MONETARY TRANSMISSION IN THE EMERGING COUNTRY CONTEXT: THE CASE OF SRI LANKA

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Abstract

The main purpose of this study is to provide a comprehensive assessment of monetary policy transmission in the emerging country context. As such, the paper examines the effectiveness, relative importance of different transmission channels, distributional effects of monetary policy across different financial institutions as well as the structural changes in monetary transmission in Sri Lanka using monthly and quarterly aggregate data and disaggregated data. Based on the empirical estimates obtained employing both unrestricted and structural vector auto regressions, this study mainly suggests that monetary policy is quite effective to influence target variables of Central Bank of Sri Lanka, i.e. output and prices. It also shows that monetary policy changes affect target variables through intermediate transmission channels such as exchange rates, asset prices as well as bank credit. Based on the bank-wise data, consistent predictions are observed to support the view that small financial institutions find it more difficult to shield their activity against a monetary policy shock than large institutions. Finally, the results suggest that transformations in the economic and financial environment play a role in increasing the sensitivity of output and prices to interest rates suggesting the changes in monetary transmission. These results provide important policy implications for emerging country central banks, particularly Central Bank of Sri Lanka.

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1. INTRODUCTION

Monetary policy plays a useful role in determining fluctuations in real output and prices (Rafiq and Mallick, 2008) and hence, it remains at the centre of macroeconomic policymaking (Mishkin, 1995). Nevertheless, monetary policy could also have unexpected or unwanted consequences, if monetary authorities do not have an accurate assessment of timing and effects of their policy on the economy (Mishkin, 1995). Hence, in order to conduct monetary policy successfully, a thorough understanding of monetary transmission mechanism (MTM, hereafter), is required.

Once the attention is focused upon MTM, subsequent questions naturally arise; (i) how monetary policy is transmitted to the economy, and (ii) what attributes of monetary policy transmission have changed? With regard to the question (i), a number of issues have been raised in monetary economics literature in relation to the channels through which monetary policy translates to the economy, lags that an economy will take to respond to monetary policy shocks, distributional effects of monetary policy. All these issues are related to effectiveness of MTM. With regard to question (ii), the key focus is placed on the changes in MTM due to rapid financial sector dynamics as advanced country MTM has changed significantly despite there are opposing views.[1] As many emerging countries have gradually become more liberalised and open over time, it is reasonable to examine whether MTM in emerging countries has changed.

Accordingly, this study intends to address the following issues related to MTM in an emerging economy: (i) is monetary policy is effective to affect target variables of the central bank, i.e. output and prices and what is the role played by different channels to transmit monetary policy actions?; (ii) how different financial institutions react to monetary policy actions?; and (iii) how monetary transmission has changed in tandem with economic and financial sector dynamics? The first proposition attempts to empirically define the key features of an emerging economy

[1] For example, Thornton (1994); Sellon (2002) for USA, Iacoviello and Minetti (2003); Juselius and Toro (2005) for the EU countries and Taylor (1995); Weber, Gerke, and Worms (2011) for a set of advanced countries provide evidence for changing MTM due to economic and financial sector dynamics. In contrast, some studies, for example, Fahrer and Rohling (1992) for Australia; Bardsen and Klovland (2000) for Norway and Angeloni and Ehrmann (2003) for EU countries, do not support this view.

MTM and to delineate the key mechanisms through which policy impulses are propagated. The second proposition focuses on identifying distributional (sectoral) effects across different financial institutions while the third proposition intends to assess the changes in propagation of monetary policy shocks. As such, the contributions of this study are enlisted as follows:

This study provides a comprehensive assessment on MTM in an emerging country setting and hence adds knowledge to the limited research available for emerging countries, particularly for small, open and recently gradually liberalised economies.[2] The study also makes a significant contribution to the discussion on MTM in emerging countries based on structural vector auto regression (VAR) modelling.[3] More importantly, unlike other emerging country studies, this study focuses on sectoral effects of monetary policy based on disaggregated data for different financial institutions. Finally, a notable contribution is made to the discussion about the shifts in emerging country MTM.[4]

Sri Lankan context is selected as the emerging country setting to carry out the empirical analysis of this study due to the following reasons. Similar to many advanced and emerging economies, two stylised facts about the Sri Lankan economy have emerged. On the one hand, it is evident that macroeconomic aggregates are less volatile during post-1980s than in the preceding decades.[5] Based on Cecchetti, Flores-Lagunes, and Krause (2006) and Hanson (2006), it can be argued that such macroeconomic success is due to the effectiveness of monetary policy.

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2 In comparison to advanced countries, a limited number of studies focus on the emerging country MTM. For example, Afandi (2005) for Indonesia, Disyatat and Vongsinsirikul (2003) for Thailand, Agha, Ahmed, Mubarik, and Shah (2005) for Pakistan, Elbourne and de Haan (2006) for transition countries of Central and Eastern Europe, Singh and Kalirajan (2007); Bhattacharyya and Sensarma (2008); Bhattacharya, Patnaik, and Shah (2011) for India, Montes (2013) for Brazil, etc.

3 For example, a limited number of research employs structural VARs to model the MTM in emerging countries [for example, Bhattacharyya and Sensarma (2008) for India, Afandi (2005) for Indonesia, Ito and Sato (2008) for a set of East Asian emerging countries, etc.].

4 The existing limited literature on the shifts in emerging country MTM includes Agung (1998) for Indonesia, Chavan and Vaidya (2003); Singh and Kalirajan (2007) for India, Alwani (2006); Singh, Razi, Endut, and Ramlee (2008) for Malaysia, Charoenseang and Manakit (2007); Hesse (2007) for Thailand, Mohanty and Turner (2008) for a set of emerging countries and Olivero, Li, and Jeon (2011a; 2011b) for Asian and Latin American countries.

5 For example, real output variability (as measured by the standard deviation of real GDP growth) has reduced from 2.1 per cent during 1950-1980 to around 1.9 per cent during 1981- 2012. Despite somewhat reversed trend during 2001-2012 (2.6 per cent), broadly a declining trend is observed particularly in the 1990s recording the lowest figure of around 1.0 per cent. Volatility in prices (as measured by the standard deviation of GDP deflator) has declined considerably from 7.6 per cent during 1950-1980 to around 4.3 per cent during 1981-2012.

As the Sri Lankan economy had adopted a range of economic and financial sector reforms since the 1980s with the acceleration in the 1990s and the continued reforms, monetary policy performance and transmission may have increased considerably. On the other hand, similar to monetary policy conduct in many advanced countries and emerging countries focusing more on price stability (Boivin, Kiley, and Mishkin, 2010), monetary policy in Sri Lanka now appears more responsive to inflationary pressures – and thereby more 'stabilising'.[6] In this endeavour, having an effective and a dynamics monetary transmission seems vital. However, despite the importance, the role of monetary policy and its transmission have not been examined extensively in the Sri Lankan context.[7]

Employing both aggregate and disaggregated data for Sri Lanka and using both unrestricted and structural forms of VAR, this study mainly finds the following: Despite the varying lags, monetary policy is effective in influencing the target variables of the monetary authority, i.e. output and prices. The results also suggest the impact of monetary policy on target variables through intermediate transmission variables such as exchange rates, asset (stock) prices as well as bank credit. Based on the balance sheet variables of different financial institutions, consistent predictions are observed to argue that small financial institutions find it more difficult to shield their activity against monetary policy shocks than relatively large institutions. The results also confirm that transformations in the economic and financial environment lead to increase the sensitivity of real output and prices to interest rates. These findings have important policy implications for monetary policy conduct, particularly in emerging countries as discussed later.

The remainder of this paper is organised as follows: Section 2 discusses the relevant theoretical underpinnings and presents the literature review. Section 3 presents the research

[6] In response to changing economic environment, Central Bank of Sri Lanka (CBSL) amended its statute, Monetary Law Act (No. 58 of 1949 amended in 2002) to streamline the objectives and to focus more on economic and price stability (Central Bank of Sri Lanka, 2005). Previously, CBSL exercised multiple objectives such as stabilisation of domestic monetary values, preservation of the stability of the exchange rate, promotion of a high level of production, employment and real income and encouragement and promotion of development of productive resources. The recent communications of the CBSL also indicate that its primary responsible is to fight inflation while securing the financial system stability (Central Bank of Sri Lanka, 2011; 2012).

[7] Jayamaha (1995) examines MTM in Sri Lanka, but it is limited to early years of deregulation. Amarasekara (2008) does not consider the relative importance, sectoral effects and structural changes in MTM.

design including the data and methodology. Section 4 is devoted for empirical results and the discussion and then Section 5 concludes.

2. THEORETICAL UNDERPINNINGS AND LITERATURE REVIEW

2.1 Monetary Transmission Mechanism and Different Channels of Transmission

The transmission mechanism illustrates how policy-induced changes in monetary policy instruments of a central bank (the nominal money stock or the short-term nominal interest rate) influence real variables such as aggregate output and employment and the key nominal variable: inflation (Mishkin, 1995; Taylor, 1995). The models and theories of MTM assume some degree of friction in the economy so that nominal prices cannot adjust immediately and proportionately following a change in monetary policy (Ireland, 2008; Walsh, 2010). Hence, theory of MTM assumes that prices react to monetary policy with a longer lag than output (Kilponen and Leitemo, 2011).

The response of macroeconomic aggregates to monetary policy shocks is explained by Bernanke and Gertler (1995) through the following: (i) Although an unanticipated tightening in monetary policy has only transitory effects on interest rates, a monetary tightening is followed by a sustained declines in real GDP and prices; (ii) Falling relatively quickly after a change in policy, final demand absorbs the initial impact of a monetary tightening (production also falls with a lag implying that inventories could rise in the short run, which declines later); (iii) the earliest and the sharpest declines in final demand can be seen in residential investment; and (iv) fixed business investment eventually declines in response to a monetary tightening after housing and consumer durables. To that end, the effectiveness of monetary policy can be gauged by models of MTM, which show the dynamic responses of key economic aggregates targeted by the central bank, i.e. output and prices, to an unanticipated tightening of monetary policy. However, it is considered itself as a 'black box' (Bernanke and Gertler, 1995; Morsink and Bayoumi, 2001) and therefore to conduct monetary policy successfully and effectively while avoiding unexpected or unwarranted consequences, monetary authorities must have an accurate assessment of the timing and the effects of their policies on the economy.

A number of propagation mechanisms of monetary policy, i.e. different channels are identified in the monetary economics literature. It is useful to distinguish the relative importance of these different channels to understand the link between the financial and real sector of the economy and to make a better choice of timing when to use various monetary instruments (Kakes and Sturm, 2002). In a seminal publication of 'Journal of Economic Perspectives' on MTM, Mishkin (1995) describes various channels through which monetary policy actions affect the economy: (i) interest rates, (ii) exchange rates, (iii) other asset prices, and (iv) credit. In the same volume, Taylor (1995) classifies these channels into two broad categories: (i) financial market prices (short-term interest rates, bond yields, exchange rates), and (ii) financial market quantities (money supply, bank credit, supply of government bonds, foreign denominated assets). Recently, Boivin et al. (2010) differentiate the channels of MTM into two broad strands: (i) neoclassical channels in which financial markets are perfect and (ii) non-neoclassical channels that involve financial market imperfections. These neoclassical channels are built upon core models of investment, consumption, and international trade behaviour (i.e. direct interest rate channels) as well as Tobin's q, wealth effects, intertemporal substitution effects and exchange rate channels. The non-neoclassical channels refer to the credit view, which includes effects on credit supply from government interventions in credit markets, bank-based channels (through lending and bank capital), and balance sheet channel (affecting both firms and households). In addition to these core channels, expectations channel has also gained some attention in the contemporary literature of MTM (Ball and Dean, 1995; Roberts, 1998; Svensson, 1999).[8] These different channels are not mutually exclusive as the overall response of the economy to a

[8] Changes in monetary policy affect expectations of the public concerning inflation, employment, growth, etc. and the changes in expectations determine economic activity of private agents. However, the impact of monetary policy through expectation channel is uncertain as it depends on the public's interpretation of such changes in monetary policy stance.

monetary action integrates the influence of a variety of channels. Also, these channels of MTM depend on the status of the economy and the financial system.

Amongst different channels of MTM, interest rates and credit view deserve much attention as monetary policy actions affect credit flows and the economy either from the 'interest rate side' or from the 'credit side' (Romer and Romer, 1994). The impact of interest rates on components of aggregate demand is the interest rate or money view, i.e. traditional channel of transmission (Bernanke and Blinder, 1988; Morris and Sellon, 1995) as well as the primary and the central transmission channel (Taylor, 1995; Sellon, 2002).[9] However, it is argued that policy-induced changes in the cost of capital are insufficient to explain the size, timing and the composition of economic responses to a monetary policy shock (Bernanke and Gertler, 1995; Kandrac, 2012) and market imperfections play a pivotal role in MTM through the so-called 'credit channels' (Kashyap and Stein, 1995; Mateut, Bougheas, and Mizen, 2006).[10] These channels arises mainly through asymmetric information in and imperfect nature of credit markets (Gertler and Gilchrist, 1993; Allen, Chui, and Maddaloni, 2004), which depend on several features of the financial system and also the size and the state of the banking system. Moreover, these financial market frictions and imperfections amplify the effects of monetary policy mainly through two distinct sub-channels: 'bank lending channel' and 'balance sheet channel' (Bernanke and Blinder, 1988; Mishkin, 1995). The bank lending channel suggests that monetary policy is transmitted through supply of bank loans (Kashyap and Stein, 1995).[11] The balance sheet channel refers to the role of financial positions of private agents play in MTM, which operates through borrowers' balance sheets (Aysun and Hepp, 2011).[12]

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9 This view claims that changes to central bank monetary policy stance influence real economic activity through interest rates affecting the opportunity cost of capital. It also takes bonds and loans to be perfect substitutes and only allows for the monetary policy effects on aggregate investment, consumption and savings through changes in interest rates (Bolton and Freixas, 2006).

10 Kakes and Sturm (2002) show that renewed interest in MTM must be seen within the context of revival of theories discussing the impact of the financial system on aggregate economic activity, which has led to the credit view of transmission.

11 Bank lending channel is referred to as 'broad credit channel' (Mateut, 2005)

12 Boivin et al. (2010) define that channels arising due to market imperfections as non-neoclassical transmission mechanisms. Such channels can arise either from government interference in markets or through imperfections

Exchange rate channel plays an important role in the context of extant internationalisation of economies and due to the advent of flexible exchange rates (Mishkin, 1995) and it works through the changes in the currency value and the adjustments in net exports affecting aggregate demand directly. Moreover, asset price channel operates mainly through capital (stock) markets and real estate markets. Hence, these channels are based on the investment decisions of firms and households (Mishkin, 1995; Boivin et al., 2010) as well as the financial wealth of the investors having implications on the aggregate demand (Sellin, 2001). Given the structure of the economy and the financial system in an emerging economy, it can be expected that different channels would have different importance in the process of transmissions.

Considering the above theoretical and empirical underpinnings, it can be hypothesised that 'an unanticipated change in monetary policy (given by an interest rate shock) causes reductions in real GDP and consumer price levels', and 'an unanticipated change in monetary policy (given by an interest rate shock) causes reductions in real GDP and consumer price levels through interest rates, credit, exchange rates and asset prices.'

2.2 Sectoral Transmission of Monetary Policy across Financial Institutions

Given the importance of financial markets and due to market imperfections, particularly in credit markets, the credit view plays a significant role in MTM (Kashyap and Stein, 1995; Kakes and Sturm, 2002). Moreover, being the key players dealing with certain types of information asymmetry, commercial banks play a significant role in the transmission process. However, Kakes and Sturm (2002) show that the fragmented nature of the financial system pose significant impacts on MTM. This is because different financial institutions are linked to diverse clientele bases with varying creditworthiness and the response of monetary policy will be different across these segments. Generally, it is perceived that commercial banks normally lend to relatively

in private markets such as asymmetric information or market segmentation that lead to barriers to efficient financial markets. For example, government intervention in housing finance and establishing ceilings on interest rates on deposits under 'Regulation Q' led to a significant credit channel involving credit supply in the US.

creditworthy customers.[13] Also, less creditworthy borrowers cannot access bank loans despite the excess supply in bank loan markets (Koo, Moon, and Shim, 2010) and they generally access financial intermediaries outside the banking sector, for example, non-bank financial intermediaries.[14] Due to the existence of different intermediaries, monetary policy can have heterogonous impacts. To that end, it raises a question on the role of different financial institutions, in particular commercial banks and other non-bank financial intermediaries, in transmitting monetary policy actions. As shown by Kashyap and Stein (1995) and Kakes and Sturm (2002), it can be expected that different financial variables related to the balance sheet of particular financial institution would react differently to monetary policy actions.

Diversity in the response of financial institutions would justify the workings of a bank lending channel. For example, it is argued that smaller banks (i) need to hold more liquid assets as a buffer against monetary shocks and (ii) would need to reduce their lending activity more sharply after a monetary contraction. In contrast, better access to non-deposit funding enables large banks to neutralise an unanticipated withdrawal of deposits (due to a change in monetary policy stance) more easily (Kashyap and Stein, 1995; 2000; Kakes and Sturm, 2002). However that (i) and (ii) are to some extent interdependent as a larger liquidity buffer enables a small bank to shield its loans portfolio. To that end, if a small bank's lending does not respond significantly to a monetary contraction, it should be reflected in a substantial reduction in its securities holdings. Large banks, on the other hand, should be able to insulate their loans portfolio from monetary shocks without having to draw down their liquid assets. Taken together, it is more difficult to neutralise the monetary shocks for small banks than the large banks. To that end, monetary policy impact could vary due to different size as well as concentration and the health of the financial system implying that MTM could differ across different financial institutions (Elbourne

13 Thakor (1996) shows that more creditworthy borrowers access commercial banks and credit the denial probability is lower for those borrowers.

14 In fact, these non-bank financial intermediaries are becoming important across the financial systems relative to banks and they are taking over a more important role as mobilisers of capital from the nonfinancial sectors while creating a general tendency toward disintermediation (Schmidt, Hackethal, and Tyrell, 1999).

and de Haan, 2006). As such, being guided by Kakes and Sturm (2002), given the significance of commercial banks as well as other financial institutions such as non-commercial banks and finance companies in Sri Lankan financial system, substantial sectoral heterogeneity of monetary policy impact can be expected.[15] In particular, it is expected that large financial institutions (typically banks) attempt to shield their loan portfolio from monetary disturbances which may rather weaken the impact of monetary policy.[16] In this context, it is hypothesised that 'a significant heterogeneity is observed in the response of deposits, securities and lending of different financial institutions to an unanticipated change in monetary policy (given by an interest rate shock).'

2.3 Shifts in Monetary Transmission Mechanism

MTM depends on the status of the economy and its financial system (Taylor, 1995) and hence, the role of the financial system and its structure in the transmission process have recently received a considerable attention in the academic literature (Garretsen and Swank, 1998).[17] Academic literature postulates a robust relationship between financial sector changes and MTM and the issue has been debated in various forums and researched extensively predominantly for advanced countries.[18] For example, Boivin et al. (2010) suggest that MTM may have changed over time in line with the structural changes in the economies, particularly in the credit markets due to factors such as financial liberalisation, globalisation, disintermediation, growth of

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15 Though commercial banks remain the largest sector, various financial institutions operate in Sri Lanka. While licensed commercial banks hold about 48 per cent of total financial sector assets, non-commercial banks (licensed specialised banks) and registered finance companies hold about 14 per cent. As argued by Kakes and Sturm (2002), the mere fact that commercial banks play an important role suggests that scope for an effective credit (particularly bank lending) channel is potentially large in Sri Lanka.

16 In contrast to Kakes and Sturm (2002), this study provides evidence based on the data for individual institutions.

17 Garretsen and Swank (1998) argue that monetary authorities were not able to meet their objectives mainly as a result of structural changes in the underlying financial and economic relationships. This has led to abandon some strategies such as monetary targeting.

18 For example, conferences on '*Changing Capital Markets: Implications for Monetary Policy*' sponsored by the Federal Reserve Bank of Kansas City (19-21 August 1993), '*Financial Innovation and Monetary Transmission*' sponsored by the Federal Reserve Bank of New York (5-6 April 2001), and '*Financial Market Developments and Their Implications for Monetary Policy*' jointly organised by the Bank of International Settlements and Bank Negara Malaysia in Kuala Lumpur (13 August 2007).

securitisation, improvements in information technology, and the interaction between changes in monetary policy actions and the way expectations are formed. To that end, there remains a vital need to examine the changes in overall MTM as profound financial sector changes in emerging countries may have altered the way in which monetary policy is transmitted to real economy (Brissimis and Magginas, 2005). However, it is a challenging task to precisely distinguish the impact of financial sector dynamics on the specific channels of MTM. On the one hand, whether and how overall MTM to output and prices has been altered due to financial sector dynamics cannot be answered on a theoretical basis alone but has to be addressed empirically (Weber et al., 2011). On the other hand, Weber et al. (2011) also show that most of the related empirical literature does not analyse whether overall MTM to output and prices is subject to change, instead the literature concentrates on specific transmission channels and asks whether specific factors have changed the working or the relative importance of such channels.

As already mentioned, price based channels such as interest rates and other financial asset prices (wealth effects) gain much importance due to financial sector changes. Also, financial sector changes have the potential to alter the MTM by affecting the market imperfections, which is the source of non-neoclassical channels and hence reduce the importance of credit based channels (Thornton, 1994; Bernanke and Gertler, 1995; Brissimis and Magginas, 2005; Altunbaş, Gambacorta, and Marques-Ibanez, 2009; Olivero et al., 2011a).[19] Empirically, while a majority studies for example, Fahrer and Rohling (1992); Disyatat and Vongsinsirikul (2003); Juselius and Toro (2005); Boivin et al. (2010); Weber et al. (2011), among others confirm the positive impact of financial sector changes on MTM, some studies contradict these propositions. For example, Bardsen and Klovland (2000); Ehrmann and Worms (2004); Alwani (2006); Aysun and Hepp (2011), etc. find somewhat contradictory evidence. However, being guided by the premise that overall strength and the effectiveness of MTM would change due to overall financial sector changes as suggested by Weber et al. (2011), it is attempted to examine whether overall MTM to

[19] Bernanke and Gertler (1995) show that with the financial deregulation and innovation, the importance of bank lending channel has most likely 'diminished' over time.

output and prices is subjected to any change in the emerging country setting rather than focusing on a specific factor and specific channel.[20] As such, it is hypothesised that 'response of real GDP and consumer price levels to an unanticipated change in monetary policy (given by an interest rate shock) is higher during the post-break period.'

Similar to the approach of Juselius (1998); Weber et al. (2011) and Berument and Froyen (2006), etc., it is intended to examine how the response of output and inflation to the innovations in monetary policy rates vary in the context of economic and financial changes. It is expected that the responses of output and prices is higher to a monetary policy shock (for example, 1 per cent change in short-term interest rate) during the post-break period.

3. RESEARCH DESIGN

This section discusses the research design of the study, i.e. sample selection and data as well as the models and the estimation methods with relevant robustness checks.

3.1 Sample Selection and Data

To conduct the empirical analysis based on the Sri Lanka context, three different samples are used: (i) MTM is established and the relative importance of different channels is examined using quarterly data (March 1996 to September 2012), (ii) sectoral effects are investigated using monthly disaggregated data (January 2004 to December 2012), and (iii) shifts in MTM relies on monthly data (January 1996 to December 2012). Accordingly, this study relies on both aggregate and disaggregated data, which offer two main benefits. First, while an aggregative approach may not provide much insight into the channels of MTM, aggregate data yields much more robust and more significant estimates of the overall influence of monetary policy than does a disaggregated approach (Duguay, 1994). Second, disaggregated data are important to address the

[20] Table B.1 presents are summary of the impact of different financial sector changes on monetary transmission.

identification problem in modelling MTM while uncovering the distributional and sectoral effects of monetary policy.[21]

The required data are mainly sourced from the published databases of the CBSL, IFS database of the IMF and also from unpublished databases of the CBSL mainly the data collected for monetary survey.

3.2 Models, Estimation Methods and Robustness

The empirical strategy of this study is based on estimating vector auto regression (VAR) models. Given the problems with large-scale econometric models such as problems of manageability, existence of identification issue, unreliability in terms of quantifying the effects of monetary policy, difficulty in modification and evaluation, inapplicability for emerging countries due to unavailability of adequate data, etc. (Duguay, 1994; Favero and Marcellino, 2001; Afandi, 2005)[22] and due to problems with single equation models such as inability to identify the parameters and to deal with simultaneity problems (Duguay, 1994; Afandi, 2005), have led to the success of VARs especially in examining MTM (Favero and Marcellino, 2001; Stock and Watson, 2001).[23] Since the seminal work of Sims (1980), VARs have become popular in estimating effects of the monetary policy on the economy as they have proved to be a convenient method of summarising the dynamic relationships among variables (Bernanke and Gertler, 1995) and

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21 MTM is generally identified using the aggregate data. However, analysis of some particular channels, for example, bank lending channel, is controversial due to fundamental identification problem, i.e. is the fall in bank lending after a monetary tightening induced by supply or by demand? (Kashyap, Stein, and Wilcox, 1993; Bernanke and Gertler, 1995). This indicates that, in contrast with the lending channel, a fall in aggregate lending after a monetary contraction may be driven by demand, rather than supply. In that case, other channels, for example, interest rates or exchange rates, may cause and economic downturn and bank lending could follow passively (Kakes and Sturm, 2002). To address this identification problem, disaggregated data can be used. As shown by Dale and Haldane (1995), the channels of MTM may depend crucially upon the degree of substitution between bank and non-bank sources of finance and it will vary across sectors while the sectoral differences are masked by the aggregate data.

