Has Money Lost Its Relevance?

Resolving the Exchange Rate Disconnect Puzzle in the Small, Open Economies

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Main Results

- A comprehensive study of role of money and Divisia in open-economy macroeconomic setting for India, UK and Poland

- It is imperative to consider the estimated responses of output, prices, money and exchange rate to monetary policy shocks in models using monetary aggregates.

- Monetary model setups with money especially Divisia provide puzzle free results

- The incorporation of Divisia money in monetary policy helps in explaining fluctuations in the exchange rate.

- Inclusion of Divisia money also promotes better out-of-sample forecasting of the exchange rate.

- Additionally, monetary variables and its effect on real effective/ nominal exchange rate are studied through the Bootstrap Bivariate Granger Causality test; test justify the use of money especially Divisia money in exchange rate models

Why Interest rate the only monetary policy instrument?

- Chrystal and McDonald (1995) claim that the velocity of the monetary aggregate in some major countries like U.S.A and U.K., took a sharp downward trend after 1980 (See Stone and Thronton, 1987)

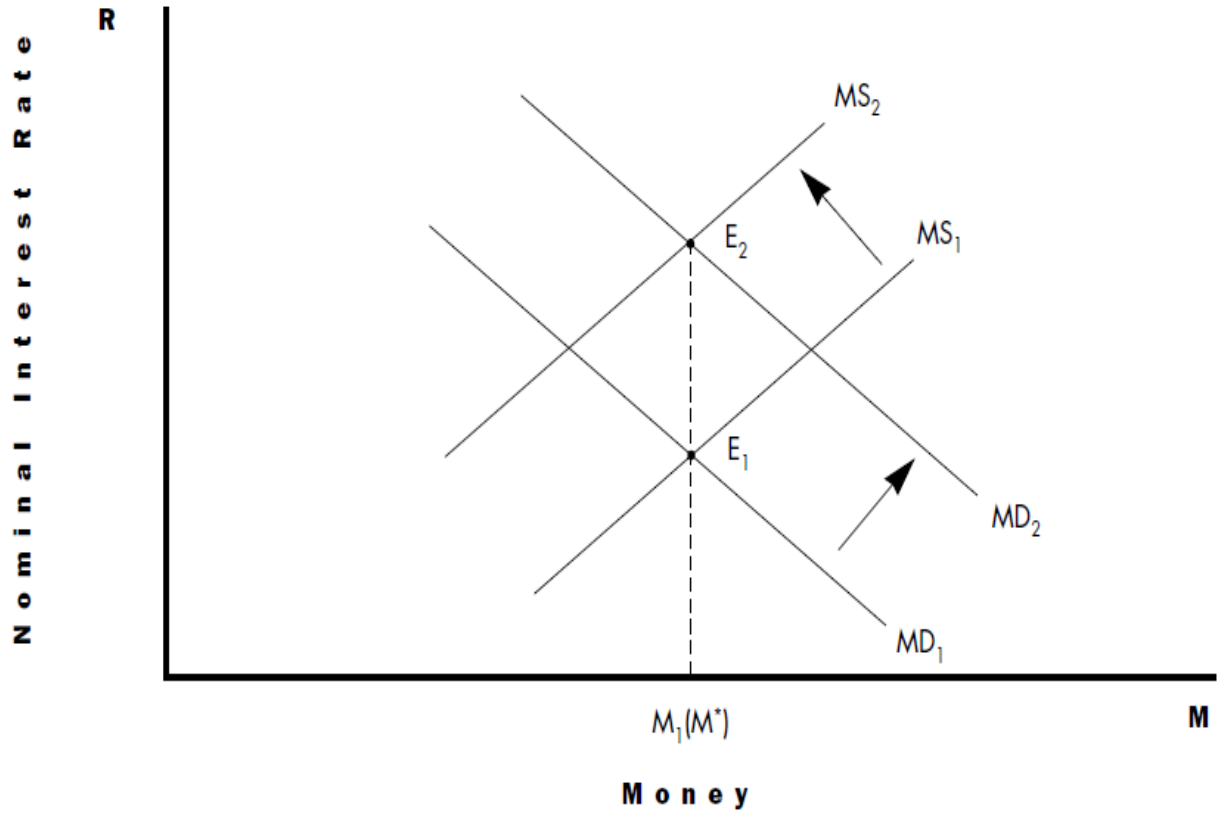
- Leeper and Roush (2003) agree with C&M that traditionally stable money demand functions were widely perceived to have broken down

- The main findings of Bernanke and Blinder (B&B, 1992) B&B are that fed fund rate is an excellent measure of the stance of monetary policy.

- The theoretical set-ups of a New Keynesian small open economy models are characterized by inflation, level of economic activity, short-term domestic rates of interest (which capture monetary policy), real exchange rate, and foreign interest rate (see Clarida et al., 2001; Svensson, 2000).

Central Bank vs Private Agents?

- If, say, the money demand curve shifts to the right from MD_1 to MD_2
- And if the central bank desires to have the money stock at M^*
- Model that separates central bank's behavior and private sector's behavior
- Aid policymaker decide how the money supply curve needs to be shifted accordingly (from MS_1 to MS_2)



Why include 'Money'?

- Practical consideration suggests including money in the Central Bank's policy rule
- Central bank usually does not have contemporaneous information on inflation and output, but it has information about money stock.
- Ireland finds money plays an informational-role by helping to forecast future nominal rate of interest (Ireland 2001a,2001b)
- Goodfriend (1999) argues that money plays a critical role even under an interest rate policy because " credibility for a price-path objective stems from a central bank's power to manage a stock of money"
- It may not be advisable to measure impact of monetary policy, and thereafter track policy transmission using interest rate alone, especially in a situation wherein rates stuck at near-zero.

Why include Divisia Money?

- Divisia money measures the aggregate flow of the 'monetary services' derived from a collection of assets that are imperfect substitutes (Barnett, 1980); captures the traditional transactional motive for holding money, that is, the money demand behavior of the private sector.

