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Exchange Rate and Output Fluctuations in the Small Open Economy of Mauritius

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Abstract

The authors estimate a VAR and compute generalized impulse response to analyze the joint dynamics of four key macroeconomic variables in the small open economy of Mauritius. Results suggest that nominal exchange rate and interest rate have limited ability to impact output growth over the medium-run. Large error bands hinder analysis of the inflation output trade-off, but evidence points to a weak relationship in the short run as well. These findings are used to shed some light into the policy response to the current worldwide economic slowdown affecting Mauritius.

This paper—a product of the Poverty Reduction and Economic Management Department, Africa Region—is part of a larger effort in the department to monitor macroeconomic developments in Mauritius and assess policy options. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at fbastos@worldbank.org.

The Policy Research Working Paper Series disseminates the findings of work in progress to encourage the exchange of ideas about development issues. An objective of the series is to get the findings out quickly, even if the presentations are less than fully polished. The papers carry the names of the authors and should be cited accordingly. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the International Bank for Reconstruction and Development/World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent.

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1. Introduction

Mauritius is a development success story. In late 1960's, its GDP per capita was a bit less than US$ 300. Fifty years later, the GDP per capita reached more than US$ 6,000. While there is debate around the explanations for such a success, the crucial role played by trade preferences in Sugar and Textile is widely acknowledged – Roy and Subramanian (2001). As preferential market access dwindled over the last five years, Mauritius had to deepen exploitation of other growth drivers. To that end, the last three years witnessed an acceleration of reforms aiming at transforming the economy in a high-value added, globally competitive and trade integrated services hub. In the process of doing so, solid macroeconomic management was reinforced as a key development pillar. A managed float regime for the exchange rate, an improving institutional framework for monetary policy and greater fiscal responsibility were all understood as necessary ingredients. At the same time, a number of longer-term initiatives dealing with human capital, infrastructure, public sector effectiveness and regulatory environment are being undertaken.

In this context, the world economic crisis initiated in late 2008 has caught Mauritius at a crossroads. Key export markets for textile and tourism are in recession, FDI inflows have slowed down and the banking sector is also vulnerable to developments in international capital markets. While the path towards solid economic performance still requires attention to various structural bottlenecks, avoiding growth decelerations today is key – Arbache and Page (2007). A mix of macroeconomic and microeconomic policies is being pursued by the government. On the macro front, policies have been characterized by a temporary fiscal stimulus, loosening of the monetary policy, and a nominal exchange rate largely determined by market forces. In this context, calls for more aggressive reduction in interest rates are common, aiming not only at a lower cost of credit but mainly at an aspired faster depreciation of the exchange rate to boost competitiveness in the exporting sector.

The concept of competitiveness can be used to motivate different and at times even conflicting policy actions. Good physical infrastructure, appropriate human capital base, technological absorption and a regulatory environment conducive to private sector development are all necessary for the fundamentals of competitiveness to exist. Unfortunately, addressing these complex issues is not simple and often takes a long time to bear fruit. In the context of the current economic slowdown and the pressing need to sustain employment and growth, a push for greater nominal exchange rate depreciation in Mauritius emerges as a quick solution to boost competitiveness of the export sector and stimulate growth. A few observations are important:

(i) With faltering external demand, domestic competitiveness (whatever one understands by it) has limited scope to be translated into strong export performance. Mauritius exports are non-diversified and key markets in Europe for tourism and textiles are undergoing severe economic downturn.

(ii) Real, not nominal exchange rates, is what really affects competitiveness. However, this is not a policy variable. Instead, it is a price that will adjust in response to internal and external equilibrium conditions and which is linked to the rest of the world through the international price level. A global recessionary environment affecting some of the Mauritius key trading partners complicate any prospects for real exchange rate devaluation and competitiveness gains that could come from it. First, currencies of developed economies are under depreciating pressure due to weak fundamentals. Second, international price levels may fall faster than domestic levels due to a relatively worse economic environment abroad. Mechanically, both factors contribute to the appreciation of the real exchange rate in Mauritius, and mitigate depreciating forces coming from subdued export performance and worsening prospects for capital accounts.