22 Duguay (1994) suggest that a small aggregative model is better suited than a large-scale model to quantify the linkages between macroeconomic variables and to present estimates of the effect of interest rates and the exchange rate on real activity and prices.

23 Garretsen and Swank (1998) show that VAR is a general dissatisfaction with the structural econometric modelling approach, in which apriori (theoretical) restrictions limit the interdependencies of the variables included in such models.

powerful tools for describing data and for generating reliable multivariate benchmark forecasts (Stock and Watson, 2001).[24] To that end, VARs appears to be widely used method to estimate MTM, particularly in the advanced countries.[25]

Also, VAR models appear appropriate for emerging countries than alternative modelling strategies because its data requirements are less demanding (Elbourne and de Haan, 2006). To that end, the VAR methodology is progressively used for emerging countries, for example, Agung (1998); Afandi (2005) for Indonesia, Disyatat and Vongsinsirikul (2003); Charoenseang and Manakit (2007) for Thailand and Elbourne and de Haan (2006) for some for transition countries, among others. Despite there are some criticisms against VARs (Rudebusch, 1998), given the main advantage in generating dynamic responses to policy shocks, the VAR models are applied in this study to identify MTM in an emerging market setting.

3.2.1 Effectiveness and Relative Importance of Channels of MTM

First, VAR models are used to examine the effectiveness of monetary policy to affect the target variables of the central bank, i.e. output and prices and the relative importance of different channels. As such, to establish MTM and examine the effectiveness of monetary policy in Sri Lanka, first, an unrestricted – baseline VAR model is estimated. This model assumes that the system is recursive and hence the Choleski decomposition is employed for identification.[26] This baseline VAR specification can be written in following matrix form:

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24 Technically, VARs explicitly recognise the simultaneity between monetary policy (such as an increase in the short-term interest rate) and the macroeconomic developments (such as the changes in output, prices, exchange rates), dependence of economic variables on monetary policy, capture the co-movements that cannot be detected in the univariate or bivariate models, place minimal restrictions on how shocks affect the economy. To that end, VARs offer an ideal combination between data-based approach and the economic theory-based coherent perspective (Fry and Pagan, 2005).

25 For example, Gertler and Gilchrist (1993); Bernanke and Gertler (1995); Boivin and Giannoni (2002); Berument and Froyen (2006); Carpenter and Demiralp (2012); Milcheva (2013) for US, Dale and Haldane (1995); Iacoviello and Minetti (2003); Tena and Tremayne (2009) for UK, Juselius and Toro (2005) for Spain, Morsink and Bayoumi (2001) for Japan, etc. and Taylor (1995) for some group of countries such as US, Germany and Japan, Ramaswamy and Slok (1998); Weber et al. (2011) for EU countries and Kim and Roubini (2000) for industrial economies and Arin and Jolly (2005) for Australia and New Zealand, etc.

26 VAR models use a variety of identifying assumptions to quantify the effects of monetary policy (Hanson, 2006) such as reduced form, recursive and structural forms (Stock and Watson, 2001). Choleski decomposition isolates

$$y_t = k + A(L)y_{t-1} + Bx_t + u_t \quad (1)$$

where y_t is the vector of endogenous variables, k is the vector of constants, x_t is the vector of exogenous variables and u_t is the vector of serially uncorrelated disturbances that have a zero mean and a time invariant covariance matrix. $A(L)$ denotes a matrix polynomial in the lag operator L and B is a coefficient matrix. In the baseline specification, the vector of endogenous variables i.e., y_t consists of key variables: real gross domestic product (GDP_t), the consumer price index (CPI_t), a measure of monetary aggregate, i.e. narrow money supply ($M1_t$) and the domestic nominal short-term interest rate given by interbank money market rate (MMR_t) and hence be written as follows.[27]

$$y'_t = (GDP_t \quad CPI_t \quad M1_t \quad MMR_t) \quad (2)$$

GDP_t and CPI_t are the key target variables of the monetary authority, which respond to innovations to the monetary policy rate. The use of narrow money aggregate ($M1_t$) is guided by the prior literature, for example, Sims (1992); Berument and Froyen (2006); Ito and Sato (2008); Rafiq and Mallick (2008); Laopodis (2013) to incorporate the impact of liquidity into the system. The use of money market rate (MMR_t) as the monetary policy indicator is also guided by the prior literature like Altunbaş, Fazylov, and Molyneux (2002); Ito and Sato (2008); Rafiq and Mallick (2008) and it captures the exogenous shifts in monetary policy stance (Gertler and Gilchrist, 1993). The ordering of the variables is consistent with the central bank response to output and inflation dynamics and dynamic structure of the economy (Disyatat and Vongsinsirikul, 2003). Therefore, policy variable is ordered last implying that an innovation in the money market rate has no contemporaneous impact on the variables in the system but has

the underlying structural errors by recursive orthogonalisation, with the innovation in the first equation untransformed, the innovation in the second equation taken as orthogonal to the first, and so on.

27 Generally, baseline VAR models include four key variables, i.e. real output, inflation rates, nominal interest rate and a financial variable of interest (for example, monetary aggregates) (Gertler and Gilchrist, 1993).

only a lagged influence on the other variables (Gertler and Gilchrist, 1993; Garretsen and Swank, 1998) and based on the standard literature of MTM, broadly a similar ordering is used throughout this study.[28] A dummy variable is included to capture the impact of the structural break occurred in 2001 due to exchange rate liberalisation, but the impact of the global financial crisis is not considered as there was no structural break in the data, which is consistent with the study of Carpenter and Demiralp (2012).

Following Gerlach and Smets (1995); Berument and Froyen (2006); Hesse (2007); Carpenter and Demiralp (2012), among others, all non-interest rate variables are measured in natural logarithms and based on the widely used X-11 procedure for seasonal adjustment (Abeysinghe and Forbes, 2005; Tena and Tremayne, 2009), variables are seasonally adjusted. The augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests all fail to reject a unit root in the levels of these time series but can be rejected in the first differences. Also, both Johansen's λ-max and λ-trace tests decisively reject the hypothesis of no cointegration for both sets of variables. If the variables in the system are non-stationary, but cointegrated, Sims, Stock, and Watson (1990) and Lütkepohl and Reimers (1992) prescribe that estimating VARs in (log) levels will provide consistent estimates. Although there is loss of efficiency in the VAR due to estimations in levels, it will prevent the loss of information about the long run relationships when a VAR is estimated in the first differences. Accordingly, being guided by prior similar research, for example, Disyatat and Vongsinsirikul (2003); Iacoviello and Minetti (2003); Berument and Froyen (2006), the unrestricted VAR model is estimated in levels using quarterly data for the period March 1996 to September 2012.[29] Since the VAR system is based on multiple regression models, estimates are diagnosed on the important assumptions about the residuals such as no serial correlation using correlograms, no heteroskedasticity using White's heteroskedasticity test and also the stability of the VAR using the inverse roots of characteristic polynomial (Lütkepohl, 2005).

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[28] For example, Gerlach and Smets (1995); Berument and Froyen (2006); Weber et al. (2011); Laopodis (2013), among others.

[29] Depending on data properties, some prior research, for example, Garretsen and Swank (1998); Hesse (2007) and Montes (2013) use vector error correction models (VECM) to estimate MTM.

Impact of monetary policy shocks on the target variables are identified based on impulse response functions (IRFs). These IRFs are useful summaries of the reactions of variables to shocks to other variables, i.e. the reaction of any dynamic system in response to exogenous shocks.[30] Also, in order to get an idea about the share of fluctuations in a given variable that are caused by different shocks, variance decompositions (forecast error decompositions) for each variable at different forecast horizons are also estimated.[31]

Thereafter, based on prior literature of MTM, for example, Dungey and Pagan (2000); Kim and Roubini (2000); Elbourne and de Haan (2006); Fraser, Macdonald, and Mullineux (2012), among others, a structural VAR (SVAR) model is estimated for Sri Lanka. This SVAR model is consistent with economic theory (Li, İşcan, and Xu, 2010) and it works by imposing enough restrictions to identify policy shocks and recognises the intertwines and complex relationships between policy variables and other macroeconomic variables (Leeper, Sims, and Zha, 1996; Boivin and Giannoni, 2006). Importantly, it is argued that the SVAR approach is better suited for small open economies like Sri Lanka than the traditional identification methods as it can capture more of the salient features of these economies (Elbourne and de Haan, 2006).[32]

In this study, consideration for a SVAR model for Sri Lankan economy is well justified due to several reasons. First, as Sri Lanka is an open economy, SVAR model allows considering the interdependence between the domestic monetary policy instrument variable and the nominal exchange rate. Second, although short-term interest rate remains the main policy variable as the CBSL targets monetary aggregates (base reserve money) as the operating target, it may not be clear or hard to determine the most appropriate monetary policy instrument used to identify

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30 Impulse responses trace out the response of current and future values of each of the variables to a one-unit increase in the current value of one of the VAR errors, assuming that this error returns to zero during the subsequent periods and that all other errors are equal to zero (Stock and Watson, 2001).

31 Variance decomposition is the percentage of the variance of the error made in forecasting a variable (say, inflation) due to a specific shock (say, the error term in the unemployment equation) at a given horizon (for example, two years) (Stock and Watson, 2001). Hence, it separates the variation in an endogenous variable into the component shocks to the VAR and provides information about the relative importance of each random shock in affecting the variables in the VAR at different horizons (Amisano and Giannini, 1997).

32 In general, Kim and Roubini (2000) argue that SVARs resolve a number of anomalies such as exchange rate, price, liquidity detected in the empirical small open economy recursive VAR models.

monetary policy shocks in Sri Lanka. The SVAR model allows combinations of monetary aggregates and the short-term interest rates helping to identify monetary policy shocks appropriately. Third, the SVAR model is preferred as it takes no account of the time series properties of the data (Dale and Haldane, 1995; MacDonald, Mullineux, and Sensarma, 2009) and due to relatively small sample size (MacDonald et al., 2009).

Being guided by the prior literature, mainly Kim and Roubini (2000), following variables are included in the SVAR model: the global commodity price index of the IMF ($COMP_t$), the US Federal funds rate ($FEDR_t$), real output (GDP_t), the consumer price index (CPI_t), money stock given by the narrow money aggregate ($M1_t$), short-term domestic interest rate given by the interbank money market rate (MMR_t) and the nominal exchange rate with respect to US dollar (EXR_t). All the variables are seasonally adjusted and specified in logs except for interest rates. Before estimating the SVAR model using these variables, first, an unrestricted VAR model is estimated and is diagnosed for stability, the absence of autocorrelation and heteroskedasticity. Then, the SVAR model is estimated, which is identified by several short run restrictions, which are discussed in detail in Appendix A. The analysis concentrates on the interaction between monetary policy and output and price developments identified based on the structural shocks that represent exogenous events, goods market equilibrium, money market equilibrium and the financial market equilibrium.[33] Using this 7-variable SVAR model, structural innovations for an unanticipated positive interest rate shock are obtained and the variance decompositions are estimated to provide a clear understanding about MTM in Sri Lanka. The model would also be re-estimated using some alternative variables in order to ensure the validity of the SVAR model.

Influence of monetary policy on output and prices through other channels of transmission, i.e. relative importance of difficult channels, is examined based on the shutdown/blocking-off method. This is based on the approach suggested by Ramey (1993), which is used by Morsink

33 While SVAR models are useful to understand the empirical regularities of MTM, imposing a structure requires a thorough understanding of monetary policy inter-linkages in the economy. As such, several blocks and restrictions are defined based on the economic theory as discussed in Appendix A.

and Bayoumi (2001) and Disyatat and Vongsinsirikul (2003). Accordingly, to examine the relative strength of different channels of transmission, IRFs of target variables (output and prices) to monetary policy shocks are compared under two scenarios, i.e. the model with relevant channel endogenous versus the model with relevant channel exogenous. Deviation of the IRF of the later model from IRF of the former model represents the strength of each channel - the larger the deviation, the stronger or more important the channel.

Recall, Eq. (1) comprises: real output, consumer price index, narrow money supply and money market rate. This baseline model is appended to include the variable representing the relevant transmission channel. Hence the endogenous vector y_t now includes one of the following variables: real loans ($RLOAN_t$) for credit channel,[34] nominal exchange rate (EXR_t) for exchange rate channel, stock market index (SMI_t) to represent the asset price channel. Finally, as per Morsink and Bayoumi (2001), all the variables are included in the vector to isolate the direct interest rate channel. In summary, MTM is defined over a monetary policy instrument (money market rates), intermediate channels of MTM (bank balance sheet variables together with asset prices) and the final policy objectives (output and prices). Responses of these target variables to monetary shocks are examined by comparing the responses when successive channels of transmission are blocked-off in the VAR and the baseline response when the channel of interest is allowed to operate. Differences in the path of output and prices would give an indication of the importance of that particular channel as a conduit for monetary policy (Disyatat and Vongsinsirikul, 2003).

3.2.2 Distributional Estimates (Sectoral Effects) of Monetary Transmission

Distributional (sectoral) estimates of MTM mainly focus on the impact of monetary policy on financial aggregates of different financial institutions that suggest the heterogeneous impact of

[34] Based on Carpenter and Demiralp (2012), real loans (loans deflated by consumer prices) are used.

monetary policy, i.e. distributional effects (Romer and Romer, 1994). This is achieved by estimating a set of VAR models using the time series data for balance sheet variables, which is based on the approach suggested in Bernanke and Blinder (1992); Gertler and Gilchrist (1993) and Kakes and Sturm (2002).[35] Considering the availability on a disaggregated basis, monthly data is used for these VAR models.[36]

These unrestricted VAR models include the industrial production index (IPI), the consumer price index, the monetary policy indicator (interbank money market rate) and relevant balance sheet variables.[37] All these variables except interest rates are de-trended and taken in logs. Balance sheet variables include deposits, total securities holdings, and lending to domestic private and the public sector. After estimating VAR models, impulse response analysis is performed for each/different groups of financial firms. These different financial institutions include licensed commercial banks (LCBs), licensed specialised banks (LSBs), regional development banks (RDBs) and registered finance companies (RFCs) operating in Sri Lanka, which all represents about 62 per cent of the total financial system. Also, separate estimates are provided for domestic and foreign LCBs and also for key domestic LCBs representing about 80 per cent of the banking sector assets.

35 Bernanke and Blinder (1992) estimate different VAR models, each including an indicator of monetary policy based on the funds rate, the unemployment rate, the CPI, and each of three bank balance sheet variables (deposits, securities, and loans). Gertler and Gilchrist (1993) estimate a set of VAR models and each model includes four variables: real output, prices, monetary policy rate and the financial variable of interest. They disaggregate the data by firm size, financial aggregate, etc. Kakes and Sturm (2002) examine different banking groups and their VECM models include balance sheet variables (deposits, lending to domestic private sector, total securities holding) as well as macroeconomic variables (short- and long-term interest rates, real output and prices) and some exogenous variables (seasonal dummies to account for German unification and other breaks).

36 Monthly VAR models are widely used in prior literature, for example, Bernanke and Blinder (1992); Dale and Haldane (1995); Kim and Roubini (2000); Disyatat and Vongsinsirikul (2003); Berument and Froyen (2006); Elbourne and de Haan (2006); Hanson (2006); Singh and Kalirajan (2007); Bhattacharya et al. (2011); Carpenter and Demiralp (2012), etc.

37 Given the unavailability of monthly GDP data, IPI is used to proxy the output. Though it is argued that IPI represents only a fraction of GDP, it captures the components of the services and the agriculture sector. For example, Bhattacharya et al. (2011) show that there is a strong correlation between GDP and IPI reflecting the overall activity due to sectoral linkages in India. The use of monthly IPI is consistent with prior research, for example Berument and Froyen (2006); Singh and Kalirajan (2007) and Laopodis (2013), among others.

3.2.3 Changes in Monetary Transmission

A sub-sample analysis is used to gauge overall changes in MTM and this is consistent with the approach of Taylor (1995); Juselius (2001); Boivin and Giannoni (2002); Juselius and Toro (2005); Berument and Froyen (2006); Weber et al. (2011), among others. Transition from a managed to a floating exchange rate regime in 2001 is considered as the break-point for sample splits. Moreover, as the CBSL adopted a policy towards increased central bank transparency, another sub-sample is defined around 2008. As per prior studies, for example, Estrella and Fuhrer (2003) and Weber et al. (2011), stability tests for the known break, i.e. Chow test show strong evidence of a break around 2001 and also around 2008.[38] These sub-samples are allowed to overlap in order to ensure the continuity of data series (Iacoviello and Minetti, 2003; Laopodis, 2013).

In this analysis, monthly- unrestricted VAR models are used employing the data for January 1996 to December 2012. The models include endogenous variables for real output (IPI_t), consumer prices (CPI_t), narrow monetary aggregates ($M1_t$), money market rate (MMR_t), and nominal exchange rates (EXR_t) as well as commodity price index ($COMP_t$) and the Federal funds rate ($FEDR_t$) as key exogenous variables. In order to examine the shifts in MTM, impulse responses and variance decompositions are mainly used for sub-samples supported by Granger causality tests.[39]

[38] Chow test statistics for 2001: F-statistic = 69.65; Prob. F (3,174) = 0.0000 and for 2008: F-statistic = 216.39; Prob. F (3,174) = 0.0000.

[39] Granger causality examine whether lagged values of one variable help to predict another variable. For example, if the unemployment rate does not help predict inflation, then the coefficients on the lags of unemployment will all be zero in the reduced-form inflation equation (Stock and Watson, 2001). It is a standard practice in the prior literature to use Granger causality tests for sub-samples to gauge the shifts in the monetary policy impact [for example, Fahrer and Rohling (1992); Stock and Watson (2001); Carpenter and Demiralp (2010)].

4. EMPIRICAL RESULTS AND DISCUSSION

4.1 Preliminary Investigations on Data

Figure C.1 in Appendix C depicts the behaviour of the variables used in quarterly VAR and SVAR models, which are estimated to gauge the effectiveness of MTM and relative importance of different channels. Also, Figure C.2 presents the behaviour of variables used in the monthly sectoral VAR models while Figure C.3 shows the behaviour of variables in monthly VAR models used to examine the shifts in transmission. Since these figures are self-explanatory, a detailed discussion is not provided.

4.2 Model Estimates

4.2.1 Effectiveness of Monetary Transmission

An unrestricted VAR model is estimated to examine the effectiveness of MTM in the emerging country. This model includes real output (GDP_t), consumer prices (CPI_t), a monetary aggregate ($M1_t$) and the short-term interbank money market rate (MMR_t) and the estimation is carried out using quarterly seasonally adjusted data (March 1996 to September 2012).

First, Panel A of Table B.2 (Appendix B) presents the results for unit root tests and cointegration test results. Both ADF and PP tests fail to reject a unit root in the levels of these time series except for interest rates, but unit roots can be rejected in first differences.[40] Hence, unit root tests suggest that interest rate is I(0), whilst all the other variables are I(1). Meanwhile, both Johansen's λ-max and λ-trace tests decisively reject the hypothesis of no cointegration for variables and indicate that there are four cointegrating vectors in the VAR system. Hence, these results confirm the appropriateness of the strategy suggested by Sims et al. (1990) and Lütkepohl

[40] Research into MTM broadly relies on ADF and PP tests [for example, Garretsen and Swank (1998); Morsink and Bayoumi (2001); Berument and Froyen (2006); Charoenseang and Manakit (2007) and Chatziantoniou, Duffy, and Filis (2013)].

and Reimers (1992) to estimate a VAR in levels despite the integrated series.[41] Therefore, estimates of the models are carried out in levels and the results are reported in Table B.3 in Appendix B.[42]

According to Panel A of Table B.4, optimal lag length under different information criteria (Schwarz and Hannan-Quinn criteria) appears to be one quarter. However, one lag is too short to capture underlying dynamics of the system and it could run into the degrees of freedom problem if many lags are included (Disyatat and Vongsinsirikul, 2003). Moreover, in the case of SVAR, it could pose a risk of over-parameterisation. Also, a lag order of one may lead to autocorrelation in the residuals and more lags tend to show greater variability in impulse responses. As such, VAR models are estimated with two lags.[43] This baseline VAR model is tested for stability condition (Panel A of Table B.5), no serial correlation (Panel A of Table B.6) and the absence of heteroskedasticity (Panel A of Table B.7). As suggested by each panel of these tables, the VAR model appears broadly valid.

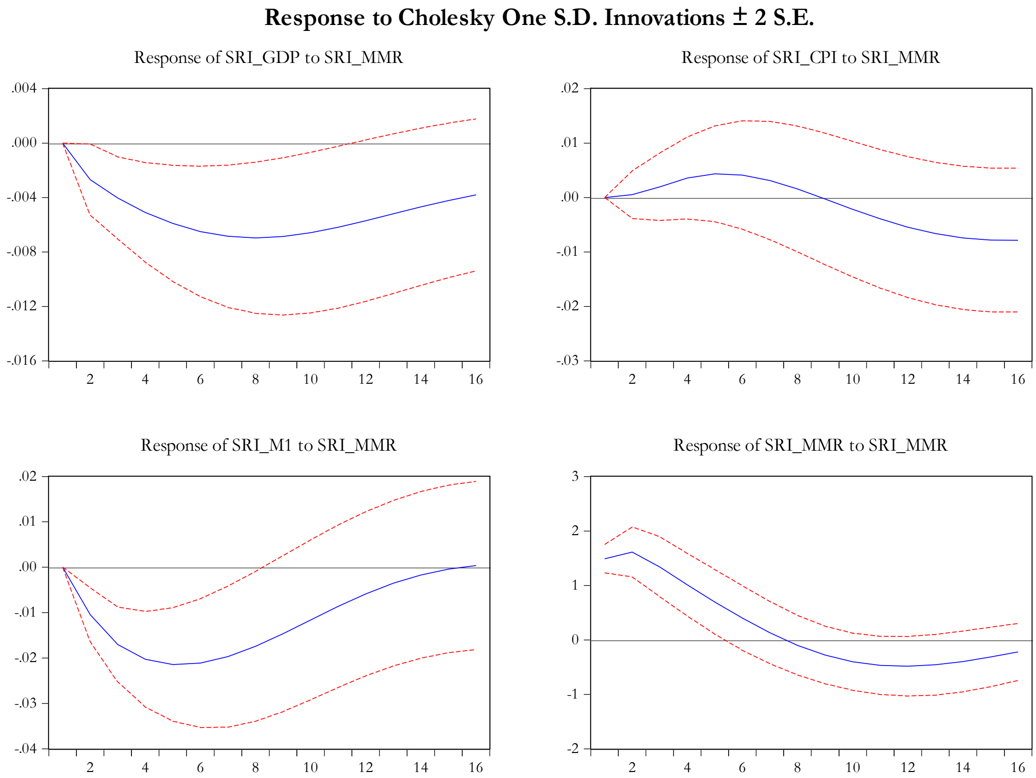
Having established a valid baseline VAR model, next, impulse response functions (IRFs), which trace out the implied dynamic paths of the endogenous variables in the system due to a one-time shock to short-term interest rate, are examined. IRFs are presented in Figure 1. According to IRFs, first, an unexpected rise in short-term interest rates causes a statistically significant decline in real output (SRI_GDP). In particular, an unexpected tightening of monetary policy gives rise to a U-shaped output response that bottoms-out after 6-8 quarters. This immediate response in output to a monetary contraction is compatible with prior research, for example, Leeper et al. (1996) and Berument and Froyen (2006) for US, Disyatat and Vongsinsirikul (2003) for Thailand, Arin and Jolly (2005) for Australia and New Zealand, etc.

41 This approach is appropriate for relatively short sample of this study with 61 quarterly observations (Elbourne and de Haan, 2006).

42 When presenting tables and graphs, 'SRI' is used in front of each variable. For example, SRI_GDP refers to GDP in Sri Lanka while consumer price is presented as 'SRI_CPI'.

43 Generally, research into MTM with quarterly data relies on two lags [for example, Ramaswamy and Slok (1998); Disyatat and Vongsinsirikul (2003) and Chatziantoniou et al. (2013)].