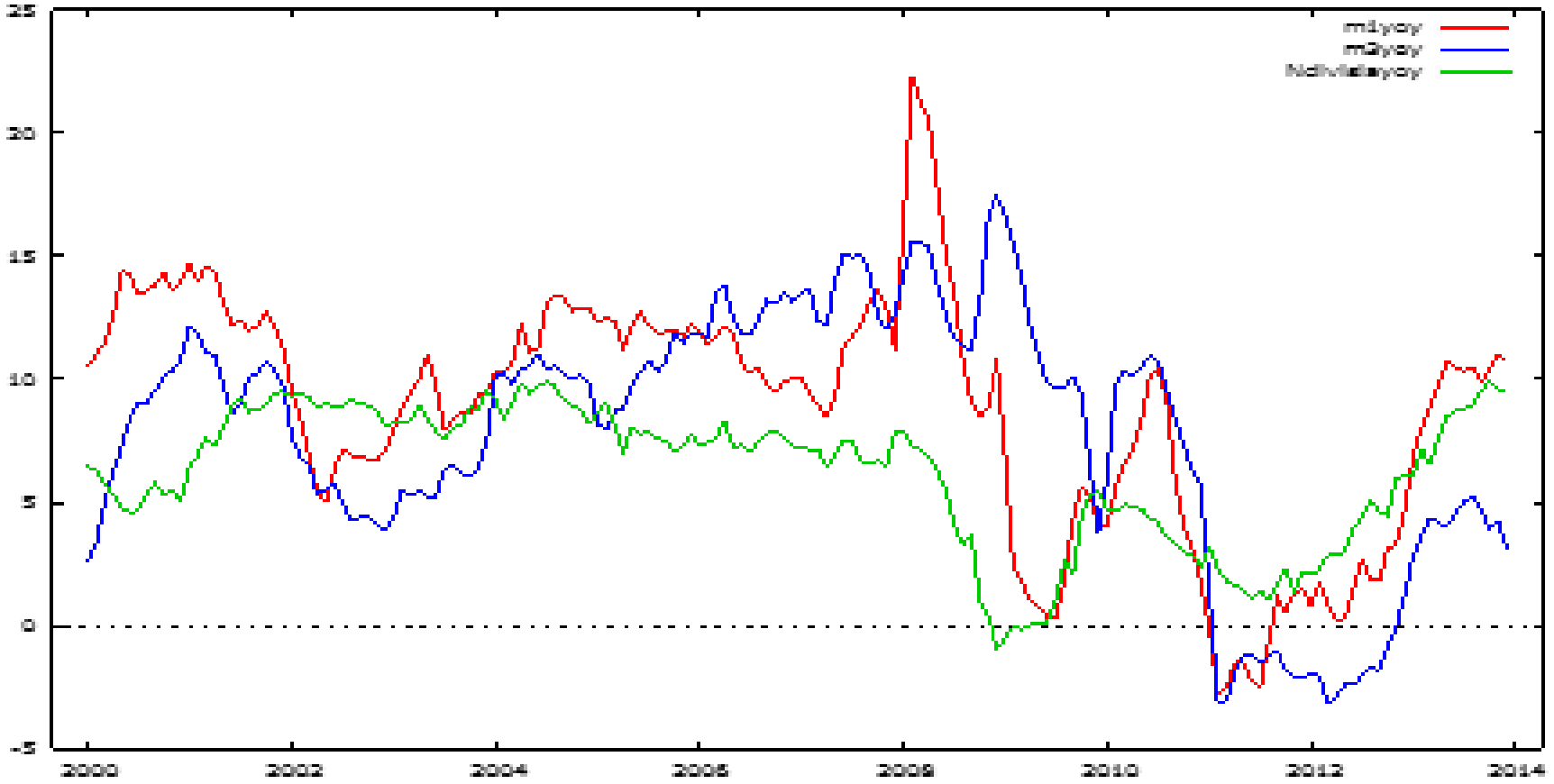
- Chrystal and McDonald (1995) believe that in a period of rapid financial liberalization data dynamics will be unable to track the exchange rate movements when simple-sum money is the preferred monetary aggregate

- Belongia and Ireland (2014) show "the loss of explanatory power for the monetary aggregates on the economic activity can be traced to the continued use of Fed's flawed simple sum aggregation method"

- The plot of simple-sum and Divisia money for UK, Poland and India suggest growth rate of simple sum monetary aggregates diverges markedly from the Divisia, before, during and after the recession of 2007-08

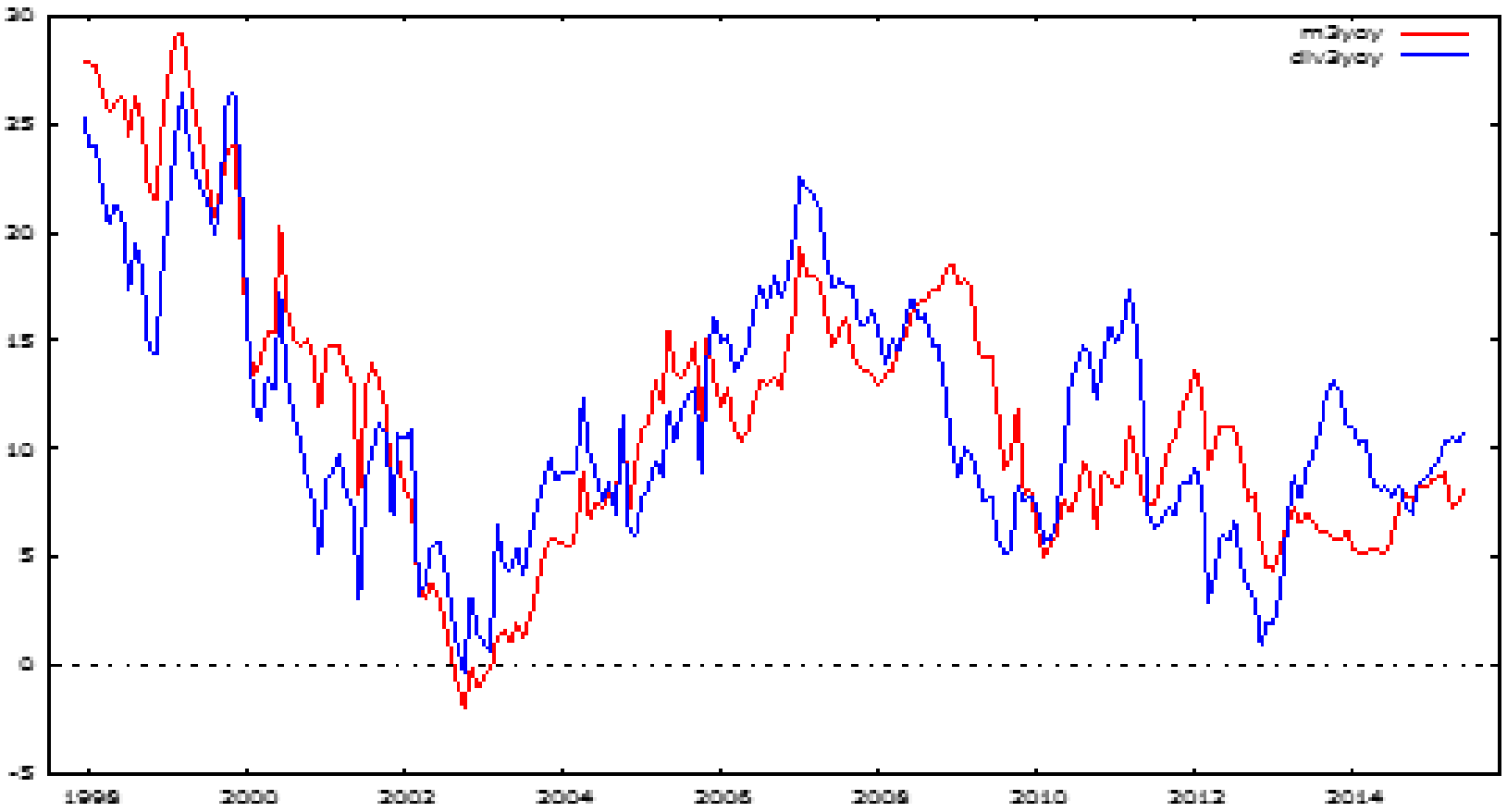
- Bootstrap Bivariate Granger Causality test justify the use of money especially Divisia money in structural VAR (SVAR) models

Growth Rates of Simple Sum M1, Simple Sum M3 and Narrow Divisia Monetary Aggregates, UK (year on year)



