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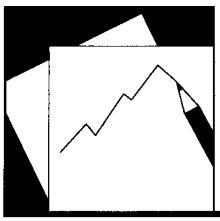

IMF Working Paper

Unraveling the Monetary Policy Transmission Mechanism in Sri Lanka

Manuk Ghazanchyan

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Unraveling the Monetary Policy Transmission Mechanism in Sri Lanka

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Abstract

In this paper we examine the channels through which innovations to policy variables—policy rates or monetary aggregates—affect such macroeconomic variables as output and inflation in Sri Lanka. The effectiveness of monetary policy instruments is judged through the prism of conventional policy channels (money/interest rate, bank lending, exchange rate and asset price channels) in VAR models. The timing and magnitude of these effects are assessed using impulse response functions, and through the pass-through coefficients from policy to money market and lending rates. Our results show that (i) the interest rate channel (money view) has the strongest Granger effect (helps predict) on output with a 0.6 percent decrease in output after the second quarter and a cumulative 0.5 percent decline within a three-year period in response to innovations in the policy rate; (ii) the contribution from the bank lending channel is statistically significant (adding 0.2 percentage point to the baseline effect of policy rates) in affecting both output and prices but with a lag of about five quarters for output and longer for prices; and (iii) the exchange rate and asset price channels are ineffective and do not have Granger effects on either output or prices.

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Contents Page

I. Background 4

II. Literature Review 5

III. Current Challenges 6

IV. Data and Methodology 14
A. Data Inspection Strategy 14
B. Methodology 15

V. Baseline VAR and Channels of Monetary Policy Transmission 17
A. Interest Rate Channel (Money View) 17
B. Bank Lending Channel (Component of the Credit View) 19
C. Exchange Rate Channel 22
D. Asset Price Channel 23

VI. More on the Channels of Monetary Policy Transmission 25

VII. VAR Model—Issue of Excess Liquidity, Output, and Inflation 27

VIII. Conclusions 28

References 38

Figures
1. Sri Lanka: Ratio of Bank Loans to GDP 7
2. Sri Lanka: Selected Financial Indicators 7
3. Sri Lanka: Banks' Liquid Asset Holdings 7
4. Sri Lanka: Selected Financial Indicators 7
5. Sri Lanka: Banks' Liabilities 8
6. Sri Lanka: Repo and Prime Lending Rates 10
7. Sri Lanka: Pass-through from Repo Rate to Money Market Rate 12
8. Sri Lanka: Pass-through from Money Market to Prime Lending Rates 12
9. Sri Lanka: Pass-through from Repo Rate to Lending-Deposit Spread 12
10. Sri Lanka: Pass-through from Money Market Rate to Lending-Deposit Spread 12

Tables
1a. Sri Lanka: Correlations Between Changes in Repo Rate and Changes in Money Market and Securities Returns 10
1b. Sri Lanka: Correlations Between Changes in Repo Rate and Changes in Money Market and Securities Returns 10
2. Sri Lanka: Correlations Between Changes in the Money Market Rates and Changes in the Lending and Deposit Rates 11
3. Sri Lanka: Impact of Policy and Money Market Rates on Long-term Domestic Rates 11

4. Selected Asian Countries: Correlations Between Changes in the Repo Rate and Changes in Money Market and Securities Returns....13
5. Selected Asian Countries: Correlations Between Changes in the Money Market Rates and Changes in the Lending and Deposit Rates....13
6. Sri Lanka: Baseline Model....18
7. Sri Lanka: Credit Channel....21
8. Sri Lanka: Credit Channel....21
9. Sri Lanka: Asset Price Channel....22
10. Sri Lanka: Expanded VAR Model....28
11. Sri Lanka: Expanded VAR Model with 12-Month Treasury Bill Rate....28

Annex
I. Data Generation Process and Unit Root Test Results....30
II. Comparison with Previous Work....36

I. BACKGROUND

Recent experience with monetary policy easing in Sri Lanka has focused attention on the efficacy of monetary transmission channels. Emphasis has been put on a more accommodative monetary stance to support growth. However, there has been a slow pass-through from policy rates to lending rates, and private credit growth has steadily declined. In this context, it is important to determine if adjustments to monetary policy instruments are impacting macroeconomic variables such as aggregate output and prices. Questions arise on two fronts: (i) which transmission channels or combination of channels (money/interest rate, bank lending, exchange rate, asset price channels) are likely to be the most effective in transmitting policy changes to output and prices; and (ii) what is the timing and magnitude of the effects of policy changes on macroeconomic variables given the strength of the transmission mechanism.

In this paper, we build on previous work (Annex II) and investigate monetary transmission mechanisms in Sri Lanka and discuss possible policy ramifications. We adopt the following approach.

- Section II provides the literature review. Section III examines the first steps in the transmission mechanism—relating changes in the policy rate to changes in money market and lending and deposit rates.[2] Section IV discusses the data and empirical strategy. Section V assesses the role of each channel by using a Vector Autoregressive (VAR) model which includes a specific variable for that channel. For example, to assess the role of the bank lending channel, the stock of bank credit or the bank lending rate is among the endogenous variables in the VAR. The significance (and timing effects) is tested both in a Granger causality setup and through impulse response functions (IRF).[3]
- Section VI adopts an alternative simulation by comparing IRFs for two models of monetary policy impact on output and prices. In one model, each channel of monetary transmission is permitted to respond endogenously to a monetary policy shock. In the other, the monetary transmission mechanism is treated as an exogenous variable.[4] The difference between the two IRFs provides a measure of the quantitative strength of each transmission channel.
- Section VII uses an eight-variable VAR model to try to explain the scope of the bank lending channel in neutralizing the policy signals on output and the role of Treasury bill rates in inflation formation.
- Section VIII concludes with a brief discussion of policy implications.

The main results of this exercise are as follows: (i) no other channel is as strong as the interest

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[2] Mishra, Montiel and Spilimbergo (2010), and Mishra and Montiel (2012).

[3] Augmented by Toda and Yamamato (1995) technique to accommodate uncertainty about the correct order of integration.

[4] Ramey (1993); Disyatat and Vongsinsirkul (2003).

rate channel in Sri Lanka. In particular (i) the exchange rate and asset price channels are ineffective and do not have Granger effects on either output or prices owing to limited movements in the exchange rate, and to limited foreign ownership and less active equity market financing for borrowers in the case of the asset price channel; (ii) the bank lending channel has an impact on output but with a lag of about 5 quarters; and (iii) on its impact on inflation, the bank lending channel is effective within about 5–10 quarters.

II. LITERATURE REVIEW

Where does the literature on monetary policy transmission stand? Transmission of monetary policy actions to the real economy and the role of distributional effects of various channels (the interest rate, the credit, the exchange rate, and the asset price channels (Mishkin, 1996)) has been a central question in both academia and policy making. Looking into the advancements in research in recent years, one can already see how close to unveiling this "black box" are the efforts of a large body of theoretical literature and a plethora of empirical papers. If previously many studies focused on the interest rate channel, the bank lending and asset price channels are also playing more important roles and are becoming widely studied (Bernanke (1993a, b), Gertler and Gilchrist (1993), Kashyap and Stein (1994), and Hubbard (1995)).

The academic and empirical literature can be studied in several dimensions. First, there is the debate based on evidence from advanced countries on the importance of monetary policy in affecting the real economy and on transmission channels including the latest merits for the bank lending channel. Second are such questions as whether the monetary policy transmission mechanism is different in low- income countries (LICs); whether the effectiveness of various channels is weaker in LICs; and why. Third, the debates (especially for developing and low-income countries) focus on the methodological issues of how best to capture the evidence related to the effectiveness of monetary policy innovations including the identification of shocks and exploring the transmission channels.

The interest rate channel through which policy innovations affect output and prices has been traditionally viewed as the main channel and was studied through the prism of IS/LM and VAR models (Sims, 1972; Christiano and others (1999)). Debates remain about precisely what factor or combination of factors account for this real effect, where innovations in policy rates affect output with the lead candidates being sticky prices, sticky wages, and imperfect competition. However, what is clear is that changes in policy rates are important only insofar as they affect aggregate outcomes through private investment and with no distributional effects on economic agents (Cecchetti (1995); and Grilli and Roubini (1995)). In addition, the credit view, or bank lending channel, focuses on the distributional consequences of monetary policy distinguishing the policy impact on individual agents' creditworthiness from the feasibility of investment projects. The exchange rate channel is examined in the context of emerging markets and low-income economies (Cushman and Zha (1995)). The studies offering an explicit account for asset prices in the monetary policy reaction function are as follows: Bernanke, Gertler and Gilchrist

(1994); Carlstrom and Fuerst (1997); Gilchrist and Saito (2006); Airaudo, Nisticò and Zanna (2012); and Pfajfar and Santoro (2007).

The literature on monetary policy takes into account fundamental differences in the financial, economic, and institutional structures of advanced, emerging, and low- income economies. Although banks are dominant formal financial intermediaries in developing countries, the formal financial system tends to be very small relative to the size of the economy. In addition, these countries have imperfect links with the private international capital markets and their central banks intervene heavily in foreign exchange markets (Mishra and others (2010), Mishra and Montiel (2012)). Aside from traditional VAR models used in identifying the impact of monetary policy shocks on the real economy in advanced countries, in a cross- country context, and, in particular, for low- and middle- income countries, the literature on methodology has mainly focused on (i) identifying the intermediate targets of monetary policy; (ii) identifying the exogenous monetary policy shocks (correct ordering of impact and affected variables and relevant decompositions (i.e, Choleski, simultaneous identifications); and (iii) exploring the channels of transmission with VAR and "exogenous tests" simulation approaches (Ramey, 1993).

Prior work on the effectiveness of monetary policy transmission for developing countries in Asia is scarce. Agha and others (2005) investigate the monetary policy in Pakistan by adopting Ramey's (1993) approach together with their own system of four variable recursive VARs (see Section VI). Later, Alam and Waheed (2006) also used recursive VARs both at the aggregate and sectoral levels for Pakistan. Mallick (2009) investigated monetary policy transmission in India using a five- variable VAR by applying both recursive and structural identification schemes. Ahmad (2008) used a VAR framework with a recursive Sims ordering of monetary policy and macroeconomic variables for Fiji and Papua New Guinea. Yang and others (2011) studied the monetary policy transmission mechanisms in Pacific islands in the context of the global financial crisis using autoregressive distributed lags (ADL) model. Work on Sri Lanka includes Perera and Wickramanayake (2013) and Vinayagathasan (2013). We compare our work with prior investigations done for Sri Lanka in Annex II.

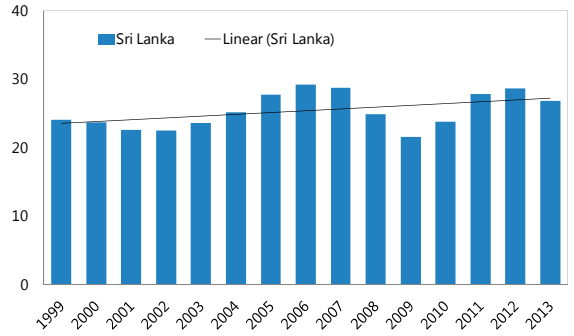
III. CURRENT CHALLENGES

Identifying the intermediate target of monetary policy has evolved to be more transparent though interventions in the foreign exchange market made the range of policy tools wider. The choice of the intermediate target of the monetary policy by the CBSL has narrowed to a monetary aggregate (with reserve money serving as the operating target) with the main policy instruments being (a) policy interest rates (interest rates on overnight repurchase and reverse repurchase agreements) and open market operations (OMO) and (b) the statutory reserve requirement (SRR) on commercial bank deposit liabilities (Central Bank of Sri Lanka, 2013). Although not defined formally, foreign exchange operations and liquidity management associated with the issuance of international bonds have also indirectly became part of monetary policy tools.