(iii) It is not clear that lower interest rates is a very effective mechanism to achieve nominal depreciation of the exchange rate in Mauritius - in particular, the portfolio channel of the capital account is not particularly strong vis a vis its other components. Additionally, direct intervention in the nominal exchange rate market to push the currency to levels that are weaker than those determined by the market would eventually be (at least partly) neutralized by higher domestic prices (import inflation). So real exchange rates, and thus competitiveness, would not be affected necessarily.

It could be argued – particularly against points (ii) and (iii) – that adjustments in the real exchange rate via price level changes are not immediate. Hence, nominal depreciation of the exchange rate would still generate a positive short-run impact. Given the current circumstances, one could claim that even a temporary boost of exchange rate competitiveness would be instrumental for the economy to withstand the bad times and perhaps even avoid policy reform stagnation/reversals that could be costly for competitiveness tomorrow. So a relevant policy question to ask is how output growth would respond to nominal exchange shocks over the space of a year or so.

We run a reduced-form VAR to shed some light into this question. Based on the observed dynamics of four key macroeconomic variables since 2001, the exercise allows one to trace the impact on output growth in response to nominal exchange rate shocks accounting for feedback effects in inflation and interest rates. It is important to highlight that the evidence presented here is not definitive by any means. First of all, this is a small-scale reduced-form model. Secondly, one could claim that the Mauritius economy is undergoing structural changes that are particularly hard to capture in an econometric exercise with the sample size used. Hence, the evidence we present should be interpreted with the due caution.

The paper is organized as follows. Next section discusses the VAR and generalized impulse response estimation. The third section presents the data set, applies unit root tests, computes and analyzes the impulse response. The fourth section is dedicated to concluding remarks.

2. The VAR approach

Since the pioneer work of Sims (1980), the VAR framework has been extensively used to analyze monetary policy issues. Bernanke and Blinder (1992), Bernanke and Mihov (1998), Kim (2001), and Bagliano and Favero (1999) are a few examples of application to analyze different aspects of monetary policy. The VAR approach, however, is often criticized for heavily depending on *ad hoc* identification assumption. In this paper, we deal with this criticism by computing generalized impulse responses, which do not rely on any *a priori* identification assumption. The reduced-form specification of the VAR is as follows:

$$Y_t = \sum_{j=1}^{p} \Phi_j Y_{t-j} + \Psi X_t + \varepsilon_t \qquad (1)$$

where $Y_t = (g_t, \pi_t, i_t, e_t)'$, with $t = 1, 2, \ldots, T$, is a 4×1 vector of jointly determined dependent variables, to be defined in the next section, $X_t = (1, op_t)$ is a 2×1 vector of deterministic and exogenous variables, $\Phi_j, j = 1, 2, \ldots, p$, and Ψ are 4×4 and 4×2 coefficient matrices. The residuals are assumed to be Gaussian $\varepsilon_t \sim iid\, N(0, \Omega)$. In the empirical analysis, the vector X_t will be augmented to include *dummy* variables for structural breaks in the time series. To select the optimal truncation lag, *p*, one can use the information criteria of Akaike and Schwartz.

Under the assumption that each time series in (1) is covariance-stationary, the VAR can be written as an infinite vector moving average (VMA) representation:

$$Y_t = \sum_{j=0}^{\infty} \Theta_j \varepsilon_{t-j} + \sum_{j=0}^{\infty} \Gamma_j X_{t-j} \qquad (2)$$

where Θ_j and Γ_j are 4×4 and 4×2 coefficient matrices with $\Theta_0 = I_4$. Note that when there are only deterministic terms in X_t, there will be no lagged variables in the augmented term.