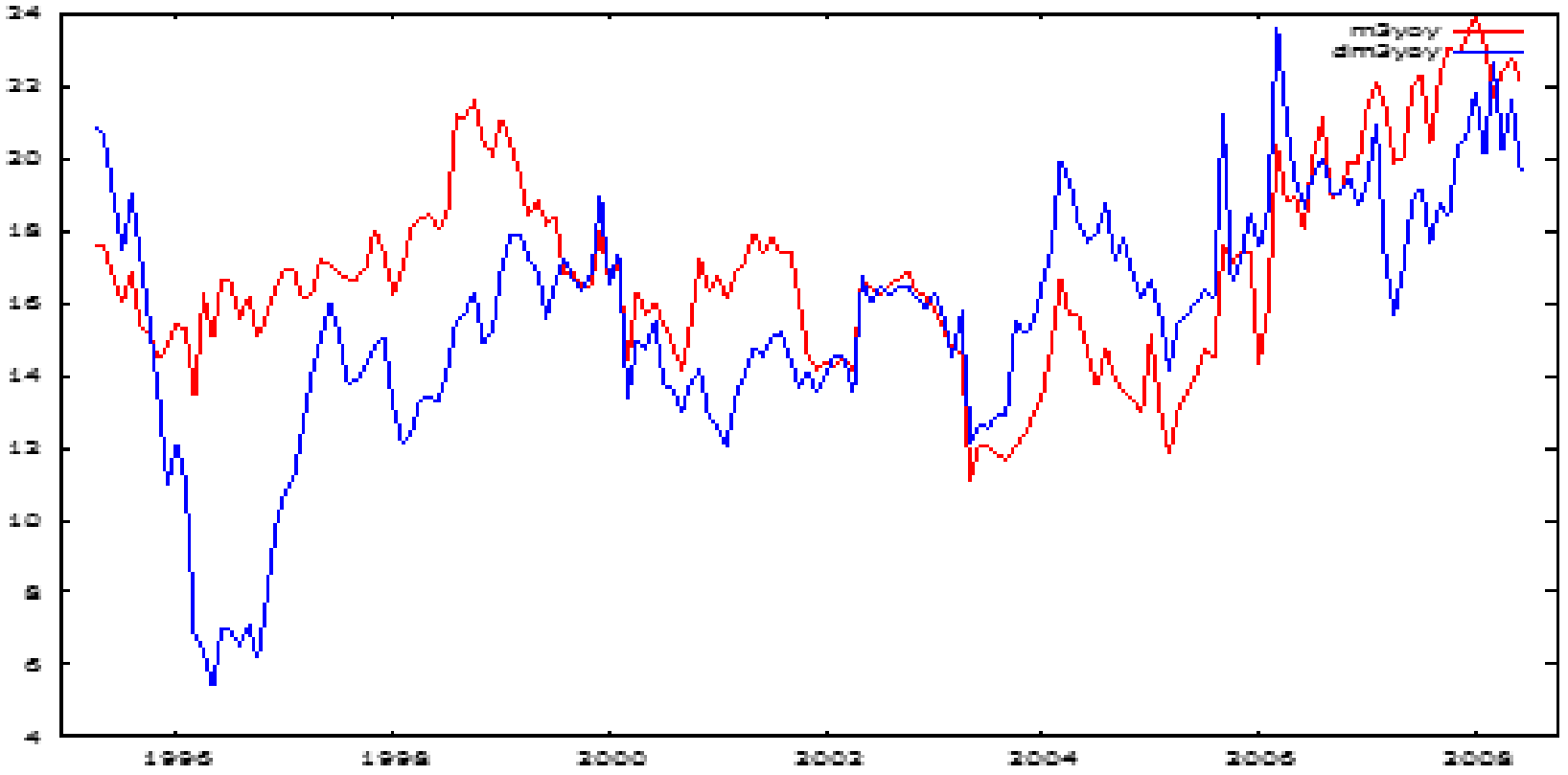
Data Source: Bank of England.

Growth Rates of Divisia 3, simple sum M3, Poland (year on year)



Data Source: National Bank of Poland.

Growth Rates of Divisia M3, Simple Sum M3, India (year on year)



Data Source: Ramachandran, et al., 2010.

Poland Bivariate Bootstrap Granger Causality: (Lags=6/12)

Null Hypothesis: Row variable does not Granger Causes Exchange Rate)

	Nominal Exchange Rate			Real Effective Exchange Rate		
	(Estimation Period 2001 Jan -2015 Jun)					
		Significance Level	Bootstrapped p-value		Significance Level	Bootstrapped p-value
Interest Rate		0.28	0.33		0.28	0.31
M1		0.16	0.23		0.02*	0.02*
M2		0.27	0.34		0.06**	0.08**
M3		0.28	0.35		0.09*	0.12
Div1		0.14	0.19		0.03*	0.04*
Div2		0.03*	0.06**		0.00*	0.00*
Div3		0.03*	0.05*		0.00*	0.00*

	Nominal Exchange Rate			Real Effective Exchange Rate		
	(Estimation Period 2001 Jan -2015 Jun)					
		Significance Level	Bootstrapped p-value		Significance Level	Bootstrapped p-value
Interest Rate		0.81	0.84		0.61	0.57
M1		0.45	0.55		0.20	0.24
M2		0.13	0.18		0.00*	0.01*
M3		0.14	0.19		0.01*	0.02*
Div1		0.44	0.53		0.27	0.31
Div2		0.05**	0.08**		0.00*	0.01*
Div3		0.06**	0.09**		0.00*	0.01*

UK Bivariate Bootstrap Granger Causality: (Lags=6/12)

Null Hypothesis: Row variable does not Granger Causes Exchange Rate)

	Nominal Exchange Rate			Real Effective Exchange Rate		
	(Estimation Period 1999 Jan-2013 Dec)					
		Significance Level	Bootstrapped p-value		Significance Level	Bootstrapped p-value
Interest Rate		0.31	0.40		0.00*	0.00*
M1		0.50	0.58		0.12	0.31
M3		0.23	0.32		0.00*	0.00*
Divisia		0.00*	0.00*		0.00*	0.01*

	Nominal Exchange Rate			Real Effective Exchange Rate		
		Significance Level	Bootstrapped p-value		Significance Level	Bootstrapped p-value
Interest Rate		0.44	0.52		0.02*	0.02*
M1		0.35	0.43		0.10	0.22
M3		0.80	0.85		0.00*	0.01*
Divisia		0.00*	0.00*		0.00*	0.00*

India Bivariate Bootstrap Granger Causality: (Lags=6/12)

Null Hypothesis: Row variable does not Granger Causes Exchange Rate)

(Estimation Period 1994 Apr-2008 Jun)						
	Nominal Exchange Rate			**Real Effective Exchange Rate**		
		Significance Level	Bootstrapped p-value		Significance Level	Bootstrapped p-value
Interest Rate		0.49	0.52		0.65	0.70
M1		0.54	0.65		0.32	0.40
M3		0.85	0.89		0.32	0.41
DL1		0.65	0.72		0.05**	0.08**
DM2		0.30	0.39		0.05**	0.08**
DM3		0.65	0.73		0.05**	0.08**

	Nominal Exchange Rate			**Real Effective Exchange Rate**		
		Significance Level	Bootstrapped p-value		Significance Level	Bootstrapped p-value
Interest Rate		0.38	0.41		0.65	0.68
M1		0.16	0.23		0.09**	0.10
M3		0.20	0.27		0.02*	0.03*
DL1		0.13	0.17		0.00*	0.00*
DM2		0.12	0.16		0.00*	0.00*
DM3		0.13	0.17		0.00*	0.00*

Model

- $B_0 y_t = k + B_1 y_{t-1} + B_2 y_{t-2} + \cdots + B_p y_{t-p} + u_t$ is the structural model

- y_t is an $n \times 1$ data vector,
- k is an $n \times 1$ data vector of constants
- u_t is an $n \times 1$ structural disturbances vector and is serially and mutually uncorrelated.
- p denotes the number of lags.