Banks are the dominant financial intermediaries in Sri Lanka. This suggests that the bank lending channel should be the main vehicle for monetary policy transmission. However, rigidities limit the effectiveness of bank lending in servicing the economy's demand for capital. The core problem (highlighted both by the monetary authorities and empirical studies) is imperfect links between policy rates and domestic and international capital markets. The decision-making process by private agents is confounded by imperfect signals in the term structure of interest rates and in the money and capital markets. Also, a lack of competition inhibits the effectiveness of the bank lending channel. The following factors are particularly important:

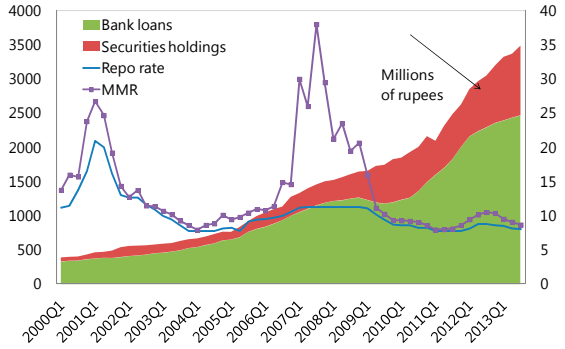
- The presence of "excess liquidity" can interfere with monetary policy transmission. Excess liquidity hinders the pass-through from policy rate adjustments to bank lending because the marginal increase in the policy rate may not be effective in forcing banks to raise their lending rates. In Sri Lanka, the ratio of bank loans to GDP has not changed significantly during the last 15 years (the average has remained close to 25 percent over time) though the post-conflict average ratio is slightly higher reaching 27 percent (Figure 1).

Figure 1. Sri Lanka: Ratio of Bank Loans to GDP
(In percent)



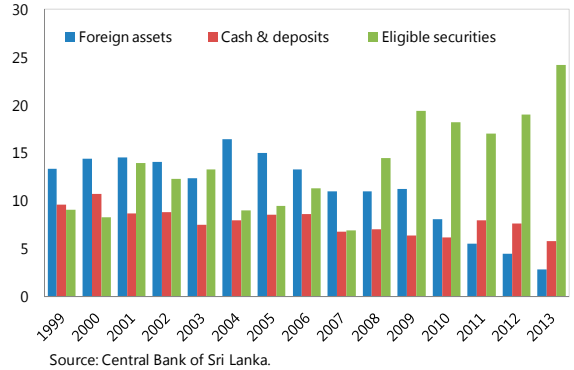
Source: Central Bank of Sri Lanka.

Figure 2. Sri Lanka: Selected Financial Indicators



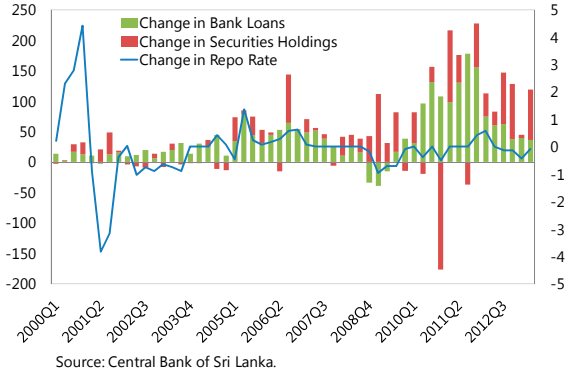
Source: Central Bank of Sri Lanka.

Figure 3. Sri Lanka: Banks' Liquid Asset Holdings



Source: Central Bank of Sri Lanka.

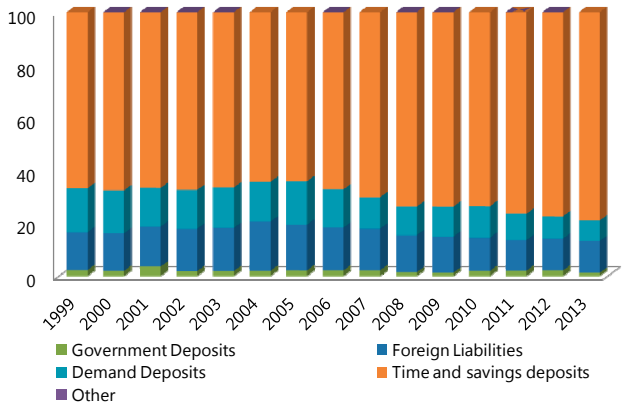
Figure 4. Sri Lanka: Selected Financial Indicators



Source: Central Bank of Sri Lanka.

- Banks' asset composition has shifted from loans to liquid assets (securities) hindering an effective response from the banking sector to monetary policy signals (Figures 2, 3, and 4). Over time, Banks' composition of assets has shifted toward holding government securities. This situation can also be described as one of "excess liquidity" insofar as banks (owing to moral suasion and a guaranteed rate of return rather than assuming the risk of new assets) choose not to lend at higher rates and instead maintain higher levels of securities. The main contributing factor for this recently has been the lack of private sector demand for loans. Figure 4 shows that the change in securities holdings prevails even after changes in the policy rate.

Figure 5. Sri Lanka: Banks' Liabilities



- Only significant increases in policy rates that would also upwardly adjust the money market and bond yields would require the banks to revert to financing themselves with deposits and to increase deposit rates. This is also evidenced with banks increasingly using other forms of funding—bond market and foreign borrowing. Figure 5 shows that the share of deposits has not much increased in the last 15 years while the share of demand deposits in total deposits has significantly declined recently.

- There is a weak correlation between central bank policy actions and money market and bank lending and deposit rates in Sri Lanka.[5] Both money market and lending and deposit rates react slowly to policy changes, thus hindering an effective transmission mechanism (Tables 1a and 1b and Table 2).[6,7] For example, an increase in the policy rate

[5] Given the high volatility in call money market rates, there is lower correlation with prime lending rates and the correlation tends to increase when an alternative money market rate, for example, 3-month Treasury bill rate, is used. In fact, interest rate pass-through is higher when prime rates and Treasury bill rates are considered. Acknowledging the existence of these intermittent volatilities, our main concern, however, is that *generally* the impact of policy rates on money market and bank rates is weak.

[6] Following Mishra and Montiel (2012), we calculated the speed and magnitude of pass-through from policy rates to money market and lending rates as follows:

$$Yit=\alpha y_{it}-1+\beta y_{it}-2+\Upsilon x_{it}+\delta x_{it}-1+\eta x_{it}-2+\varepsilon_{it}$$

Where y is the change in the affected rate and x the change in the impact rate. The short-run effect is measured with Υ and the long- run impact by $(\Upsilon+ \delta+ \eta)/(1- \alpha- \beta)$. Contemporaneous correlations are in the first column of Tables 1, 2, and 3. Coefficients in the tables show the pass-through from a one percentage point change in impact rates to affected rates. We analyze both the pass-through of changes in policy rates to money market rates and the pass-through from money market rates to lending and deposit rates.

[7] In Table 1b, we recalculated both contemporaneous and longer-term correlations of money market rates following changes in money market repo rates in lieu of policy repo rates to accommodate the possibility that money market repo rates carry more information about policy innovations. We find those correlations even weaker and thus our

(continued…)

by one percentage point increases the money market rate by only 0.35 percentage point, and an increase in the money market rate by one percentage point increases lending and deposit rates by only 0.68 and 0.19 percentage point, respectively. By contrast, in Malaysia an increase in the policy rate by one percentage point increases the money market rate by about 0.94 percentage point, and an increase in the money market rate by one percentage point increases lending and deposit rates by 0.96 and 0.98 percentage point, respectively. However, the longer-term effects of policy changes on lending rates can be more significant in Sri Lanka, because the spread narrows over time (Figure 6).

- The impact of policy and money market rates on long-term bond yields is weak[8]. We have also calculated both contemporaneous and longer-term effects of policy and money market rates on bond yields for 3, 5, and 10-year maturities (Table 3). Results show that there is some perverse contemporaneous relationship between the policy rates and bond yields although this dissipates when using the money market repo rate (see Footnote 6). Regardless of the definition of repo rates, there is only a long-run meaningful impact of policy and money market rates on bond yields.

baseline inference did not change. In addition, the longer-term impact of money market repo rates on bond yields is much weaker compared to the effects of policy repo rate (Table 3).

[8] The relationship between policy rates and long-term government bond yields can be further influenced by other factors including inflation expectations and the market conditions for the government bonds.

Table 1a. Sri Lanka: Correlations Between Changes in Repo Rate and Changes in Money Market and Securities Returns

Contemporaneous	Short-term	Long-term
Change in repo rate		
Change in call market rate		
0.4343	2.5904	1.5013
Change in repo rate		
Change in WALR 1/		
0.5515	0.8300	1.1278
Change in repo rate		
Change in prime lending rate		
0.6565	1.3707	1.1339
Change in repo rate		
Change in 3 month T bill		
0.6198	0.7358	0.9649
Change in repo rate		
Change in 6 month T bill		
0.6265	0.7586	0.9390
Change in repo rate		
Change in 12 month T bill		
0.6290	0.5005	0.9369
Change in repo rate		
Change in deposit rate		
0.3852	0.2063	0.8416

Source: IMF staff estimates.

1/ Weighted average lending rate.

Table 1b. Sri Lanka: Correlations Between Changes in Repo Rate and Changes in Money Market and Securities Returns 1/

Contemporaneous	Short-term	Long-term
Change in repo rate		
Change in call market rate		
0.0739	0.1989	0.6556
Change in repo rate		
Change in WALR 2/		
0.8838	0.5178	1.1988
Change in repo rate		
Change in prime lending rate		
0.4683	0.7779	1.1431
Change in repo rate		
Change in 3 month T bill		
0.3890	0.5111	1.1735
Change in repo rate		
Change in 6 month T bill		
0.5167	0.6527	1.1977
Change in repo rate		
Change in 12 month T bill		
0.5336	0.6368	1.1952
Change in repo rate		
Change in deposit rate		
0.3351	0.0611	0.7065

Source: IMF staff estimates.

1/ Market repo rate is used for policy rate.
Data are available from 2004:3.

2/ Weighted average lending rate.

Table 2. Sri Lanka: Correlations Between Changes in the Money Market Rates and Changes in the Lending and Deposit Rates

Contemporaneous	Short-term	Long-term
Change in call market rate		
Change in prime rate		
0.5915	0.4079	0.7449
Change in call market rate		
Change in WALR 1/		
0.1989	0.1493	0.8240
Change in call market rate		
Change in deposit rate		
0.0968	0.0228	0.3010

Source: IMF staff estimates.
1/ Weighted average lending rate

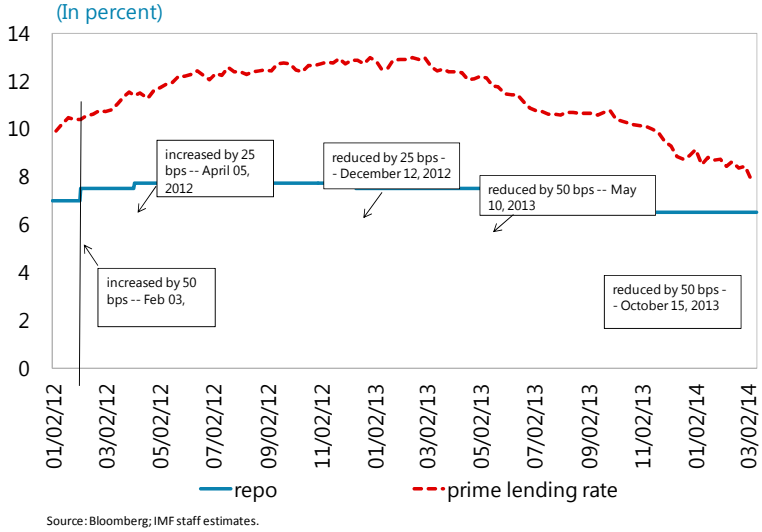
Table 3. Sri Lanka: Impact of Policy and Money Market Rates on Long-term Domestic Rates

	Repo rate and bond rates		
	3 year	5 year	10 year
Contemporaneous	0.7197	-0.0262	-0.0398
Short-term effects	2.3665	1.7195	1.5991
Long-term effects	2.7527	2.2041	1.7484
	Market repo rate and bond rates		
	3 year	5 year	10 year
Contemporaneous	0.5444	0.5176	0.4122
Short-term effects	0.8861	0.6587	0.4188
Long-term effects	1.1992	0.9441	0.7022
	Call market and bond rates		
	3 year	5 year	10 year
Contemporaneous	0.5708	0.5347	0.4511
Short-term effects	0.5362	0.4343	0.3354
Long-term effects	0.7649	0.7099	0.4241

Source: IMF staff estimates.

