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Abstract

Most empirical studies on monetary policies have found exchange rate effects that are inconsistent with Dornbusch's overshooting hypothesis. Bjornland (2009) finds evidence of exchange rate overshooting by using interest rate alone as the monetary policy instrument. However, theoretically consistent way of identifying monetary policy requires capturing dual interaction between central bank's reaction to economic conditions and private sector's response to policy action. This calls for the introduction of 'monetary' aggregates back in the models of exchange rate determination. Motivated by Bjornland's result, identification is achieved by imposing short-run and long-run restrictions while keeping the short-run interactions between monetary policy and exchange rate free. Using more appropriate econometric technique in a model aligned to theory, our paper rediscovers the validity of Dornbusch Overshooting hypothesis for Australia, Canada, New Zealand and Sweden more accurately and more robustly than Bjornland's original model.

Keywords: Monetary Policy; Money Demand; Structural VAR; Exchange Rate Overshooting

JEL Classification: C32, E41, E51, E52, F31, F41

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1.1 Introduction

Dornbusch's exchange rate overshooting marks the birth of the modern international economics. The theory predicts that a contractionary monetary policy shock should lead to on impact appreciation of the exchange rate (overshooting) and thereafter depreciation in line with the uncovered interest parity condition. Surprisingly, most empirical studies have found exchange rate effects that are largely inconsistent with Dornbusch overshooting. Eichenbaum and Evans (1995) have found that contractionary monetary policy shock lead to sharp and persistent appreciation in both the real and nominal exchange rate (delayed overshooting or forward discount bias puzzle) in small open economies.

Cushman and Zha (1997) observe that the monetary authority must have a fairly accurate idea of the money demand side, when formulating policy response to changing economic conditions. The important point is that central banks need to know: *How much of a change in the economy's money stock is influenced by monetary policy (i.e., money supply side) and how much of that change is happening due to the monetary asset portfolio shifts of the private sector (i.e., money demand side)*? Leeper and Roush (2003) find that the liquidity effect and the impact of the rate cuts on output and inflation depend on how we capture the role of money in the model. Leeper and Roush find large and significant effects on the estimated real and nominal effects of policy in models which includes both money and funds rate. Barnett et. al (2016) also assessed the role of different forms of money in exchange rate determination for India establishing its significant role.

It is difficult to identify the monetary policy and correctly capture the response of the exchange rate without the knowledge of the money demand behavior of private agents. Therefore contrary to Bjornland (2009), money is introduced back into the model along with the nominal short-term interest rate. Also correct error bands are computed, summing the lags of the coefficients drawn from Monte Carlo procedure, which is evidently not done by Bjornland (2009). The model identification generates 'significant' appreciation of exchange rate on impact to a monetary policy shock and depreciation thereafter in line with UIP condition, validating Dornbusch's exchange rate overshooting hypothesis. The variance decomposition analysis shows that money demand and money supply shocks explain better the exchange rate fluctuations vis-a-vis Bjornland's original model. The results confirm the importance of adopting monetary aggregates in such models.

1.2 Estimation

The reduced form $VAR(p)$ can be written as:

$$A(L)Y_t = u_t \quad (1)$$

Where Y_t is a $n \times 1$ data vector. The VAR can be written in terms of its moving average representation, $Y_t = C(L)u_t$. The $C(L)$is the convergent matrix polynomial in the lag operator L. u_t is the vector of reduced form residual and $\epsilon_t$is the vector of structural disturbance where, $u_t = R\epsilon_t$. The VAR can be written in terms of the structural shock as follows;

$$Y_t = D(L)\,\epsilon_t \qquad (2)$$

where, $D(L) = C(L)R$. To go from the reduced form VAR to structural interpretation, restrictions need to be imposed on R. The short-run identification scheme for a 6-variable VAR[2] is based on equation (3).