- $Y_t = [\ oil_t \ \ rfed_t \ \ iip_t \ \ \pi_t \ \ M_t \ \ R_t \ \ ER_t]$

Model

- $y_t = c + \emptyset_1 y_{t-1} + \emptyset_2 y_{t-2} + \cdots + \emptyset_p y_{t-p} + \epsilon_t$ is the reduced form model
- ϵ_t is the reduced form residuals

- $u_t = B_0 \epsilon_t$

- It is possible to recover the structural parameters from the reduced form model
- It requires the model be either exactly identified or over-identified

Identification Assumptions

$$\begin{pmatrix} u_t^{oil} \\ u_t^{rfed} \\ u_t^{iip} \\ u_t^{\pi} \\ u_t^{M} \\ u_t^{R} \\ u_t^{ER} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ b21 & 1 & 0 & 0 & 0 & 0 & 0 \\ b31 & b32 & 1 & 0 & 0 & 0 & 0 \\ b41 & 0 & b43 & 1 & 0 & 0 & 0 \\ 0 & b52 & b53 & b54 & 1 & b56 & b57 \\ b61 & 0 & 0 & 0 & b65 & 1 & b67 \\ b71 & b72 & b73 & b74 & b75 & b76 & 1 \end{pmatrix} \begin{pmatrix} \epsilon_t^{oil} \\ \epsilon_t^{rfed} \\ \epsilon_t^{iip} \\ \epsilon_t^{\pi} \\ \epsilon_t^{M} \\ \epsilon_t^{R} \\ \epsilon_t^{ER} \end{pmatrix}$$

Identification Assumptions

- World price of oil and foreign interest rate, is not affected by any domestic variable but the domestic variables are affected by outside shocks "contemporaneously"
- Output and prices respond with a lag to changes in domestic monetary policy variables and exchange rates
- In addition to the real income and the domestic interest rate, the money demand function also depends on the foreign interest rate and the prevailing exchange rates
- Monetary policy (interest rate) is set after observing the current value of money supply, the interest rate and the exchange rate
- Exchange rate is one of the most volatile variables in the model and is quick to react to almost all shocks

Model and Puzzles

- **Price puzzle** is a phenomenon where a contractionary monetary policy shocks identified with an increase in interest rates, leads to a persistent rise in price level instead of a reduction of it.

- The **liquidity puzzle** is an empirical finding when a money market shock is associated with increases in the interest rate instead of a decrease.

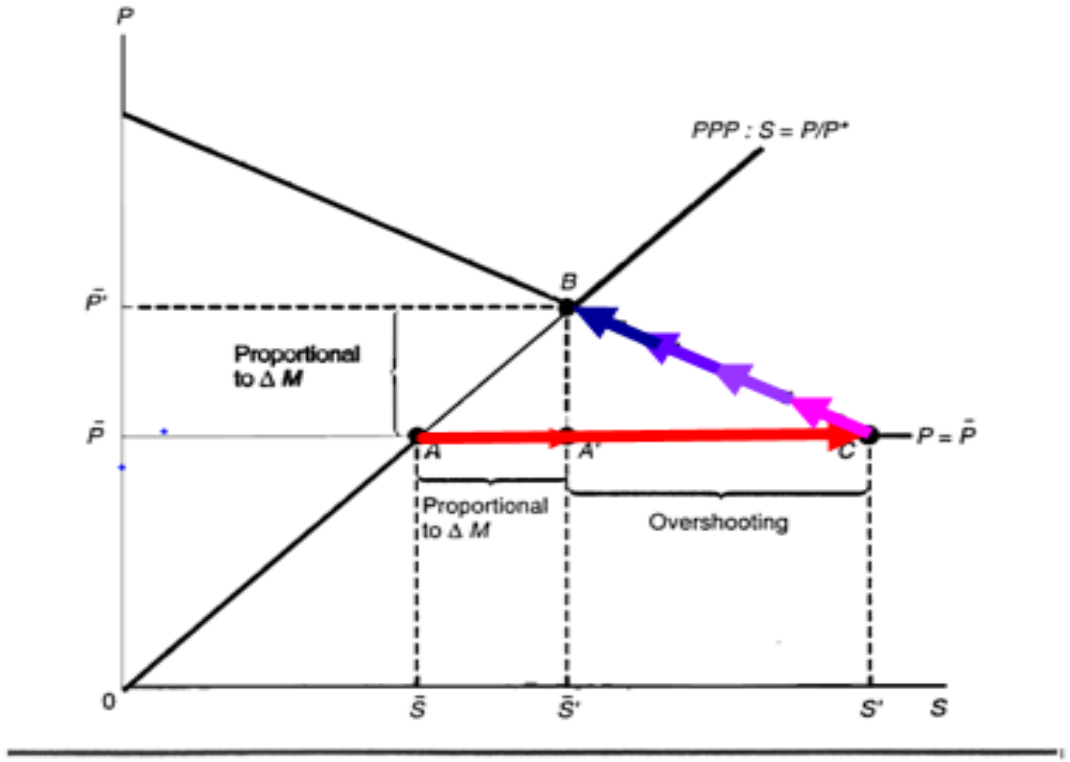
- The **exchange rate puzzle** occurs when a restrictive domestic monetary policy leads to on impact depreciation of domestic currency.

- Or, if it appreciates, it does so for a prolonged period of time violating the uncovered interest parity condition which is known as the **forward discount bias puzzle** or delayed overshooting.

The Dornbusch Overshooting

FIGURE 26.5 THE DORNBUSCH OVERSHOOTING DIAGRAM

An increase in the money supply, M, raises the price level, P, and spot rate, S, proportionately in the long run by PPP (at B). In the short run, however, P is tied down. As a result, S increases more than proportionately in the short run at C; that is, it overshoots its long-run equilibrium.



- According to Rogoff, Dornbusch's masterpiece, "**Expectation and Exchange Rate Dynamics", JPE, 1976**
- Two relationships lie at the heart of overshooting

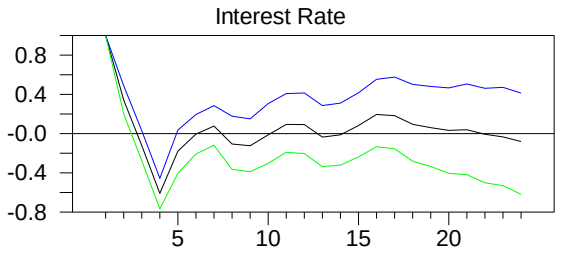
$$i_{t+1} = i^* + E_t(e_{t+1} - e_t)$$

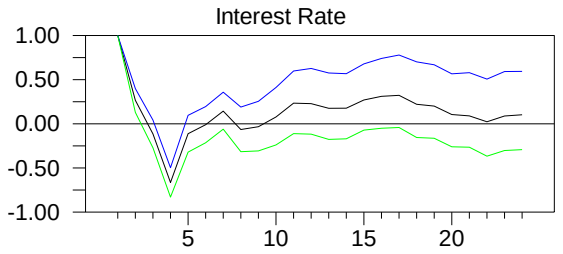
$$m_t - p_t = \eta i_{t+1} + \Phi y_t$$

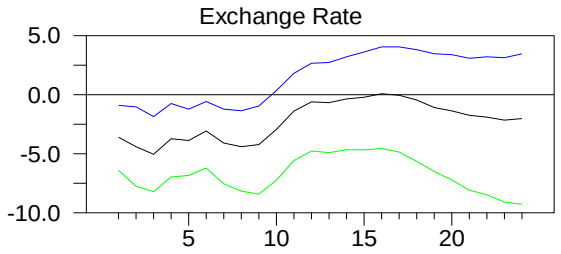
- Here Dornbusch's brilliant answer
  (1) *Initial impact appreciation must be larger than LR appreciation*
  (2) *Initial excess appreciation leaves room for ensuing deprecation*

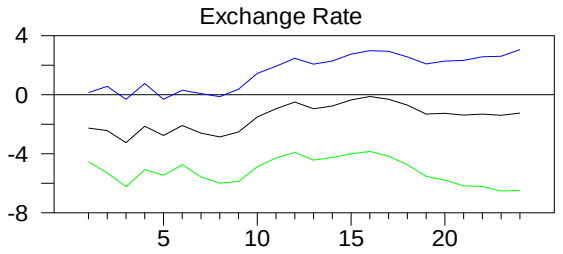
Impulse Responses for Monetary Policy Shocks : INDIA