The VMA representation in (2) is used to compute impulse-response functions. A key issue, however, refers to the identification of the structural residuals, which are functions of the reduced form ones. A standard practice in the empirical literature is to adopt a Cholesky triangular decomposition, where the variables are ordered according to an assumed decreasing exogeneity ranking. Under some circumstances, this identification strategy is equivalent to the one proposed by Sims (1980). In general, the results are quite sensible to changes in the *ad hoc* order of the variables. To overcome this limitation, Pesaran and Shin (1998) proposed the generalized impulse responses (GIR), which are invariant to reorder of the variables in the VAR.

Given some assumptions on ε_t, they show that GIR are unique and fully take account of correlations among different shocks.

The standard-deviation scaled GIR of the effect of a shock in the i^{th} equation, $i = 1, 2, 3, 4$, at time *t* on Y_{t+n}, *n* periods ahead, is represented by:

$$GIR_i(n) = \sigma_{ii}^{-1/2}\Theta_n\Sigma\xi_i \qquad (3)$$

where σ_{ii} are the main diagonal elements of $\Sigma = E\left(\varepsilon_t\varepsilon_t^{'}\right)$ for all *t*, with $\Sigma = \left\{\sigma_{ji},\ j,i = 1,2,3,4\right\}$ a positive definite matrix, Θ_n is a coefficient matrix from (2), and ξ_i is an 4×1 selection vector with unity as its i^{th} element and zeros elsewhere. Cleary, the GIR in (3) does not depend on any lower triangular matrix, which defines the variables ordering in a Cholesky stile residual decomposition.

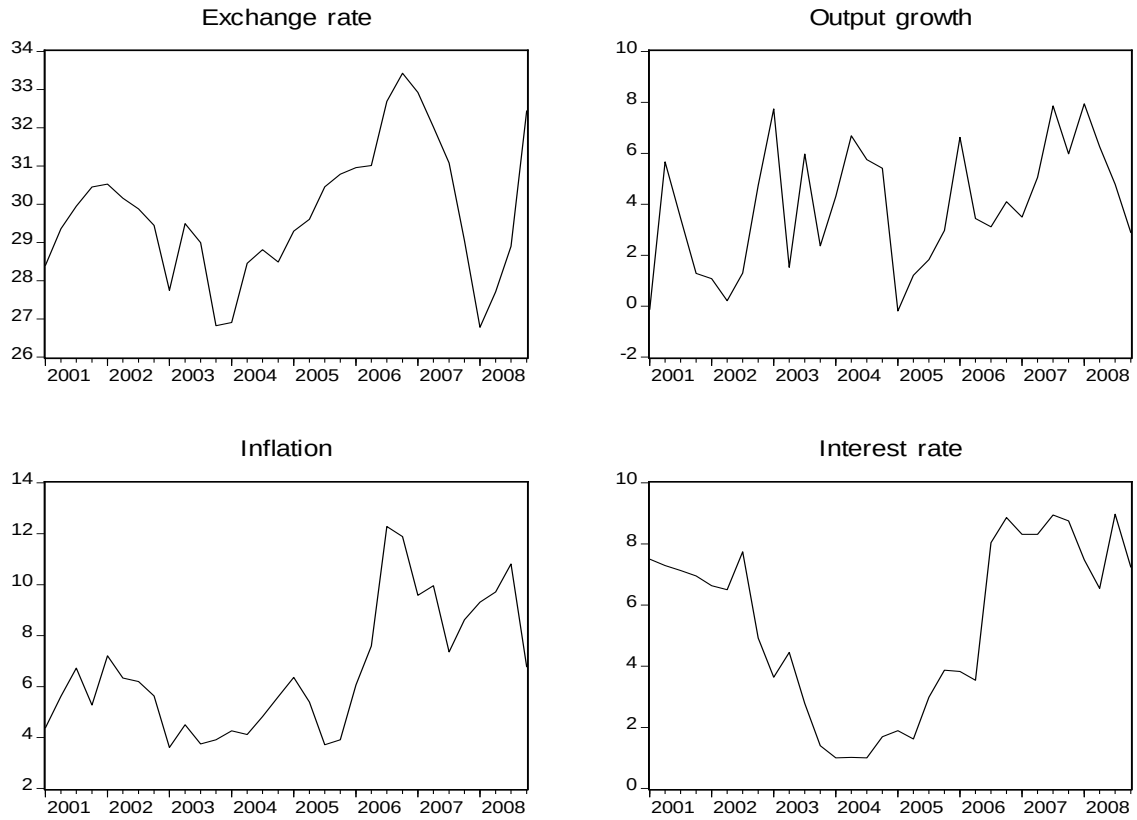
Kim (2009) argues against using GIR because they employ a set of extreme identifying assumptions. Economic inference based on GIR would be misleading, unless the covariance matrix is diagonal. In order to address those issues, we use a standard Cholesky identification scheme to compute orthogonalized impulse response and show that the main results also hold under a conventional ordering of the variables.