$$Y_t \;=\; \begin{pmatrix} rfor_t \\ \pi_t \\ gdp_t \\ r_t \\ \Delta(m_t - p_t) \\ \Delta rer_t \end{pmatrix} = C(L) \begin{pmatrix} r_{11} & 0 & 0 & 0 & 0 & 0 \\ r_{21} & r_{22} & 0 & 0 & 0 & 0 \\ r_{31} & r_{32} & r_{33} & 0 & 0 & 0 \\ r_{41} & r_{42} & r_{43} & r_{44} & 0 & r_{46} \\ r_{51} & r_{52} & r_{53} & r_{54} & r_{55} & r_{56} \\ r_{61} & r_{62} & r_{54} & r_{64} & r_{65} & r_{66} \end{pmatrix} \begin{pmatrix} \epsilon_t^{rfor} \\ \epsilon_t^{\pi} \\ \epsilon_t^{gdp} \\ \epsilon_t^{MP} \\ \epsilon_t^{\Delta MD} \\ \epsilon_t^{\Delta RER} \end{pmatrix} \qquad (3)$$

Vector Y_t represents the following variables: foreign interest rate ($rfor$), inflation (π), real output (gdp), interest rate (r), real money demand ($m - p$) and real exchange rate (rer). The restrictions on R are based on small open economy assumptions. Output and prices respond to changes in domestic monetary policy variables and exchange rates with a lag. Output responds to domestic price instantaneously. The money demand function usually depends on output, prices and the domestic interest rate. In the small open economy framework, people's willingness to hold cash also depends on foreign interest rates and exchange rates. The monetary authority sets the interest rate after observing the current level of economic activity and exchange rate, and regularly monitors the foreign interest rate. The real exchange rate variable in the model is quick to react to all shocks. $r_{45} = 0$ in (3) is used to identify the money supply vis-à-vis money demand. The Central Bank do not care about money when setting its interest rates.

In order to achieve exact identification, we assume long-run policy neutrality according to which the monetary policy shock does not affect the real money demand and the real exchange rate in the long run. It is implemented by setting $D_{54}(1) = D_{64}(1) = 0$, where each element of $D(1)$ matrix is the sum of structural VAR coefficients, the long-run multiplier matrix.

[2] Differencing of variables does not provide gain in asymptotic efficiency of the model and may throw away information regarding co-movements in the data.

$$D(1) = \begin{pmatrix} . & . & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & 0 & . & . \\ . & . & . & 0 & . & . \end{pmatrix} \tag{4}$$

The model allows free short-run interactions between the three variables- money, domestic interest rates and the real exchange rate. The real money demand and the real exchange rate is in differenced form so that when long-run restrictions are applied to the first differenced variable, the effects of a monetary policy shock on the level of the variable will sum to zero.

1.3 Empirical Results

The data is directly taken from Bjornland's website to render comparisons. All variables are in logarithms (except the interest rates) and are seasonally adjusted. Inflation (π) is the annual change in log of consumer prices. M1 money is used for all countries and M3 for Sweden due to unavailability of early M1 data. The quarterly VAR is estimated and the lags are selected by sequential likelihood ratio test. 3 lags are selected for all the countries and 2 lags for Canada. Also our model is stable with largest root being less than one.

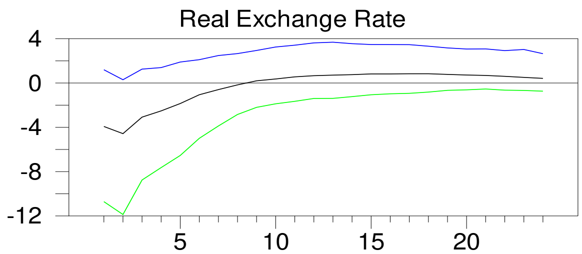
1.3.1 Impulse Response Functions

On using the corrected error bands, which are usually wider than reported by Bjornland (2009), the original Bjornland model (Figure 1, left panel) shows 'insignificant' exchange rate overshooting for almost all countries in the dataset. On the other hand, we see that our model (Figure 1, right panel) exhibit 'significant' exchange rate overshooting. The corrected error bands are computed using the lag sums for the coefficients drawn from the Monte Carlo procedure rather than the OLS estimates of the coefficients.