Model with Divisia M3	Model with M3









Impulse Responses for Monetary Policy Shocks : INDIA

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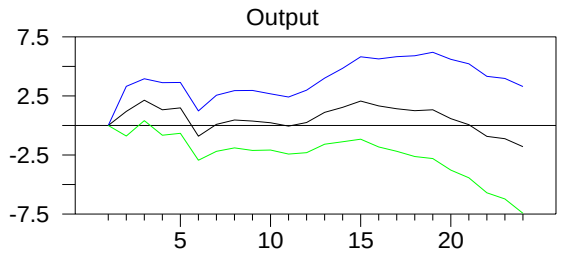
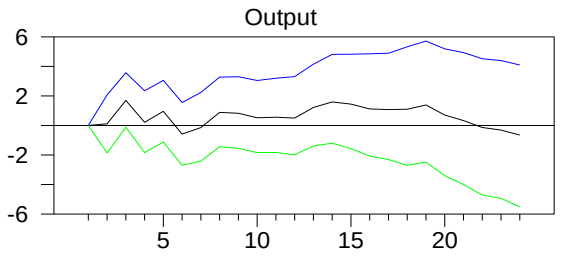
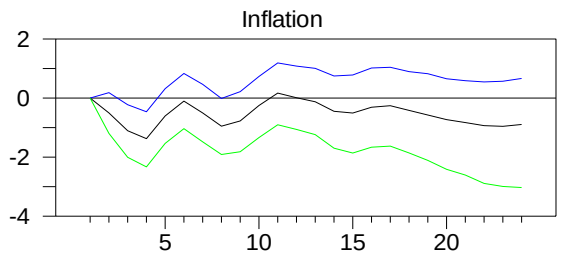
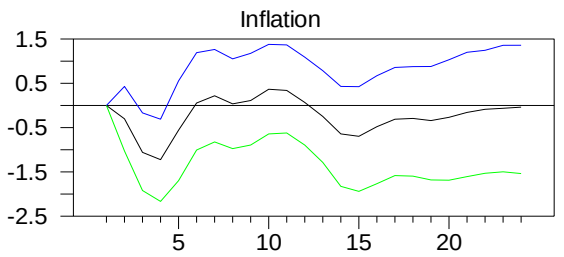
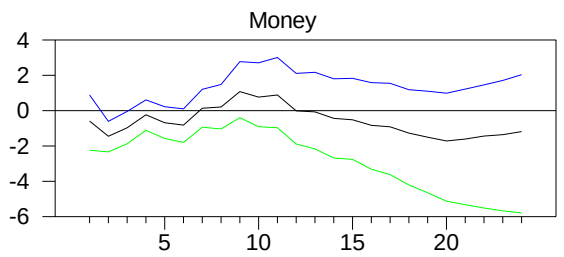
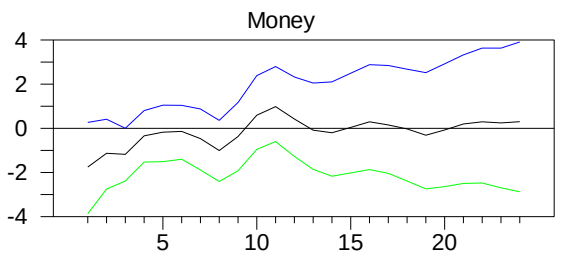






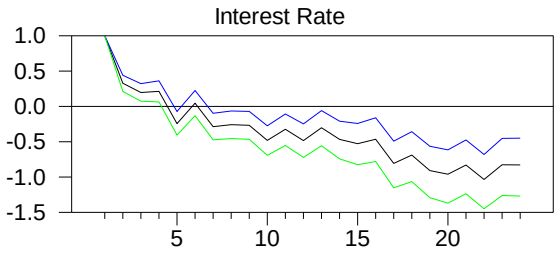


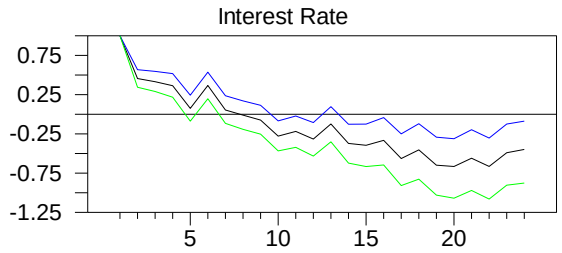


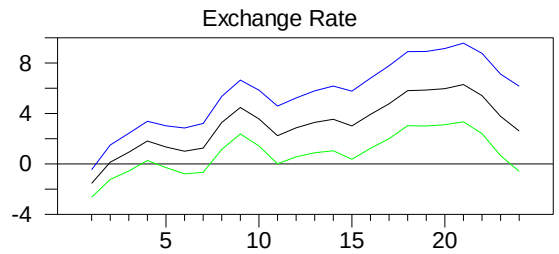


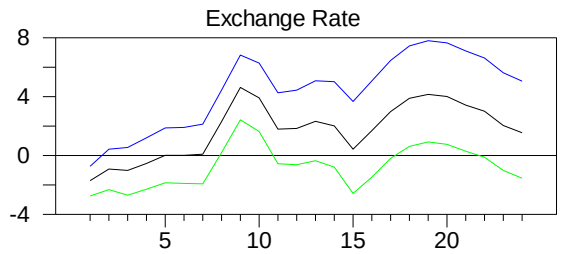
Impulse Responses for Monetary Policy Shocks : UK

Model with Divisia M3	Model with M3









Impulse Responses for Monetary Policy Shocks : UK

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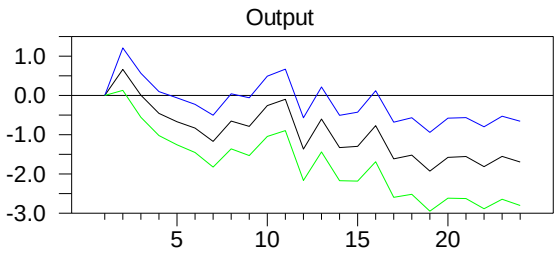
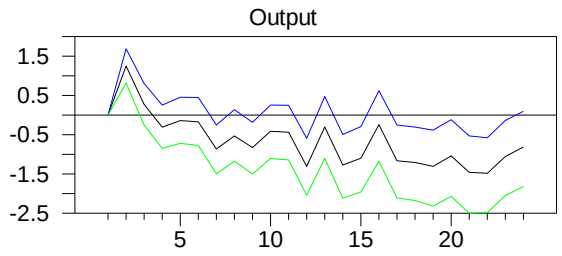
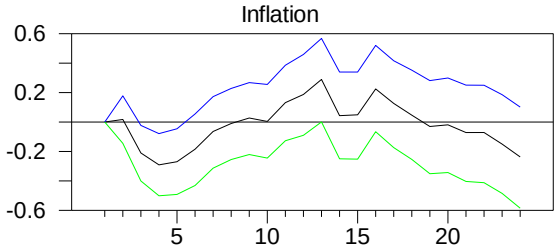
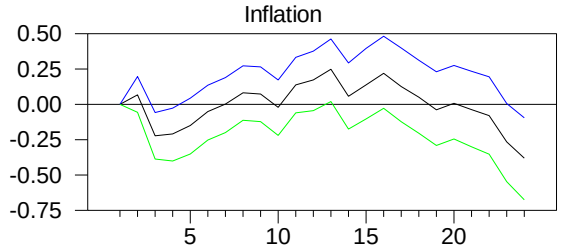
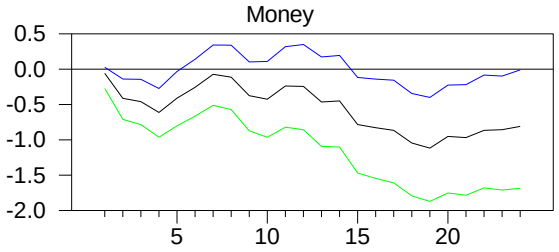
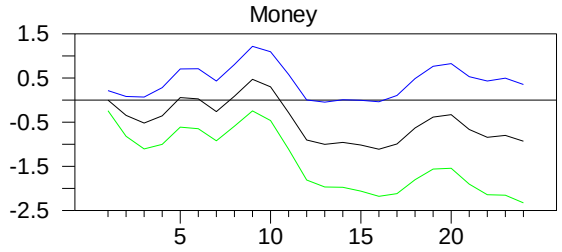
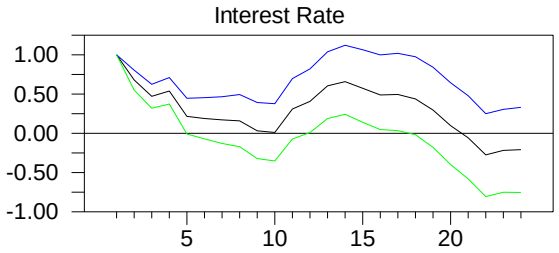
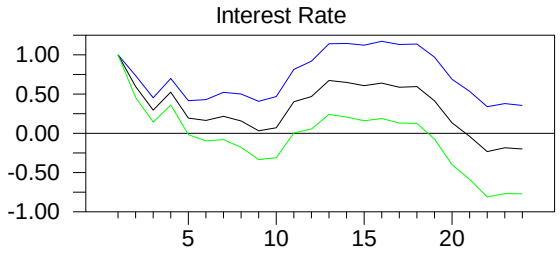
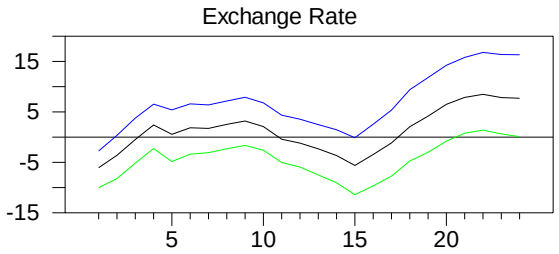
	