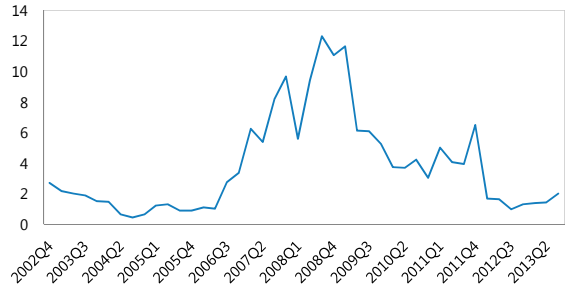
- There have been significant shifts recently in the pass-through from policy rates to money market rates and lending and deposit rates in Sri Lanka (Figures 7 and 8). The impact of money market rates on the spread between the lending and deposit rates has also been magnified recently. This only confirms our earlier observation that, although eventually, the money market rates might move the lending rate, the change in the deposit rate is negligible as banks have abundant excess liquidity to counteract the policy change and have no short-term funding needs (Figures 9 and 10).

Figure 6. Sri Lanka: Repo and Prime Lending Rates
(In percent)



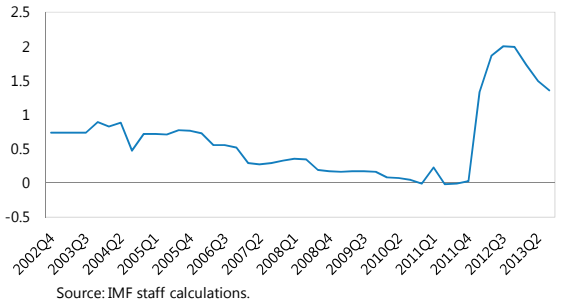
Source: Bloomberg; IMF staff estimates.

Figure 7. Sri Lanka: Pass-through from Repo Rate to Money Market Rate 1/



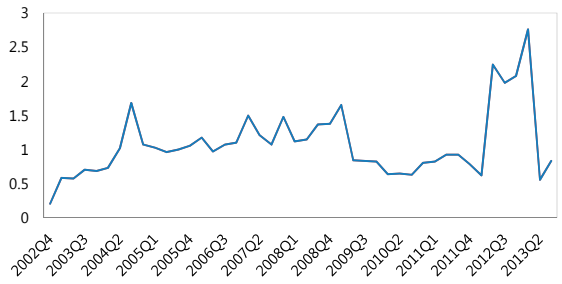
Source: IMF staff calculations.
1/ Using the dynamic multiplier method with rolling window of 44 observations.

Figure 8. Sri Lanka: Pass-through from Money Market to Prime Lending Rates 1/



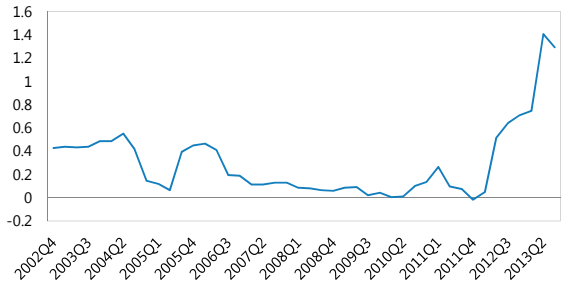
Source: IMF staff calculations.
1/ Using the dynamic multiplier method with rolling window of 44 observations.

Figure 9. Sri Lanka: Pass-through from Repo Rate to Lending-Deposit Spread 1/



Source: IMF staff calculations.
1/ Using the dynamic multiplier method with rolling window of 44 observations.

Figure 10. Sri Lanka: Pass-through from Money Market Rate to Lending-Deposit Spread 1/



Source: IMF staff calculations.
1/ Using the dynamic multiplier method with rolling window of 44 observations.

- In a cross-country perspective, the weak contemporaneous impact of monetary policy adjustments is striking (Table 4 and Table 5). Looking at the ASEAN-4 countries (Indonesia, Malaysia, the Philippines, and Thailand), and India and Vietnam, it is evident that in almost all cases (excluding India), the contemporaneous responses of market and lending rates to policy changes are very high; however, for all rates the coefficients of pass-through for Sri Lanka are below average. Another interesting observation is that in all comparator countries, most of the pass-through from changes in the policy rates occurs contemporaneously, and then the impact fades away. In Sri Lanka the opposite appears true—the longer effects dominate.

Table 4. Selected Asian Countries: Correlations Between Changes in the Repo Rate and Changes in Money Market and Securities Returns

India			Indonesia			Malaysia			Philippines			Thailand			Vietnam			Average		
Contemporaneous	Short-term	Long-term	Contemporaneous	Short-term	Long-term	Contemporaneous	Short-term	Long-term	Contemporaneous	Short-term	Long-term	Contemporaneous	Short-term	Long-term	Contemporaneous	Short-term	Long-term	Contemporaneous	Short-term	Long-term
Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate		
Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate		
0.5265	1.7019	1.2082	0.8336	1.4617	1.1907	0.9905	0.7196	1.0067	0.6580	0.4204	0.3201							0.7521	1.0759	0.9314
Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate		
Change in 3 month T bill			Change in 3 month T bill			Change in 3 month T bill			Change in 3 month T bill			Change in 3 month T bill			Change in 3 month T bill			Change in 3 month T bill		
0.7843	0.6396	1.0430	0.8360	0.1867	0.2403	0.9390	0.7937	0.9856	0.7272	0.0225	0.4650	0.9835	0.7249	0.9971	0.4119	0.5218	0.4387	0.7803	0.4815	0.6949
Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate		
Change in 6 month T bill			Change in 6 month T bill			Change in 6 month T bill			Change in 6 month T bill			Change in 6 month T bill			Change in 6 month T bill			Change in 6 month T bill		
0.9222	1.5566	1.1637	0.7570	1.1999	0.9127	0.9489	1.2848	1.1729	0.8489	2.3765	1.0747	0.9943	0.8536	0.9875				0.8942	1.4543	1.0623
Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate		
Change in 12 month T bill			Change in 12 month T bill			Change in 12 month T bill			Change in 12 month T bill			Change in 12 month T bill			Change in 12 month T bill			Change in 12 month T bill		
0.8167	0.5655	0.9777	0.8643	1.5358	1.2294				0.9239	2.7643	1.7389	0.9926	2.8410	2.7922				0.8994	1.9267	1.6846
Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate			Change in repo rate		
Change in deposit rate			Change in deposit rate			Change in deposit rate			Change in deposit rate			Change in deposit rate			Change in deposit rate			Change in deposit rate		
0.5862	0.1854	0.6772	0.8865	0.4185	1.2896	0.9033	0.7422	0.7478	0.8856	-0.1239	-0.0040	0.2919	0.2602	0.4544	0.7133	0.4913	0.2466	0.7111	0.3289	0.5686

Source: IMF staff estimates.

Table 5. Selected Asian Countries: Correlations Between Changes in the Money Market Rates and Changes in the Lending and Deposit Rates 1/

India			Indonesia			Malaysia			Philippines			Thailand			Vietnam			Average		
Contemporaneous	Short-term	Long-term	Contemporaneous	Short-term	Long-term	Contemporaneous	Short-term	Long-term	Contemporaneous	Short-term	Long-term	Contemporaneous	Short-term	Long-term	Contemporaneous	Short-term	Long-term	Contemporaneous	Short-term	Long-term
Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate		
Change in prime lending rate			Change in prime lending rate			Change in prime lending rate			Change in prime lending rate			Change in prime lending rate			Change in prime lending rate			Change in prime lending rate		
0.6578	0.0368	0.1491				0.9709	0.6320	0.6740	0.4983	0.0112	-0.0311							0.7090	0.2267	0.2640
Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate		
Change in WALR 2/			Change in WALR			Change in WALR			Change in WALR			Change in WALR			Change in WALR			Change in WALR		
			0.9193	0.2113	0.3437	0.8869	0.6061	0.7103	0.4341	-0.0253	0.0917							0.7468	0.2641	0.3819
Change in money market rate			Change in money market rate			Change in money market rate			Change in money market rate			Change in money market rate			Change in money market rate			Change in money market rate		
Change in WALR			Change in WALR			Change in WALR			Change in WALR			Change in WALR			Change in WALR			Change in WALR		
						0.8898	0.6111	0.7124	0.9247	0.3246	0.9117	0.6918	0.3356	0.4642				0.8355	0.4237	0.6961
Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate			Change in call market rate		
Change in deposit rate			Change in deposit rate			Change in deposit rate			Change in deposit rate			Change in deposit rate			Change in deposit rate			Change in deposit rate		
0.5740	0.0384	0.2565	0.8933	0.1890	0.6814	0.9791	0.8171	0.8558	0.4102	-0.0892	-0.0418							0.7142	0.2389	0.4380

1/ Data for Indonesia are not available.
2/ Weighted average lending rate
Source: IMF staff estimates.

IV. DATA AND METHODOLOGY

A. Data Inspection Strategy

We use quarterly seasonally adjusted data from 2000Q1 to 2013Q3. Quarterly data are capable of producing reasonable sample sizes based on relatively short time spans. Also, quarterly data have become increasingly appealing for the purposes of multivariate inference and testing of hypotheses. Using quarterly data avoids possible qualification of the results to which studies using monthly GDP data can be subject. For example, quarterly data have a higher signal to noise ratio. All variables are taken from the International Monetary Fund's (IMF) *International Financial Statistics (IFS)*. The summary statistics for key model variables are presented in Table 1 (Annex I). The data are expressed in natural logarithms(except interest rates, which are in level form) and are seasonally adjusted by multiplicative and additive MA (moving average) or AR (autoregressive) terms. Knowing the pitfalls arising from using seasonally adjusted data, such as the loss of information from automatic detrending, seasonal dummy variables, whenever seasonality was observed, are added to the models describing the series as in Table 1, Annex 1.[9] Since there are no theoretical grounds for preferring one form of seasonality or another, the choice of series has also been determined in light of information pertaining to the Sri Lankan economy.

In characterizing relationships between output, prices, and policy-related variables, stationarity properties of the data are important. Equally important is making the correct assumption about the true data generating process (DGP). If the data are I (1), the macroeconomic variables should be modeled as unit root processes; nonetheless there is some uncertainty regarding the order of integration in achieving stationarity. In a trend stationary process (TSP) the effects of shocks disappear in the long run when t moves farther away from the moment of the shock. With differenced stationary process (DSP) the effect of the shock remains. Making an error in the determination of the DGP could lead to wrong inferences.

Data pre-testing and appropriate handling of trends and stationarity are highly stressed by the academic literature to arrive at more reliable estimation techniques, including obtaining correct estimation equations.[10] If some of the variables are stationary and others are nonstationary, the latter should be incorporated into the VAR in first-differences to avoid problems of spurious correlation. However, in relatively short time series, traditional unit root tests—for example, Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP)—have little power to distinguish between unit roots and stationary series that are mean-reverting but do so slowly. Hence, these tests are biased toward nonrejection of unit roots for short time series (Dejong and others, 1992). With 54 quarterly observations at hand this issue is relevant for this study. Although first-

[9] See Franses (1991).

[10] See, for example, Nelson and Kang (1981), Hafer and Kutan (1997), and Boschen and Mills (1992).

differencing all variables guards against the possibility of mishandling a nonstationary variable, Christiano and Ljungqvist (1988) demonstrate that series should not be differenced unnecessarily because of the low power of time-series tests on growth variables. Also, missing the presence of structural breaks in the data can lead to wrong conclusions regarding the unit root process for a series (Perron, 1989). This bias may be relevant if dramatic events occur during the sample period under study, that is, the 2008–09 global financial crisis.

The strategy for inspecting data is as follows: First, based on the initial data inspection and on the behavior of autocorrelation functions, possible equations of DGP describing the series are selected. This also assumes the selection of appropriate lag lengths and seasonal dummy variables. When misspecification errors are detected, the equations for DGP are respecified. For example, if the Chow test suggests a structural break, then P-break tests are conducted further including appropriate dummies for possible break dates in equations of the DGP describing the series (Annex I, Table 2). Second, when the relatively reliable equation of DGP describing the series is selected, based on AIC (Akaike Information Criterion), SBC (Schwarz's Bayesian Criterion), the lowest SSR (Sum of Squared Residuals), and the Q statistics for the autocorrelation of the residuals, the unit root tests are conducted on these "true" equations describing the DGP of the series. Conclusions regarding whether the series should be differenced in the baseline VAR model are reported in Annex I, Table 3.