Figure 1: Impulse Response Functions of Baseline VAR Model



Source: Model Estimates

Second, prices (SRI_CPI) initially report a positive reaction to an interest rate innovation, which seems somewhat contradictory. However, this is common in MTM literature and is referred to as 'price puzzle'. For example, Dale and Haldane (1995) for UK, Leeper et al. (1996) for the US, Morsink and Bayoumi (2001) for Japan, Disyatat and Vongsinsirikul (2003) for Thailand, Arin and Jolly (2005) for Australia and New Zealand, etc. report similar positive responses in prices.[44]

Third, following an interest rate shock, monetary aggregates (SRI_M1) react immediately and it is consistent with Leeper et al. (1996); Kim and Roubini (2000); Ito and Sato (2008) and Rafiq and Mallick (2008). Leeper et al. (1996) describe this monetary contraction as a strong liquidity

[44] In the VAR systems, positive orthogonalised shocks to central bank policy rates are related to a protracted rise in the price levels suggesting that some inflation indicator is missing from the VAR (Laopodis, 2013). This is well-established as 'price puzzle', i.e. prices increase following an interest rate tightening (Sims, 1992; Leeper et al., 1996; Kim and Roubini, 2000). Sims (1992) suggests that the price puzzle might be due to the fact that interest rate innovations partly reflect inflationary pressures leading to price increases and also states as the failure to include a rich enough specification of the information available to policymakers.

effect. However, according to Figure 1, the effect on M1 is not persistent as it bottoms out by the fourth quarter and starts dissipating. As noticed by Duguay (1994), this might be suggesting that central bank actions have more direct impact on interest rates (and exchange rates) than monetary aggregates. Meanwhile, interest rate shock (SRI_MMR) is quite persistent, which starts returning to its initial levels after about seven quarters. As expected, the shock results in a considerable initial increase, with short-term money market rate is actually peaking after two quarters. After this peak, there is a steady decline and the response becomes insignificant by the seventh quarter. It continues to decline below its initial level and reaches the lowest point by 11-12 quarters after the shock, and then begins to increase towards the base level.

In order to examine the contributions to fluctuations in a given variable caused by different shocks, variance composition (VD) for each variable at forecast horizons of one through to four years is examined. Complete set of results are presented in Table B.8 in Appendix B and the main focus is placed on real output (SRI_GDP) and prices (SRI_CPI). Accordingly, output (SRI_GDP) indicates that, after four years, interest rate shocks account for about 31 per cent of the fluctuation in output, with own shocks accounting for most of the rest. This is similar to some empirical results for US and other countries indicating that interest rate innovations lead to long run fluctuations in economic activity. However, this needs be validated based on a model that considers economic theory more closely.

Meanwhile, VD for prices (SRI_CPI) indicates that after four years, money account for 41 per cent of the fluctuation in prices while own shocks account for more than 50 per cent of the variance. Interest rate innovations alone account only for about 5 per cent after four years. Taken together, the results of the baseline VAR model confirm that an unanticipated monetary policy shock causes reductions in output and prices albeit to varying lags.

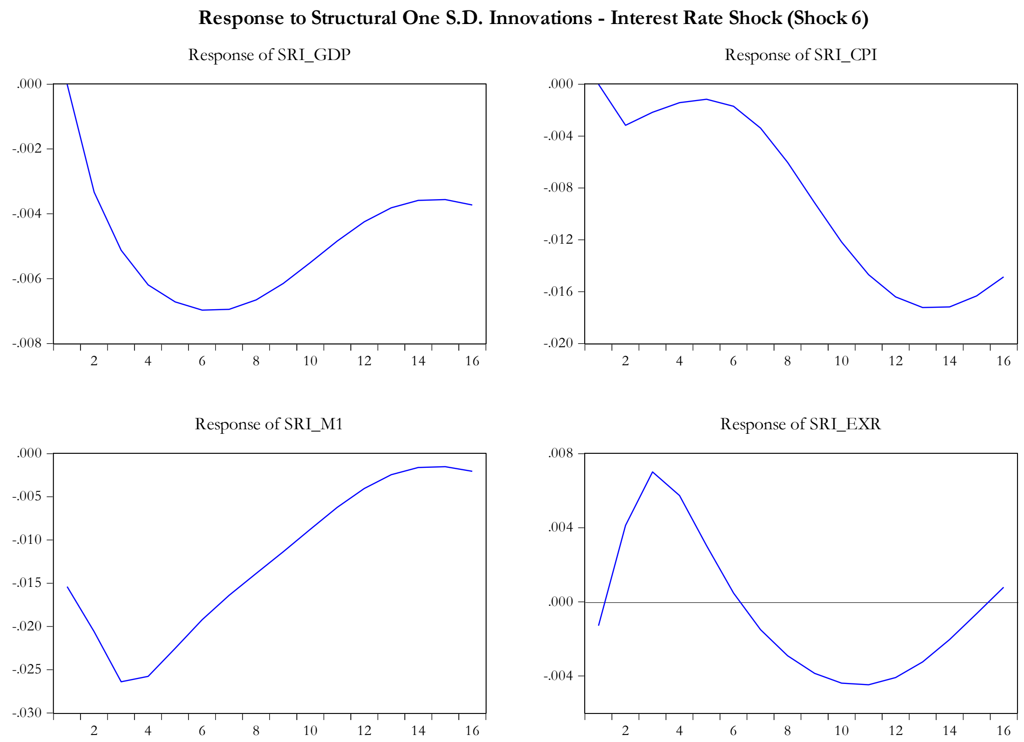
Next, the validity of these results is investigated using the SVAR model estimates. Prior to estimating the SVAR model, an unrestricted VAR model is estimated.[45] Thereafter, based on A_B approach of Amisano and Giannini (1997), the SVAR model is estimated and the detailed estimates are reported in Table B.10. The Likelihood Ratio (LR) test is used to examine over-identification restrictions of the model and as per the LR test, the validity of over-identification restrictions cannot be rejected at the standard significance level. This suggests that there is evidence that identifying restrictions imposed on the system are supported by the Sri Lankan data. The contemporaneous coefficients of this table provide some information regarding the importance of particular variables and the restrictions in the VAR system. However they do not provide information about the dynamic relationships between the variables. To that end, prior literature, for example, Leeper et al. (1996); Kim (2001); Elbourne (2008); Li et al. (2010), among others, relies on dynamic responses to structural shocks in order to identify the effects and to gauge the effectiveness of monetary policy innovations. Accordingly, IRFs (structural innovations) are used to identify monetary policy effects and the key responses are extracted and presented in Figure 2.

Figure 2 suggests that the SVAR model is a satisfactory description of MTM in Sri Lanka and an adequate explanation of theoretical underpinnings. Accordingly, a monetary policy shock represented by a one-standard deviation innovation to interbank money market rate (shock 6 of the SVAR model) has the following effects. First, target variable output (SRI_GDP) responds without much delay. In fact, GDP starts declining steadily within the first year of the shock and reach the maximum between 4-5 quarters. The quick fall in output is quite consistent with prior research such as in Kim and Roubini (2000) for UK and Canada, Dungey and Pagan (2000);

45 As shown in Panel B of Table B.2, data series appear to be integrated of order one except for interest rates. As per the results of the same panel for Johansen cointegration tests, many cointegrating relations are present. Accordingly, the VAR model can be estimated in (log) levels. Similar to the basic VAR model, lag length criterion suggest that one lag would be sufficient (Panel B of Table B.4), however given the reasons discussed above, two lags are selected. The unrestricted VAR results are presented in Table B.9 in Appendix B. Also, Panel B of Tables B.5, B.6 and B.7 confirm that the model is stable, no violation of no serial correlation assumption and no heteroskedatic issue in the residuals.

Berkelmans (2005) and Fraser et al. (2012) for Australia and Li et al. (2010) for US and Canada, etc. Roughly after 6-7 quarters, the impact on output starts reversing and thus declines towards the base.

Figure 2: Structural Innovations (Impulse Response Functions) of SVAR Model



Source: Model Estimates

Following a monetary contraction, despite there remains a marginal reversal during the first year, price levels (SRI_CPI) decreases persistently to reach a maximum of about 1.5 per cent to a 1 per cent increase in interest rates by the twelfth quarter. Broadly similar price responses have been observed in prior literature. For example, Dungey and Pagan (2000) for Australia, Kim and Roubini (2000) for Italy, Elbourne (2008) for UK, Ito and Sato (2008) for Thailand and Philippines observe that despite there are some delays and at a slower pace, prices continue to fall following an interest rate shock. Moreover, these structural innovations highlight that price puzzle becomes weak and the impact of monetary policy on prices is persistent although it starts dissipating in the long run. Overall, the results show that both output and prices respond negatively to an unanticipated rise in interest rates (monetary contraction) and the price reaction is high and persistent. Broadly, the results suggest that monetary policy is effective to affect the target variables of the monetary authority.

In addition to the target variables, impact of monetary policy on other intermediate variables is also noted. First, as in Leeper et al. (1996) for USA and Kim and Roubini (2000) for UK, monetary aggregates (M1) responds to monetary policy shock showing some liquidity effect though it is not persistent supporting the view that central bank actions have no direct and persistent effects on monetary aggregates (Duguay, 1994). Second, exchange rate reports some increase initially. However, the effect is relatively short lived and then turns into negative. This indicates that after an unexpected shock to interest rates, nominal exchange rates quickly depreciate up to 2-3 quarters indicating some evidence for an exchange rate puzzle though it starts to appreciate from about the sixth quarter.[46] These observations also correspond with similar research for small open economies. For example, Fraser et al. (2012) observe that in the presence of a monetary policy shock, exchange rate rises initially, but the effect is relatively short lived. However, this could result due to the violation of uncovered interest parity (UIP) condition.[47] Meanwhile, Kim and Roubini (2000) show that initial increase in the exchange rate is justifiable in a VAR model for an open economy where a non-recursive identifying restriction is imposed on the monetary reaction function. In the context of Indonesia, Afandi (2005) argues that an increase in the domestic interest rate often follows exchange rate depreciation in attempt to sterilise the expansionary effect of the central bank intervention in the foreign exchange market. The same can be observed for Sri Lanka as exchange rates tend to depreciate during the periods of monetary tightening (see the circled areas in Figure C.4 in Appendix C).

Overall, the results of the SVAR model suggest: (i) potency of monetary policy in influencing output and prices as well as other intermediate variables such as money and exchange rates, (ii)

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46 Kim and Roubini (2000) discuss several anomalies such as the 'liquidity', 'price', 'exchange rate' and 'forward discount bias' puzzles related to the effects of monetary policy in closed and open economies.

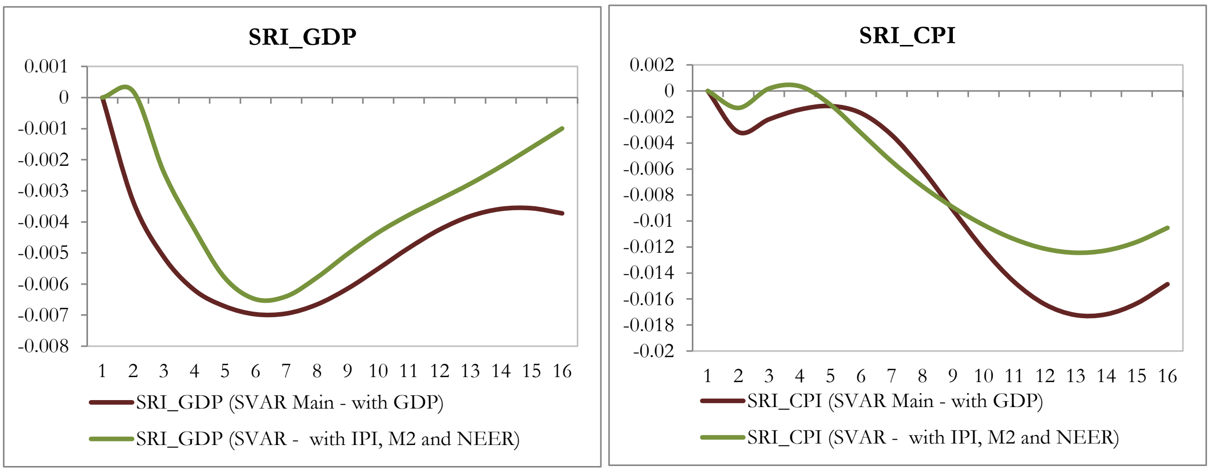
47 UIP predicts that monetary policy shock (contraction) should be accompanied by an initial appreciation of the currency and subsequent long and persistent depreciation. As per Taylor (1995), changes in risk premia on domestic assets or deviations from rational expectations may explain violations of the UIP.

absences of output puzzle (increase in output in response to a contractionary monetary shock), price puzzle (increase in price levels in response to a contractionary monetary shock) and the liquidity puzzle (increase in monetary aggregate in response to a contractionary monetary shock), and (iii) an existence of an exchange rate puzzle (exchange rate depreciates in response to a contractionary monetary shock).

Furthermore, forecast error variance decomposition (VD) for each variable up to four years is calculated to identify the fluctuations in target variables. As per these VD values presented in Table B.11, some key observations are noted for target variables. First, except for the own shock, in the short run (around the second quarter), the highest source of variance in output (SRI_GDP) is coming from the global commodity prices. In the period commencing from about 4-5th quarter, the observable variation in GDP is explained by money shock. However, as observed by Dale and Haldane (1995) and Elbourne (2008), the impact of money is not substantially high as it only accounts for about 13 per cent of the total GDP variation. In the long run, exchange rate shocks dominate the variation in GDP. Second, as in Ito and Sato (2008), in the short run, commodity price shocks appear the main source of fluctuations in prices apart from its own shock. After about four quarters, innovations in both money and exchange rates dominate the price variations. Consistent with some similar studies, for example, Morsink and Bayoumi (2001), money shock (M1) continues to dominate even after the sixteenth quarter confirming that money is the main source of long run movements in prices. Moreover, similar to Ito and Sato (2008) for Indonesia, Korea, Thailand, and the Philippines, it is observed that nominal exchange rate shock is an important determinant in the fluctuations of prices. Although, interest rate shocks remain modest and the maximum impact seems to be about 12 per cent of the total price variation by about ninth quarter, its impact remains broadly persistent over the time horizon. Again, the evidence is consistent with the results of Ito and Sato (2008).

Several alternative models are specified and estimated to ensure the robustness of the results though they are not reported to preserve the space. Amongst them, an alternative SVAR model with different variables such as the industrial production index, a broad money aggregate (M2), nominal effective exchange rates is broadly compatible with the main (7-variable) SVAR model (Figure 3). To that end, it is evident that MTM is Sri Lanka well explained by the standard 7-varibale SVAR model suggested by Kim and Roubini (2000) for advanced countries.

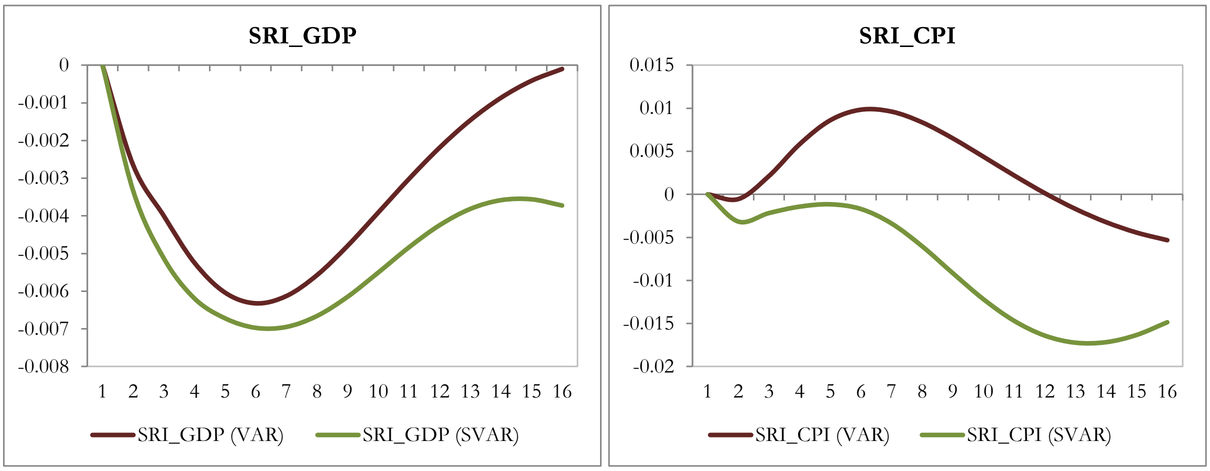
Figure 3: 7-Variable SVAR and Alternative SVAR Models



Source: Model Estimates

Also, the results of the unrestricted VAR and SVAR models are compared (Figure 4). Both VAR and SVAR models explain monetary policy effects in Sri Lanka as output (SRI_GDP) and prices (SRI_CPI) broadly report similar responses for both estimates.

Figure 4: Comparison of 7-Variable VAR and SVAR Models



Source: Model Estimates

4.2.2 Relative Importance of Transmission Channels

In order to gauge the relative importance of different channels of MTM, the baseline VAR model is appended using variables that capture particular channels and two sets of IRFs are presented. The first looks at IRFs of two target variables (output and prices) to monetary policy shocks via the interbank money market rate in the presence of intermediate variables (bank loans, exchange rates and stock prices). The second set of results focuses on the relative importance by comparing the relative strength of different transmission channels. Accordingly, IRFs are calculated with the variable treated as endogenous in the VAR model and with the same is included as an exogenous variable. The relative importance of a particular channel is gauged by the deviation of the response of that blocked channel from the baseline impulse response.

4.2.2.1 Bank Lending Channel

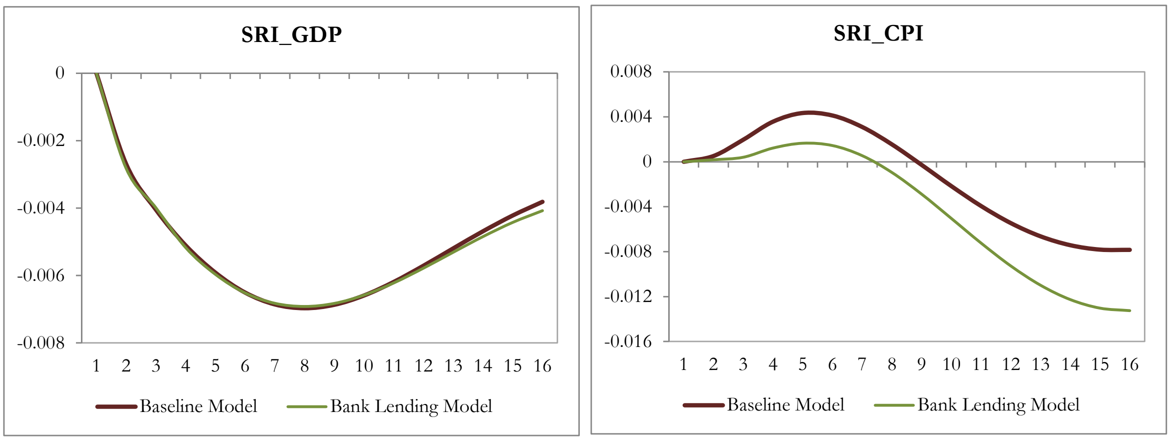
To identify the bank lending channel based on the aggregate data, the baseline VAR model (Eq. 1) is appended using log of real bank credit ($RLOAN_t$). As such, the appended VAR model comprises of GDP_t, CPI_t, $M1_t$, $RLOAN_t$ and MMR_t with the similar specifications and the models are also tested for key diagnostics. As the discussion predominantly relies on IRFs, model estimates are not reported.[48] Figure 5 presents a comparison of IRFs for baseline and bank lending models.

According to Figure 5, IRF for output (SRI_GDP) in the bank lending model is broadly similar to the IRF of the baseline model. However, price responses report somewhat noticeable differences. In fact, the response of prices to interest rate shocks is larger than the baseline model indicating an existence of significant effects of bank lending. Also, price puzzle appears

[48] The results for VAR estimates and diagnostics consume a large extent of space, and hence the results are unreported. In fact, prior literature mainly relies on IRF and VD analyses without reporting model estimates. For the presentation purpose, two standard error bands are not presented with impulse responses.

relatively low and the impact of interest rate innovation on prices is persistent in the bank lending model.

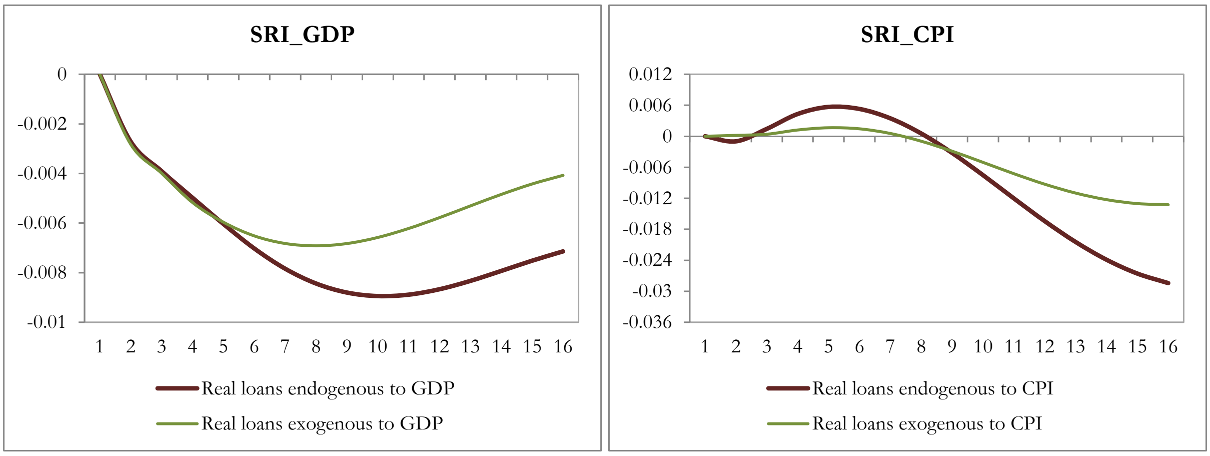
Figure 5: Comparison of Baseline VAR and Bank Lending VAR Models



Source: Model Estimates

To gain clear insight on the relative importance, shut-down method is used. As such, Figure 6 presents IRFs to examine the relative importance of bank lending channel, which are obtained by exogenising (blocking-off) bank loans in the calculation of IRFs.

Figure 6: Comparison of VAR Models with Bank Lending Endogenous and Exogenous



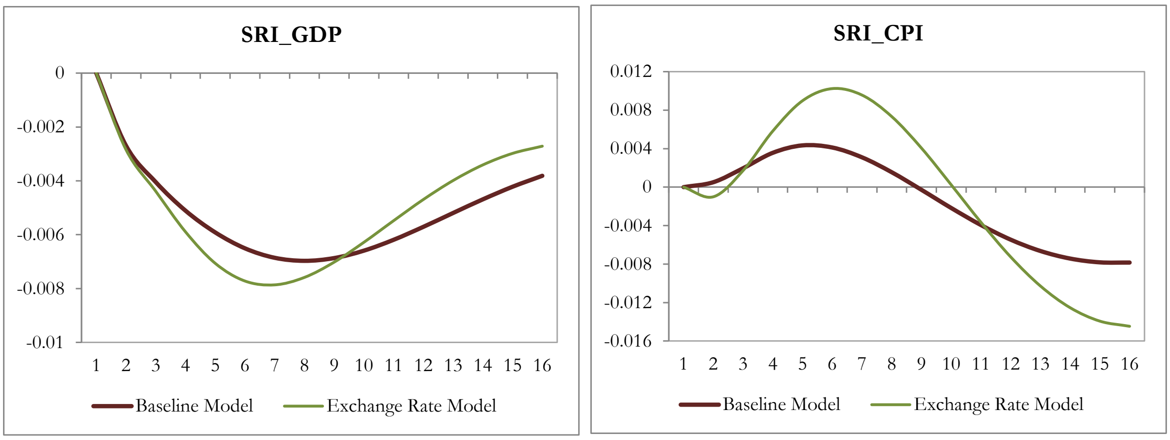
Source: Model Estimates

The left-hand side panel of Figure 6 indicates that output (SRI_GDP) response to an interest rate shock with and without real loans exogenised is broadly similar during first five quarters. However, during the latter part of the horizon, a notable difference is observed. In particular, it is evident that output response is clearly dampened when the role of bank loans is blocked-off. Similarly, the impact of interest rate shock is much pronounced for prices (SRI_CPI) when bank loans are endogenous in comparison to the shock of when bank loans are blocked-off. The existence of a significant bank lending channel in Sri Lanka is justifiable as there is somewhat heavy reliance on bank credit as a source of funding in Sri Lanka, which is a common feature for emerging countries (Cole, Moshirian, and Wu, 2008).[49]

4.2.2.2 Exchange Rate Channel

Exchange rate channel gains much prominence in small – open economies like Sri Lanka.[50] Theoretically, a nominal depreciation of the exchange rate caused by a monetary easing, combined with sticky prices, results in a depreciation of the real exchange rate in the short run and thus higher net exports. To examine the exchange rate channel, the baseline VAR model is augmented with the log of nominal exchange rate (EXR_t) and hence the VAR model comprises of GDP_t, CPI_t, $M1_t$, $MMR_t$and EXR_t.[51] Relevant IRFs are presented in Figures 7 and 8.