	
	

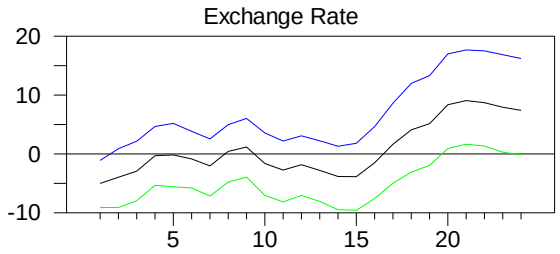
Impulse Responses for Monetary Policy Shocks : POLAND

Model with Divisia M3	Model with M3









Impulse Responses for Monetary Policy Shocks : POLAND

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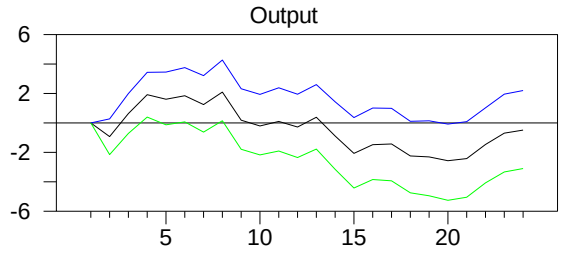
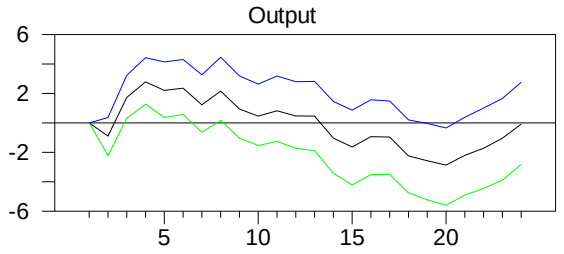
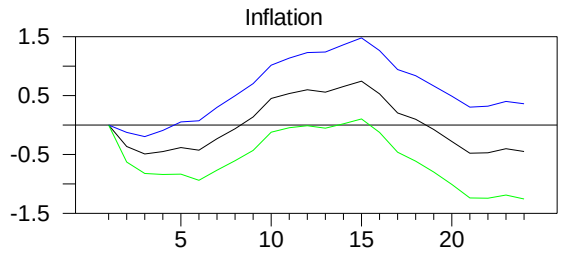
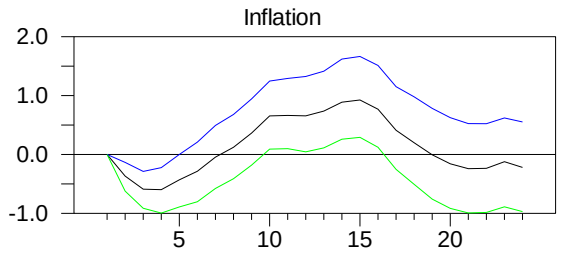
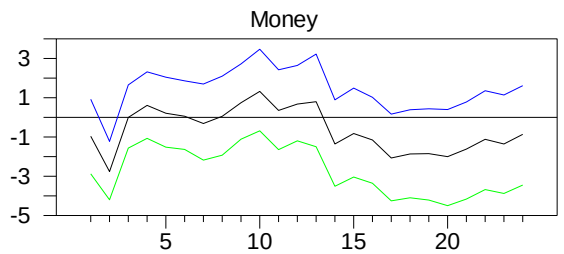
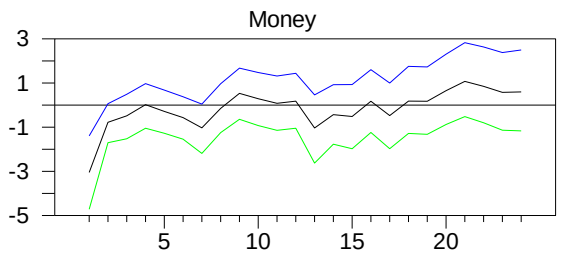












Variance Decomposition of Exchange Rate due to Money Supply Shocks

Month	1	2	4	8	12	16	20	24
INDIA								
Model(M3)	8	8	10	9	7	6	6	5
Model(DivisiaM3)	14	14	16	14	12	11	10	8
Model(DivisiaM2)	17	18	21	15	13	12	11	9
Model(DivisiaL1)	14	15	16	14	12	12	11	8
UK								
Model(M1)	11	9	5	3	4	2	3	3
Model(M3)	4	2	2	2	5	3	5	5
Model(Divisia)	4	2	3	4	9	10	16	18

Variance Decomposition of Exchange Rate due to Money Supply Shocks

Month	1	2	4	8	12	16	20	24
POLAND								
Model(M2)	5	3	2	2	2	2	3	8
Model(Divisia2)	7	4	3	3	3	4	4	7
Model(M3)	4	3	2	2	2	2	3	7
Model(Divisia3)	7	4	3	3	4	4	4	7

Variance Decomposition of Exchange Rate due to Money Demand Shocks

Month	1	2	4	8	12	16	20	24
INDIA								
Model(M3)	1	2	2	3	2	2	2	3
Model(DivisiaM3)	1	<1	1	2	2	3	4	3
Model(DivisiaM2)	<1	1	1	1	1	2	3	2
Model(DivisiaL1)	<1	<1	1	2	2	3	4	3
UK								
Model(M1)	2	1	1	2	1	1	1	1
Model(M3)	1	2	2	2	2	2	1	1
Model(Divisia)	1	1	2	10	12	13	15	17