B. Methodology

The standard methodology proposed by Sims (1972) in using Granger causality is followed to describe the relationship between monetary policy variables and both output and prices in Sri Lanka, where policy variables are ordered after nonpolicy variables. This procedure implies that policy variables are determined based on the knowledge of contemporaneous shocks to output and prices, but that output and prices respond to changes in policy variables with a lag. Although having known shortcomings, this approach has several advantages.

- First, it provides a basis for characterizing the stylized facts about relationships between policy variables and output and prices in Sri Lanka.

- Second, it requires minimal assumptions about underlying economic relationships, which is useful given the uncertainties about the evolving structure of the Sri Lankan economy in the post-conflict period. No a priori presumption as to which variables have more influence on output and prices is made and hence all three measures of monetary policy tools (money supply, interest rate, and exchange rate) are included in the VAR.

The baseline VAR model above is estimated using the following five variables from 2000Q1 and 2013Q3: output, prices, money supply, interest rates, and exchange rates expressed in levels or first-differences of the variables inferred from stationarity tests (Annex I, Table 2).

In addition, to accommodate uncertainty about the correct order of integration, we use the modifications of the Granger-causality test proposed by Toda and Yamamoto (1995), which are robust to the order of integration of the variables. Specifically, suppose that we assume the true lag length of the VAR to be p; the standard Granger method tests the hypothesis that lags 1 through p of the ith variable are jointly insignificant in the equation for the jth variable. The Toda–Yamamoto test makes use of the fact that, although the order of integration of the endogenous variables may be uncertain, the upper bound is usually known. Taking the maximum order of integration of the variables in the VAR to be k, the Toda–Yamamoto test estimates a VAR with p + k lags and then tests whether the first p lags of the variable i are significant in the jth equation. As with the standard Granger-causality tests, the test statistic has a $\chi 2$ asymptotic distribution but the disadvantage is that including the k additional lags of the endogenous variables reduces the power of the test.

Whereas the Toda-Yamamoto tests provide a scalar measure of the significance of policy variables in predicting movements in output and prices, the direction and timing of effects can be characterized using impulse response functions computed from VAR models. We follow the approach discussed in detail by Christiano and others (1999). We estimate a reduced-form VAR and identify monetary policy shocks through assumptions about variable ordering. Formally, the reduced- form VAR is written as:

$$Y_t\,(1) = A_0 + A_1 Y_{t-1} + \cdots + A_k Y_{t-k} + u_t$$

where Y_t is a vector of policy and nonpolicy variables, A_0 is a vector of constants, A_{t-j} is a matrix of coefficients on variables lagged j periods, u_t is a vector of serially uncorrelated disturbances that have mean zero and variance–covariance matrix $\sum_{U,}^{2}$ and k is the number of lags. Because this is a reduced-form representation of a structural model in which some variables may affect others contemporaneously, the error terms are composites of underlying shocks to variables in the system according to the following specification:

$$\begin{vmatrix} u_{1t} \\ u_{2t} \\ \cdots \\ u_{jt} \end{vmatrix} = \begin{vmatrix} 1 & \theta_{12} & \theta_{13} & \ldots & \theta_{1j} & \varepsilon_{1t} \\ \theta_{21} & 1 & \theta_{23} & \ldots & \theta_{2j} & \varepsilon_{2t} \\ & & & & & \\ \theta_{j1} & \theta_{j2} & \theta_{j3} & \ldots & 1 & \varepsilon_{jt} \end{vmatrix}$$

As an example, the time-t innovation to a monetary policy variable, u_t, reflects not only the exogenous shock to that variable, ε_{it} , but it may also include adjustments made in response to contemporaneous exogenous shocks to other variables in the system. To identify the underlying shocks to monetary policy, the matrix θ is assumed to be lower triangular, that is, by the Choleski decomposition, and policy variables are ordered in the VAR after nonpolicy variables. The ordering of the policy variables goes as follows: money supply is ordered first followed by policy rate and exchange rate to reflect their respective likely degrees of endogeneity to economic conditions in Sri Lanka. We also experimented with alternative orderings and

replaced broad money with reserve money definitions with the sensitivities explained in Section V.

V. Baseline VAR and Channels of Monetary Policy Transmission

A. Interest Rate Channel (Money View)

According to the money view, the reduction of the money supply by the authorities (and increasing the policy rate) reduces investment and hence output. The interest rate channel affects firms' spending on investment through the cost of capital and household spending on durable goods.[11] The change in interest rate also affects aggregate demand through the intertemporal profile of household consumption, which depends on the degree of intertemporal substitution in consumption and the prevalence of credit rationing in the financial system. The strength of this channel depends on a correctly aligned expectation mechanism and, therefore, a normal yield curve, as well as on the speed of adjustment of long-term yields to changes in the short-term interest rates. These links were tested as shown below.

The policy rate has significant predictive value for output in Sri Lanka, and money supply weakly Granger-causes (helps predict) prices (Table 6).[12] Output declines by about 0.6 percent in the second quarter and by about 0.5 percent during the entire period of nearly three years after innovations to the repo rate.[13] The repo rate effect on prices—of about 0.2 percent—is through the money market rate though with a lagged response embedded in the nominal interest rate (price puzzle).[14] Policy variables jointly have significant predictive value for both output and prices.

[11] Mishra, Montiel, and Spilimbergo (2010).

[12] Using market repo rates in lieu of announced repo rates for the period from 2004Q3 to 2013Q3, where the data for money market repo rates were available, does not reduce the impact of the interest rate channel though significantly increases the impact of direct money supply on output versus the policy rate itself.

[13] Including the U.S. refinancing rate in the model reduces the impact of the policy rate on output by about 0.2 percentage point, making the total impact 0.3 percent during the three-year period.

[14] We have also run the baseline VAR with core inflation (data are available from 2003Q1 to 2013Q3) as the weight of food in the consumer price index (CPI) is about 41 percent and our results did not differ significantly. Our tests also show that an oil price shock has a significant impact on inflation. In particular, a one percent shock to the oil price will increase the price level by about 0.9 percent within 10 quarters.

Table 6. Sri Lanka: Baseline Model

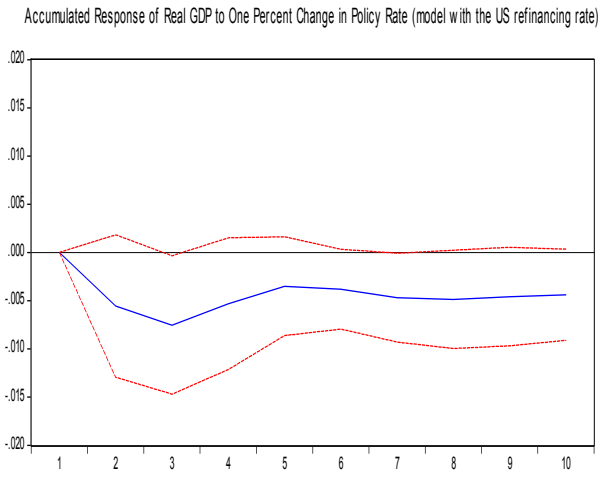
Granger causalities		
Sri Lanka		
	Impact on output	
	F-stat	p-values
Money supply 1/	0.32	0.57
Interest rate (repo)	11.78***	0.00
Exchange rate	0.09	0.77
Policy variables jointly	7.72***	0.00
	Impact on prices	
	F-stat	p-values
Money supply 1/	4.79**	0.03
Interest rate (repo)	2.44	0.13
Exchange rate	1.66	0.20
Policy variables jointly	5.92***	0.00

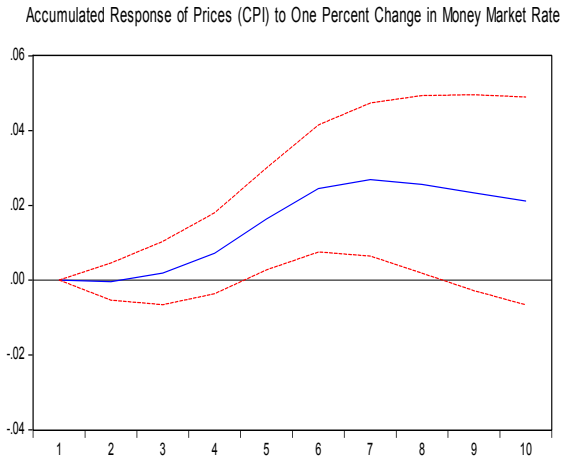
p values show the significance of lagged monetary policy variables for output and prices
F statistic at (1, 47)
Critical values are 7.17 at 1% level; 4.03 at 5% level and 2.76 at 10% level
***significant at 1%
**significant at 5%
*significant at 10%
Notes.(i) The optimal lag is selected based on LR=1
F statistic for joint significance is at (4, 48)
Critical values are 3.72 at 1% level, 2.56 at 5% level and 2.01 at 10% level

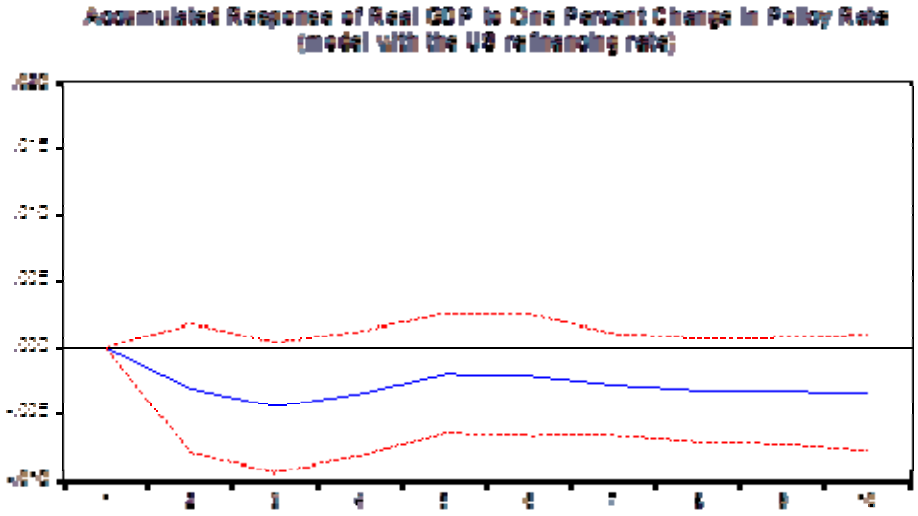
1/ Defined as broad money (M2b). We have retested the model with reserve money and the significance of the repo rate affecting output fades away.

Source: IMF staff calculations.

The variance decomposition shows that almost 6 percent of the change in GDP is explained by the variance in the policy rate within a three-year period. For inflation, the money supply explains about 4 percent of fluctuations and the rest is explained by inflation inertia.







B. Bank Lending Channel (Component of the Credit View)

The bank lending channel (proxied by the lending rates and private credit) is a contributing channel to the traditional money view. It can be described as banks' response—by changing the supply of loanable funds—to the changes in the supply of funds (deposit base) or changes in the policy rate by the monetary authorities. Competition among banks would be expected to cause an increased supply of funds to augment the availability of bank credit for bank loan-dependent borrowers (the impact on the real economy would depend on the share of firms without alternative forms of financing or the substitutability of loans in investors' portfolios), who, in turn, will increase spending affecting aggregate demand.[15]

The bank lending channel contributes to policy innovations that affect output, albeit weakly and with a significant lag.[16] Several observations are worth considering in this model.

- There is weak Granger causality between private credit and output, but a stronger relationship between the prime lending rate and output (Tables 7 and 8).[17]
- Private credit contributes to the interest rate channel by about 0.2 percent starting in the second quarter but only in the model with exchange rates. This means that a policy

[15] The bank lending channel is one component of the credit view on which there is a focus in this paper. The general credit view also includes the balance sheet channel (or financial accelerator mechanism (Bernanke and Gertler (1995)) together with the notion of agency problems arising from asymmetric information and costly enforcement of contracts in the financial market. The asymmetry of information makes internal finance (i.e, through retained earnings) of new investment projects cheaper than external finance.