Figure 7: Comparison of Baseline and Exchange Rate VAR Models



Source: Model Estimates

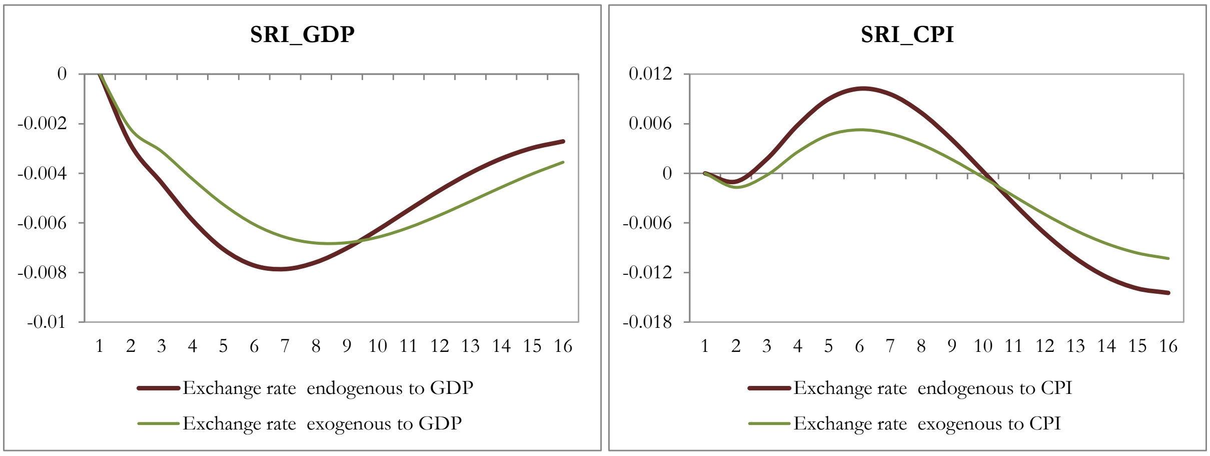
49 For example, according to the data for Sri Lanka, a significant positive correlation (0.94) is observed between GDP and bank loans proving the importance of bank lending.

50 As discussed above, the extent to which monetary policy can affect movements in exchange rates is largely influenced by the theory of uncovered interest rate parity (UIP). This theory suggests that expected future changes in the nominal exchange rate are related to the difference between domestic and foreign interest rates. The UIP enables a monetary authority to influence the exchange rate, which in turn affects relative prices of domestic and foreign goods, thus affecting net exports and output.

51 The use of nominal exchange rate in the VAR system is consistent with prior studies of MTM, for example, Dale and Haldane (1995); Arin and Jolly (2005); Elbourne and de Haan (2006), etc.

According to Figure 7, directions of impulse responses for both baseline and exchange rate VAR models are broadly similar. However, there remain some differences in the magnitude suggesting the existence of an exchange rate channel. Figure 8 further depicts the reaction output and prices to innovations in interest rates with and without the nominal exchange rate exogenised and hence examines the relative importance of exchange rates in MTM. With the exchange rate channel blocked-off, output (SRI_GDP) and price (SRI_CPI) responses appear to be somewhat dampened. For example, trough output is lower in the exogenous model than the case when the exchange rate is endogenous suggesting that endogenous presence of the nominal exchange rate magnifies the effect of a monetary policy shock. Also, evidence suggests that nominal exchange rate is sensitive to the changes in interest rates, which then affect prices through import prices indicating the existence of an exchange rate channel.

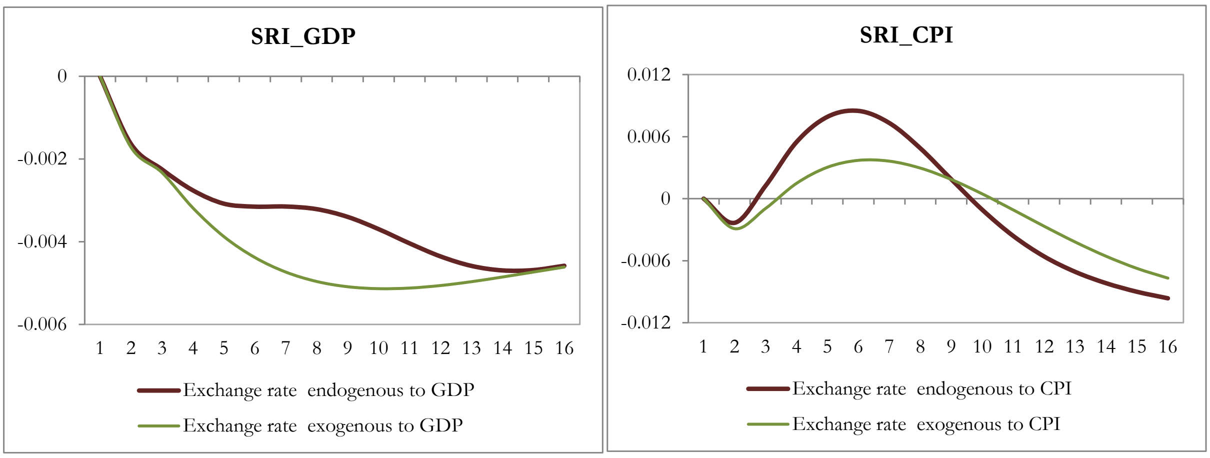
Figure 8: Comparison of VAR Models with Exchange Rate Endogenous and Exogenous



Source: Model Estimates

However, Disyatat and Vongsinsirikul (2003) suggest that evidence related to exchange rate channel should be viewed with some caution as modifications to the exchange rate system and the regime changes could have implications on the non-linear movements in exchange rates. Thereafter, the relevant VAR model is re-estimated excluding the impact of the fixed exchange rate regime (period prior to 2001 with the managed floating system) as reported in Figure 9.

Figure 9: Comparison of VAR Models with Exchange Rate Endogenous and Exogenous (Post-Exchange Rate Liberalisation Period)



Source: Model Estimates

A priori, it can be expected that move towards a more liberalised exchange rate regime will enhance the effects of monetary policy as monetary policy is subordinate to the maintenance of the exchange rate in a fixed regime.[52] Also, it can be expected that move from a fixed to floating exchange rate regime would enhance the importance of the exchange rate channel for the reason that nominal exchange rates are not allowed to fluctuate in the former case. According to Figure 9, in the case of output (SRI_GDP) responses, blocking-off the exchange rate channel does not greatly dampen the impact of monetary policy. In fact, the output response seems much higher when the nominal exchange rate is exogenised. However, in the case of prices (SRI_CPI), blocking-off the exchange rate channel dampens the impact suggesting that exclusion of data for the period prior to 2001 tends to highlight the significance of exchange rate channel. Nevertheless, similar to the case of output, evidence is not sound. As such, exclusion of the data for managed exchange rate period does not increase the significance of the exchange rates in propagating monetary shocks. This may be suggesting the impact of exchange rate management policy of the CBSL. Even though the move towards a free floating exchange rate regime is considered as a significant event, still the exchange rate is largely affected by the central bank

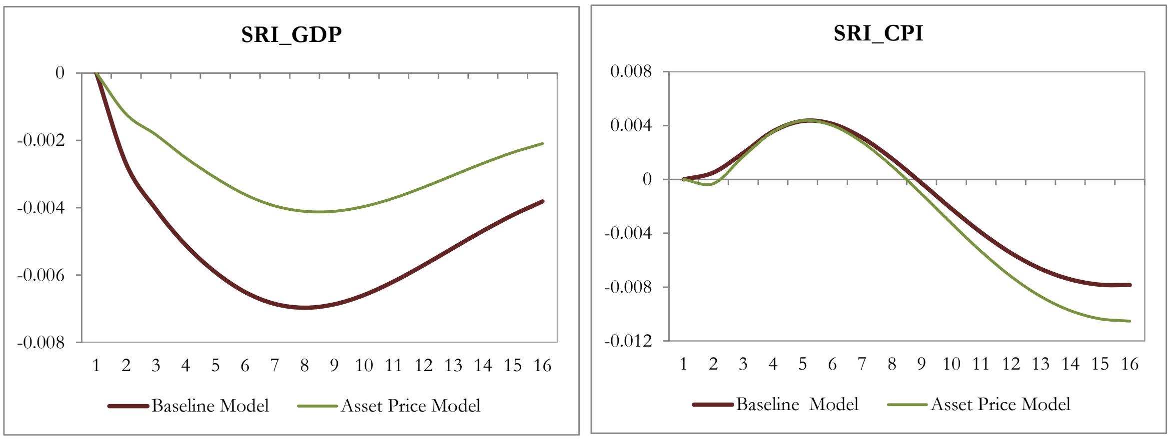
52 For an open economy, operating with a fixed exchange rate regime, there is a little scope for independent conduct of monetary policy and the effective MTM. This is known as 'impossible trinity', which suggests that no country can enjoy a fixed exchange rate, open capital account and independent monetary policy.

intervention and hence it may be argued that the full impact of exchange rate liberalisation is not realised.

4.2.2.3 Asset Price Channel

Propagation of monetary policy shocks via asset prices can be examined using either real estate models (land and/or housing price) models (Elbourne, 2008; Weber et al., 2011) or long-term interest rates (Berument and Froyen, 2006).[53] However, investigations on asset price channel broadly relies on equity market prices (Disyatat and Vongsinsirikul, 2003; Rigobon and Sack, 2004).[54] Accordingly, the baseline VAR model is appended to include log of stock market index (SMI_t) and Figure 10 presents a comparison of IRFs.

Figure 10: Comparison of Baseline and Asset Price Models



Source: Model Estimates

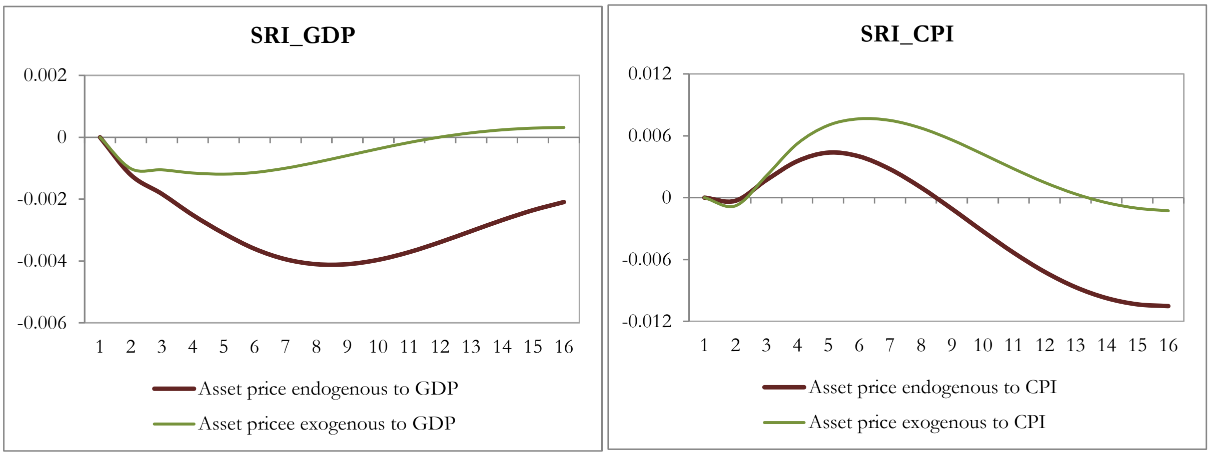
[53] House prices are the most important asset for households in advanced countries. Unlike other assets, housing has a dual role of being both a store of wealth and an important durable consumption good. Shifts in house prices will therefore affect the wealth of homeowners having a bearing on the consumption and investment. As the value of collateral changes, it will also affect the availability of credit for borrowing-constrained agents. Finally, increased house prices can have a stimulating effect on housing construction (due to the Tobin's *q* effect). Hence, a shock to house prices affects real growth and consumer prices.

[54] Monetary easing can boost equity prices by making equity relatively more attractive to bonds (since interest rates fall) as well as improving the earnings outlook for firms as household spending rises. Hence, high equity prices can propagate monetary impulses in two main ways: (i) higher equity prices increases the market value of firms relative to the replacement cost of capital, i.e. Tobin's *q* effect, spurring investment, and (ii) increases in equity prices translate into higher financial wealth of households and therefore higher consumption. In addition, to the extent that higher equity prices raises the net worth of firms and households and also improve their access to funds, the effects captured would partly reflect the 'balance sheet channel' (Disyatat and Vongsinsirikul, 2003).

According to Figure 10, output (SRI_GDP) response to an interest rate shock is lower than the baseline model. However, price responses shown in the right-hand side panel suggest that interest rate response is somewhat higher for prices (SRI_CPI) due to the presence of asset prices. The significance of asset prices in transmitting monetary policy shocks can be clearly examined by exogenising asset prices on the calculation of impulse responses as in Figure 11.

It is observed that exogenising of asset prices significantly dampens the response of output (SRI_GDP) and prices (SRI_CPI) indicating the existence of an asset price channel. In particular, although a significant deviation is not observed between the endogenised and exogenised responses for first 2-3 quarters, a notable difference is observed from about the fourth quarter.

Figure 11: Comparison of VAR Models with Asset Prices Endogenous and Exogenous



Source: Model Estimates

The existence of an asset price channel in Sri Lanka could be due to growing penetration and the developments in stock market activity, although they are not high as in advanced and some emerging countries. For example, stock market capitalisation to GDP has increased from about 8 per cent in 1990 to about 44 per cent by 2011, while the number of publicly listed companies per capita has increased by about 20-30 per cent suggesting some increases in penetration. More interestingly, private credit by deposit money banks to GDP has increased by about 50 per cent during this period whereas stock market capitalisation to GDP has increased more than 300 per cent. Hence, many indicators suggest that firms' reliance on equity financing is becoming significant though bank credit continues to remain dominant source. It is common in emerging countries that asset price channel is gaining much importance in propagating monetary policy shocks (Disyatat and Vongsinsirikul, 2003). On the other hand, existence of an asset price channel in Sri Lanka could be due to the absence of major crises in the Sri Lankan capital markets (Afandi, 2005).

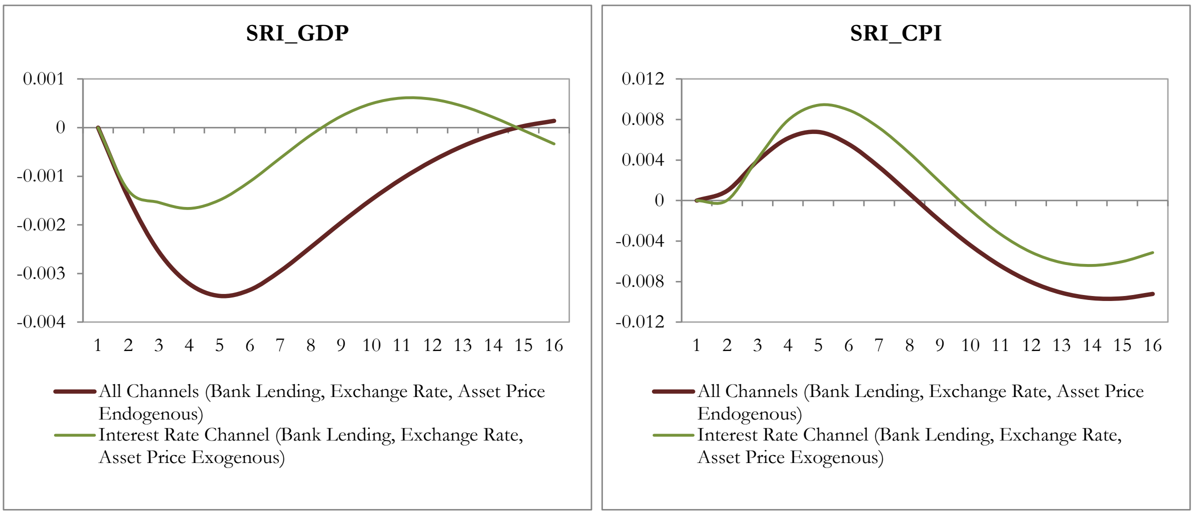
4.2.2.4 Summary Model

A summary VAR model is estimated for two purposes: first, to isolate and identify the workings of traditional direct interest rate channel in the presence of other channels and second, to allow all channels to operate simultaneously while examining their impact on target variables.[55] Accordingly, the baseline unrestricted VAR model is appended to include variables for bank lending, exchange rates and asset prices and hence the relevant model comprises of GDP_t, CPI_t, $M1_t$, $RLOAN_t$, SMI_t, MMR_t and EXR_t (in the given order) as well as the exchange rate dummy (EXR_DUM) to control for the structural changes in relation to exchange rate liberalisation. In order to serve the first purpose, the model is estimated by including bank loans, the nominal exchange rate and the stock market index and then, output and price responses are compared with and without these variables exogenised. Figure 12 presents IRFs for the direct interest rate channel based on these model estimates.

Figure 12 suggests that interest rate channel accounts for about one third of the responses of output (SRI_GDP) and prices (SRI_CPI), particularly after about four quarters. In other words, other three channels (bank lending, exchange rates and asset prices) together explain the remainder of MTM. Next, the same summary VAR model is used with shut-down (blocking-off) method to ascertain the relative importance of each transmission channel. Figure 13 presents the results.

[55] This traditional channel associates a monetary policy change (for example, easing) with the changes (fall) in real interest rates (since prices are sticky in the short run) that causes interest rate sensitive components of aggregate demand (rise), i.e. investment spending to changes (rise) which results on change (rise) in output.

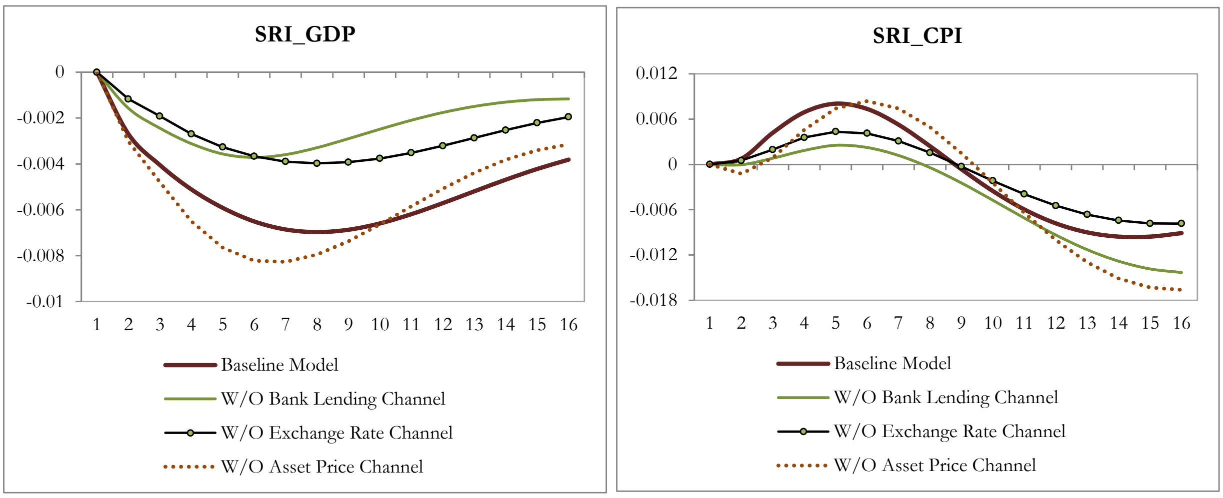
Figure 12: Comparison of Direct Interest Rates and Other Channels



Source: Model Estimates

The left-hand side panel of Figure 13 suggests that output (SRI_GDP) response is significantly dampened when bank lending and exchange rate channels are blocked-off indicating the existence of those two channels. Although the asset price channel is not much significant for some time, after the tenth quarter, it shows some importance indicating that asset price channel has effects in the long run. A similar scenario is observed for responses in prices (SRI_CPI) in the right-hand side panel. In particular, in the long run (after about 9-10 quarters), the impact of exchange rates appears to be playing a significant role.

Figure 13: Comparison of Relative Importance of Different Channels



Source: Model Estimates

Variance decomposition (VD) estimates reported in Table 1 are also used to observe the relative importance of different channels.

Table 1: Variance Decomposition of Output and Prices with Different Channels

This table presents forecast error variance decomposition of output (SRI_GDP) in Panel A and prices (SRI_CPI) in Panel B in response to a short-term interest rate (SRI_MMR) shock.

Panel A: Variance Decomposition of SRI_GDP

Period	S.E.	SRI_GDP	SRI_CPI	SRI_M1	SRI_RLOAN	SRI_SMI	SRI_MMR	SRI_EXR
1	0.010	100.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.014	87.82	0.42	2.41	2.32	5.22	1.81	0.00
3	0.017	76.32	1.32	3.87	4.28	9.71	4.28	0.22
4	0.019	66.72	1.76	4.71	5.35	15.20	5.97	0.28
5	0.022	58.39	1.85	4.99	6.09	21.65	6.80	0.22
6	0.024	51.35	1.75	4.93	6.61	28.25	6.87	0.23
7	0.027	45.59	1.58	4.68	6.92	34.33	6.46	0.44
8	0.029	40.97	1.38	4.36	7.05	39.46	5.86	0.92
9	0.032	37.31	1.20	4.03	7.05	43.52	5.23	1.66
10	0.034	34.45	1.06	3.74	6.96	46.54	4.67	2.58
11	0.036	32.23	0.96	3.50	6.81	48.66	4.22	3.64
12	0.037	30.52	0.89	3.30	6.61	50.06	3.85	4.77
13	0.039	29.21	0.86	3.14	6.40	50.89	3.58	5.93
14	0.040	28.21	0.84	3.03	6.18	51.29	3.36	7.10
15	0.041	27.45	0.83	2.94	5.96	51.38	3.19	8.25
16	0.042	26.87	0.82	2.89	5.75	51.25	3.06	9.37

Panel B: Variance Decomposition of SRI_CPI

Period	S.E.	SRI_GDP	SRI_CPI	SRI_M1	SRI_RLOAN	SRI_SMI	SRI_MMR	SRI_EXR
1	0.0169	1.73	98.27	0.00	0.00	0.00	0.00	0.00
2	0.0249	0.96	90.41	0.79	0.63	5.72	1.00	0.48
3	0.0300	1.29	81.99	0.69	1.05	10.87	2.07	2.06
4	0.0329	1.86	75.65	0.57	0.87	12.41	3.74	4.92
5	0.0349	2.39	70.26	0.51	1.23	12.16	5.43	8.01
6	0.0363	2.91	65.85	0.50	2.30	11.47	6.41	10.55
7	0.0374	3.47	62.30	0.82	3.66	10.86	6.55	12.34
8	0.0383	4.03	59.32	1.80	4.85	10.32	6.24	13.44
9	0.0396	4.55	56.59	3.51	5.62	9.71	6.07	13.95
10	0.0412	4.94	53.90	5.63	5.89	9.06	6.52	14.06
11	0.0433	5.17	51.18	7.67	5.77	8.53	7.69	13.99
12	0.0458	5.27	48.45	9.24	5.41	8.30	9.32	14.01
13	0.0484	5.27	45.71	10.21	4.97	8.45	11.06	14.33
14	0.0512	5.22	42.98	10.62	4.52	8.96	12.60	15.09
15	0.0538	5.14	40.31	10.60	4.13	9.72	13.77	16.33
16	0.0564	5.06	37.73	10.29	3.80	10.58	14.51	18.03

Source: Model Estimates

Numerical values of this table indicate the percentage fluctuation of output (SRI_GDP) and prices (SRI_CPI) due to shocks representing each channel, i.e. higher the fluctuation, higher the relative importance of that channel. For example, in the case of output (SRI_GPD), equity prices (SRI_SMI) explain about 50 per cent of GDP fluctuation at the horizon of 12 quarters. The long run impact of asset prices on GDP is consistent with the observations discussed above.