3. Results

3.1 Data

The model has five macroeconomic variables: (i) real output growth, (ii) inflation, (iii) interest rate (iv) nominal exchange rate, and (v) oil price. The first four are treated as endogenous while the last one is exogenous in the model. Real output growth (g_t) is obtained directly from the Central Statistics Office and calculated on the basis of the GDP deflator. Inflation (π_t) measures yearly variation in the Consumer Price Index and is also obtained from the Central Statistics Office. The interest rate (i_t) used is the weighted average interbank rate published by the Bank of Mauritius, which is not a pure policy variable and should be understood as capturing the liquidity stance of the economy. Nominal exchange rate (e_t) is obtained from the same source. We also use oil prices (op_t) as an exogenous variable in the VAR. The data is quarterly and the sample runs from 2001Q1 to 2008Q4. Figure 1 display the time series.

Figure 1 – Time series



3.2 Unit root tests

The assumption of stationarity must be tested in the data. Traditional tests, however, based on Dickey-Fuller and Phillips-Perron, are criticized for suffering from lower power and size distortions. As stressed by Ng and Perron (2001), statistical power is lower for highly persistent time series, while size problems are determined by the presence of a strong negative MA component in the series representation. Improvements in the test procedure have been proposed by Perron and Ng (1996), Elliott, Rothenberg and Stock (1996), and Ng and Perron (2001). Essentially, the modifications evolve the combined use of GLS detrended data and the modified Akaike information criterion to choose the optimal truncation lag for the augmented term of the test equation. Asymptotic critical values for both tests, labeled $MADF^{GLS}$ and MPP^{GLS}, are reported in Ng and Perron (2001).

The presence of structural breaks in the time series might severely bias the previous tests. To account for such breaks, it is applied tests proposed by Perron (1997) and Lee and Strazicich (2003), which endogenously select the time of the breaks. Perron (1997) proposes a test that

allows for a change in both intercept and slope at time T_b, which is made perfectly correlated with the data. A potential problem with the Perron (1997) test is that it assumes no structural break under the null of unit root. Lee and Strazicich (2001) show that this assumption can result in spurious rejections. The two-break minimum LM unit root test, due to Lee and Strazicich (2003), is unaffected by whether or not there is a break under the null hypothesis. The results are reported in Table 1.