[16] The effects of policy rates on lending rates and thus the contribution of the bank lending channel can be different during monetary policy cycles (tightening and loosening periods). We have run separate tests on these distinct periods with no additional insights into our understanding of the impact of the bank lending channel.

[17] We have simulated the same exercise with the weighted average lending rate and the inference was that only the prime lending rate has a significant impact on output.

tightening will reduce output by 0.7 percent starting from the second quarter when the reduction of private credit is also associated with real exchange rate appreciation.

- The prime rate has a significant Granger effect on output and reduces it by about 0.1 percent more after about five quarters. Consistent with the results, the variance decomposition shows that about 8 percent of GDP shocks are explained by the prime lending rate; about 6 percent by the policy rate; and about 7 percent by private credit.
- There is no Granger causality from either bank credit or the lending rate on core and headline inflation in the model for the bank lending channel. Policy variables jointly Granger-cause (help predict) both output and prices. We will return to this observation in Section VI.

The effectiveness of the bank lending channel depends also on the speed of pass-through and the level of competition. As seen earlier, pass-through is slow in Sri Lanka, which explains the initially unstable and lagged impact of lending rates on output. As to why the supply of bank loans does not increase in response to rate changes, the arguments usually refer to banks' ability to attract external funds. Further, banks may simply purchase more securities rather than undertake higher lending. The degree of competition among banks also determines the response of banks' lending rates to banks' cost of funds. In a noncompetitive environment banks will not pass on their reduced costs of funding to their loan rates[18].

[18] Perera, Wickramanyake and Ralston (2013) show that bank lending channel in Sri Lanka has been recently weakened by commercial banks engaging in off-balance sheet lending and other activities (guarantees, commitments and derivative transactions such as foreign exchange contracts, forwards, futures and options, swap and credit derivatives). In addition, bank lending channel could be weakened by the general lack of trust in state banking, and also strong influences of shadow banking activities (personal and tailor made bank lending approaches).

Table 7. Sri Lanka: Credit Channel

Granger causalities
Sri Lanka

	Impact on output	
	F-stat	p-values
Money supply 1/	1.21	0.31
Interest rate (repo)	3.18*	0.05
Exchange rate	0.15	0.86
Private credit	2.82*	0.07
Policy variables jointly	3.7***	0.00
	Impact on prices	
	F-stat	p-values
Money supply 1/	1.42	0.25
Interest rate (repo)	2.15	0.13
Exchange rate	0.18	0.84
Private credit	0.47	0.63
Policy variables jointly	2.64**	0.06

p values show the significance of lagged monetary policy variables for output and prices
F statistic at (2, 40)
Critical values are 5.18 at 1% level; 3.23 at 5% level and 2.44 at 10% level
***significant at 1%
**significant at 5%
*significant at 10%
Notes (i) The optimal lag is selected based on LR=2
F statistic for joint significance is at (10, 41)
Critical values are 2.80 at 1% level, 2.08 at 5% level and 1.70 at 10% level

1/ Defined as broad money (M2b). We have retested the model with reserve money and with no significant difference in our findings. In addition, the impact of reserve money on private credit has proven to be highly significant.

Source: IMF staff calculations.

Table 8. Sri Lanka: Credit Channel

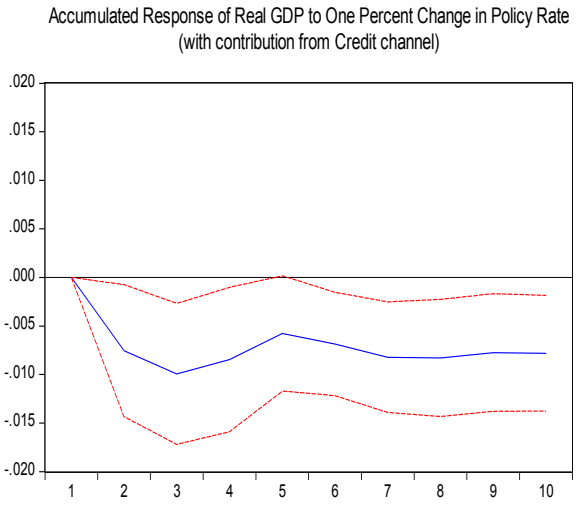
Granger causalities
Sri Lanka

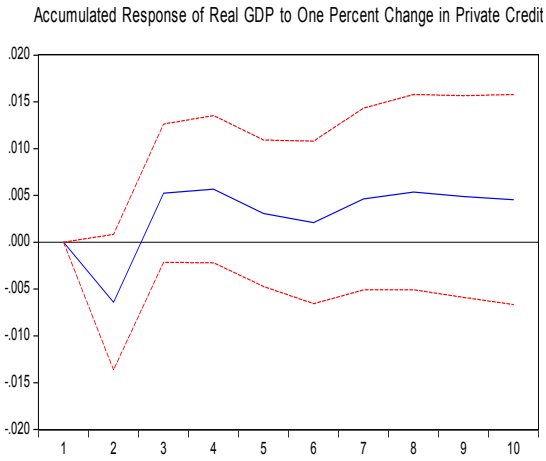
	Impact on output	
	F-stat	p-values
Money supply 1/	1.21	0.31
Interest rate (repo)	3.18*	0.05
Prime lending rate 2/	3.58**	0.04
Private credit	2.82*	0.07
Policy variables jointly	3.7***	0.00
	Impact on prices	
	F-stat	p-values
Money supply	1.42	0.25
Interest rate (repo)	2.15	0.13
Prime lending rate	0.77	0.47
Private credit	0.47	0.63
Policy variables jointly	2.64**	0.06

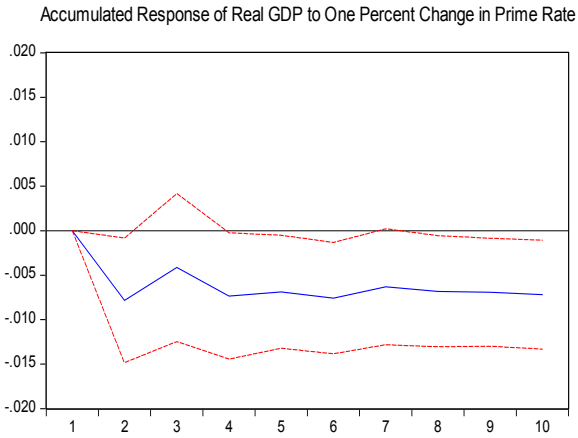
p values show the significance of lagged monetary policy variables for output and prices
F statistic at (2, 40)
Critical values are 5.18 at 1% level; 3.23 at 5% level and 2.44 at 10% level
***significant at 1%
**significant at 5%
*significant at 10%
Notes (i) The optimal lag is selected based on LR=2
F statistic for joint significance is at (10, 41)
Critical values are 2.80 at 1% level, 2.08 at 5% level and 1.70 at 10% level

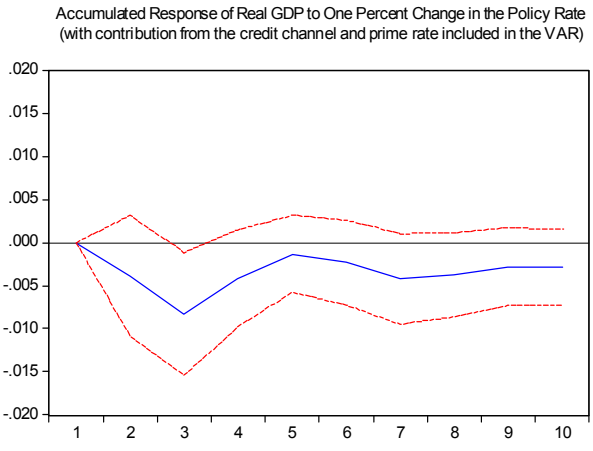
1/ Tests with reserve money have not changed our findings.
2/ Only the prime lending rate has a Granger effect on output and with the private credit variable included in the VAR, the test with weighted average lending and money market rate was not significant at any conventional level.

Source: IMF staff calculations.







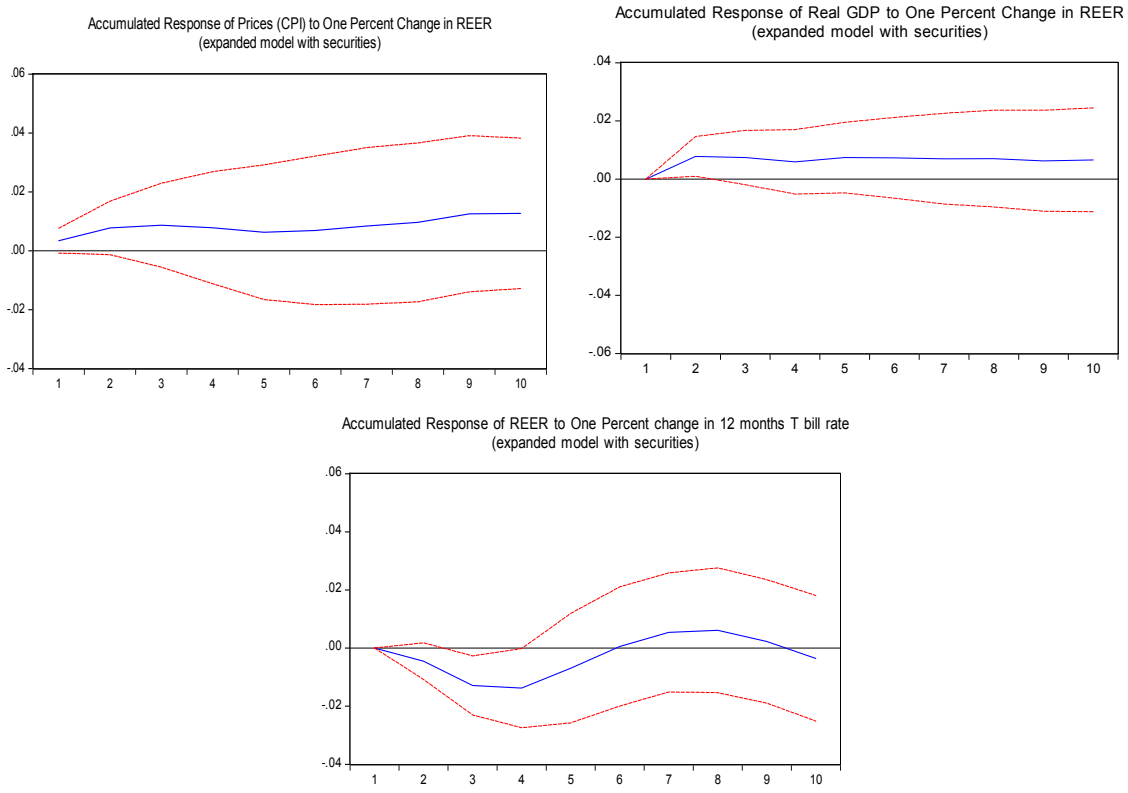


C. Exchange Rate Channel

The exchange rate channel kicks in when policy rate adjustments trigger changes in short- term market and lending and deposit rates—including on government securities. Under a floating regime and perfect capital mobility, changes in the nominal and (with sticky prices) real exchange rates induce expenditure switching between domestic and foreign goods and affect aggregate demand through net exports. A number of factors may be limiting the exchange rate channel, including: (i) continued management of the exchange rate during periods of volatility (i.e., a managed as opposed to free float); (ii) the degree of capital mobility in Sri Lanka is limited both jurisdictionally and in practice; (iii) and the growing importance of short-term external borrowing and potential currency mismatch with negative expenditure-reduction effects offsetting expenditure-switching effects on output.

The exchange rate channel (proxied by the nominal exchange rate, the NEER, and the real effective exchange rate, the REER) is weakly contributing to other channels but has no significance on its own. There is no Granger effect (predicting) of the exchange rate on either

output or on prices. However, the presence of the exchange rate in the model with the bank lending channel augments its influence on output by about 0.2 percent, and variance decomposition shows that about 8 percent of output fluctuations are explained by the changes in the exchange rate. Also, the exchange rate responds to changes in short-term rates on government bonds.[19] The cumulative effect fades after about 4 quarters, and the impact on output even sooner.