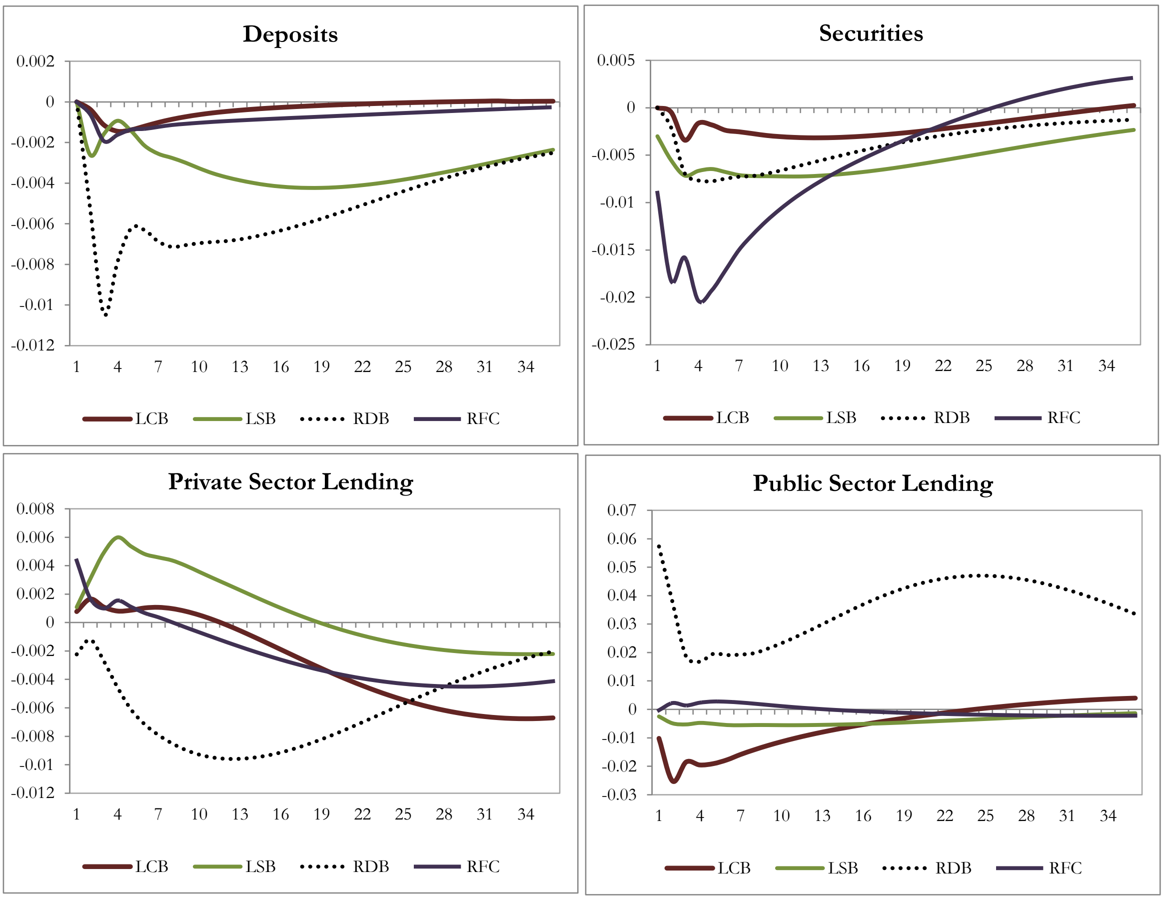
Furthermore, the ranking of the magnitude of such fluctuations provide an indication of the relative importance of particular channels. As such, for output, asset price channel (SRI_SMI) dominates followed by bank lending (SRI_RLOAN) and exchange rates (SRI_EXR), respectively with the least importance of interest rates (SRI_MMR) in the longer horizon. On the other hand, exchange rates (SRI_EXR) and interest rates (SRI_MMR) exhibit more importance in the long run in transmitting monetary policy shocks to prices. Although credit channel (bank lending channel) is operating in Sri Lanka, in the long run, the effect appears to be diluted possibly due to the impact of financial sector changes that have led to increased importance of price based channels. Overall, the results support the existence of four conduits in transmitting monetary policy shocks in the Sri Lankan economy despite their relative strength is different.

4.2.3 Distributional Estimates (Sectoral Effects) of Monetary Policy

As financial institutions play a considerable role in MTM, sectoral estimates (distributional effects) would be important to gauge how different financial institutions react to monetary policy. As discussed above, in order to identify sectoral effects across financial institutions, unrestricted VAR models are estimated using monthly data (January 2004 - December 2012) across different financial institutions and groups. These models include an industrial production index, the consumer price index, the monetary policy indicator (interbank money market rate) and the balance sheet variables (deposits, lending – both private and public sector and securities holding). As estimations provide a large set of estimates, the results for VAR model estimates are unreported. As such, by following the method of Gertler and Gilchrist (1993) and Kakes and Sturm (2002), IRFs are examined. Figure 14 presents the responses of balance sheet variables of different financial institutions to an unanticipated monetary shock simulated over a period of three years (36 months).

The top-left hand side panel shows the impact on deposits. The response of deposits to a monetary policy shock is generally considered as evidence to suggest that monetary works through money (Bernanke and Blinder, 1992).[56] Consistent with the evidence provided in prior research, for example, Bernanke and Blinder (1992); Gertler and Gilchrist (1993) and Kakes and Sturm (2002), it is observed that bank deposits decline with the rise in monetary policy rates. The effect is immediate for all the institutions despite there are different magnitudes.

Figure 14: Reactions of Balance Sheet Variables of Different Financial Institutions



Source: Model Estimates

The lowest impact is reported for LCBs and the highest and much persistent impact is observed for RDBs, which are small institutions compared to LCBs. The behaviour of LCBs is very similar to the behaviour of German banks reported in Kakes and Sturm (2002). Accordingly, despite the immediate fall in deposits, LCBs (as well as RFCs) are not that sensitive to monetary policy shocks. In fact, the correlation between the money market rate and deposits of LCBs as

56 Bernanke and Blinder (1992) provide evidence consistent with the view that monetary policy works at least in part through credit i.e., bank loans as well as through money i.e., bank deposits.

well as correlation between money market rate and deposits of RFCs is about -0.15 and -0.14 per cent, respectively. The same is well confirmed by two panels of Figure C.5 in Appendix C depicting the movements in interest rates and long-term deposits of LCBs and RFCs.[57]

The top right-hand side panel of Figure 14 refers to the behaviour of securities. Similar to the deposits, securities holding of LCBs do not respond significantly implying that they do not need a buffer of liquid assets in order to absorb monetary shocks. At the same time, both LSBs and RDBs respond to monetary policy by drawing down their securities holdings to attenuate the impact of policy shocks. It seems that the impact appears to be substantial for RFCs. However, generally LCBs and LSBs (including RDBs) maintain relatively a high percentage of liquid assets despite the declining trend observed in recent years while RFCs hold a lower percentage of liquid assets.[58] Nevertheless, high response of RFCs indicates that they reduce securities holding to withstand the monetary policy shock. Such response of financial institutions is much common in monetary policy literature. For example, Bernanke and Blinder (1992) show that following tight money, banks tend to sell off their securities and only after security holdings have dwindled, then loans begin to contract substantially. In particular, immediately after a monetary policy shock, the fall in (bank) assets is concentrated almost entirely in securities and therefore loans hardly move. However, shortly thereafter, the security holdings begin gradually to be rebuilt, while loans start falling and when security holdings almost returned to their original value in the long run, and the decline in deposits is reflected in loans. Broadly, a similar situation is observable from Figure 14.

The lower panel of Figure 14 presents the response of both private and public sector lending and it appears that both LCBs and LSBs respond with a considerably long lag. Appendix Figure C.6, which presents the lagged changes in private sector lending and the money market rates, confirms this observation. The continued expansion in lending activity in LSBs for suggests the slower adjustments in interest rates offered by LSBs and continued borrowings by the borrowers

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57 However, these two different institutions serve two different market segments. In particular, RFCs provide intermediary services mainly to less credit worthy and small and medium scale entrepreneurs.

58 For example, by end 2012, liquid asset to total asset ratio for LCBs and LSBs remained at 24 per cent and 45 per cent, respectively while the same ratio for RFCs remained at around 7 per cent.

before realise the full impact of monetary tightening. In LCBs, lending initially shows a positive reaction for LCBs and then starts contracting. Kakes and Sturm (2002) show that such perverse positive response can be largely explained by short-term loans, which is most likely explanation for the Sri Lankan LCB market as well.[59] For example, monetary survey data of the CBSL suggest that about 20-30 per cent of the loan portfolio of LCBs consists of short-term lending and this ratio is more than 30 per cent for some private LCBs. It also suggests the rigidity of changing loan supply in the short run. For example, Bernanke and Blinder (1992) argue that loans are quasi-contractual commitments whose stock is difficult to change quickly.

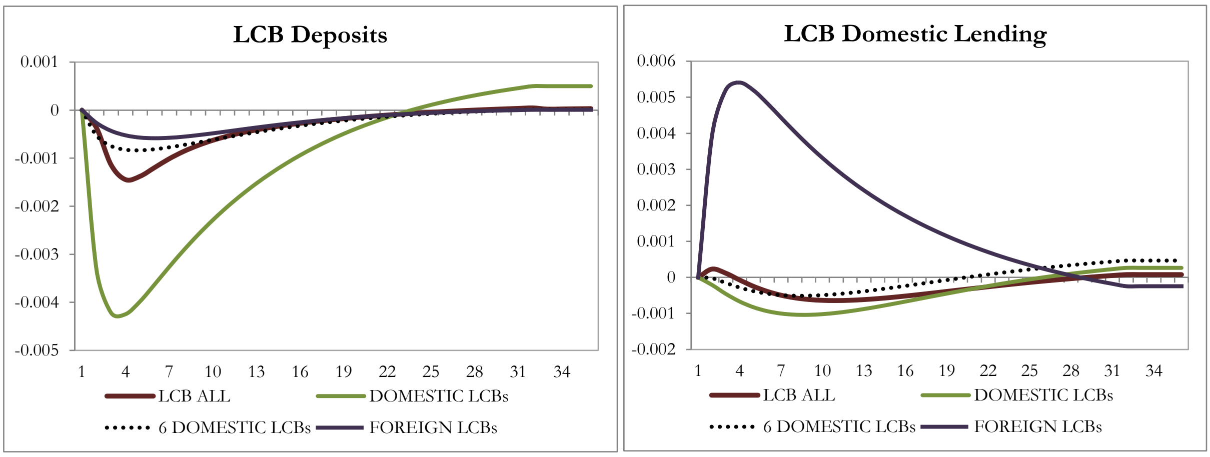
Unlike LCBs and LSBs, both RFCs and RDBs report an immediate response to monetary policy shocks and the impact appears to be more persistent for RFCs. In comparison to LCBs and LSBs, these institutions are relatively small and hence could be seen as more vulnerable to monetary policy shocks and hence, it is difficult to them to neutralise a monetary policy shocks (Kashyap and Stein, 1995; Kakes and Sturm, 2002). Consistent with this, evidence observed for RFCs and RDBs suggest that their response is much higher in reducing lending. Nevertheless, in contrast to private sector lending, a substantial impact is not observed for public sector lending. On the other hand, RFCs and RDBs do not report any negative impact, however their lending to public sector is minimum (out of total assets, public sector lending is less than 1 per cent for RDBs and around 4 per cent for RFCs). More importantly, impact on the public sector loan portfolio of LSBs is marginal and it is also important to note that the share of public sector lending out of total assets in LSBs is high as around 49 per cent whereas it is only about 12 per cent for LCBs. This is not surprising as LSBs remain the major captive source of government borrowing. Taken together, evidence presented in this section supports the hypothesis that there exists a significant heterogeneity in the response of deposits, securities and lending of different financial institutions to an unanticipated change in monetary policy. The impact appears to be

[59] These short-term loans are likely to increase after a monetary contraction as firms may demand more short-term loans to compensate for declining cash flows or shorten the maturity of their debt.

substantial for small financial institutions thus the evidence is in line with the predictions of bank lending channel.

Moreover, as LCBs show some lower responsiveness to monetary policy shocks than other institutions, and being dominant players in the financial system, it is worthwhile to further examine the behaviour of LCBs. As such, IRFs for different LCB groups are estimated as reported in Figure 15.

Figure 15: Impulse Response Functions of Deposits and Lending of LCBs



Source: Model Estimates

The left-hand side panel of Figure 15 shows the impact of monetary shock on deposits. It appears that the impact on deposits of foreign LCBs is marginal. Generally, it is noted that foreign banks own a small fraction of the total asset of a particular banking system although they enjoy high levels of profitability (Claessens, Demirgüç-Kunt, and Huizinga, 2001) and this is much applicable to emerging countries (Sathye, 2003). Similarly, foreign LCBs operating in Sri Lanka only hold about 9 per cent of total banking sector deposits. Their marginal response also suggests that foreign LCBs are linked with a specific category of customers, and hence are not sensitive to interest rate movements.[60] Moreover, somewhat low response is observed for major 6 domestic LCBs. Meanwhile, relatively high response is observed for all domestic LCBs. This

[60] Buch and Golder (2001) show that foreign banks hardly penetrate the markets traditionally serviced by domestic banks because of the competitive disadvantages face in assessing credit risks and raising deposits from the domestic clients.

indicates that remaining banks in the domestic LCBs category, i.e. small banks (around 18 LCBs owe 20 per cent of total LCB sector assets), are affected by the monetary contraction.

The right-hand side panel depicts the impact on domestic lending. Again, a lower response is observed for lending activity of foreign LCBs that only account for 7 per cent of total private sector lending. It is worthwhile to note that a majority of foreign LCBs do not entirely rely on domestic sources and therefore they are not largely affected by domestic monetary contractions as they can draw on their parent institution for additional funding and capital. Moreover, similar to the case of deposits, all domestic LCBs exhibit a higher response whereas major domestic (6) LCBs report relatively a lower impact indicating that small banks are more vulnerable to the monetary policy shocks.

4.2.4 Shifts in Monetary Transmission Process

This section offers an assessment of whether financial sector dynamics observed over the last two decades have been fundamental to weaken or strengthen the effectiveness of overall MTM in Sri Lanka. This analysis is based on Granger Causality tests, impulse responses and variance decomposition analyses for sub-samples.

First, being guided by Fahrer and Rohling (1992) and Carpenter and Demiralp (2010), Granger causality tests are conducted for different sub-samples and these results are presented in Table B12 in Appendix B. The shaded cells in the table indicate the significant values (at 10 per cent or better) rejecting the stated hypothesis and hence indicating the ability of one variable in predicting the other. For example, for the null hypothesis 'SRI_M1 does not Granger cause SRI_CPI', probability value is 0.0052 for the sub-sample 2008-2012. This confirms that the null hypothesis is rejected indicating that the narrow money aggregate predicts (causes) the movements in consumer prices. The results indicate that short-term interest rates (MMR) do not Granger-cause these target variables during the pre-break periods hence interest rates do not appear predicting the movements in output (SRI_GDP) and prices (SRI_CPI). In contrast, the results for post-break sub-samples clearly indicate that MMR Granger-cause these target variables, i.e. short-term interest rates predict the movements in output and prices. Accordingly, it is feasible to conclude that MTM has undergone changes over time.

Next, unrestricted VAR models are estimated to investigate the shifts in MTM. Based on previous studies, shifts in MTM are examined using IRFs and forecast error variance decompositions (VD) over different sub-samples.[61] Accordingly, Figure 16 presents IRFs for target variables over different samples and the comparison closely follows the approach of Fahrer and Rohling (1992); Iacoviello and Minetti (2003) and Weber et al. (2011). Separate and combined IRFs for both sub-periods suggest a reasonable reaction of endogenous target variables to an unanticipated restrictive monetary policy shock. These IRFs clearly demonstrate that monetary tightening is instrumental to affect real output (SRI_IPI) as a significant contraction is observed. Importantly, the impact of monetary tightening appears more sustained in the post-break period. This observation is consistent with the evidence reported in some prior studies, for instance, Iacoviello and Minetti (2003) for the UK, Finland and Sweden.

The separate and combined IRFs for price (SRI_CPI) reactions to a monetary shock suggest that price reaction is significant despite there are certain lags. Though some evidence on price puzzle is observed for both periods, during the post-break period, price puzzle appears low. Also, during the post-break period, monetary policy impact on prices appears more pronounced and persistent. These observations are well in line with some prior research, for example, Weber et al. (2011) for Euro area countries. Hence, comparison of IRFs for both periods is suggestive for a shift in MTM in Sri Lanka and both output and prices appear to be reacting faster and stronger to a monetary policy shock during the post-break period.[62]

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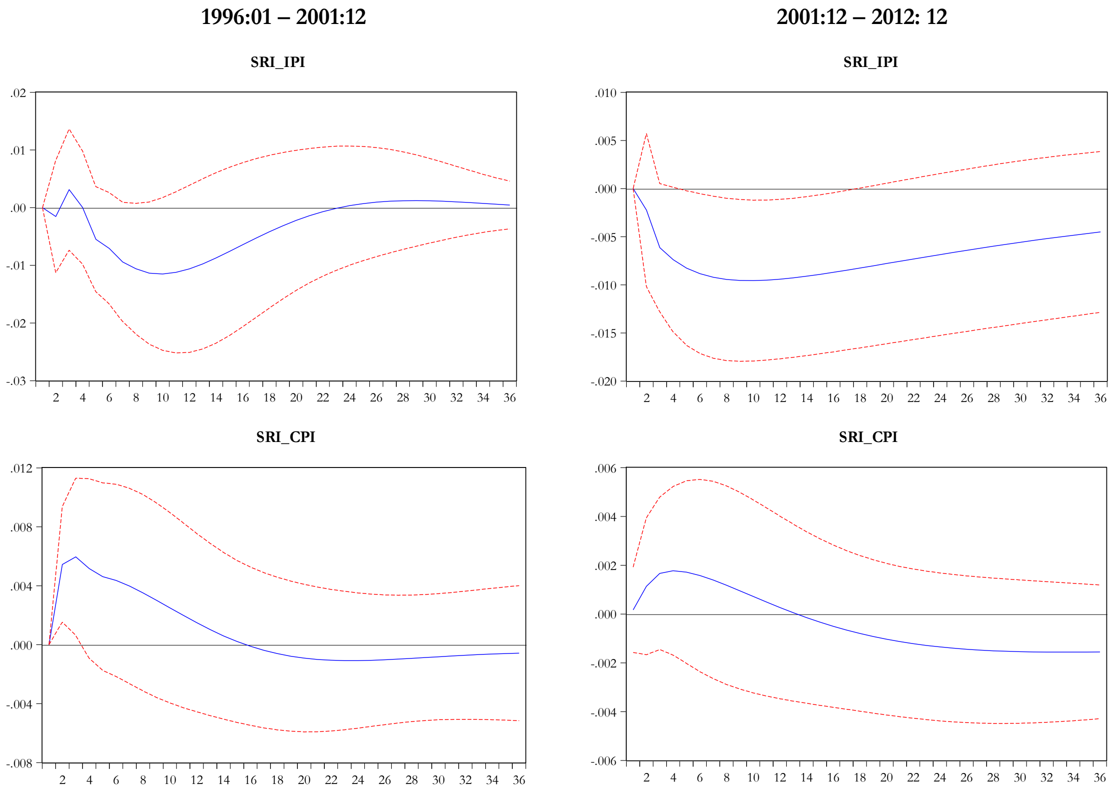
[61] For example, Fahrer and Rohling (1992); Boivin and Giannoni (2002); Iacoviello and Minetti (2003); Berument and Froyen (2006); Weber et al. (2011) and Laopodis (2013).

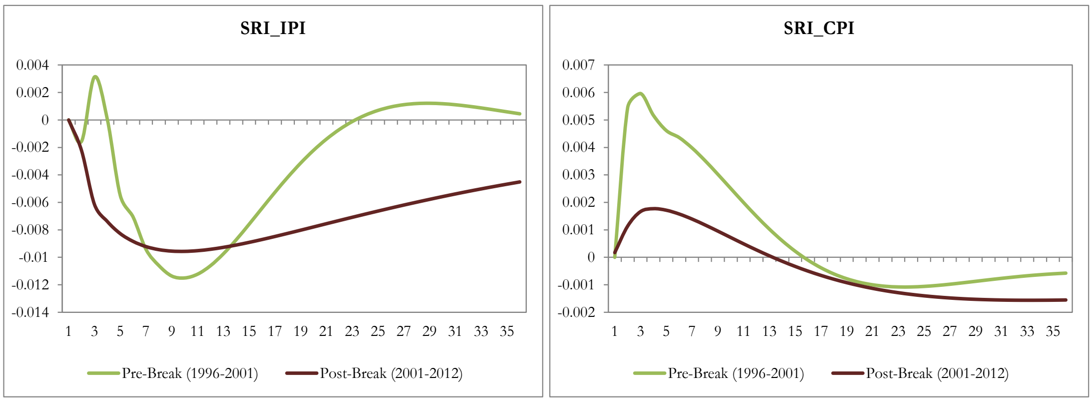
[62] Considering another break around 2008, an additional sub-sample is defined for the period 2008-2012. This break coincides with recent changes to monetary policy practice of the CBSL, particularly with regard to increased transparency and the reliance on interest rate based policies. Figure C.7 presents IRFs for sub-samples confirming the same evidence observed in Figure 16. In fact, the response of output and prices appear much stronger for the sub-sample 2008 – 2012.

Figure 16: Impulse Response Functions during Pre- and Post-Break Periods

Panel A: Separate IRFs



Panel B: Combined IRFs



Source: Model Estimates

In order to gain better insights on the changes in MTM, Berument and Froyen (2006) suggest comparing instantaneous and maximum impact of IRFs, which is broadly similar to the method of Ito and Sato (2008) comparing the values of IRFs over different time horizons. As guided by these studies, Table 2 presents a similar comparison of IRF values.

Table 2: Responses of Output and Prices to a 1 Per cent Innovation of the Money Market Rate

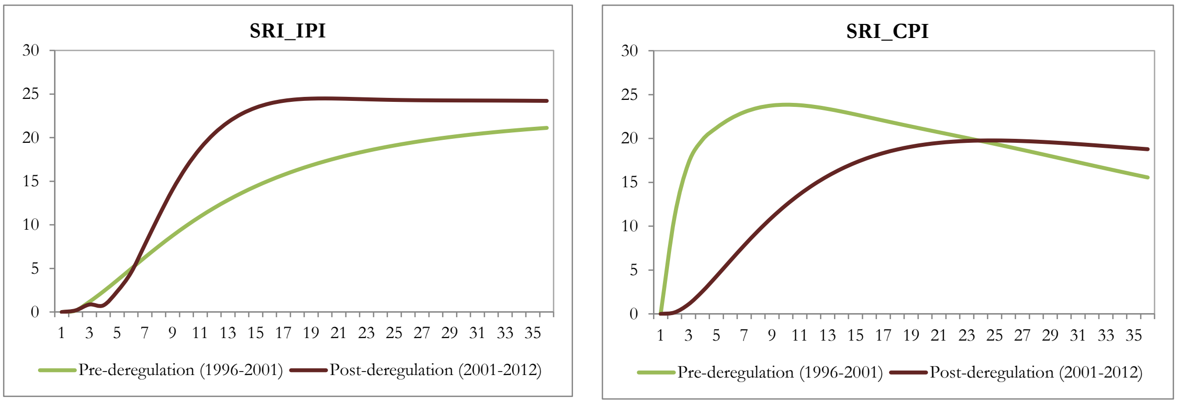
This table presents contemporaneous and maximum response of output (IPI) and prices (CPI) in response to a short-term interest rate (MMR) shock. Instantaneous response is the impact during the same period. Maximum response is the largest response in the expected direction, i.e. contraction in IPI and CPI as the movement in the money market rate following the innovation.

	Full Sample	Sub-samples			
	1996-2012	1996-2001	2001-2012	2001-2008	2008-2012
Panel A: Output (IPI)					
Instantaneous	0.00	0.00	0.00	-0.06	0.00
Maximum	-0.95	-1.15	-0.96	-0.45	-1.46
Panel B: Price (CPI)					
Instantaneous	0.02	0.03	0.02	0.00	0.00
Maximum	-0.23	-0.11	-0.16	-0.30	-0.53

From Table 2, it can be seen that instantaneous response is not substantially higher for both output and prices. However, the positive instantaneous response for prices has somewhat declined across sub-samples indicating some weakening of the price puzzle. The maximum response provides a clearer picture of the changes in MTM. Despite the change is not consistent, maximum response for output suggests that the impact of monetary policy has changed across sub-samples. Especially, price reactions show that the impact of monetary policy shock is higher during post-break periods. For example, the maximum response is about 0.53 per cent to 1 per cent increase in money market rate during the most recent sub-sample of 2008-2012 in comparison to 11 per cent increase for the period 1996-2001.

Finally, in order to provide further evidence about changes in MTM and hence to confirm the robustness of the above stated observations, variance decompositions (VD) are used. Figure 17 presents per cent of the k-step-ahead forecast error variance of output (IPI) and prices (CPI) due to monetary shocks (innovations to MMR) for pre- and post-break periods. The evidence seen in Figure 17 is clearly suggestive for shifts in MTM. In particular, the share of the variation in output and prices for a monetary policy shock is larger at majority of the horizons in the post-break periods.

Figure 17: Variance Decomposition of Output and Prices for Interest Rates Shock (Pre- and Post-Break Periods)



Source: Model Estimates

Altogether, the results broadly suggest that due to economic and financial sector dynamics, monetary policy shocks presented by interest rate shocks have more powerful effects on target variables of the monetary authority with the prices featuring the clearest and most supportive results.