Table 1 – Unit root tests

	MADF^{GLS}			**MPP^{GLS}**		
	Z={1}	**Z={1, t}**	***lags***	**Z={1}**	**Z={1, t}**	***lags***
g_t	-0.280	-3.391*	5; 1	-0.678	-2.607	5; 1
π_t	-0.626	-1.379	4; 4	-0.811	-1.142	4; 4
i_t	-1.282	-1.472	0; 0	-1.192	-1.254	0; 0
e_t	-1.770	-2.029	0; 0	-1.539	-1.796	0; 0
op_t	-0.814	-2.472	3; 0	-1.123	-1.940	3; 0
5% cv	-1.95	-3.19		-1.98	-2.91	
	Perron (1997)					
	Model	**Statistic**	***Lags***	**Break**	**5% cv**	
g_t	IO2	-250.14**	12	2004:03	-5.59	
π_t	IO2	-28.525**	12	2007:03	-5.59	
i_t	IO1	-4.381	10	2004:03	-5.23	
e_t	IO2	-223.96**	12	2007:04	-5.59	
op_t	AO	-5.413*	1	2004:02	-4.83	
	Lee e Strazicich (2003)					
	Model	**Statistic**	***Lags***	**Break 1**	**Break 2**	**5% cv**
g_t	2	-8.479**	3	2004:3	2007:3	-5.29
π_t	2	-8.024**	3	2002:3	2006:1	-5.29
i_t	2	-5.483*	4	2003:3	2006:1	-5.29
e_t	2	-5.860*	2	2003:3	2007:2	-5.29
op_t	2	-10.099**	1	2004:4	2007:3	-5.29

Note: * and ** mean that the null of unit root is rejected at the 5 and 1% significance level, respectively. cv stands for critical value.

The first panel of Table 1 shows that, except for output growth under the MADF^{GLS} test with constant and trend, the null of unit root is not rejected at the standard 5% significance level according to both tests. This result, however, might be due to the presence of structural breaks.

The Perron (1997) test reaches a different conclusion. The results, reported in the second panel of Table 1, indicate that all time series but nominal interest rate are stationary once a structural

break is appropriately modeled. The time of the break is endogenously chosen by the maximum value of the *t-statistic* on the coefficient of the shift *dummy* variable. The adverse result for the nominal interest rate might be because it has more than one break in the period, as suggested by Figure 1.

The last panel of Table 1 reports results for the Lee and Strazicich (2003) two-break LM unit root test. It indicates that nominal interest rate should be joined to the other time series as a stationary variable. The times of the endogenously chosen two-breaks coincide with the changes observed in Figure 1. Thus, the results of Table 1 suggest that output growth, inflation rate, nominal interest rate, exchange rate, and oil price are stationary in the period under consideration.

3.3 Impulse Response and Policy Implications

To assess the impact of nominal exchange rate shocks over output growth taking into consideration inflation and interest rate dynamics, we obtain impulse response functions from the estimated VAR above. We use Pesaran's approach of generalized impulse as a decomposition method. The truncation lag was set to 4, according to the information criteria of Akaike and Schwartz. Accumulated responses to one standard-deviation innovation in each structural residual, along with two-standard deviations confidence intervals, are presented in Figures 2 and 3 of the appendix. Table 2 reports the time series statistics and values of responses for each variable.

The results suggest that a depreciating shock to nominal exchange rates have a negative impact on output growth. The accumulated negative impulse is statistically different than zero over the first four quarters following the shock. After that, the impact of exchange rate on output improves but it remains negative and statically not significant. As mentioned before, for various reasons one must exercise caution in drawing implications from this result, but it suggests that shocks in the form of nominal exchange rate devaluations have limited ability to spur growth in the short/medium-run.