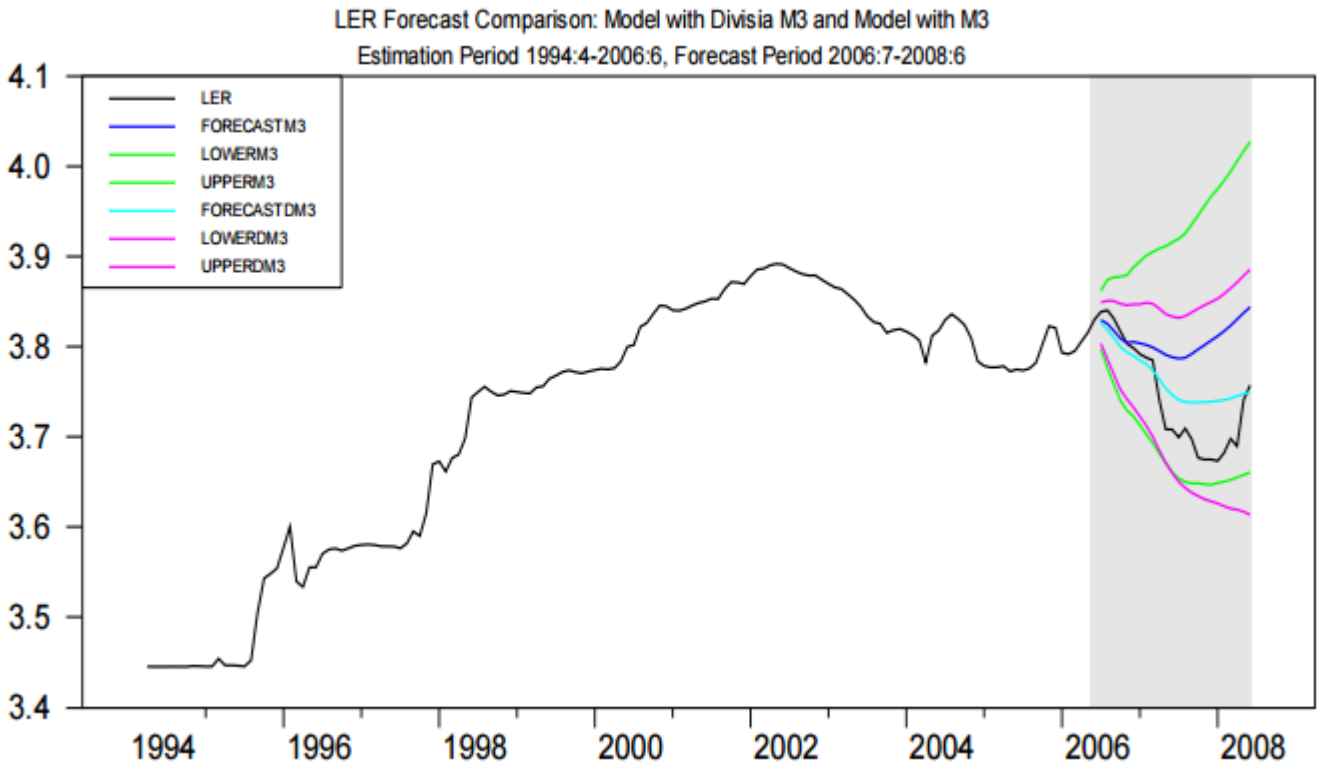
Variance Decomposition of Exchange Rate due to Money Demand Shocks

Month	1	2	4	8	12	16	20	24
POLAND								
Model(M2)	5	6	8	12	15	12	14	12
Model(Divisia2)	4	12	27	30	27	17	12	10
Model(M3)	4	4	7	11	15	12	12	11

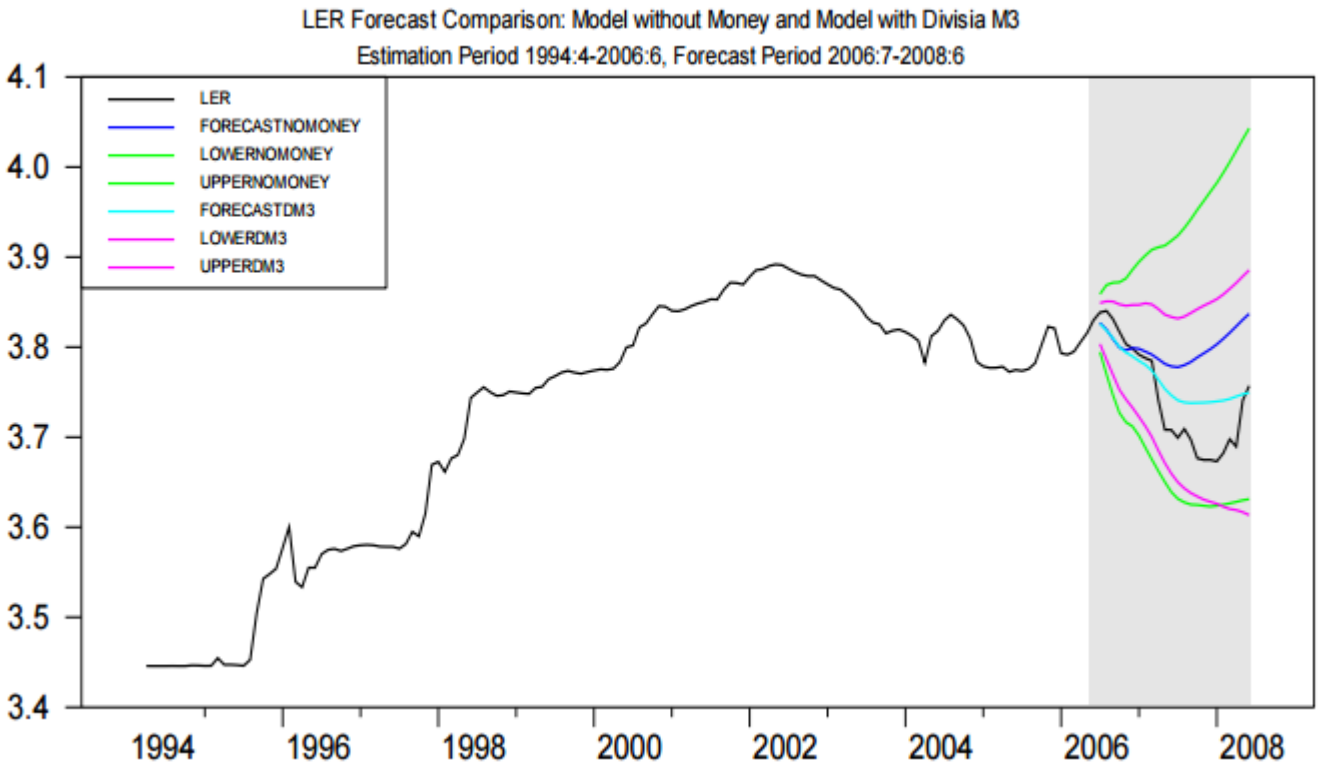
Forecast statistics: RMSE

Steps	1	4	8	12	20	24
INDIA						
Model(DivisiaM3)	0.016817	0.045093	0.08162	0.11592	0.130837	0.082902
Model(M3)	0.016819	0.045097	0.081626	0.115927	0.130855	0.082923
UK						
Model(M1)	0.016	0.038	0.068	0.106	0.193	0.235
Model(M3)	0.016	0.039	0.06	0.097	0.229	0.523
Model(Divisia)	0.014	0.027	0.022	0.034	0.015	0.045
POLAND						
Model(M1)	2.48	8	15.82	17.53	19.54	16.48
Model(Divisia1)	2.46	7.82	15.62	17.46	19.79	17.14
Model(M3)	2.46	7.51	13.97	16.68	20.43	18.2
Model(Divisia3)	2.42	7.4	14.47	16.65	20.72	18.66