5. CONCLUSIONS AND POLICY IMPLICATIONS

In this study, a comprehensive assessment is carried out on MTM within an emerging country that has experienced significant economic and financial sector changes. Based on the empirical estimates, the following messages are reported. First, both baseline unrestricted VAR and structural VAR models confirm the significance of monetary policy to affect target variables of the monetary authority, i.e. output and prices. In fact, estimated impulse response functions and the variance decomposition analyses provide robust and consistent results with regard to the impact of (restrictive) monetary policy shocks on (declining) output and prices. Empirical investigations based on the shut-down methodology confirm the impact on target variables through intermediate variables such as bank lending, exchange rates as well as asset prices. On the whole, the results show that interest rate channel is the most important transmission channel in Sri Lanka while the other channels are in existence and effective. Second, empirical predictions are consistent with the views of bank lending channel, which states that small financial institutions find it more difficult to shield their loan portfolio than relatively large institutions against a monetary policy shocks. Finally, the impact of economic and financial sector dynamics on the link between monetary policy and target variables was examined and the results suggest that transformations in the economic and financial environment play a role to increase the policy sensitivity of output and prices.

As such, this study draws some important policy implications. First, the results provide greater assurance on the potency of monetary policy in an emerging country context. In particular, although monetary policy in a regulated and opaque regime is considered effective via direct controls and instruments, it seems that market based-indirect approach of monetary policy, i.e. reliance on interest rate instruments, appears more effective in a liberalised and open economic and financial environment. Furthermore, existence of an asset price channel provides evidence on the impact of capital market developments, especially stock markets, as they convey useful information about monetary policy conditions. Moreover, as the exchange rate channel appears influential particularly on the price dynamics, it may be argued that exchange rates may not be used to have an effective impact on output. Second, sectoral estimates suggest that monetary policy poses differential impacts across financial institutions pointing to some heterogeneity in the transmission process. Since heterogeneous impact of monetary policy has detrimental effects on the success of monetary policy, it points to the importance of considering the differences in financial institutions when setting an appropriate monetary policy stance. In that sense, some direct policies such as moral suasion may be deemed as appropriate to pursue financial institutions to react to monetary policy. This is because, if the effects of monetary policy on the real economy needs to be enhanced, the entire financial system and its components needs be affected by monetary policy shocks (Fahrer and Rohling, 1992).[63] Third, shifts in overall transmission due to economic and financial sector changes further suggest the importance of adopting relevant policies and introducing financial sector reforms. In particular, as suggested by Iacoviello and Minetti (2003); Weber et al. (2011) further deregulation of the financial sector while focusing on the convergence of regulatory framework would allow easy and more effective conduct of monetary policy.

From the perspective of the CBSL, implications are well in line with its move towards a monetary policy framework focusing on indirect instruments to conduct monetary policy and the adoption of a dual method (economic and monetary analyses) within a multi-pronged approach that relies predominantly on interest rates (Central Bank of Sri Lanka, 2005; 2011). As the reaction of nominal variables (prices to monetary policy) has substantially enhanced during the post-deregulation periods, i.e. prices are more responsive to interest rate shocks, it provides a strong justification for moving towards an inflation targeting framework, which is considered as an appropriate monetary policy framework for emerging countries.[64] However, it needs to be validated by specific research into inflation targeting in Sri Lanka (Perera, 2008).

Finally, this study however has a number of caveats leaving some space for future research. First, this study mainly relies on VAR and SVAR models, which are the most popular methods to examine MTM. In particular, this study closely follows the approach of Kim and Roubini (2000) with some modifications to examine emerging country monetary transmission where the application of SVAR is very limited. Being guided by this initial attempt, identification of the effects of unanticipated monetary policy shock on target variables as well as the interaction of intermediate variables within the SVAR frameworks remain a promising area for future research

63 Kakes and Sturm (2002) however suggest that the impact of heterogeneity should not be overstated. For example, large banks lending activity is mainly concentrated on manufacturing or some prime sectors which are sensitive to cyclical effects and the borrower heterogeneity.

64 Mishkin (2000) argues that although inflation targeting is not a panacea, it can be a highly useful for monetary policy in a number of emerging countries.

into emerging country MTM.[65] Also, due to the complexity between economic variables as well as the limitations of SVAR models for emerging countries, it is worthwhile to focus on alternative modelling approaches such factor-augmented vector auto regressions (FAVAR). However, such approaches demand a data rich environment.

To that end, another noteworthy issue is the data limitation. In particular, although models based on monthly data provide consistent results, it is observed that MTM in Sri Lanka (as well as for emerging countries) is appropriately modelled on quarterly data. However, the use of quarterly data is severely constrained and also modelling of MTM for pre-1990s is limited by the unavailability of comparable and reliable quarterly datasets. The use of monthly data is also constrained due to incompatible base periods and due to the high volatility associated with monthly data. In particular, it was felt vital that sectoral estimates and the shifts in MTM need to be estimated using quarterly data, but the attempt was inhibited by the unavailability of a long series of disaggregated data and it appears a common problem for many emerging countries. This calls for building an adequately lengthy quarterly database and also comparable databases for emerging countries to provide more plausible estimates. Moreover, although the sectoral analysis appears a valuable contribution in the context of emerging counties, more caution needs to be exercised when making conclusions based on such sectoral results. For example, Kakes and Sturm (2002) too emphasise that sectoral analysis only focuses on the 'first stage' of the particular transmission channel. To that end, further disaggregation is required to perform more precise tests of the behaviour of financial institutions. It was attempted to fulfil this need at least by disaggregating commercial bank data and to provide some sensible estimates. At the same time, it would be important to consider inter-institutional relationships with regard to lending behaviour and also different regulatory arrangements when modelling MTM for an emerging country.

[65] As argued by Kim and Roubini (2000), it would be important to append the reference model depending on the country-policy specific factors.

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APPENDIX A

Reduced form VAR models and the Cholesky decomposition are widely used to identify MTM. However, they do not deeply consider economic theory. The Cholesky decomposition presumes that a shock to a variable does not contemporaneously affect the variables that precede it in the ordering, but does affect them with a lag. Accordingly, the VAR model is sensitive to the ordering of variables. In order to overcome this deficiency, a model-based identification strategy to estimate the impact of the shocks is required. Accordingly, structural VAR (SVAR) models are used to identify a monetary shock, which is based on the economic theory. That is, generally, restrictions imposed on the contemporaneous correlations in the SVAR model to identify the structural shocks reflect the operating procedures of the central bank and basic macroeconomic principles (Li et al., 2010). To that end, SVAR provides a method address the concerns of monetary authorities by imposing enough restrictions to identify an exogenous policy shock, without having to specify a complete or large-scale models of the economy (Boivin and Giannoni, 2006). It explicitly recognises the intertwined and complex relationships between a policy variables and other key macroeconomic variables (Leeper et al., 1996). The structural representation of the VAR model of order p takes the following general form:

$$A_0 y_t = c_0 + \sum_{i=1}^{p} A_i y_{t-i} + \varepsilon_t \tag{A.1}$$

where y_t is a 7×1 vector of endogenous variables, i.e. $y_t = (COMP_t, FEDR_t, GDP_t, CPI_t, M1_t, MMR_t, EXR_t)$, A_0 represents the 7×7 contemporaneous matrix, A_i are 7×7 autoregressive coefficient matrices, ε_t is a 7×1 vector of structural disturbances, assumed to have zero covariance.[66] The covariance matrix of the structural disturbances takes the

[66] There is no agreement about number of variables required in the SVAR setting to represent an economy. For example, Dungey and Pagan (2000) use eleven variables while Fraser et al. (2012) use six variables. Meanwhile, seven variable VARs as suggested in Kim and Roubini (2000) are widely used. As guided by Kim and Roubini (2000), this study employs 7 variables: a commodity price index ($COMP_t$), the US federal funds

following form $E[\varepsilon_t\varepsilon_t] = D \equiv [\sigma_1^2\sigma_2^2\sigma_3^2\sigma_4^2\sigma_5^2\sigma_6^2\sigma_7^2] \times I$. In order to get the reduced form of the structural model [Eq. (A.1)], both sides are multiplied with A_0^{-1} to get the following:

$$y_t = a_0 + \sum_{i=1}^{p} B_i y_{t-i} + e_t \qquad \text{(A.2)}$$

where, $a_0 = A_0^{-1}c_0$, $B_i = A_0^{-1}A_i$ and $e_t = A_0^{-1}\varepsilon_t$, i.e. $\varepsilon_t = A_0 e_t$. The reduced form errors e_t are linear combinations of the structural errors ε_t, with a covariance matrix of the form $E[e_t e_t'] = A_0^{-1}DA_0^{-1\prime}$. The structural disturbances can be derived by imposing appropriate restrictions on A_0.[67] Accordingly, the short-run restrictions applied in this model are the following:

$$\begin{bmatrix} \varepsilon_{comps} \\ \varepsilon_{fedrs} \\ \varepsilon_{gdps} \\ \varepsilon_{cpis} \\ \varepsilon_{m1s} \\ \varepsilon_{mmrs} \\ \varepsilon_{exrs} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & 0 & 1 & 0 & 0 & 0 & 0 \\ a_{41} & 0 & a_{43} & 1 & 0 & 0 & 0 \\ 0 & 0 & a_{53} & a_{54} & 1 & a_{56} & 0 \\ a_{61} & 0 & 0 & 0 & a_{65} & 1 & a_{67} \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & 1 \end{bmatrix} \times \begin{bmatrix} e_{comp} \\ e_{fedr} \\ e_{gdp} \\ e_{cpi} \\ e_{m1} \\ e_{mmr} \\ e_{exr} \end{bmatrix} \qquad \text{(A.3)}$$

where, $comps$ is world commodity price shocks, $fedrs$ is Federal funds rate shock, $gdps$ is real output (income) shock, $cpis$ is price shock, $m1s$ is money supply shock, $mmrs$ is interest rate (monetary policy shock) and $exrs$ is exchange rate shock and all are structural disturbances. e_{comp} to e_{exr} are the residuals in the reduced form equations, which represent the unexpected movements (given information in the system) of each variable. The analysis concentrates on the interaction between monetary policy and output and price developments identified based on the structural shocks consists of several blocks as explained below:[68]

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rate ($FEDR_t$), real output (GDP_t), the consumer price index (CPI_t), the money stock ($M1_t$), the short-term domestic interest rate (MMR_t) and the nominal exchange rate with respect to the US dollar (EXR_t). All the variables are seasonally adjusted and specified in logs except for interest rates.

67 Method suggested by Amisano and Giannini (1997), often called the A-B model is employed to identify the SVAR. The innovations can be represented as $Au_t = Be_t$, where u_t represents the structural error and e_t is the reduced form shocks. This strategy imposes enough restrictions on both matrices.

68 In general, there are three assumptions on imposing restrictions: First, being a small open economy, the external sector does not have a contemporaneous effect by the domestic variables. Second is the controls imposed on the timing of the information. If the data are not available contemporaneously, it is possible to

(i) Exogenous Block:

This represents the shocks originating in the external world, and is given by world commodity prices ($COMP_t$) and the Federal funds rate ($FEDR_t$), i.e. first two rows of Eq. (F.3). Commodity prices help to avoid the price puzzle and hence to avoid priori any possible problems of misspecification (Sims, 1992).[69] As emerging countries heavily rely on imported commodities and they are vulnerable to commodity prices and by following Boivin and Giannoni (2006); Elbourne and de Haan (2006) and Fraser et al. (2012)], global commodity price of the IMF ($COMP_t$) is used instead of oil prices to isolate negative external supply shocks, i.e. imported inflation (Chatziantoniou et al., 2013). $COMP_t$ is ordered first because commodity prices are unlikely affected contemporaneously by any other shocks except the commodity price (supply) shocks per se, while commodity price shocks likely affect all variables in the system contemporaneously. Since the monetary authority follows a feedback rule by reacting to information in the economy when setting its monetary policy, the model is controlled for the systematic component of the policy rule to identify the exogenous monetary policy changes (Kim and Roubini, 2000). The Federal funds rate ($FEDR_t$) is used to isolate the exogenous monetary policy changes, i.e. to control for the component of domestic monetary policy that is a reaction to foreign monetary policy shocks.

The identifying restriction in the equations for commodity prices and for Federal funds rates [Rows 1 and 2 in Eq. (A.3)] considers these variables as being contemporaneously exogenous to any variable in the domestic economy. As per Kim and Roubini (2000), the commodity price is included in the Federal funds rate equation to consider the idea that the US Fed will tighten its monetary policy in response to commodity prices related to inflationary shocks. In other words, while commodity price is treated as fully exogenous, the

impose zero restrictions. Third, assumption is imposing behavioural assumptions. Accordingly, it is assumed several restrictions on domestic and foreign variables.

69 Some prior research, for example, Kim and Roubini (2000) use the world oil price as the major proxy for these exogenous shocks. Replacing the oil price with a broader commodity price index allows for a wider range of supply shocks and the negative inflationary shocks (Elbourne and de Haan, 2006).

Federal funds rate depends contemporaneously on the commodity price variable reflecting that this variable plays a proxy for measures of anticipated inflation (Afandi, 2005).

(ii) Goods Market Equilibrium:

Real output (GDP_t) and prices (CPI_t) in Row 3 and 4 represent the goods market equilibrium. The large number of zero restrictions in these rows is consistent with a model exhibiting nominal rigidities (Elbourne and de Haan, 2006). In other words, as per Kim and Roubini (2000), it is assumed that the block of equations determining the output and prices from which all the other variables are excluded with the exception of commodity prices. Hence, money, interest rates or exchange rates do not affect the real activity and prices contemporaneously.[70] However, commodity prices do enter this block based on a cost mark-up rule for prices, which is common in the theoretical literature (Elbourne and de Haan, 2006). Furthermore, price levels responds contemporaneously to the real activity as the equation for prices include the impact of GDP on CPI. Hence, inflation reacts contemporaneously only to an income shock and a global shock, i.e. imported inflation (Kim and Roubini, 2000).

(iii) Money Market Equilibrium:

Money supply ($M1_t$) and the money market rate (MMR_t) in Row 5 and 6, respectively, represent the money market equilibrium. The money demand equation in Row 5 indicates that the demand for real money balances depends on real income, prices and interest rate. This indicates that money is responsive to income, price and monetary policy shocks (Chatziantoniou et al., 2013). The money market rate, i.e. equation in Row 6 represents the reaction function of the monetary authority, which depends on global commodity prices, monetary aggregates and the nominal exchange rate (Kim and Roubini, 2000). By following

[70] Kim and Roubini (2000) assumes that real activity responds to prices and financial signals only with a lag.

Sims and Zha (1998), it is assumed that monetary policy does not respond contemporaneously to output or prices since relevant data are not available contemporaneously. At the same time, the reaction function of the monetary authority does not depend on the current values of the Federal funds rate. One justification for this assumption is that, contemporaneously, monetary authorities care more about unexpected change in exchange rate (for example, against the US dollar) rather than the unexpected changes in (for example, the US) interest rates per se or contemporaneously, the (the US) interest rate does not have additional information for other (non-US) monetary authorities after they consider their exchange rate against the foreign currency (Kim and Roubini, 2000). By including the commodity price and the exchange rate in the reaction function, it is attempted to control for current systematic responses of monetary policy to the state of the economy.[71]

(iv) Financial Market Equilibrium:

Row 7 is based on an arbitrage equation describing the exchange rate market and it considers the effects of the identified monetary shocks on the value of the domestic currency. This equation allows the exchange rate to respond contemporaneously to all variables considering the assumption that the exchange rate is a financial variable, i.e. a forward looking asset price, which reacts immediately to information and hence has contemporaneous effects generated by all variables (Kim and Roubini, 2000; Elbourne and de Haan, 2006).

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71 The assumptions of Kim and Roubini (2000) for exchange rates are still valid for emerging countries like Sri Lanka. On the one hand, similar to many other countries, Sri Lanka has been implicitly and explicitly concerned about the effects of a depreciation of the domestic currency on the developments in inflation. On the other hand, by controlling for the components of interest rate movements that are systematic responses to a depreciation of the domestic currency, it is possible to identify the interest rate innovations that are truly exogenous contractions in monetary policy and that should lead to a currency appreciation.

APPENDIX B

Table B.1: Financial Sector Changes, Interest Rate Pass-Through and Monetary Transmission Channels

This table presents major impacts of different financial sector changes on monetray transmisosn mechanism. Based on the previous literature, this table is restricted to key features of financial sector changes, which directly affect interest rate pass-through and monetary transmission. However, this list is not complete and exhaustive.

Feature of Financial Sector Change	Key Aspects/Impacts on Financial System	Major Impact on Interest Rate Pass-Through	Major Impact on Monetary Transmission Channels
Structural Changes	Changes in legal, institutional and market structures; changes in monetary policy operating frameworks; increases in competition	Increase (size and speed of) interest rate pass-through	Structural changes facilitate reductions in financial constraints and hence, impact transmission: increase the importance of interest rate and asset price channels and reduce the importance of credit channels
Financial Liberalisation	Deregulation of interest rates (resulting market determination of interest rates); relaxations of capital controls; increases in competition; greater financial integration	Liberalisation of interest rates and greater competition increase (size and speed of) interest rate pass-through; relaxing capital controls and financial integration make domestic interest rates less effective	Liberalisation of interest rates impacts to increase the importance of interest rate and asset price channels and reduce credit channels; relaxing capital controls and financial integration make exchange rate channel and foreign interest rates more important (however, if it cause to increase domestic competition interest rate channels could be important)
Financial Deepening	Developments in capital markets; increase non-bank intermediation and disintermediation	Increase (size and speed of) interest rate pass-through	Increase the importance of interest rate and asset price channels and reduce the importance of credit channels (however, impact could vary depending on the ownership of financial assets, size of non-bank intermediaries, etc.)
Financial Innovation	Product innovation (securitisation; use of derivatives); process innovation (developments in payment and settlement systems)	Increase (size and speed of) interest rate pass-through	Interest rate channels considered as unaffected while asset price channels become important; decline in the importance of credit channels
Financial Consolidations	Changes in competition	Interest rate pass-through is dependent on the resulting competitive environment	Impact of transmission is mixed and uncertain
Implications of the Government Intervention	Reduction in government intervention and the reliance on the funds of the banking sector and captive source by governments	Increase (size and speed of) interest rate pass-through due to creation of market based environment	Reduction of government intervention has a positive impact as interest rate determination would be based on market mechanism; reduction of non-market based lending activity; developments in capital market tend to reduce credit based channels
Increased Monetary Policy Transparency	Reduction in information asymmetry	Increase (size and speed of) interest rate pass-through and reduce volatility	Increase in interest rate and asset price channels; impact on credit channel is uncertain; reduce lags in transmission
Overall Financial Sector Changes	Changes that lead to structural and regulatory changes, financial deepening, enhanced competition, market based monetary policy framework, etc.	Increase (size and speed of) interest rate pass-through and reduce volatility	Increase the importance of interest rate and asset price channels while reducing the importance of credit based channels; Rise in interest rate elasticity of aggregate demand over time with the financial sector changes; Increase in overall strength and dynamics of monetary transmission to output and prices

Source: Complied by the author based on the prior literature

Table B.2: Unit Root Tests and Cointegration – Baseline VAR and SVAR Models

This table presents unit root and cointegration test results for variables used for VAR models. Panel A presents the results for variables used for baseline VAR models and Panel B presents the results for variables used for structural VAR model. Variables are as follows: output (SRI_GDP), prices (SRI_CPI), narrow money (SRI_M1), short-term money market rate (SRI_MMR), nominal exchange rate (SRI_EXR), commodity price index (COMP) and Federal funds rate (FEDR).

Panel A: Baseline VAR Model

Unit Root Tests

Variable	Augmented Dickey-Fuller Test				Phillips-Perron Test			
	Level		First Difference		Level		First Difference	
	t-Statistic	Prob.	t-Statistic	Prob.	Adj. t-Stat	Prob.*	Adj. t-Stat	Prob.*
SRI_GDP	-1.921	0.6319	-8.139	0.0000	-1.305	0.8781	-8.275	0.0000
SRI_CPI	-2.541	0.3082	-6.346	0.0000	-1.923	0.6315	-6.361	0.0000
SRI_M1	-2.512	0.3218	-6.215	0.0000	-2.789	0.2064	-6.215	0.0000
SRI_MMR	-5.924	0.0000			-5.682	0.0001		

Johansen's Cointegration Test

Trend assumption: No deterministic trend (restricted constant)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**	Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.4213	72.44	40.17	0.0000	None *	0.4213	35.01	24.16	0.0012
At most 1 *	0.2651	37.43	24.28	0.0006	At most 1 *	0.2651	19.71	17.80	0.0255
At most 2 *	0.1612	17.72	12.32	0.0057	At most 2 *	0.1612	11.25	11.22	0.0495
At most 3 *	0.0961	6.467	4.130	0.0131	At most 3 *	0.0961	6.467	4.130	0.0131

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level

Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Panel B: Structural VAR Model

Unit Root Tests

Variable	Augmented Dickey-Fuller Test				Phillips-Perron Test			
	Level		First Difference		Level		First Difference	
	t-Statistic	Prob.	t-Statistic	Prob.	Adj. t-Stat	Prob.*	Adj. t-Stat	Prob.*
SRI_GDP	-1.921	0.6319	-8.139	0.0000	-1.305	0.8781	-8.275	0.0000
SRI_CPI	-2.541	0.3082	-6.346	0.0000	-1.923	0.6315	-6.361	0.0000
SRI_M1	-2.512	0.3218	-6.215	0.0000	-2.789	0.2064	-6.215	0.0000
SRI_MMR	-5.924	0.0000			-5.682	0.0001		
SRI_EXR	-2.009	0.5853	-5.565	0.0001	-1.794	0.6967	-5.565	0.0001
COMP	-0.337	0.9128	-6.078	0.0000	-2.707	0.2373	-4.940	0.0008
FEDR	-3.541	0.0098			-3.672	0.0068		

Johansen's Cointegration Test

Trend assumption: No deterministic trend (restricted constant)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**	Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.6283	188.7	111.8	0.0000	None *	0.6283	63.34	42.77	0.0001
At most 1 *	0.5477	125.3	83.94	0.0000	At most 1 *	0.5477	50.77	36.63	0.0006
At most 2 *	0.3201	74.55	60.06	0.0019	At most 2	0.3201	24.69	30.44	0.2195
At most 3 *	0.2373	49.86	40.17	0.0040	At most 3	0.2373	17.34	24.16	0.3179
At most 4 *	0.2283	32.52	24.28	0.0037	At most 4	0.2283	16.59	17.80	0.0753
At most 5 *	0.1547	15.93	12.32	0.0119	At most 5	0.1547	10.76	11.22	0.0604
At most 6 *	0.0777	5.178	4.130	0.0272	At most 6 *	0.0777	5.178	4.130	0.0272

Trace test indicates 7 cointegrating eqn(s) at the 0.05 level

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table B.3: Estimates of Baseline VAR Model

This table presents the estimates for baseline VAR model. Variables are as follows: output (SRI_GDP), prices (SRI_CPI), narrow money (SRI_M1), short-term money market rate (SRI_MMR) and exchange rate liberalisation dummy (EXR_DUM). 2 lags are used for estimates. Standard errors are in parentheses. Estimates are based on quarterly data for the period March 1996 – September 2012.

