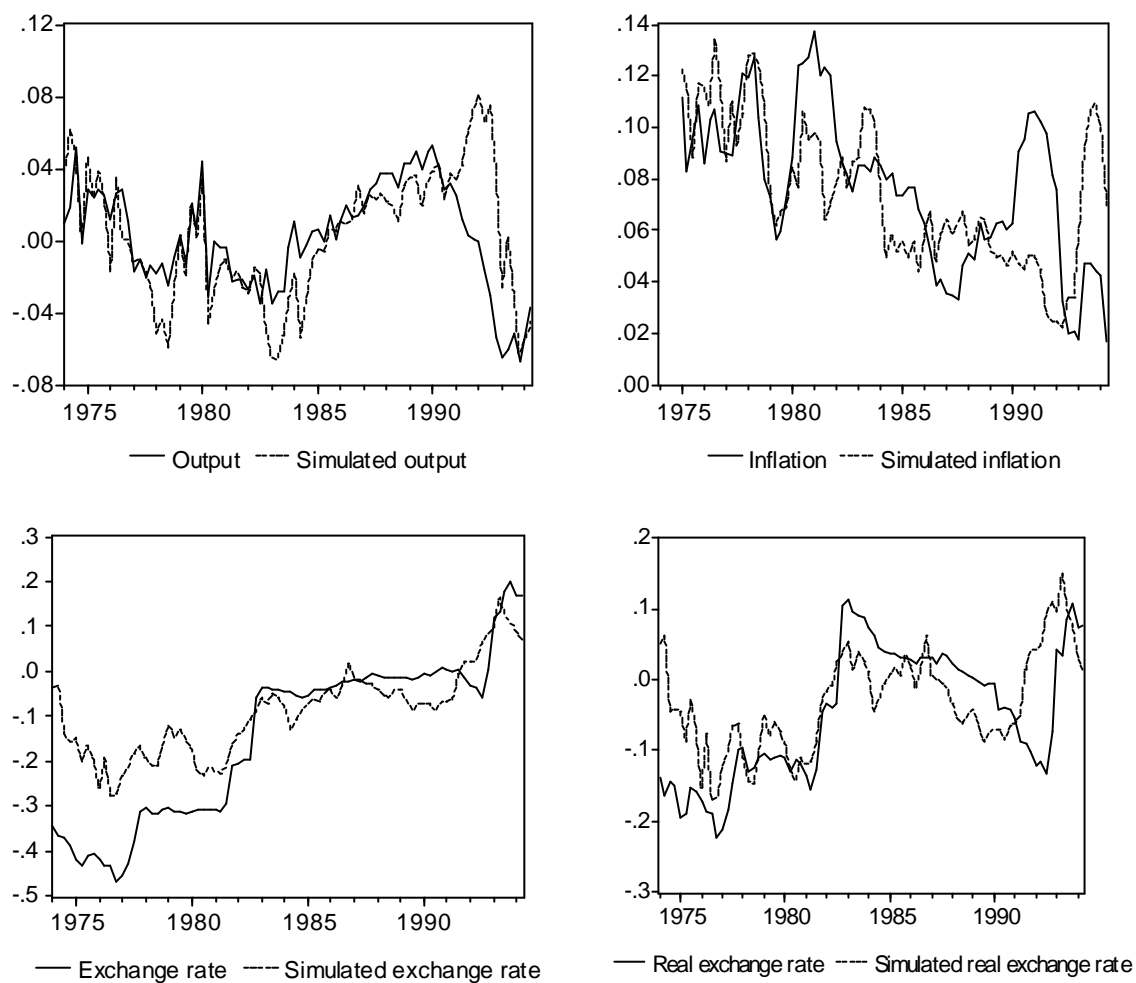


Figure 4: Actual and simulated output, inflation, real exchange rate and nominal exchange rate under a flexible price level target of 2 percent per year.