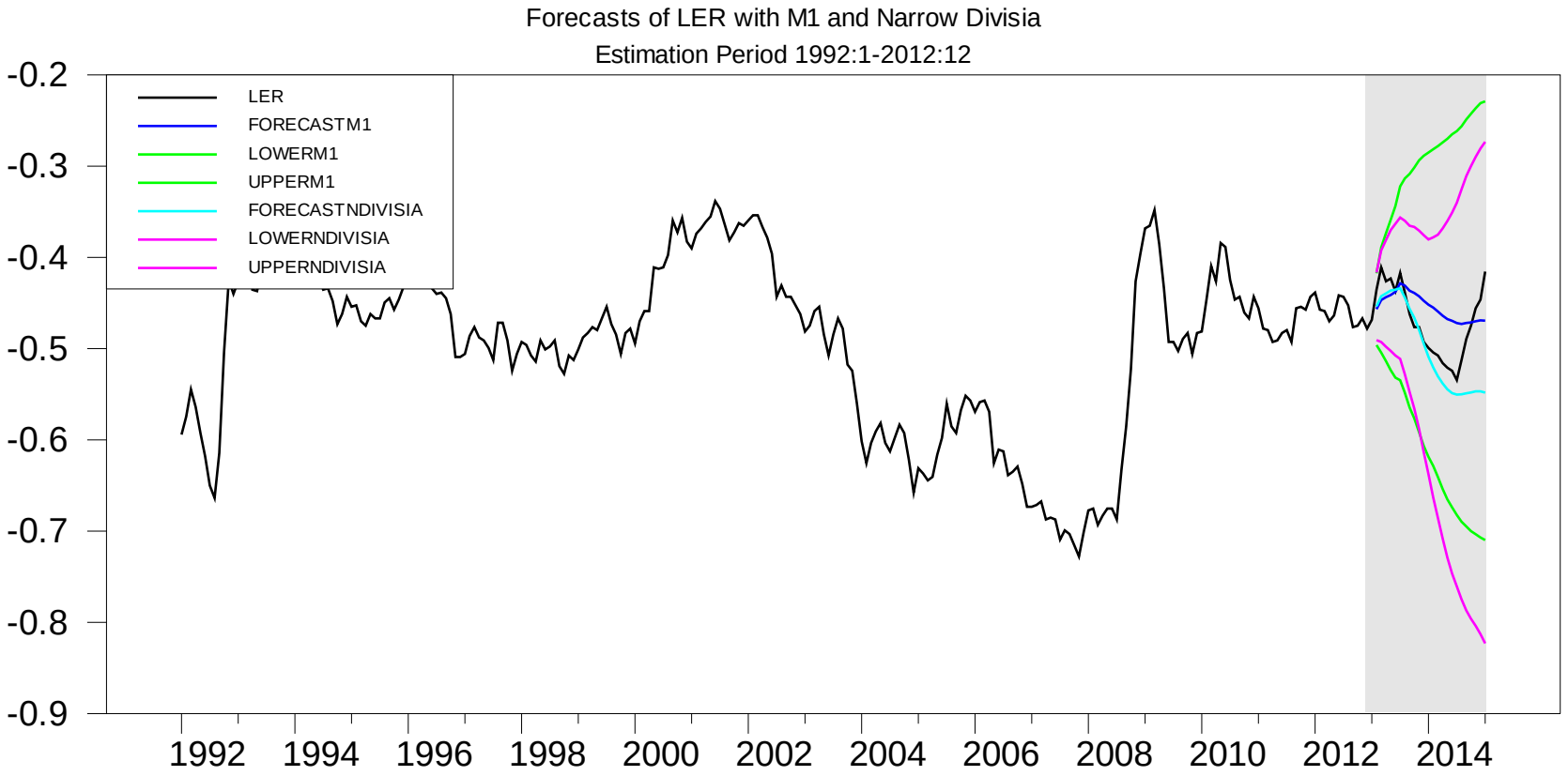
Forecast statistics: India Out-of-Sample forecast



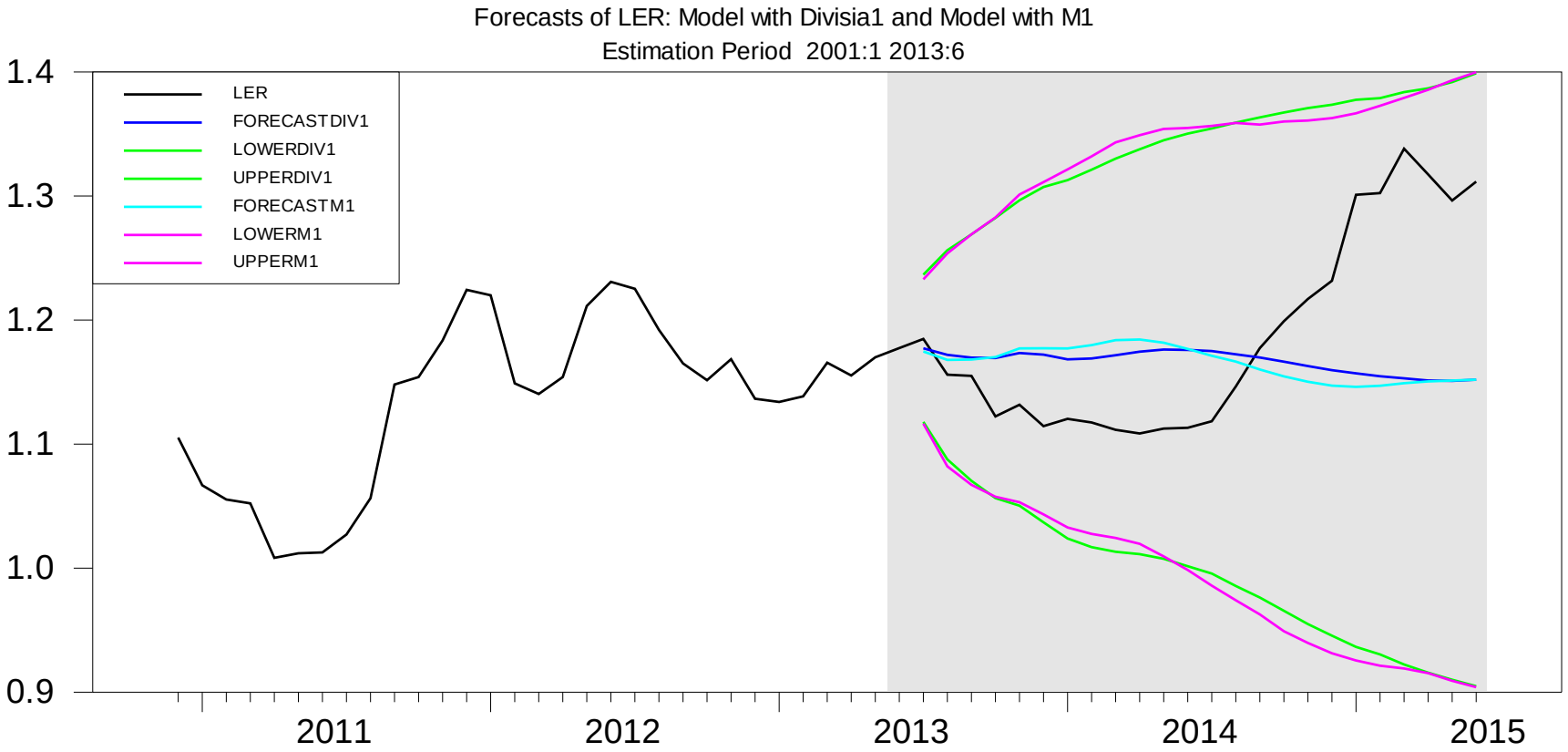
Forecast statistics: India Out-of-Sample forecast



Forecast statistics: UK Out-of-Sample forecast



Forecast statistics: Poland Out-of-Sample forecast



Conclusion

- The estimated SVAR model for India, Poland and UK is able to get rid of the major puzzles (IRFs)

- Exchange rate overshooting is captured by allowing contemporaneous response between ER and monetary policy. Both money supply and money demand are to used to identify the monetary policy shock

- FEVD results shows when monetary aggregates are introduced, money market equilibrium conditions are captured better and money plays both 'causal' and 'informational' role

Conclusion

- We did the out-of-sample forecasting, across simple-sum monetary models and Divisia money models

- In general, the inclusion of money lowered the RMSE values and Divisia money model did fairly better than simple-sum model

- Additionally, Bootstrap Granger Causality test justify the use of monetary aggregate more importantly, the Divisia money in exchange rate models

THANK YOU