	SRI_GDP	**SRI_CPI**	**SRI_M1**	**SRI_MMR**
SRI_GDP(-1)	0.7772	0.0502	0.1244	5.382
	(0.1390)	(0.2223)	(0.3014)	(19.34)
SRI_GDP(-2)	0.1614	-0.0652	-0.2494	-1.383
	(0.1362)	(0.2179)	(0.2955)	(18.96)
SRI_CPI(-1)	0.0041	1.153	0.2906	18.13
	(0.0722)	(0.1155)	(0.1566)	(10.05)
SRI_CPI(-2)	-0.0112	-0.2692	-0.1628	-25.27
	(0.0681)	(0.1089)	(0.1477)	(9.478)
SRI_M1(-1)	0.0523	0.2058	0.8993	4.998
	(0.0626)	(0.1001)	(0.1357)	(8.709)
SRI_M1(-2)	-0.0144	-0.0989	0.0387	-1.078
	(0.0608)	(0.0972)	(0.1318)	(8.456)
SRI_MMR(-1)	-0.0018	-0.0006	-0.0066	1.043
	(0.0009)	(0.0014)	(0.0020)	(0.1253)
SRI_MMR(-2)	0.0010	0.0037	0.0020	-0.1696
	(0.0010)	(0.0016)	(0.0022)	(0.1402)
C	0.3991	-0.5865	1.878	-66.30
	(0.3810)	(0.6094)	(0.8264)	(53.03)
EXR_DUM	0.0004	-0.0554	0.0221	-2.206
	(0.0128)	(0.0205)	(0.0278)	(1.786)
R-squared	0.9980	0.9987	0.9984	0.8379
Adj. R-squared	0.9977	0.9985	0.9981	0.8113
Sum sq. resids	0.0067	0.0171	0.0314	129.3
S.E. equation	0.0110	0.0176	0.0239	1.533
F-statistic	3056.5	4611.3	3797.8	31.58
Log likelihood	206.2	175.7	155.9	-114.6
Akaike AIC	-6.038	-5.099	-4.489	3.833
Schwarz SC	-5.703	-4.764	-4.155	4.168
Mean dependent	13.10	4.579	12.11	11.76
S.D. dependent	0.2287	0.4491	0.5527	3.530
Determinant resid covariance (dof adj.)		4.67E-11		
Determinant resid covariance		2.39E-11		
Log likelihood		425.8739		
Akaike information criterion		-11.87304		
Schwarz criterion		-10.53496		

Table B.4: Lag Order Selection Criteria

This table presents the results for lag order selection criteria. Panel A presents the results for baseline VAR model and Panel B presents the results for structural VAR model. Variables are as follows: output (SRI_GDP), prices (SRI_CPI), narrow money (SRI_M1), short-term money market rate (SRI_MMR), exchange rate liberalisation dummy (EXR_DUM), nominal exchange rate (SRI_EXR), commodity price index (COMP) and Federal funds rate (FEDR). * indicates lag order selected by the criterion. Following are the criteria:

- LR: sequential modified LR test statistic (each test at 5% level)
- FPE: Final prediction error
- AIC: Akaike information criterion
- SC: Schwarz information criterion
- HQ: Hannan-Quinn information criterion

Panel A: Baseline VAR Model

Endogenous variables: SRI_GDP SRI_CPI SRI_M1 SRI_MMR
Exogenous variables: C EXR_DUM
Sample: 1996Q1 2012Q3
Included observations: 61

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-14.0082	NA	2.42e-05	0.721581	0.998417	0.830075
1	393.9978	735.7485	6.35e-11	-12.13107	-11.30057*	-11.80559*
2	408.2907	23.89967	6.78e-11	-12.0751	-10.69093	-11.53263
3	420.8898	19.41504	7.74e-11	-11.9636	-10.02575	-11.20414
4	438.3775	24.65471	7.67e-11	-12.01238	-9.520852	-11.03592
5	465.3562	34.49746*	5.70e-11*	-12.37234*	-9.327141	-11.1789
6	475.2899	11.39931	7.66e-11	-12.17344	-8.574573	-10.76301

Panel B: Structural VAR Model

Endogenous variables: SRI_GDP SRI_CPI SRI_M1 SRI_MMR SRI_EXR
Exogenous variables: C COMP FEDR EXR_DUM
Sample: 1996Q1 2012Q3
Included observations: 61

Lag	LogL	LR	FPE	AIC	SC	HQ
0	226.7128	NA	7.85e-10	-6.77747	-6.08538	-6.506234
1	585.1767	611.1515	1.41e-14	-17.71071	-16.15351*	-17.10043*
2	601.3875	24.98064	1.95e-14	-17.42254	-15.00023	-16.47321
3	622.8515	29.55688	2.33e-14	-17.30661	-14.01918	-16.01823
4	661.1752	46.49114	1.69e-14	-17.74345	-13.59091	-16.11603
5	709.9821	51.20718*	9.41e-15	-18.524	-13.50635	-16.55754
6	747.6679	33.36125	8.38e-15*	-18.93993*	-13.05717	-16.63442

Table B.5: Stability of VAR Models

This table presents stability tests of VAR models. Panel A presents the results for baseline VAR model and Panel B presents the results for structural VAR model. Variables are as follows: output (SRI_GDP), prices (SRI_CPI), narrow money (SRI_M1), short-term money market rate (SRI_MMR), exchange rate liberalisation dummy (EXR_DUM), nominal exchange rate (SRI_EXR), commodity price index (COMP) and Federal funds rate (FEDR).Both panels confirm the stability of VAR models, i.e. as suggested by Lütkepohl (2005), inverse roots of the characteristic polynomial all have modulus less than one and lie inside the unit circle (based on unreported inverse root graphs) indicating the VAR system is stable (stationary).

Panel A: Baseline VAR Model

Roots of Characteristic Polynomial
Endogenous variables: SRI_GDP SRI_CPI SRI_M1 SRI_MMR
Exogenous variables: C EXR_DUM
Lag specification: 1 2

Root	Modulus
0.994803 - 0.026273i	0.99515
0.994803 + 0.026273i	0.99515
0.896883 - 0.247628i	0.93044
0.896883 + 0.247628i	0.93044
0.191680 - 0.323893i	0.376362
0.191680 + 0.323893i	0.376362
-0.195512	0.195512
-0.099112	0.099112

No root lies outside the unit circle.
VAR satisfies the stability condition.

Panel B: Structural VAR Model

Roots of Characteristic Polynomial
Endogenous variables: COMP FEDR SRI_GDP SRI_CPI SRI_M1 SRI_MMR SRI_EXR
Exogenous variables: C EXR_DUM
Lag specification: 1 2

Root	Modulus
0.992901	0.992901
0.896167	0.896167
0.816518 - 0.218806i	0.845327
0.816518 + 0.218806i	0.845327
0.568778	0.568778
0.311414 - 0.419437i	0.522404
0.311414 + 0.419437i	0.522404
-0.167481 - 0.175203i	0.242376
-0.167481 + 0.175203i	0.242376
-0.220466	0.220466
4.37e-11 - 3.58e-06i	3.58E-06
4.37e-11 + 3.58e-06i	3.58E-06
-1.72E-06	1.72E-06
1.72E-06	1.72E-06

No root lies outside the unit circle.
VAR satisfies the stability condition.

Table B.6: VAR Residual Serial Correlation Lagrange Multiplier (LM) Tests

This table presents serial correlation tests of VAR models. Panel A presents the results for baseline VAR model and Panel B presents the results for structural VAR model. Serial correlation in residuals is examined using the multivariate Lagrange Multiplier (LM) test for residual serial correlation and also the correlograms (auto correlation plots). The multivariate LM test for residual serial correlation up to three lags confirms that it cannot be rejected the null of no serial correlation for all cases. These results are consistent with unreported correlograms, which do not show significant violation of no serial correlation assumption.

Panel A: Baseline VAR Model

Null Hypothesis: no serial correlation at lag order h
Sample: 1996Q1 2012Q3
Included observations: 65

Lags	LM-Stat	Prob
1	17.79	0.3364
2	18.66	0.2868
3	14.43	0.5669

Probs from chi-square with 16 df.

Panel B: Structural VAR Model

Null Hypothesis: no serial correlation at lag order h
Sample: 1996Q1 2012Q3
Included observations: 65

Lags	LM-Stat	Prob
1	56.22	0.2228
2	44.01	0.6753
3	55.60	0.2403

Probs from chi-square with 49 df.

Table B.7: VAR Residual Heteroskedasticity Tests

This table presents heteroskedasticity tests of VAR models. Panel A presents the results for baseline VAR model and Panel B presents the results for structural VAR model. Test for the absence of heteroskedasticity in the error process is based on the White's heteroskedasticity test (White's test for heteroskedasticity is carried out with no cross terms, as sample size is not large enough to check with cross terms). Despite marginal significance, these results suggest that there appears no heteroskedatic issue in the residuals.

Panel A: Baseline VAR Model

Sample: 1996Q1 2012Q3
Included observations: 65

Joint test:

Chi-sq	df	Prob.
197.95	170	0.07

Individual components:

Dependent	R-squarec	F(17,47)	Prob.	Chi-sq(17)	Prob.
res1*res1	0.2643	0.993	0.4816	17.18	0.4423
res2*res2	0.4580	2.337	0.0112	29.77	0.0280
res3*res3	0.2988	1.178	0.3177	19.42	0.3048
res4*res4	0.1967	0.677	0.8087	12.78	0.7506
res2*res1	0.3547	1.520	0.1290	23.06	0.1474
res3*res1	0.3036	1.205	0.2974	19.73	0.2880
res3*res2	0.3637	1.581	0.1086	23.64	0.1295
res4*res1	0.3539	1.514	0.1310	23.00	0.1492
res4*res2	0.4726	2.477	0.0073	30.72	0.0216
res4*res3	0.3774	1.676	0.0824	24.53	0.1057

Panel B: Structural VAR Model

Sample: 1996Q1 2012Q3
Included observations: 65

Joint test:

Chi-sq	df	Prob.
819.87	812	0.4164

Individual components:

Dependent	R-squarec	F(29,35)	Prob.	Chi-sq(29)	Prob.
res1*res1	0.6739	2.494	0.0053	43.80	0.0383
res2*res2	0.5467	1.456	0.1438	35.54	0.1874
res3*res3	0.4002	0.805	0.7227	26.02	0.6247
res4*res4	0.7460	3.544	0.0002	48.49	0.0131
res5*res5	0.3030	0.525	0.9607	19.69	0.9022
res6*res6	0.7264	3.204	0.0006	47.21	0.0177
res7*res7	0.4567	1.014	0.4795	29.68	0.4299
res2*res1	0.7716	4.076	0.0001	50.15	0.0087
res3*res1	0.5626	1.552	0.1068	36.57	0.1575
res3*res2	0.5081	1.247	0.2646	33.03	0.2766
res4*res1	0.4991	1.203	0.2988	32.44	0.3008
res4*res2	0.4640	1.045	0.4467	30.16	0.4060
res4*res3	0.4708	1.074	0.4170	30.60	0.3845
res5*res1	0.5205	1.310	0.2213	33.83	0.2455
res5*res2	0.3914	0.776	0.7559	25.44	0.6552
res5*res3	0.2263	0.353	0.9974	14.71	0.9871
res5*res4	0.4542	1.004	0.4907	29.52	0.4381
res6*res1	0.3497	0.649	0.8819	22.73	0.7888
res6*res2	0.5440	1.440	0.1509	35.36	0.1930
res6*res3	0.4848	1.135	0.3569	31.51	0.3418
res6*res4	0.4659	1.053	0.4385	30.28	0.4000
res6*res5	0.5126	1.269	0.2486	33.32	0.2651
res7*res1	0.5106	1.259	0.2556	33.19	0.2701
res7*res2	0.5007	1.210	0.2928	32.54	0.2965
res7*res3	0.5146	1.279	0.2416	33.45	0.2601
res7*res4	0.3571	0.670	0.8634	23.21	0.7668
res7*res5	0.3969	0.794	0.7355	25.80	0.6363
res7*res6	0.5741	1.627	0.0847	37.31	0.1384

Table B.8: Variance Decomposition for Baseline VAR Model

This table presents forecast error variance decomposition of output (SRI_GDP), prices (SRI_CPI), narrow money (SRI_M1) and short-term interest rate (SRI_MMR) for the baseline VAR model. Cholesky Ordering: SRI_GDP SRI_CPI SRI_M1 SRI_MMR.

Variance Decomposition of SRI_GDP:

Period	S.E.	SRI_GDP	SRI_CPI	SRI_M1	SRI_MMR
1	0.0109	100.0	0.00	0.00	0.00
2	0.0145	94.90	0.02	1.60	3.48
3	0.0176	88.99	0.24	3.13	7.64
4	0.0203	82.96	0.41	4.56	12.07
5	0.0227	77.33	0.46	5.81	16.41
6	0.0249	72.22	0.41	6.89	20.48
7	0.0269	67.69	0.35	7.86	24.10
8	0.0286	63.73	0.39	8.74	27.14
9	0.0302	60.29	0.61	9.57	29.53
10	0.0316	57.24	1.09	10.40	31.27
11	0.0329	54.50	1.89	11.24	32.37
12	0.0342	51.95	3.02	12.13	32.90
13	0.0353	49.53	4.47	13.07	32.94
14	0.0365	47.17	6.18	14.09	32.56
15	0.0376	44.85	8.09	15.18	31.88
16	0.0388	42.55	10.13	16.36	30.96

Variance Decomposition of SRI_M1:

Period	S.E.	SRI_GDP	SRI_CPI	SRI_M1	SRI_MMR
1	0.0238	1.96	0.03	98.01	0.00
2	0.0359	2.31	1.65	87.54	8.50
3	0.0471	1.73	1.73	78.56	17.99
4	0.0569	1.23	1.84	71.83	25.11
5	0.0652	0.95	2.35	66.78	29.93
6	0.0723	0.87	3.45	62.85	32.83
7	0.0786	0.96	5.24	59.70	34.10
8	0.0842	1.18	7.73	57.07	34.02
9	0.0893	1.48	10.85	54.77	32.90
10	0.0942	1.82	14.41	52.69	31.08
11	0.0991	2.18	18.16	50.78	28.88
12	0.1039	2.54	21.85	49.05	26.56
13	0.1088	2.86	25.27	47.53	24.34
14	0.1137	3.16	28.27	46.26	22.30
15	0.1186	3.44	30.80	45.27	20.49
16	0.1235	3.70	32.84	44.55	18.91

Variance Decomposition of SRI_CPI:

Period	S.E.	SRI_GDP	SRI_CPI	SRI_M1	SRI_MMR
1	0.0186	0.43	99.57	0.0000	0.00
2	0.0285	0.41	97.94	1.62	0.03
3	0.0360	0.46	95.40	3.83	0.32
4	0.0421	0.48	92.24	6.33	0.95
5	0.0474	0.49	88.72	9.21	1.59
6	0.0521	0.48	85.06	12.52	1.94
7	0.0564	0.45	81.36	16.24	1.95
8	0.0604	0.41	77.62	20.19	1.77
9	0.0641	0.37	73.87	24.18	1.57
10	0.0677	0.33	70.17	27.98	1.51
11	0.0713	0.32	66.61	31.40	1.67
12	0.0749	0.35	63.29	34.32	2.04
13	0.0785	0.43	60.30	36.70	2.57
14	0.0822	0.56	57.71	38.56	3.17
15	0.0858	0.76	55.56	39.94	3.73
16	0.0895	1.01	53.86	40.93	4.20

Variance Decomposition of SRI_MMR:

Period	S.E.	SRI_GDP	SRI_CPI	SRI_M1	SRI_MMR
1	1.541	0.76	1.36	4.40	93.48
2	2.307	0.35	5.77	3.39	90.49
3	2.710	0.38	7.06	2.50	90.06
4	2.907	0.61	6.74	2.35	90.30
5	3.003	0.89	6.32	2.82	89.97
6	3.055	1.16	6.53	3.68	88.63
7	3.096	1.35	7.52	4.69	86.45
8	3.144	1.45	9.02	5.57	83.96
9	3.202	1.47	10.64	6.18	81.72
10	3.266	1.44	12.02	6.47	80.07
11	3.328	1.39	13.01	6.51	79.10
12	3.382	1.34	13.58	6.41	78.67
13	3.423	1.32	13.82	6.27	78.59
14	3.451	1.32	13.85	6.17	78.65
15	3.468	1.34	13.80	6.14	78.72
16	3.477	1.37	13.73	6.19	78.71

Table B.9: Estimates of Unrestricted 7-Variable VAR Model

This table presents estimates for 7-variable VAR model. Variables are as follows: commodity price index (COMP), Federal funds rate (FEDR), output (SRI_GDP), prices (SRI_CPI), narrow money (SRI_M1), short-term money market rate (SRI_MMR), nominal exchange rate (SRI_EXR) and exchange rate liberalisation dummy (EXR_DUM). 2 lags are used in the model. Standard errors are in parentheses. Estimates are based on quarterly data for the period March 1996 – September 2012.

	COMP	FEDR	SRI_GDP	SRI_CPI	SRI_M1	SRI_MMR	SRI_EXR
COMP(-1)	0.7661	-0.5954	0.0140	0.0267	0.0156	1.861	0.0692
	(0.1508)	(0.5283)	(0.0224)	(0.0346)	(0.0480)	(3.193)	(0.0443)
COMP(-2)	-0.2397	0.2633	-0.0261	-0.0005	-0.0596	-1.104	-0.0297
	(0.1331)	(0.4663)	(0.0198)	(0.0305)	(0.0424)	(2.818)	(0.0391)
FEDR(-1)	0.0306	1.530	0.0083	-0.0117	0.0181	0.1332	-0.0206
	(0.0348)	(0.1218)	(0.0052)	(0.0080)	(0.0111)	(0.736)	(0.0102)
FEDR(-2)	-0.0337	-0.5582	-0.0080	0.0161	-0.0143	0.4633	0.0224
	(0.0373)	(0.1307)	(0.0055)	(0.0086)	(0.0119)	(0.790)	(0.0110)
SRI_GDP(-1)	0.5981	-2.181	0.6464	0.1963	0.0744	3.095	0.0299
	(0.9687)	(3.393)	(0.1439)	(0.2222)	(0.3082)	(20.51)	(0.2842)
SRI_GDP(-2)	-0.2484	-1.955	0.1160	0.2050	0.0156	4.015	0.1888
	(1.042)	(3.649)	(0.1547)	(0.2389)	(0.3315)	(22.06)	(0.3057)
SRI_CPI(-1)	1.397	1.843	0.0506	0.9413	0.2712	13.22	-0.5480
	(0.6267)	(2.195)	(0.0931)	(0.1437)	(0.1994)	(13.27)	(0.1839)
SRI_CPI(-2)	-1.824	-1.909	0.0317	-0.1798	-0.1257	-13.81	0.4230
	(0.5798)	(2.031)	(0.0861)	(0.1330)	(0.1845)	(12.28)	(0.1701)
SRI_M1(-1)	0.8158	1.631	0.0608	0.0605	0.7595	-3.5639	-0.2024
	(0.4702)	(1.6470)	(0.0698)	(0.1078)	(0.1496)	(9.955)	(0.1380)
SRI_M1(-2)	-0.1449	0.8741	0.0217	-0.1204	0.1022	-0.0407	0.1517
	(0.4215)	(1.4763)	(0.0626)	(0.0967)	(0.1341)	(8.923)	(0.1237)
SRI_MMR(-1)	-0.0072	-0.1268	-0.0020	-0.0019	-0.0076	0.8379	0.0021
	(0.0069)	(0.0241)	(0.0010)	(0.0016)	(0.0022)	(0.1455)	(0.0020)
SRI_MMR(-2)	0.0214	0.1060	0.0021	0.0013	0.0036	-0.2329	-0.0050
	(0.0080)	(0.0282)	(0.0012)	(0.0018)	(0.0026)	(0.1702)	(0.0024)
SRI_EXR(-1)	-0.9932	3.234	-0.0001	-0.0068	-0.1349	8.193	1.173
	(0.5443)	(1.907)	(0.0808)	(0.1248)	(0.1732)	(11.52)	(0.1597)
SRI_EXR(-2)	0.8409	-4.851	-0.0852	0.2169	0.1967	-4.242	-0.1076
	(0.6605)	(2.314)	(0.0981)	(0.1515)	(0.2102)	(13.983)	(0.1938)
C	-8.103	33.165	2.187	-4.497	-0.1865	-65.59	-2.100
	(6.050)	(21.19)	(0.8984)	(1.387)	(1.925)	(128.1)	(1.775)
EXR_DUM	-0.2268	-1.098	0.0014	-0.0545	0.0125	-1.705	0.0446
	(0.0858)	(0.3004)	(0.0127)	(0.0197)	(0.0273)	(1.815)	(0.0252)
R-squared	0.9832	0.9905	0.9984	0.9990	0.9987	0.8596	0.9937
Adj. R-squared	0.9780	0.9876	0.9979	0.9987	0.9983	0.8166	0.9917
Sum sq. resids	0.2498	3.0649	0.0055	0.0131	0.0253	111.96	0.0215
S.E. equation	0.0714	0.2501	0.0106	0.0164	0.0227	1.512	0.0209
F-statistic	190.93	340.17	1980.83	3205.70	2522.20	20.00	511.65
Log likelihood	88.52	7.04	212.48	184.24	162.95	-109.90	168.22
Akaike AIC	-2.231	0.276	-6.046	-5.176	-4.522	3.874	-4.684
Schwarz SC	-1.696	0.811	-5.510	-4.641	-3.986	4.409	-4.149
Mean dependent	4.503	2.976	13.098	4.579	12.111	11.762	4.532
S.D. dependent	0.4817	2.2438	0.2287	0.4491	0.5527	3.530	0.2301

Determinant resid covariance (dof adj.)	1.92E-18
Determinant resid covariance	2.66E-19
Log likelihood	744.4663
Akaike information criterion	-19.4605
Schwarz criterion	-15.71387

Table B.10: Estimates of 7-Variable Structural VAR Model

This table presents the estimates for 7-variable SVAR model using the same variables in Table B.9 and for the sample (March 1996-September 2012). Short-run restrictions are given in matrix A. C(1) to C(12) are estimated coefficients. LR statistic is used to test for over-identification.

Model: Ae = Bu where E[uu']=I

Restriction Type: short-run pattern matrix

A =

1	0	0	0	0	0	0
C(1)	1	0	0	0	0	0
C(2)	0	1	0	0	0	0
C(3)	0	C(7)	1	0	0	0
0	0	C(8)	C(10)	1	C(14)	0
C(4)	0	0	0	C(12)	1	C(16)
C(5)	C(6)	C(9)	C(11)	C(13)	C(15)	1

B =

C(17)	0	0	0	0	0	0
0	C(18)	0	0	0	0	0
0	0	C(19)	0	0	0	0
0	0	0	C(20)	0	0	0
0	0	0	0	C(21)	0	0
0	0	0	0	0	C(22)	0
0	0	0	0	0	0	C(23)

	Coefficient	**Std. Error**	**z-Statistic**	**Prob.**
C(1)	-0.865189	0.421009	-2.055037	0.0399
C(2)	-0.038896	0.017777	-2.187993	0.0287
C(3)	-0.102516	0.026439	-3.877503	0.0001
C(4)	0.178616	4.364433	0.040925	0.9674
C(5)	0.093286	0.042359	2.202275	0.0276
C(6)	-0.004591	0.010005	-0.458852	0.6463
C(7)	0.032250	0.178029	0.181152	0.8562
C(8)	0.010603	0.456265	0.023239	0.9815
C(9)	0.518216	0.248207	2.087836	0.0368
C(10)	0.012305	0.199297	0.061742	0.9508
C(11)	-0.303184	0.170573	-1.777449	0.0755
C(12)	-46.629860	129.3019	-0.360628	0.7184
C(13)	-0.074215	0.379333	-0.195646	0.8449
C(14)	0.012854	0.021184	0.606795	0.5440
C(15)	0.000129	0.005575	0.023103	0.9816
C(16)	-40.409900	54.72498	-0.738418	0.4603
C(17)	0.071399	0.006262	11.40175	0.0000
C(18)	0.242349	0.021255	11.40175	0.0000
C(19)	0.010233	0.000898	11.40175	0.0000
C(20)	0.014688	0.001288	11.40175	0.0000
C(21)	0.024948	0.016112	1.548445	0.1215
C(22)	1.968424	2.053040	0.958785	0.3377
C(23)	0.019505	0.003312	5.889142	0.0000

Log likelihood	674.35			
LR test for over-identification:				
Chi-square(5)	8.673		Probability	0.1395

Estimated A matrix:

1.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
-0.865189	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000
-0.038896	0.000000	1.000000	0.000000	0.000000	0.000000	0.000000
-0.102516	0.000000	0.032250	1.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.010603	0.012305	1.000000	0.012854	0.000000
0.178616	0.000000	0.000000	0.000000	-46.62986	1.000000	-40.4099
0.093286	-0.004591	0.518216	-0.303184	-0.074215	0.000129	1.000000

Estimated B matrix:

0.071399	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.242349	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.010233	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.014688	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.024948	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	1.968424	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.019505

Table B.11: Variance Decomposition for 7-Variable Structural VAR Model

This table presents forecast error variance decomposition of commodity price index (COMP), Federal funds rate (FEDR), output (SRI_GDP), prices (SRI_CPI), narrow money (SRI_M1), short-term interest rate (SRI_MMR) and nominal exchange rate (SRI_EXR) for the 7-variable SVAR model. These shocks are represented as Shock 1 to Shock 7 as given in the table.