Table 2 – Time series statistics and responses to one STD innovation

	Time Series Statistics			
	Growth	Inflation	Interest	Exchange
Mean	3,8980	6,6017	5,3378	29,7828
VAR	5,7642	6,1845	7,8172	3,0418
STD	2,4009	2,4869	2,7959	1,7441
	Response of Growth to:			
Step	Growth	Inflation	Interest	Exchange
1	1,7809	-0,4559	-1,1646	-1,0449
2	0,6562	-0,2028	-0,5884	-0,5193
3	0,1865	-0,1123	0,1502	-0,6395
4	0,5372	-0,0915	-0,5231	-0,7666
	Response of Inflation to:			
	Growth	Inflation	Interest	Exchange
1	-0,2470	0,9651	0,6944	0,0132
2	-0,3325	0,2530	0,2665	0,5244
3	-0,4314	0,2251	0,2337	0,9533
4	-0,8508	0,4725	0,7278	0,8822
	Response of Interest Rate to:			
	Growth	Inflation	Interest	Exchange
1	-0,5649	0,6216	0,8639	0,1910
2	-0,6144	0,2669	0,3434	0,7701
3	-0,9707	0,3850	0,5029	1,6004
4	-1,3725	0,9567	1,3561	0,9721
	Response of Exchange Rate to:			
	Growth	Inflation	Interest	Exchange
1	-0,5724	0,0133	0,2156	0,9756
2	-0,9272	0,4497	0,6980	1,0431
3	-0,7365	0,4696	0,4896	0,9260
4	-0,7892	0,5064	0,7417	0,7334

Because of the nature of the exercise, our ability to identify the precise mechanism linking exchange rate and output fluctuation is limited. So, the focus is on the empirical relationships and what the data tell us. Nonetheless, the set of estimated impulse responses uncovers empirical feedback relationships that can be used to shed some light into the policy discussion at hand. Positive shocks to the nominal exchange rate (depreciating shocks) are found to lead to an increase in the interest rate. This may reflect monetary policy responding to import inflation pressures, but that can only be part of the explanation since the interest rate used in the estimation is not a pure policy variable. More broadly, the evidence suggests that depreciating

shocks to the nominal exchange rate lead to a tighter liquidity stance in the domestic capital markers, which disfavors output growth. This effect is estimated to be statistically significant over four quarters, casting some doubt on the feasibility of a crisis strategy based on monetary loosening combined with non-conventional exchange-rate policy aimed at maintaining the currency at a weaker level than allowed by the market. Depreciating shocks to the nominal exchange rate are estimated to lead to inflationary pressures, but statistical significance is not verified. The results may be interpreted as interest rates responding quickly to nominal exchange rate fluctuations and cushioning inflationary pressure.

Negative shocks (reduction) to interest rates are found to lead to an increase in output growth. One could suggest, then, that monetary policy is an effective tool to stimulate the economy. This result should be interpreted with particular caution. Firstly, the impulse is estimated to be statistically significant for only one quarter after the shock. Second, it is difficult to rationalize such an immediate impact of interest rates on output. Normally the transmission mechanism of monetary policy takes much longer. Because the variable used captures a broader concept of liquidity stance, it may be possible that it is capturing other short-term factors affecting growth. In any event, the empirical evidence does not back up monetary policy as a tool with particularly strong impact on output by itself, which does not mean it cannot play an important role as part of a coordinated (fiscal and monetary) policy response.

A positive shock to GDP growth also impacts other key macroeconomic variables. Nominal exchange rate is found to appreciate over four quarters following a growth shock. After that, the impact is no longer statistically significant. Again, it is difficult to pin down the mechanisms working behind this result, as our atheoretical structure does not identify the exact nature of the output shock. However, a possible implication, relevant for the current scenario, would be that a successfully implemented fiscal stimulus policy could lead to appreciating pressures in the nominal exchange rate.

4. Conclusion

Coordination between fiscal and monetary policies has been a key measure adopted by the Government of Mauritius since the world economic crisis started in 2008. A fiscal stimulus package based predominantly on infrastructure investment coupled with 250 basis point reduction in the policy rate implemented by the Central Bank will contribute to a soft landing of the domestic economy. There are limits, however, to what macroeconomic policy can achieve. This is particularly true in a commodity dependent island economy with small domestic markets that rely on international trade to achieve its growth potential. The empirical evidence presented in this paper corroborates the point and, in addition, casts doubt on the extent that a policy of nominal exchange rate depreciation can sustain short-run growth in Mauritius. Withstanding the

effects of the negative external environment invites a combination of macroeconomic and microeconomic policy actions. The burden of alleviating heightened social costs associated with the economic slowdown must be shared among multiple policy instruments. Macro policies will play a supporting role in aggregate demand management given lack of appetite from the private sector, but they cannot replace the engines of growth.