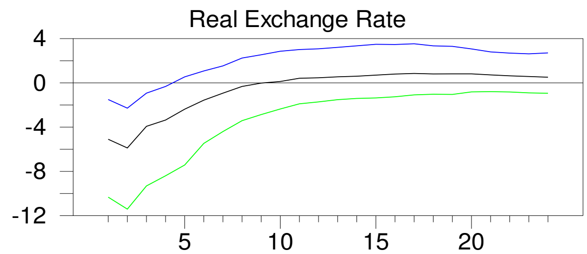
Figure 1: Impulse responses to Monetary Policy shock[3]

Model Bjornland | **Model with Money Demand**

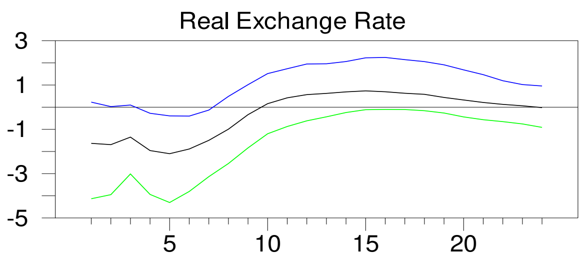
Australia (Model Bjornland)



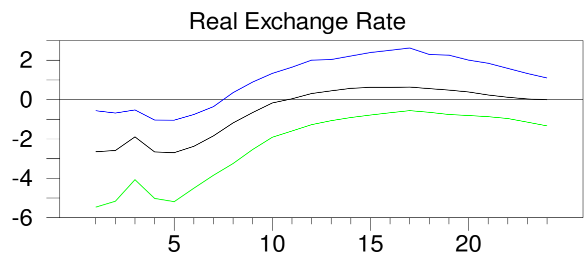
Australia (Model with Money Demand)



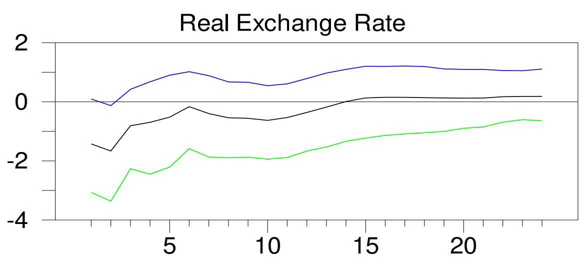
New Zealand (Model Bjornland)



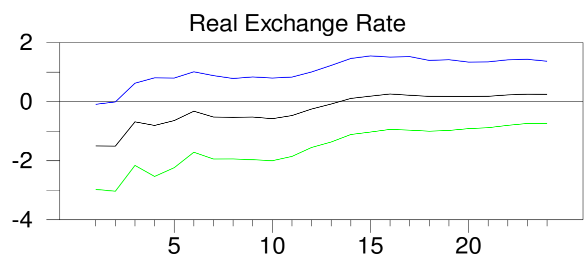
New Zealand (Model with Money Demand)



Sweden (Model Bjornland)



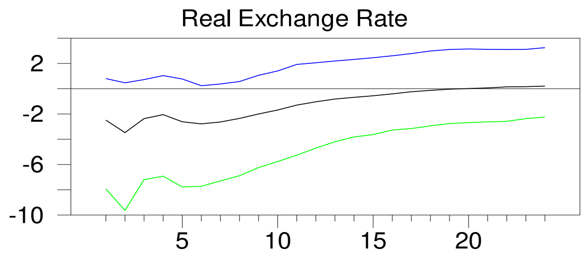
Sweden (Model with Money Demand)

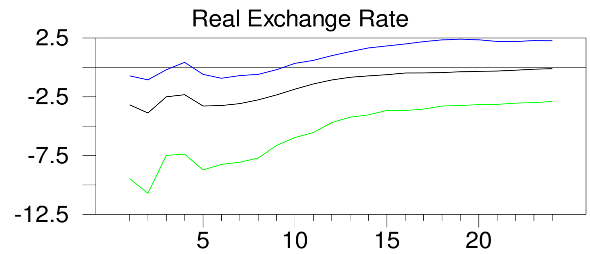


Canada

Canada

[3] A decrease in exchange rate implies appreciation. The statistical significance of impulse responses are examined using the Bayesian Monte Carlo integration in RATS to draw 1000 replications. The 0.16 and 0.84 fractiles correspond to the upper and lower lines of the probability bands.