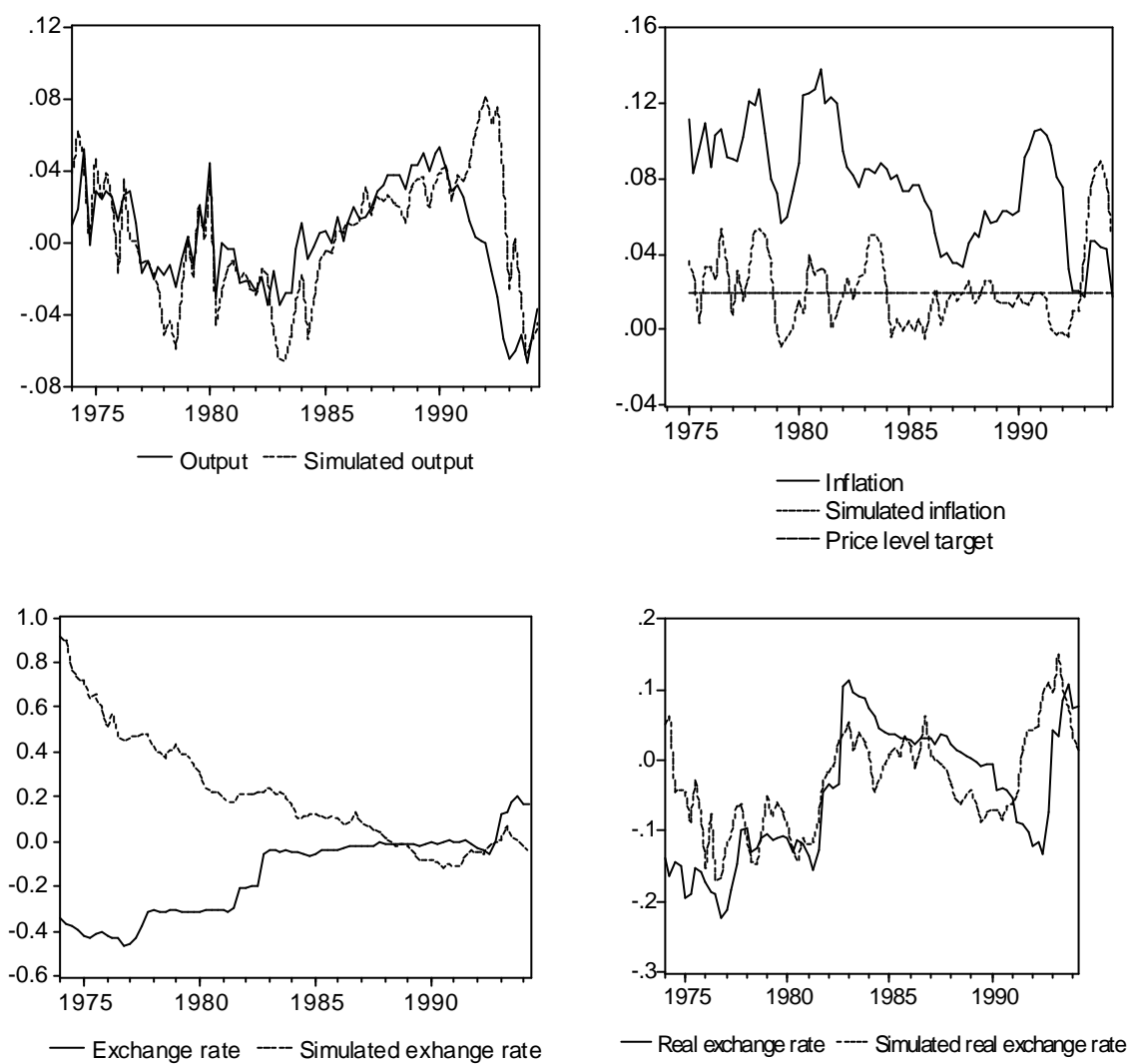


Figure 5: Output and real exchange rate after removing the trend