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Figure 2 – Generalized impulse response functions

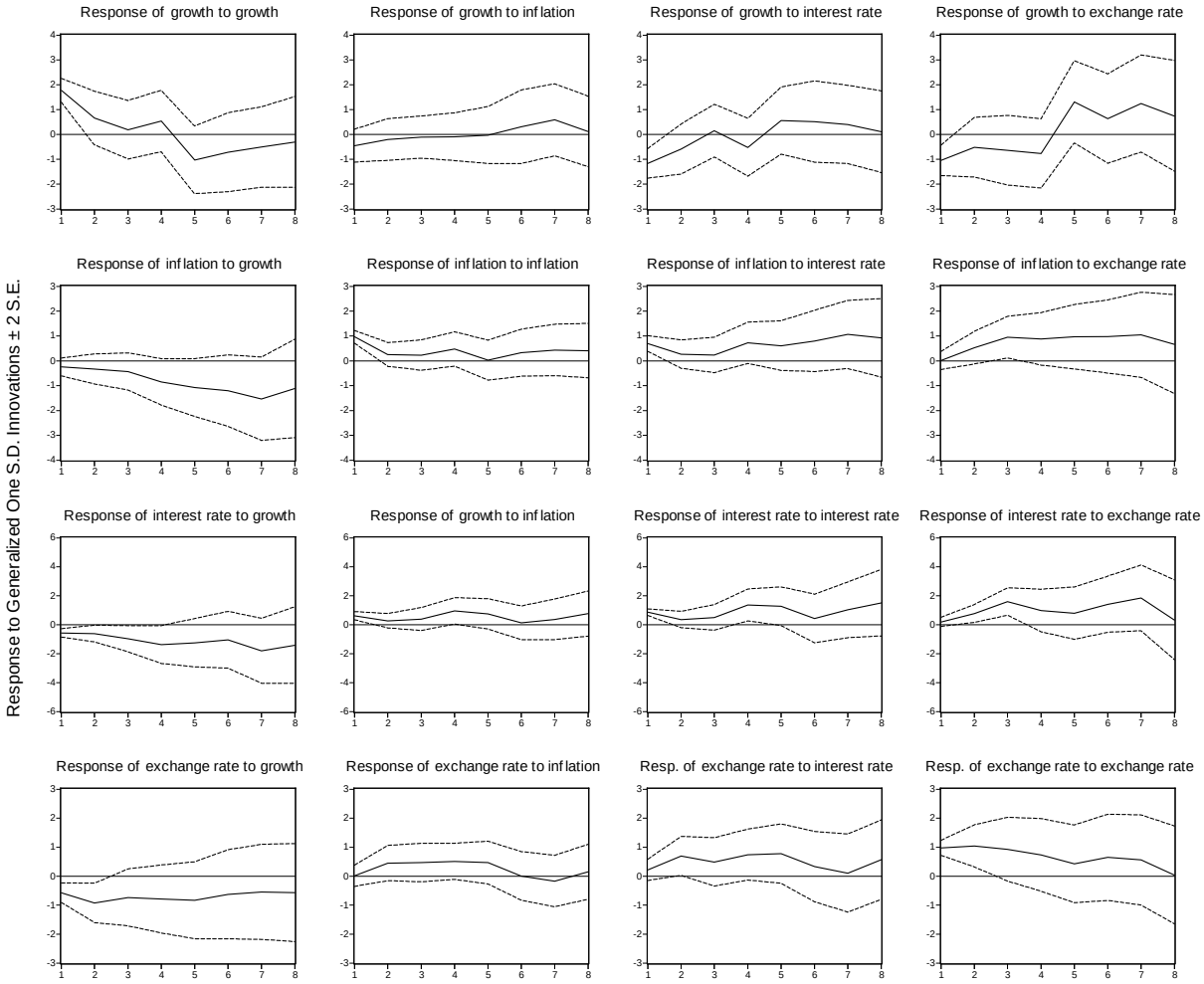


Figure 3 – Accumulated generalized impulse response functions