For Australia (1987:1-2004:4), on impact to a unit monetary policy shock real, exchange rate appreciates significantly by 5% vis-a vis an insignificant appreciation of 4% in Bjornland's model before depreciating back to the long run equilibrium. For New Zealand (1990:1-2004:4), the exchange rate appreciates by less than 2% on impact to a monetary policy shock in the original model and becomes significant after a couple of quarters, following monetary policy shock. In our model, however, real exchange rate significantly appreciates by 3%. Similarly, a unit monetary policy shock for Canada (1987:4-2004:4), real exchange rate appreciates significantly by 3.75% in our model vs insignificant appreciation of less than 3% for Bjornland model. For the case of Sweden (1988:1-2003:4) both the models exhibits almost similar 'insignificant' exchange rate overshooting.

We are able to get theoretically consistent behavior for prices, output and money in addition to exchange rates in our model due to a monetary policy shock[4] reasserting our identification assumptions. The model is also robust to use of different number of lags, different ordering of variables and different sample periods.

1.3.2 Variance decomposition Analysis

Australian monetary policy plays much more important role in explaining the exchange rate variation and explains in our model 45% (vs 39%) and 40% (vs. 36%) variance in exchange rates in the 1st and 4th quarter, respectively. This trend continues. Monetary policy shock explains more of exchange rate variations in our model compared to Bjornland's model, which enables the model to correctly capture the impact responses of exchange rates to a monetary policy shock. In addition, money demand shock plays a significant role in explaining the exchange rate variation with its contribution becoming more important for later quarters. Similarly for New Zealand, interest rate explains about 21% and 15% of the exchange rate fluctuation in the 1st, and 4th quarter, respectively, as compared to 12% and 10% from Bjornland's model. The money demand shock by

[4] Results available on request.

itself plays the most important role for New Zealand explaining substantial variation in exchange rate till the final period of the analysis

Table 1								
Contribution of **Money Supply Shocks** and **Money Demand Shocks** to **Exchange Rate Variation** (in percentages)								
Quarters	**Australia**		**New Zealand**		**Sweden**		**Canada**	
	MS	**MD**	**MS**	**MD**	**MS**	**MD**	**MS**	**MD**
1	45	1	21	43	17	67	36	4
4	40	6	15	28	8	55	26	13
16	12	15	3	35	2	26	10	15
24	8	16	2	44	2	25	5	14

For Canada, the monetary policy shock consistently explains a high percentage of exchange rate variation and is able to explain up to 10% percentage of variation in the 16th quarter similar to Bjornland. However, in our model, the money demand shock, from a moderate beginning has nontrivial contribution later in explaining the real exchange rate variations. We get similar variance decomposition results between our model and Bjornland model for Sweden. However money demand with broader monetary aggregates plays substantial role in explaining Swedish exchange rate fluctuations.

1.4 Conclusion

Bjornland (2009) found evidence of exchange rate overshooting. However, on careful examination using the correct econometric technique, we find that some of the impulse responses following a monetary policy shock holds ‘insignificant’. Models of exchange rates should adopt both the money demand and money supply equations to capture the dynamics of money market instead of having interest rate alone as the monetary policy instrument. Alternative to Bjornland (2009), both money supply and money demand are used to rightly identify the monetary policy shock and in addition to that, error bands are computed correctly. We now find evidence of significant exchange rate overshooting with tighter error bands for exchange rate responses to monetary policy shock. Our results shows when monetary aggregates are introduced in the model, money market equilibrium conditions are captured better.

References:

Barnett,W.A., Bhadury S. S., Ghosh T., 2016. An SVAR Approach to Evaluation of Monetary Policy in India: Solution to the Exchange Rate Puzzles in an Open Economy, Open Economies

Review, (), 1-23, DOI 10.1007/s11079-016-9403-2

Bjornland,H. C., 2009. Monetary policy and Exchange rate overshooting: Dornbusch was right after all, Journal of International Economics 79 64-77

Cushman, David O.; Zha Tao. Identifying monetary policy in a small open economy under flexible exchange rates, Journal of Monetary Economics, 1997, Vol.39 (3), pp. 433-448.

Dornbusch, R., 1976. Expectations and Exchange Rate Dynamics. Journal of Political Economy 84, 1161-1176.

Eichenbaum, Martin; Evans, Charles L. Some Empirical Evidence on the Effects of shocks to Monetary Policy on Exchange Rate, The Quarterly Journal of Economics, 1 November 1995, Vol. 110(4), pp.975-1009.

Leeper, E. M., J.E. Roush, 2003. Putting “M” Back in Monetary Policy, Journal of Money, Credit and Banking Vol.35, No.6.