D. Asset Price Channel

The mechanics of the asset price channel (proxied by the stock market index) in the workings of the monetary transmission mechanism are as follows: An increase in the policy rate (monetary tightening) can reduce equity prices by making equity relatively less attractive compared to bonds, as well as worsening the earnings outlook for firms (since household spending declines). Lower equity prices lead, in turn, to a drop in financial wealth of both households and firms. Hence, households reduce consumption, and for firms, their market value relative to the replacement cost of capital declines and this delays new investment (Tobin's q effect).

[19] For the exchange rate channel, we have tried several VAR specifications with different interest rates on government securities (3, 6, and 12-month Treasury bill rates) and money market rates (overnight call market and other money market rates). The strongest impulse on the REER is received from the model with the 12-month Treasury bill rate.

The asset price channel (proxied by the index of the Colombo stock exchange) has no meaningful impact on output and prices. Previous results where the policy rate had a significant impact on output and reduced it by about 0.5 percent during the entire shock period did not change with the asset price channel included in the model (Table 9).

Table 9. Sri Lanka: Asset Price Channel

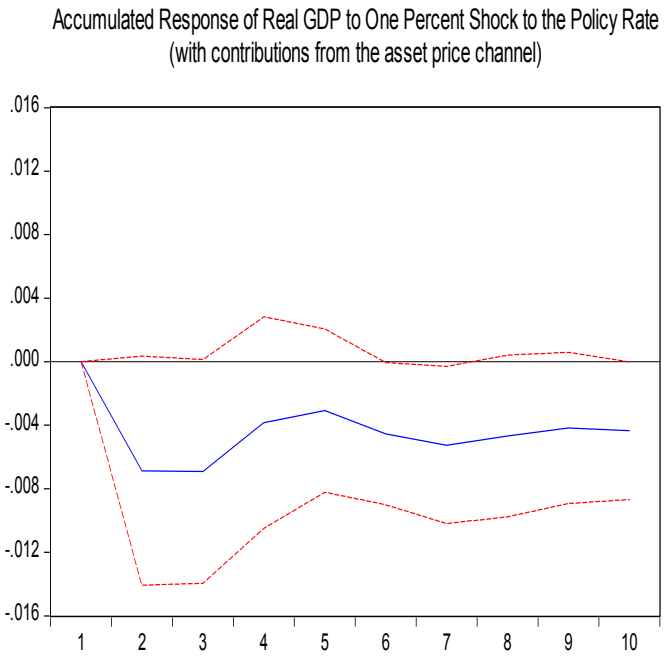
Granger causalities
Sri Lanka

	Impact on output	
	F-stat	p-values
Money supply 1/	0.32	0.57
Interest rate (repo)	11.78***	0.00
Exchange rate	0.09	0.77
Stock market index	0.30	0.59
Policy variables jointly	1.72*	0.19
	Impact on prices	
	F-stat	p-values
Money supply 1/	1.42	0.25
Interest rate (repo)	2.43*	0.12
Exchange rate	1.66	0.20
Stock market index	1.36	0.25
Policy variables jointly	2.23**	0.03

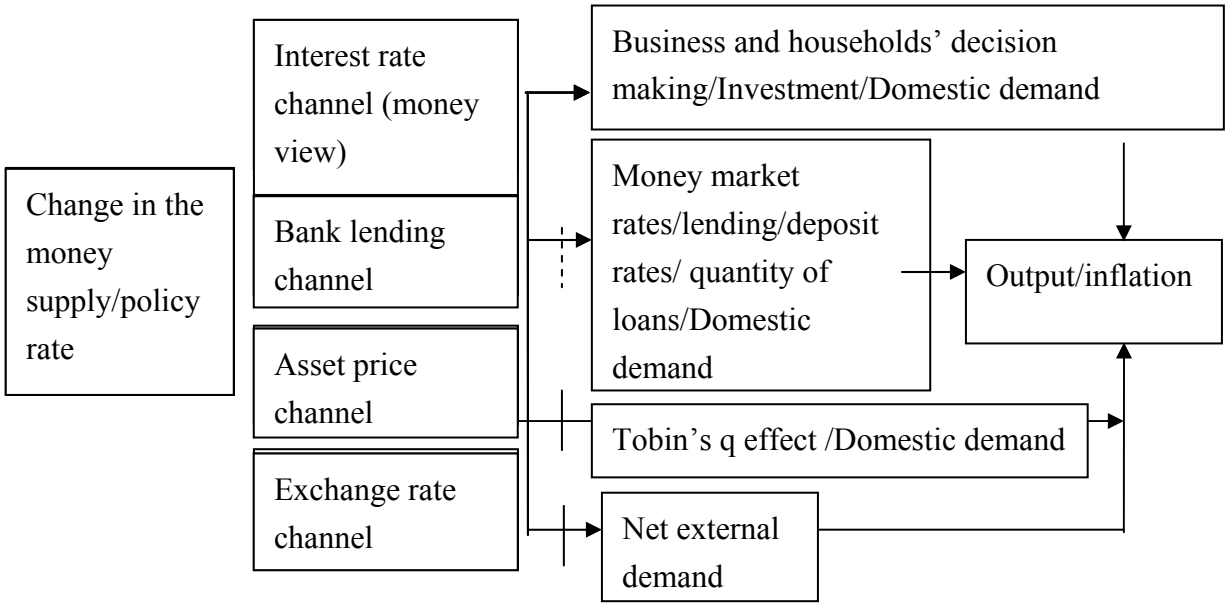
p values show the significance of lagged monetary policy variables for output and prices
F statistic at (2, 40)
Critical values are 5.18 at 1% level; 3.23 at 5% level and 2.44 at 10% level
***significant at 1%
**significant at 5%
*significant at 10%
Notes (i) The optimal lag is selected based on LR=2
F statistic for joint significance is at (10, 41)
Critical values are 2.80 at 1% level, 2.08 at 5% level and 1.70 at 10% level

1/ Defined as broad money (M2b). We have retested the model with reserve money and with no significant difference in our findings.

Source: IMF staff calculations.

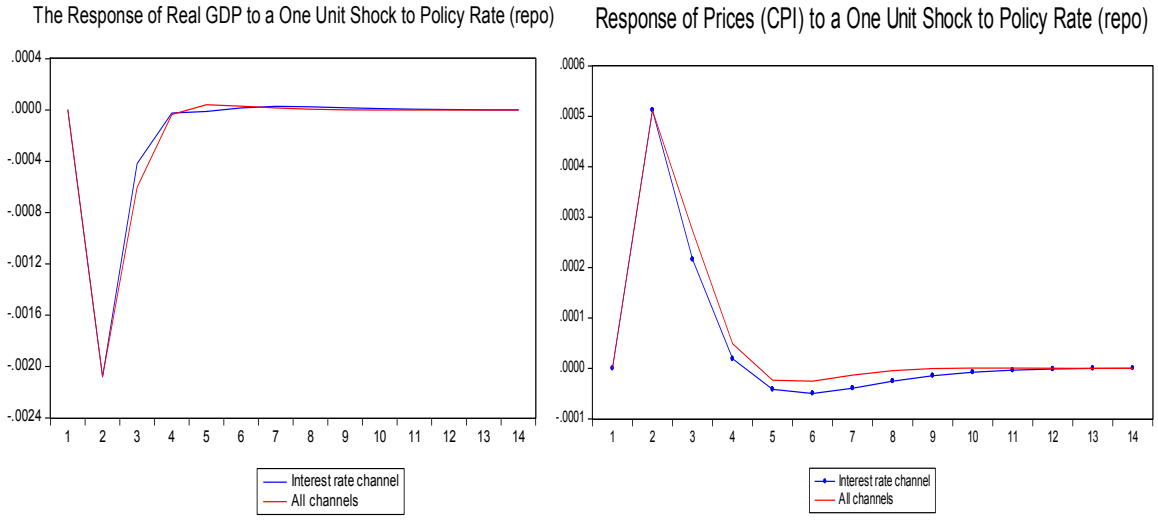


The following chart summarizes the monetary policy transmission dynamics discussed above for Sri Lanka (with vertical lines showing that the channel is ineffective). The dashed line for the bank lending channel indicates its partial significance in the monetary transmission channel in Sri Lanka.



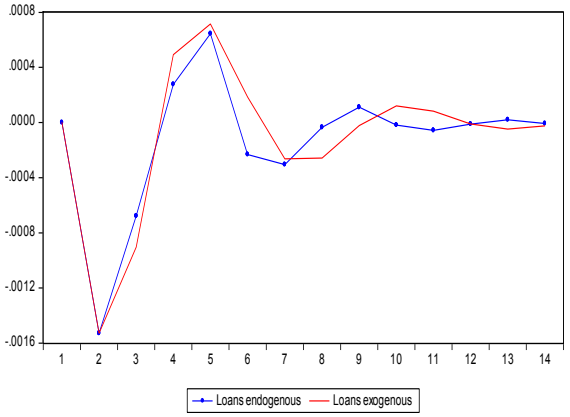
VI. More on the Channels of Monetary Policy Transmission

Exogeneity tests provide further evidence on the impact and timing of various transmission channels. In this section, we assess the impact of various channels on output and prices using the approach suggested by Ramey (1993) and Disyatat and Vongsinsirikul (2003). In particular, each monetary policy channel is evaluated with, and without, being endogenized for the baseline period of study from 2000Q1 to 2013Q3.[20] The output and price responses are evaluated with each channel blocked off in the VAR and compared when it is part of the model. The IRFs of both models are plotted below with the differences indicating the strength of each channel. The interest rate channel is compared with all other channels combined. The results are as follows: (i) the strongest monetary policy channel in Sri Lanka is the interest rate channel; (ii) the bank lending channel is operational on its impact on output (5 quarters) and prices (5–10 quarters) but with a significant lag. The contribution of the bank lending channel to the policy rate in affecting inflation is strongest among all other channels (note that we did not have these results with the Granger effect in Section V, B). This observation on the timing also echoes earlier results of a longer- term convergence of policy rates and money market and other interest rates.

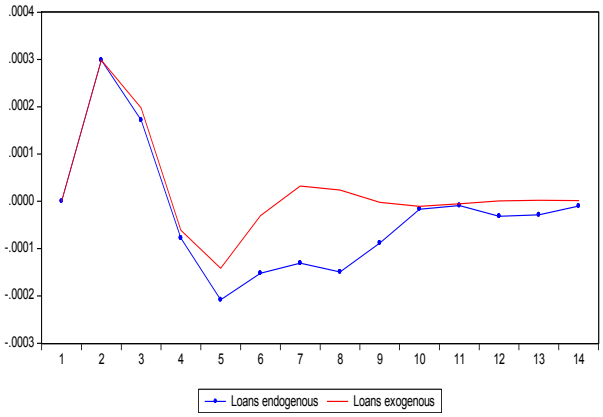


[20] The exercise also covers the period from 1995Q1 to 2013Q3 with no major differences in the results.