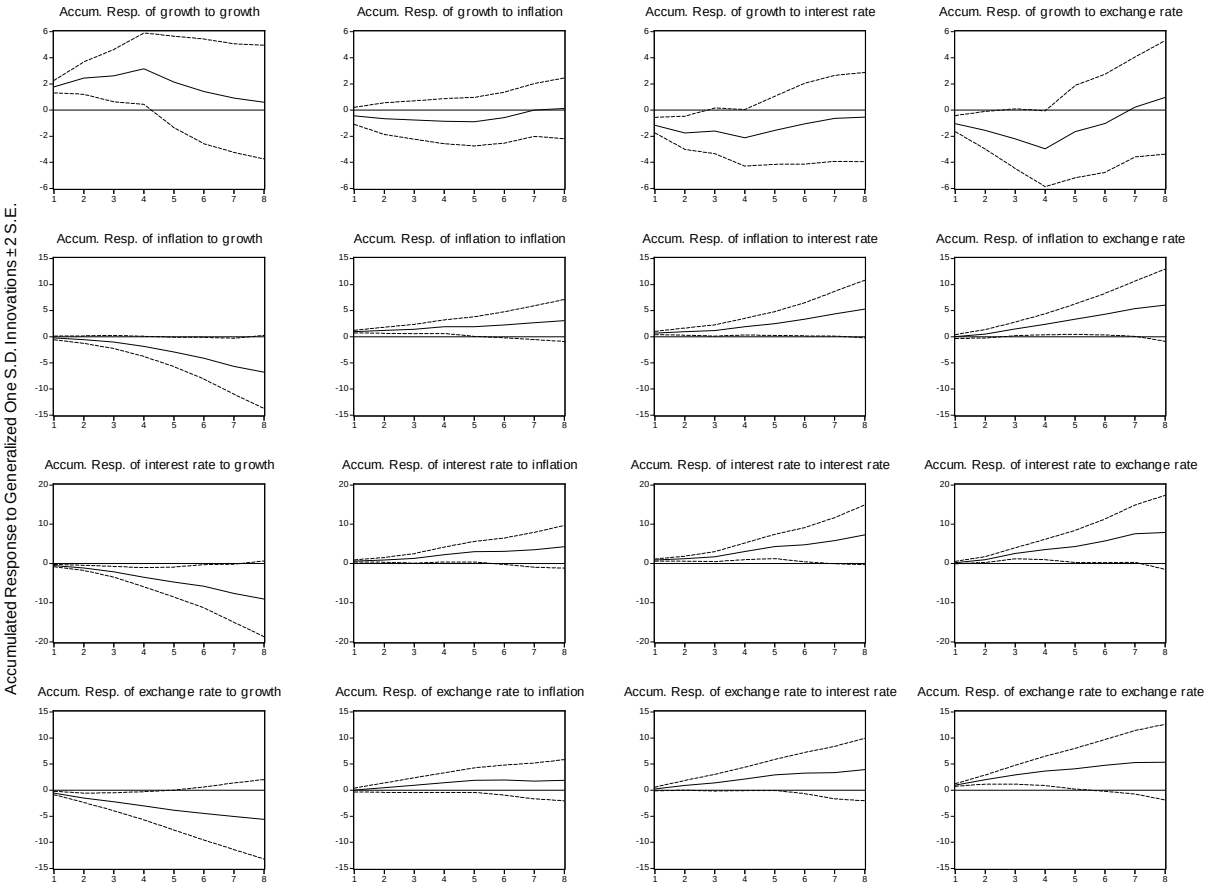


Figure 4 – Ortogonalized impulse response functions
(Cholesky ordering: exchange rate, interest rate, inflation, and growth)