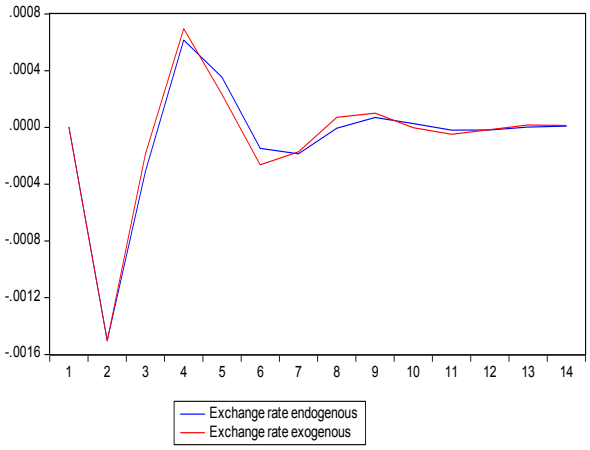
Response of Real GDP to a One Unit Shock to Policy Rate (repo)



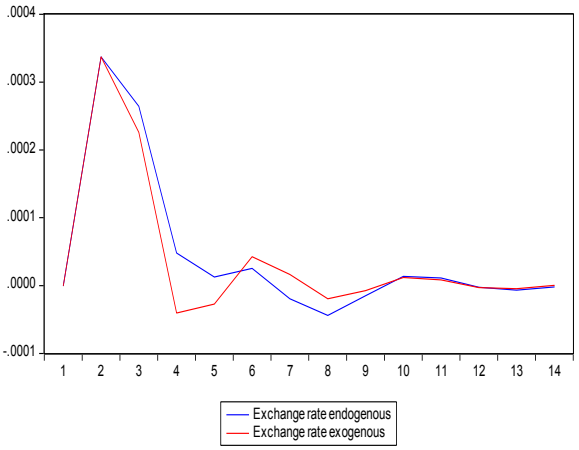
Response of Prices (CPI) to a One Unit Shock to Policy Rate (repo)



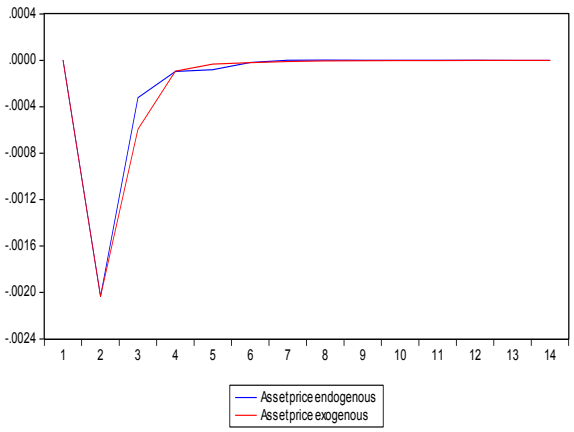
Response of Real GDP to One Unit Shock to Policy Rate (repo)



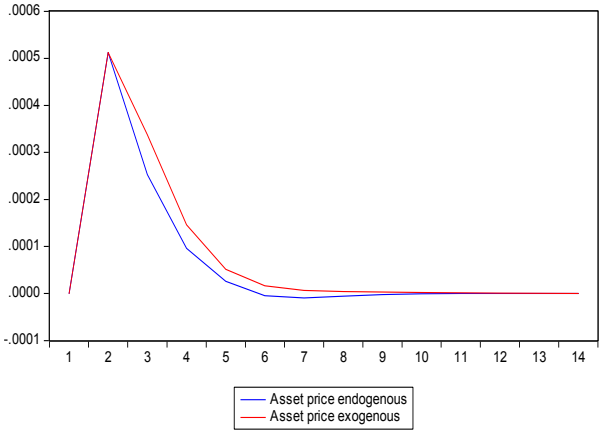
Response of Prices (CPI) to One Unit Shock to Policy Rate (repo)



Reponse of Real GDP to One Unit Shock to Policy Rate (repo)



Reponse of Price (CPI) to One Unit Shock to Policy Rate (repo)



VII. VAR Model—Issue of Excess Liquidity, Output, and Inflation

The securitization of bank portfolios could be a drag on monetary policy transmission, and the impact of Treasury bill rates on inflation is much stronger than the role of the policy rate. Two expanded VAR models are used to assess these assumptions[21]. They include real GDP, the CPI, the money supply (alternating with reserve money), policy interest rate, outstanding deposits (in the first model, Table 10) and securities in the banking system (in the second model, Table 11), the 12-month Treasury bill rate, the exchange rate, and private credit.

The impact of policy rates on output can be dampened when the bank lending channel becomes muted and the impulses from policy rates land in the securities market. The interesting confirmation of this result is the significant Granger effect of the policy rate when deposits are available, and the lack of any Granger effect from the policy rate (although money supply still weakly Granger-causes (helps predict) output) without deposits in the model. More importantly, the 12-month Treasury bill rates Granger-cause (help predict) prices (a one percent reduction in the 12-month Treasury bill rate will increase prices by about 0.2 percent within two quarters). This is an important observation as any purchase of securities by banks will, in effect, increase liquidity.

Consistent with the results, 20 percent of variance in GDP and inflation is explained by the changes in the money supply (12 percent) and 12-month Treasury bill rate (8 percent). Interestingly, given (i) the longer convergence between the changes in the policy and other rates, and the fact that (ii) Treasury bill and money market rates significantly affect inflation, and (iii) that the bank lending channel is important for price formation (as shown in Section VI), it can be inferred that the impact of policy rates or money supply on inflation is not observable until the later periods when all rates converge.

[21] These models (together with the expanded models including stock market index) are also estimated to ensure that our estimates do not suffer from omitted variable bias. Our results did not change with all policy variables simultaneously included in those models.

Table 10. Sri Lanka: Expanded VAR Model

Granger causalities
Sri Lanka

	Impact on output		Impact of policy rate on	
	F-stat	p-values		
Money supply 1/	1.21	0.31		
Interest rate (repo)	3.18*	0.05		
Exchange rate	0.15	0.86		
Securities	0.20	0.82	0.21	0.81
Private credit	2.82*	0.07	1.89	0.16
Deposits	0.93	0.40	0.02	0.98
Policy variables jointly	1.62	0.12		
	Impact on prices			
	F-stat	p-values		
Money supply 1/	1.42	0.25		
Interest rate (repo)	2.15	0.13		
Exchange rate	0.18	0.84		
Securities	1.63	0.21		
Private credit	0.47	0.63		
Deposits	0.13	0.88		
Policy variables jointly	1.57	0.13		

p values show the significance of lagged monetary policy variables for output and prices
F statistic at (2, 36)
Critical values are 5.28 at 1% level; 3.26 at 5% level and 2.46 at 10% level
***significant at 1%
**significant at 5%
*significant at 10%
Notes (i) The optimal lag is selected based on LR=2
F statistic for joint significance is at (14, 37)
Critical values are 2.62 at 1% level, 1.97 at 5% level and 1.69 at 10% level

1/ Defined as broad money (M2b). We have retested the model with reserve money and with no significant difference in our findings.

Source: IMF staff calculations.

Table 11. Sri Lanka: Expanded VAR Model with 12-Month Treasury Bill Rate

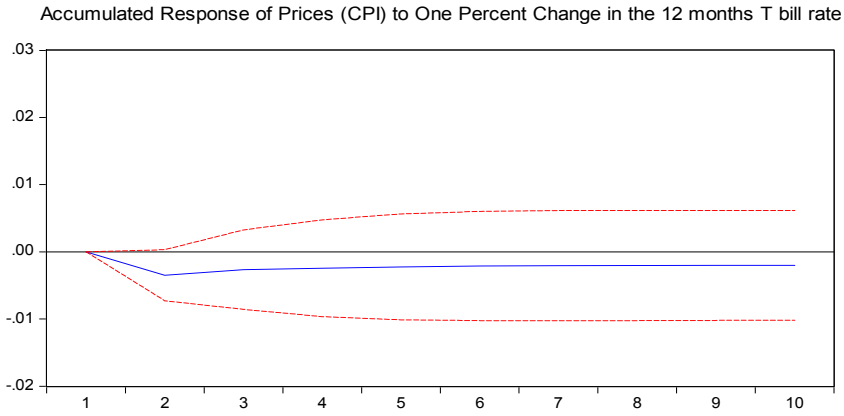
Granger causalities
Sri Lanka

	Impact on output		Impact of policy rate on	
	F-stat	p-values		
Money supply 1/	3.08**	0.04		
Interest rate (repo)	1.47	0.24		
Exchange rate	0.78	0.51		
Securities	0.36	0.78	2.04	0.12
Private credit	2.12	0.11	1.51	0.23
Twelve-month Treasury bill 12	0.41	0.75	5.85***	0.00
Policy variables jointly	3.22***	0.01		
	Impact on prices			
	F-stat	p-values		
Money supply 1/	0.97	0.41		
Interest rate (repo)	2.32*	0.09		
Exchange rate	0.51	0.68		
Private credit	1.32	0.28		
Twelve-month Treasury bill 12	4.08**	0.01		
Policy variables jointly	2.82***	0.01		

p values show the significance of lagged monetary policy variables for output and prices
F statistic at (3, 28)
Critical values are 4.57 at 1% level; 2.95 at 5% level and 2.29 at 10% level
***significant at 1%
**significant at 5%
*significant at 10%
Notes (i) The optimal lag is selected based on LR=3
F statistic for joint significance is at (21, 29)
Critical values are 2.58 at 1% level, 1.95 at 5% level and 1.69 at 10% level

1/ Defined as broad money (M2b). We have retested the model with reserve money and with no significant difference in our findings.

Source: IMF staff calculations.



VIII. CONCLUSIONS

The interest rate channel is the most important monetary policy transmission channel in Sri Lanka as it directly affects the decision making of economic agents. However, the roles of bank lending and the exchange rate and asset price channels should be strengthened going forward. Our results showed that each of these channels, if fully operational, can significantly contribute to the effectiveness of the monetary policy transmission mechanism in Sri Lanka. For example, the bank lending channel adds another 0.2 percentage point to the baseline 0.5 percent decrease in output in response to innovations in the policy rate. Also, the contribution of the exchange rate channel through real appreciation in the model with private credit causes an additional 0.2 percent reduction of output to the increase in the policy rate.

To address the weakness of the bank lending channel, as well as to increase the short- run pass-through between the policy rates and market and lending rates, a more competitive banking system should be encouraged. Some potential measures in this regard include: (i) developing alternative sources of financing, such as the capital market; (ii) reducing the role of state banks in the financial system to avoid the pitfalls associated with state banking including lack of trust in transparency; and (iii) creating avenues to connect bank financing with the real economy.

To bring forward the exchange rate channel, the authorities need to limit the interventions in the foreign exchange market to focus on smoothing excessive fluctuations and allow flexibility to Sri Lankan rupee. Together with this, the authorities could gradually increase the degree of capital mobility and allow more transparent and active foreign participation in domestic secondary securities and deposit markets. This is given Sri Lankan circumstances and progress towards maintaining macroeconomic and financial stability. The further development of a competitive export base would significantly increase the value added of the exchange rate channel.

To make the asset channel operational, the authorities should adopt necessary institutional reforms to increase the transparency and entry into equity and property markets for both residents and nonresidents. As economic agents participate more actively in the asset markets, and nonbanking assets grow as a proportion of their total wealth, dependence on bank financing may decrease. Allowing the asset price channel to work will enhance the market allocation of wealth and sustain the efficiency of the transmission mechanism.

Annex I. Data Generation Process and Unit Root Test Results

Table 1: Sri Lanka: Models Describing the DGP(Data Generating Processes) for Series 1/

CMR				St			
	Model 1	**Model 2**	**Model 3***		**Model 1***	**Model 2**	**Model 3**
AIC	-1.87	-1.87	-1.91	AIC	-0.94	-0.94	-0.93
Schwarz	-1.68	-1.60	-1.68	Schwarz	-0.90	-0.83	-0.86
SSR	0.38	0.34	0.34	SSR	1.19	1.10	1.15
Q(4) 2/	1.4126 (0.842)	1.0177 (0.907)	1.0197 (0.907)	Q(4)	1.6142 (0.806)	2.6787 (0.613)	1.7144 (0.788)
Q(8)	2.7547 (0.949)	2.2557 (0.972)	2.2585 (0.972)	Q(8)	10.109 (0.257)	11.81 (0.16)	10.29 (0.245)
Q(12)	9.2318 (0.683)	5.0018 (0.958)	4.9933 (0.958)	Q(12)	11.728 (0.468)	14.743 (0.256)	11.824 (0.46)
Model 1	No Constant No trend			Model 1	No Constant No trend		
Model 2	Constant and a trend			Model 2	Constant and a trend		
Model 3	Constant			Model 3	Constant		

1/ Model selected for unit root testing.
2/ Q(p)=Ljung Box Statistics for the residuals (significance level in parentheses).

Tb				Lending Rate			
	Model 1	**Model 2***	**Model 3**		**Model 1**	**Model 2**	**Model 3***
AIC	-1.14	-1.49	-1.23	AIC	-2.64	-2.77	-2.80
Schwarz	-1.11	-1.26	-1.08	Schwarz	-2.53	-2.58	-2.65
SSR	0.97	0.55	0.76	SRR	0.20	0.16	0.16
Q(4)	3.0563 (0.548)	2.1344 (0.711)	3.0489 (0.55)	Q(4)	2.0276 (0.731)	3.8554 (0.426)	3.5322 (0.473)
Q(8)	5.081 (0.749)	2.4063 (0.966)	3.76 (0.878)	Q(8)	3.1467 (0.925)	4.9978 (0.758)	4.6849 (0.791)
Q(12)	13.007 (0.369)	5.0071 (0.958)	8.2366 (0.766)	Q(12)	12.679 (0.393)	12.108 (0.437)	11.631 (0.476)
Model 1	No Constant No trend			Model 1	No Constant No trend		
Model 2	Constant and a trend			Model 2	Constant and a trend		
Model 3	Constant			Model 3	Constant		

RGDP

	Model 1	Model 2*	Model 3
AIC	-4.85	-5.45	-4.76
Schwarz	-4.66	-5.22	-4.57
SRR	0.02	0.01	0.02
Q(4)	7.848 (0.097)	2.5749 (0.631)	5.2976 (0.258)
Q(8)	9.2501 (0.322)	5.965 (0.651)	6.1192 (0.634)
Q(12)	10.435 (0.578)	11.392 (0.496)	8.9362 (0.708)
Model 1	No Constant No trend		
Model 2	Constant and a trend		
Model 3	Constant		

CPI

	Model 1*	Model 2	Model 3
AIC	-5.54	-5.56	-5.54
Schwarz	-5.43	-5.38	-5.40
SRR	0.01	0.01	0.01
Q(4)	0.1719 (0.997)	0.3087 (0.989)	0.1684 (0.997)
Q(8)	1.6826 (0.989)	1.9903 (0.981)	1.7181 (0.988)
Q(12)	2.7618 (0.997)	2.8336 (0.997)	2.9844 (0.996)
Model 1	No Constant No trend		
Model 2	Constant and a trend		
Model 3	Constant		

M2

	Model 1	Model 2*	Model 3
AIC	-5.88	-5.93	-5.78
Schwarz	-5.76	-5.74	-5.71
SRR	0.01	0.01	0.01
Q(4)	1.673 (0.796)	2.5409 (0.637)	0.0487 (1)
Q(8)	2.41 (0.966)	3.9084 (0.865)	1.0285 (0.998)
Q(12)	4.0102 (0.983)	5.952 (0.918)	2.8395 (0.997)
Model 1	No Constant No trend		
Model 2	Constant and a trend		
Model 3	Constant		

REER

	Model 1	Model 2	Model 3*
AIC	-4.77	-4.68	-5.01
Schwarz	-4.65	-4.53	-4.79
SSR	0.02	0.02	0.02
Q(4)	7.4055 (0.116)	13.086 (0.011)	8.2049 (0.084)
Q(8)	13.814 (0.087)	21.42 (0.006)	12.722 (0.122)
Q(12)	18.605 (0.099)	32.601 (0.001)	18.037(0.115)
Model 1	No Constant No trend		
Model 2	Constant and a trend		
Model 3	Constant		

CP

	Model 1	Model 2*	Model 3
AIC	-2.98	-3.10	-2.97
Schwarz	-2.87	-2.91	-2.82
SRR	0.14	0.12	0.14
Q(4)	1.9508 (0.745)	0.4422 (0.979)	1.8245 (0.768)
Q(8)	8.3537 (0.4)	6.25 (0.619)	7.9068 (0.443)
Q(12)	12.135 (0.435)	7.7468 (0.805)	11.43 (0.493)

Model 1 No Constant No trend
Model 2 Constant and a trend
Model 3 Constant

OP

	Model 1	Model 2*	Model 3
AIC	-1.10	-1.17	-1.08
Schwarz	-0.99	-0.98	-0.93
SRR	0.90	0.78	0.88
Q(4)	1.8856 (0.757)	1.0923 (0.895)	1.6298 (0.803)
Q(8)	4.9434 (0.764)	3.2166 (0.92)	4.7188 (0.787)
Q(12)	5.0939 (0.955)	3.4994 (0.991)	4.8877 (0.962)

Model 1 No Constant No trend
Model 2 Constant and a trend
Model 3 Constant

U.S. Rate

	Model 1	Model 2*	Model 3
AIC	0.29308	0.08	0.10
Schwarz	0.09	0.23	0.22
SRR	3.16	2.89715	3.077673
Q(4)	6.4921 (0.165)	3.4203 (0.49)	5.317 (0.256)
Q(8)	8.3156 (0.403)	7.4026 (0.494)	8.6199 (0.375)
Q(12)	18.95 (0.09)	15.103 (0.236)	15.155 (0.233)

Model 1 No Constant No trend
Model 2 Constant and a trend
Model 3 Constant

Repo

	Model 1	Model 2	Model 3*
AIC	-2.77	-2.76	-2.78
Schwarz	-2.66	-2.57	-2.63
SRR	0.17	0.16	0.16
Q(4)	1.8277 (0.767)	1.1134 (0.892)	1.4296 (0.839)
Q(8)	7.9156 (0.442)	7.6182 (0.472)	7.7391 (0.459)
Q(12)	18.297 (0.107)	17.454 (0.133)	17.073 (0.147)

Model 1 No Constant No trend
Model 2 Constant and a trend
Model 3 Constant

SEC

	Model 1*	Model 2	Model 3
AIC	-0.23	-0.22	-0.19
Schwarz	-0.12	-0.03	-0.04
SRR	2.15	2.02	2.15
Q(4)	0.1623 (0.997)	0.1995 (0.995)	0.1506 (0.997)
Q(8)	0.8043 (0.999)	0.9417 (0.999)	0.7696 (0.999)
Q(12)	0.8043 (0.994)	3.5576 (0.990)	2.9789 (0.996)

Model 1 No Constant No trend
Model 2 Constant and a trend
Model 3 Constant

DEP

	Model 1	Model 2*	Model 3
AIC	-4.76	-4.84	-4.78
Schwarz	-4.69	-4.69	-4.67
SRR	0.02	0.02	0.02
Q(4)	0.3822 (0.984)	0.3923 (0.983)	0.3046 (0.990)
Q(8)	3.0582 (0.931)	4.0383 (0.854)	3.7179 (0.882)
Q(12)	3.2541 (0.993)	4.8144 (0.964)	4.4048 (0.975)

Model 1 No Constant No trend
Model 2 Constant and a trend
Model 3 Constant

Deposit rate

	Model 1	Model 2*	Model 3
AIC	-3.47	-3.86	-3.66
Schwarz	-3.32	-3.60	-3.43
SRR	0.08	0.03	0.06
Q(4)	1.1187 (0.891)	0.5215 (0.971)	1.0833 (0.897)
Q(8)	3.7899 (0.876)	3.469 (0.902)	1.9544 (0.982)
Q(12)	12.689 (0.392)	10.383 (0.582)	7.5748 (0.817)

Model 1 No Constant No trend
Model 2 Constant and a trend
Model 3 Constant

Table 2. Sri Lanka: Summary of the Results of Stationarity Tests

Series	Is the series stationary? 1/ 2/						Should the series be differenced in the analysis?
	ADF	PP 3/	NP	KPSS 4/	ERS	P-break 5/	
Interest rate (repo)	No	No	No	No	Yes	No	Yes
M2	No	No	No	No	Yes	No	Yes
Exchange rate	No	No	No	No	Yes	No	Yes
Real GDP	Yes	No	No	No	Yes	Yes	Yes
CPI 6/	Yes	Yes	N/A	N/A	N/A	No	No
Lending rate	Yes	No	Yes	Yes	No	No	Yes
Twelve-month Treasury bill rate	No	No	No	Yes	Yes	No	Yes
Call market rate	Yes	No	Yes	Yes	No	No	Yes
Private Credit	Yes	No	Yes	Yes	No	No	Yes
Stock market index	Yes	Yes	N/A	N/A	N/A	No	No
U.S. refinancing rate	No	No	No	No	Yes	No	Yes
Oil Price	No	No	No	Yes	Yes	No	Yes
Securities	No	No	N/A	N/A	N/A	No	Yes
Deposits	No	No	No	Yes	Yes	No	Yes
Deposit rate	No	No	Yes	Yes	No	Yes	Yes

1/ ADF-Augmented Dickey-Fuller. PP=Phillips-Perron. ERS=DF-GLS by the method of Elliot, Rothenberg, and Stock.
NP=Ng-Perron.P-break=Perron's test allowing for structural break. KPSS=Kwiatkowski, Phillips,Schmidt and Shin
2/ Significance is tested at 5% level
3/ MacKinnon (1996) one-sided p-values are reported for PP statistics
4/ In all tests the null hypothesis is the unit root of the series except in KPSS where stationarity of series is the null
5/The critical values for Perron's test are taken from Perron (1989) p. 1376-1377: λ is taken for Model C at 5% significance level
The critical values for t when λ=0.7 are -4.75 at 1% level; -4.18 at 5% level and -3.86 at 10% level.
6/ Our test results show that the variable for CPI is stationary and thus should not be differenced in the model.
We have also taken a conservatve approach and run the VAR models with differnecd CPI.
7/In the paper, a conservative approach is taken and the VAR tests are run with differenced CPI and interest rates in levels.

Table 3. Descriptive Statistics of Selected Variables, 2000Q1 to 2013Q3

	Mean	Median	Maximum	Minimum	Standard Deviation
Repo rate	9.444	8.58	19.33	7	2.776
Three-month T-bill rate	11.32	10.1	21.3	6.98	3.892
Twelve-month T-bill rate	11.882	11.17	20.21	7.14	3.891
Prime rate	13.69	12.8	22.24	8.94	3.762
Δ CPI	0.024	0.021	0.065	-0.021	0.017
Δ Real GDP	0.013	0.01	0.087	-0.105	0.031
Δ Reserve money	0.029	0.029	0.095	-0.079	0.031
Δ Broad money	0.037	0.038	0.07	0.001	0.013
Δ Overall credit	0.038	0.044	0.124	-0.135	0.04
Δ Private credit	0.037	0.04	0.107	-0.025	0.027

Sources: Sri Lankan authorities; and IMF staff estimates.

Note: Δ denotes the quarter-on-quarter difference in the logarithm of the variables (seasonally adjusted). The sample covers 2000Q1 to 2013Q3.

Annex II. Comparison with Previous Work

Our findings are broadly in line with the previous work on the monetary transmission mechanism in Sri Lanka except for the conclusions on the impact of policy innovations on inflation. Previous studies (Perera and Wickramanayake (2013); Fernandez and others (2004) have showed that interest rate and credit channels—whereby the central bank's monetary decision influences economic activities through its policy rate and, hence, through the market and lending interest rates--are the dominant monetary policy channels in Sri Lanka with IMF Fernandez and others (2004) downplaying the relative importance of the bank lending channel. We agree with this and we believe that the investment channel whereby the policy rates affect the decision-making process of the economic agents is the strongest channel in Sri Lanka.

On the other hand, the importance of the monetary shocks in affecting inflation has been controversial. Fernandez and others (2004) showed that "shocks to output and inflation (roughly in equal proportion) explain most of its variability rather than monetary shocks." The lack of a high impact of policy measures on prices is explained by the higher weight of food in the price index and inflation inertia - the latter by the backward-looking wage formation in the government sector. With a larger sample (from 1995 to 2013) (Perera and Wickramanayake (2013) found prices to be responsive to monetary shocks though the presence of "price puzzle" overshadowed true inference on how prices respond to monetary shocks. We encountered this problem too. Ratnasiri (2009) found that money growth has effects on inflation in the long run but the output gap has no significance in explaining inflation.

In our paper, we found no difference between the results with CPI and core inflation. Second, we found that money growth does, in fact, weakly Granger-cause (helps predict) inflation and, in the expanded model with securities and Treasury bill rates, 20 percent of inflation is explained by changes in money growth and Treasury bill rates.

Finally, based on our initial results of exogeneity tests on the bank lending channel and the significant impact of Treasury bill and money market rates on inflation, we believe that the banks' behavior in responding to policy signals can alter the direction of these signals from output to inflation. In particular, banks may be tempted to neutralize any policy action by counteractive transactions in the government securities market thereby affecting inflation dynamics in Sri Lanka. Having said this, it is also possible that, owing to the slow adjustment of money and other rates to changes in the policy rates, the long -run impact on inflation is visible only through those rates rather than directly from the policy variables; the previous studies, which did not examine the timing effects of rate convergence, did not raise this possibility. The fact that the Sri Lankan authorities are keen to investigate these pass-through channels between policy and money market rates is welcome.

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