Variance Decomposition of COMP:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.0665	100.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.1030	83.78	0.01	0.82	7.11	4.79	0.03	3.46
3	0.1289	62.24	1.85	2.89	9.95	11.69	0.68	10.70
4	0.1421	51.48	7.18	2.60	9.84	15.37	2.40	11.13
5	0.1528	44.88	12.15	2.69	8.67	14.87	6.95	9.79
6	0.1627	40.38	13.61	2.89	7.68	13.53	12.34	9.58
7	0.1691	37.98	13.66	2.75	7.27	13.39	15.83	9.11
8	0.1737	36.31	13.47	2.62	7.39	15.17	16.41	8.64
9	0.1782	34.63	13.17	2.52	7.65	18.13	15.69	8.22
10	0.1821	33.22	12.87	2.46	7.76	20.76	15.05	7.88
11	0.1849	32.36	12.60	2.49	7.77	22.43	14.70	7.65
12	0.1864	31.91	12.40	2.59	7.79	23.31	14.48	7.53
13	0.1873	31.63	12.33	2.67	7.86	23.72	14.33	7.47
14	0.1881	31.38	12.46	2.68	7.99	23.84	14.22	7.44
15	0.1887	31.17	12.70	2.66	8.13	23.78	14.13	7.42
16	0.1892	31.03	12.98	2.66	8.22	23.67	14.06	7.39

Variance Decomposition of SRI_GDP:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.0106	8.28	0.00	91.72	0.00	0.00	0.00	0.00
2	0.0133	15.68	0.87	75.02	1.18	0.48	0.59	6.18
3	0.0159	15.86	2.25	54.05	3.05	4.50	1.26	19.04
4	0.0192	12.07	3.40	41.01	6.24	8.56	0.87	27.85
5	0.0219	9.86	4.11	32.65	8.88	9.87	1.06	33.58
6	0.0243	8.52	4.22	26.43	11.29	10.69	1.39	37.46
7	0.0270	7.40	3.88	21.66	14.12	11.86	1.73	39.35
8	0.0295	6.58	3.50	18.27	16.81	12.69	1.89	40.25
9	0.0316	6.13	3.25	15.99	19.01	12.97	1.88	40.77
10	0.0331	5.90	3.10	14.56	20.83	12.93	1.85	40.84
11	0.0342	5.81	3.01	13.71	22.33	12.70	1.86	40.58
12	0.0349	5.82	2.96	13.22	23.50	12.37	1.92	40.22
13	0.0354	5.90	2.94	12.95	24.37	12.06	1.98	39.81
14	0.0358	6.02	2.94	12.84	24.96	11.82	2.03	39.39
15	0.0361	6.14	2.96	12.85	25.28	11.73	2.05	38.98
16	0.0363	6.23	3.03	12.92	25.36	11.83	2.06	38.58

Variance Decomposition of FEDR:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.2568	6.50	93.50	0.00	0.00	0.00	0.00	0.00
2	0.4965	3.20	79.10	0.77	1.77	11.19	2.38	1.60
3	0.7376	1.53	66.44	2.53	2.21	23.46	1.65	2.18
4	0.9362	0.98	59.59	4.20	1.95	30.47	1.33	1.48
5	1.1137	0.77	53.59	5.61	2.16	35.79	0.94	1.14
6	1.2822	0.61	46.74	7.20	2.93	40.34	0.86	1.32
7	1.4467	0.48	39.97	8.28	4.24	43.91	0.92	2.20
8	1.6021	0.39	34.31	8.72	5.80	46.14	0.96	3.68
9	1.7353	0.34	30.20	9.12	7.22	47.08	1.00	5.06
10	1.8341	0.32	27.52	9.74	8.33	47.07	1.07	5.96
11	1.8975	0.32	25.90	10.44	9.16	46.50	1.19	6.48
12	1.9334	0.35	24.98	11.08	9.75	45.74	1.35	6.74
13	1.9514	0.37	24.53	11.59	10.13	45.09	1.48	6.81
14	1.9596	0.38	24.34	11.93	10.29	44.71	1.56	6.78
15	1.9656	0.39	24.23	12.09	10.28	44.67	1.58	6.75
16	1.9753	0.40	24.04	12.07	10.18	44.89	1.57	6.85

Variance Decomposition of SRI_CPI:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.0151	16.75	0.00	0.00	83.12	0.00	0.13	0.00
2	0.0211	23.94	5.77	0.08	69.72	0.07	0.42	0.00
3	0.0248	25.09	4.84	2.45	61.72	0.08	5.67	0.14
4	0.0272	25.61	4.40	3.36	54.70	0.60	10.22	1.12
5	0.0299	23.80	4.97	2.95	45.58	3.00	9.89	9.82
6	0.0330	20.69	5.55	2.56	37.40	5.24	9.58	18.98
7	0.0357	18.18	6.24	2.70	32.07	5.51	10.64	24.65
8	0.0380	16.41	7.41	2.79	28.49	4.88	11.38	28.64
9	0.0401	14.91	8.91	2.63	25.63	5.34	11.53	31.03
10	0.0422	13.46	10.39	2.40	23.08	7.84	11.35	31.48
11	0.0445	12.12	11.43	2.19	20.79	12.25	10.72	30.49
12	0.0468	11.00	11.77	2.01	18.83	17.90	9.84	28.65
13	0.0492	10.05	11.39	1.89	17.28	24.03	8.97	26.39
14	0.0515	9.21	10.59	1.80	16.22	29.91	8.18	24.08
15	0.0538	8.48	9.72	1.70	15.66	34.88	7.50	22.06
16	0.0559	7.89	9.04	1.61	15.52	38.47	6.96	20.52

Variance Decomposition of SRI_M1:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.0231	0.04	0.00	0.32	0.30	64.04	35.30	0.01
2	0.0346	1.87	1.51	0.71	6.07	73.43	15.90	0.52
3	0.0460	1.93	3.47	0.73	9.77	73.45	9.08	1.58
4	0.0543	1.44	4.73	0.56	10.28	75.02	6.55	1.42
5	0.0596	1.76	5.33	0.72	10.12	75.35	5.53	1.18
6	0.0625	2.15	5.05	1.02	10.19	75.04	5.43	1.12
7	0.0646	2.21	4.78	1.14	10.71	74.46	5.65	1.06
8	0.0663	2.11	5.00	1.09	11.60	73.62	5.57	1.02
9	0.0677	2.03	5.53	1.09	12.47	72.55	5.35	0.99
10	0.0686	1.99	6.19	1.19	12.94	71.46	5.25	0.99
11	0.0692	1.96	6.89	1.37	12.95	70.27	5.21	1.34
12	0.0701	1.91	7.61	1.68	12.63	68.72	5.10	2.35
13	0.0716	1.83	8.26	2.16	12.15	66.71	4.89	3.99
14	0.0736	1.74	8.76	2.86	11.67	64.36	4.63	5.98
15	0.0759	1.64	9.03	3.77	11.29	61.83	4.38	8.06
16	0.0782	1.55	9.06	4.80	11.06	59.23	4.18	10.13

Variance Decomposition of SRI_EXR:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	0.0214	10.08	0.61	4.36	0.92	8.11	0.79	75.13
2	0.0364	7.42	0.72	2.22	6.49	18.48	0.63	64.04
3	0.0473	7.69	1.21	1.50	10.08	23.24	0.37	55.90
4	0.0559	6.67	1.66	1.48	12.11	24.10	0.30	53.69
5	0.0629	5.51	2.15	1.41	13.77	23.10	0.69	53.36
6	0.0679	4.83	2.49	1.80	15.27	21.81	1.42	52.38
7	0.0717	4.51	2.64	2.33	16.71	20.49	2.12	51.20
8	0.0748	4.40	2.74	2.49	18.12	19.31	2.51	50.43
9	0.0771	4.41	2.94	2.54	19.29	18.39	2.63	49.80
10	0.0787	4.49	3.36	2.65	20.06	17.72	2.62	49.10
11	0.0798	4.57	4.01	2.78	20.45	17.24	2.61	48.34
12	0.0806	4.64	4.82	2.90	20.54	16.91	2.62	47.56
13	0.0813	4.69	5.76	3.03	20.46	16.63	2.66	46.78
14	0.0820	4.71	6.82	3.15	20.29	16.34	2.70	45.99
15	0.0828	4.71	8.01	3.27	20.06	16.06	2.72	45.16
16	0.0837	4.66	9.29	3.41	19.77	15.87	2.73	44.26

Variance Decomposition of SRI_MMR:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	1.4425	0.41	0.00	0.36	0.26	62.39	36.57	0.01
2	2.0010	0.22	0.45	0.19	0.57	65.25	30.67	2.65
3	2.1952	0.31	1.85	0.94	0.58	60.16	29.49	6.67
4	2.2989	0.55	4.74	1.80	0.53	55.54	26.90	9.95
5	2.4416	0.51	10.56	1.99	0.83	49.23	25.02	11.86
6	2.6139	0.51	16.61	1.73	1.60	43.17	22.70	13.67
7	2.7629	0.59	20.68	1.81	2.22	39.53	20.43	14.74
8	2.8741	0.60	22.79	2.14	2.24	39.18	18.89	14.17
9	3.0088	0.55	23.05	2.40	2.10	41.60	17.30	13.00
10	3.2108	0.48	21.70	2.65	2.48	45.18	15.23	12.27
11	3.4493	0.42	19.77	3.01	3.30	48.12	13.22	12.16
12	3.6699	0.38	18.02	3.49	4.22	49.72	11.72	12.44
13	3.8434	0.39	16.66	4.08	5.10	50.12	10.79	12.87
14	3.9668	0.42	15.67	4.67	5.91	49.74	10.30	13.30
15	4.0479	0.43	15.05	5.12	6.65	49.00	10.07	13.68
16	4.0957	0.43	14.79	5.40	7.25	48.23	9.95	13.95

Shock1: COMP shock
Shock2:FEDR shock
Shock3: GDP shock
Shock4: CPI shock
Shock5: M1 shock
Shock6: MMR shock
Shock7: EXR shock

Table B.12: Granger Causality Tests for Different Sub-samples (1996 - 2012)

This table presents Granger causality between variables. Variables are as follows: Consumer price index (SRI_CPI), industrial production index (SRI_ IPI), narrow money (SRI_ M1), short-term money market rate (SRI_ MMR), nominal exchange rate (SRI_ EXR), commodity price index (COMP) and Federal funds rate (FEDR). An F-statistic is used to test the hypothesis that the coefficients on the lags of 'X' are jointly zero in regression of 'Y' on both lags of 'Y' and 'X'. By following the lag information criteria, 2 lags are used. Shaded cells indicate significant values (at any level below 10 per cent) rejecting the null hypothesis that variable 'X' does not Granger cause the variable 'Y'. Sample is from 1996:01 to 2012:12. Two sample breaks are used: First, break in 2001 considering the exchange rate liberalisation and second, break in 2008 considering the increased central bank communication and transparency.

Null Hypothesis	Full Sample	Pre-Break Sub-Sample	Post-Break Sub-Samples		
	1996-2012	1996-2001	2001-2012	2001-2008	2008-2012
SRI_CPI does not Granger Cause SRI_IPI	0.2160	0.5457	0.1827	0.6786	0.0216
SRI_IPI does not Granger Cause SRI_CPI	0.8255	0.2932	0.9463	0.9148	0.2800
SRI_M1 does not Granger Cause SRI_IPI	0.1229	0.0045	0.1077	0.8111	0.0012
SRI_IPI does not Granger Cause SRI_M1	0.6336	0.2787	0.5694	0.5888	0.2472
SRI_MMR does not Granger Cause SRI_IPI	0.0393	0.6664	0.0802	0.0514	0.0084
SRI_IPI does not Granger Cause SRI_MMR	0.1625	0.4801	0.2443	0.3548	0.5785
SRI_EXR does not Granger Cause SRI_IPI	0.2561	0.4983	0.1461	0.5771	0.2053
SRI_IPI does not Granger Cause SRI_EXR	0.1820	0.3914	0.4206	0.5694	0.2360
COMP does not Granger Cause SRI_IPI	0.0194	0.0209	0.0689	0.1496	0.1870
SRI_IPI does not Granger Cause COMP	0.2651	0.0138	0.4551	0.5884	0.0151
FEDR does not Granger Cause SRI_IPI	0.0142	0.1144	0.0328	0.1220	0.2974
SRI_IPI does not Granger Cause FEDR	0.4777	0.7087	0.1297	0.0393	0.3161
SRI_M1 does not Granger Cause SRI_CPI	0.0247	0.0269	0.0412	0.0507	0.0052
SRI_CPI does not Granger Cause SRI_M1	0.4015	0.0951	0.8577	0.2214	0.4482
SRI_MMR does not Granger Cause SRI_CPI	0.0302	0.1297	0.0721	0.0070	0.0000
SRI_CPI does not Granger Cause SRI_MMR	0.0811	0.8156	0.1177	0.0426	0.1043
SRI_EXR does not Granger Cause SRI_CPI	0.6404	0.0028	0.3421	0.2108	0.8239
SRI_CPI does not Granger Cause SRI_EXR	0.5077	0.3410	0.0226	0.0248	0.2148
COMP does not Granger Cause SRI_CPI	0.0002	0.1586	0.0003	0.0054	0.0183
SRI_CPI does not Granger Cause COMP	0.0609	0.1366	0.0515	0.4642	0.0541
FEDR does not Granger Cause SRI_CPI	0.0601	0.6019	0.0146	0.2458	0.3169
SRI_CPI does not Granger Cause FEDR	0.1031	0.0290	0.4930	0.6950	0.4311
SRI_MMR does not Granger Cause SRI_M1	0.0018	0.1082	0.0123	0.0451	0.0000
SRI_M1 does not Granger Cause SRI_MMR	0.1038	0.1018	0.8286	0.1438	0.1928
SRI_EXR does not Granger Cause SRI_M1	0.0248	0.1530	0.4638	0.5692	0.6349
SRI_M1 does not Granger Cause SRI_EXR	0.7212	0.2608	0.1010	0.0381	0.3208
COMP does not Granger Cause SRI_M1	0.0032	0.0806	0.0545	0.1412	0.0226
SRI_M1 does not Granger Cause COMP	0.0018	0.5819	0.0045	0.0211	0.0359
FEDR does not Granger Cause SRI_M1	0.0098	0.1388	0.0683	0.1739	0.3382
SRI_M1 does not Granger Cause FEDR	0.1900	0.1902	0.1735	0.1923	0.8332
SRI_EXR does not Granger Cause SRI_MMR	0.3026	0.8362	0.9298	0.1140	0.8231
SRI_MMR does not Granger Cause SRI_EXR	0.7356	0.8829	0.6998	0.5214	0.9196
COMP does not Granger Cause SRI_MMR	0.6610	0.3194	0.5965	0.0927	0.0245
SRI_MMR does not Granger Cause COMP	0.8975	0.8254	0.9847	0.7908	0.1882
FEDR does not Granger Cause SRI_MMR	0.0002	0.2654	0.0003	0.0066	0.0000
SRI_MMR does not Granger Cause FEDR	0.0043	0.2883	0.0099	0.0273	0.0015
COMP does not Granger Cause SRI_EXR	0.1913	0.5836	0.0754	0.0976	0.2915
SRI_EXR does not Granger Cause COMP	0.0690	0.9680	0.0584	0.0906	0.6607
FEDR does not Granger Cause SRI_EXR	0.7250	0.1305	0.7138	0.5908	0.4981
SRI_EXR does not Granger Cause FEDR	0.1230	0.0403	0.6436	0.7354	0.9114
FEDR does not Granger Cause COMP	0.1008	0.1822	0.2053	0.1451	0.4666
COMP does not Granger Cause FEDR	0.2720	0.3507	0.6764	0.7832	0.0740

APPENDIX C

Figure C.1: Behaviour of Variables in Quarterly VAR Models

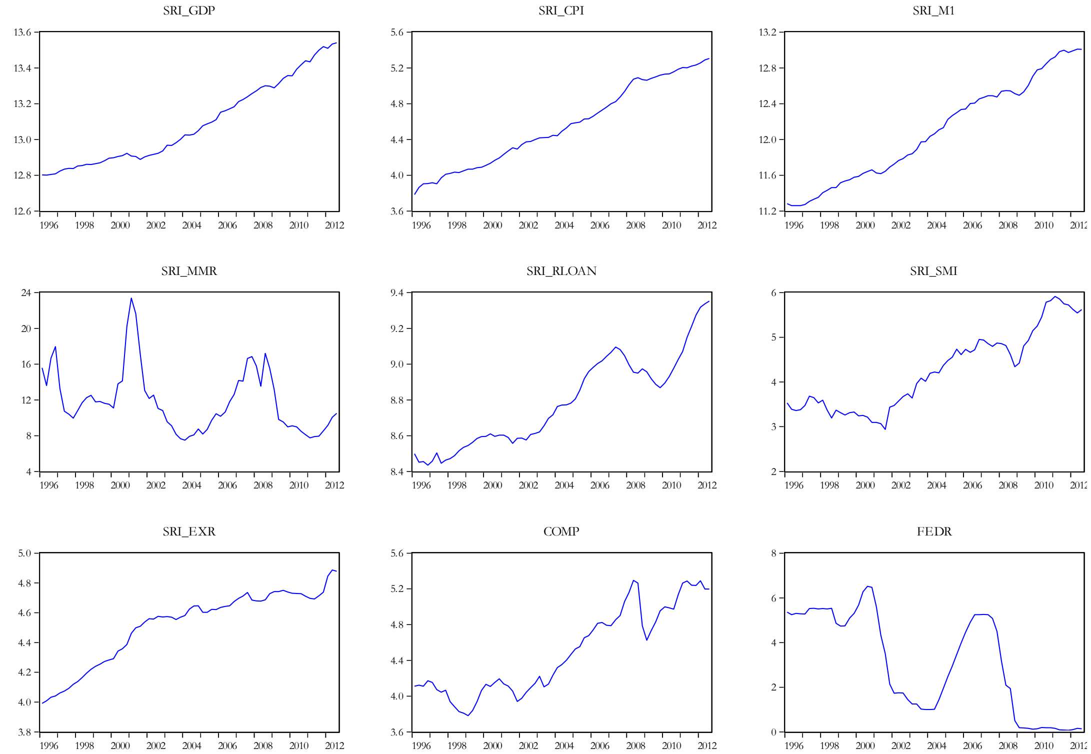


Figure C.2: Behaviour of Variables in Monthly Sectoral VAR Models

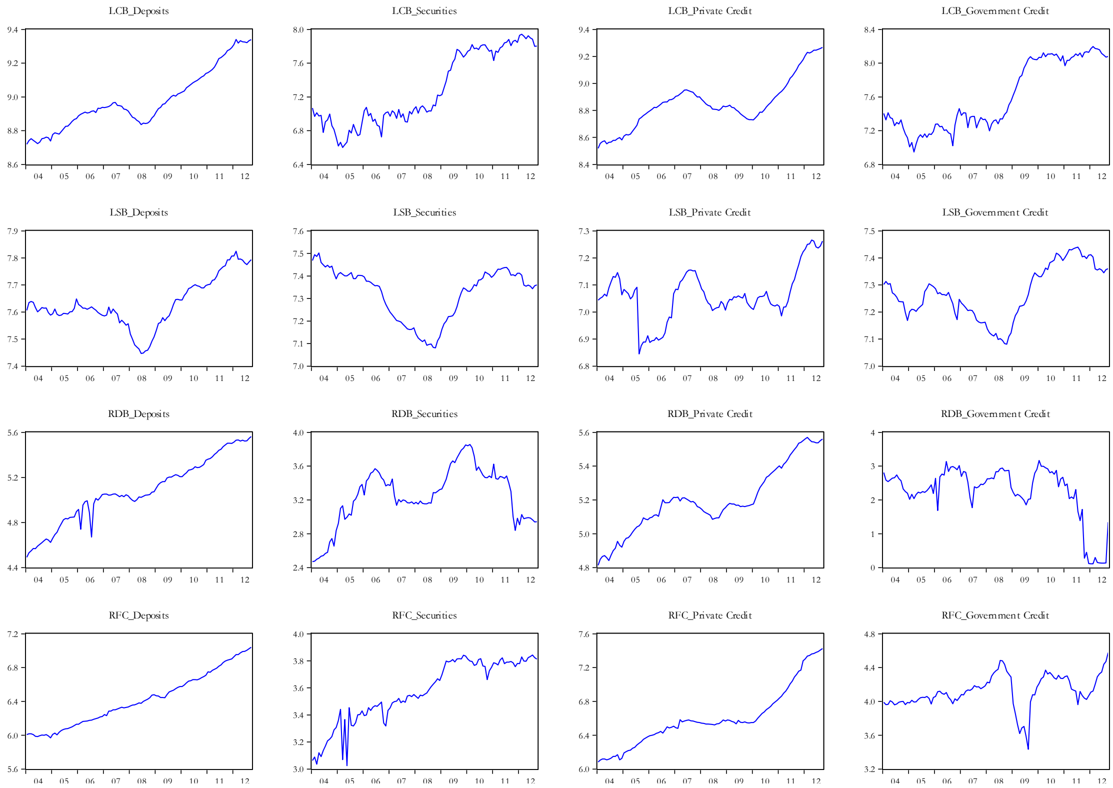


Figure C.3: Behaviour of Variables in Monthly VAR Models for Shifts in MTM

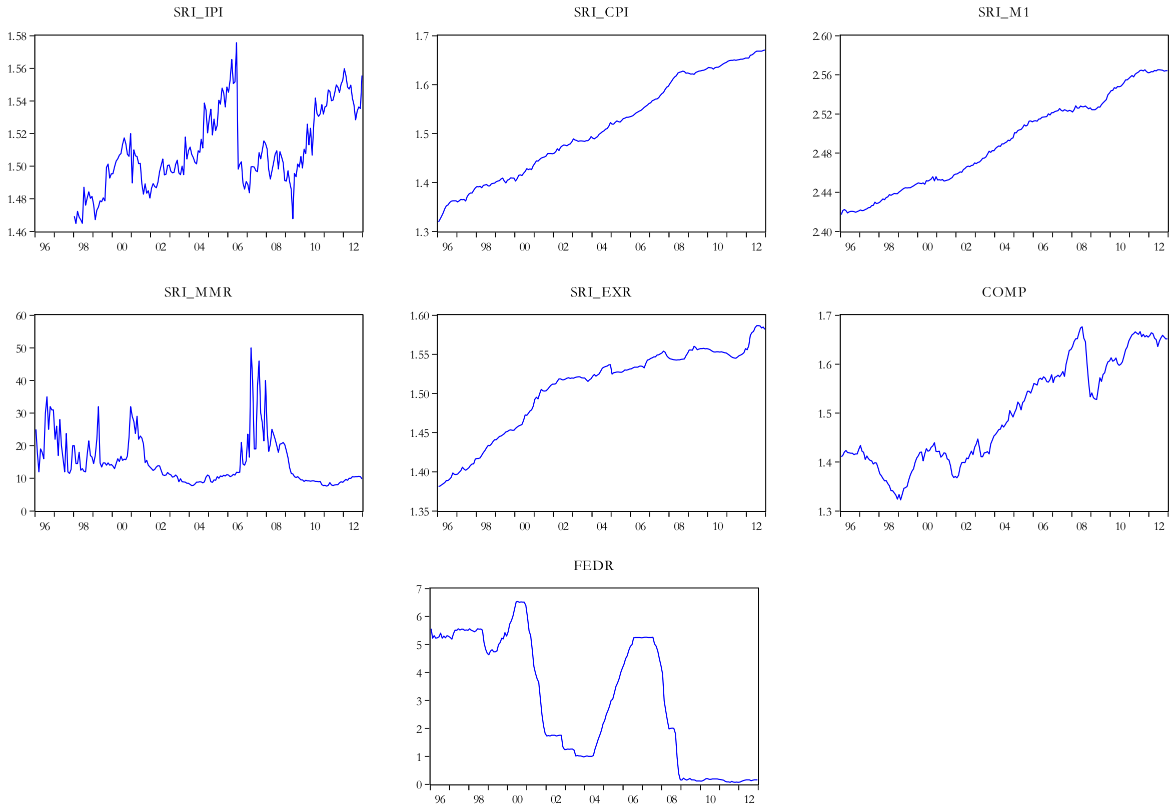
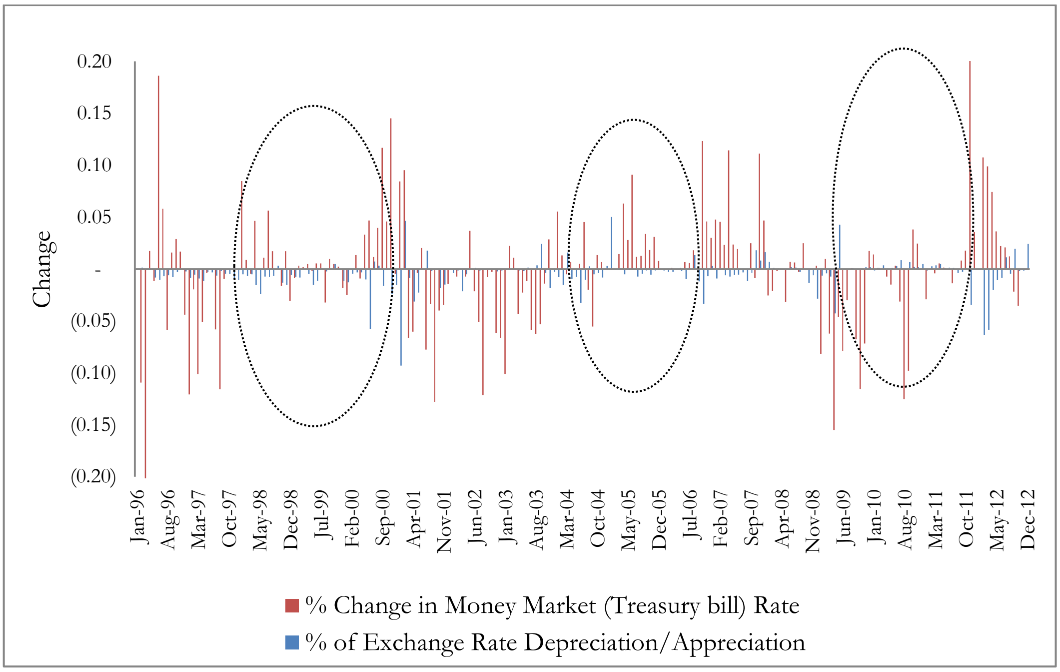
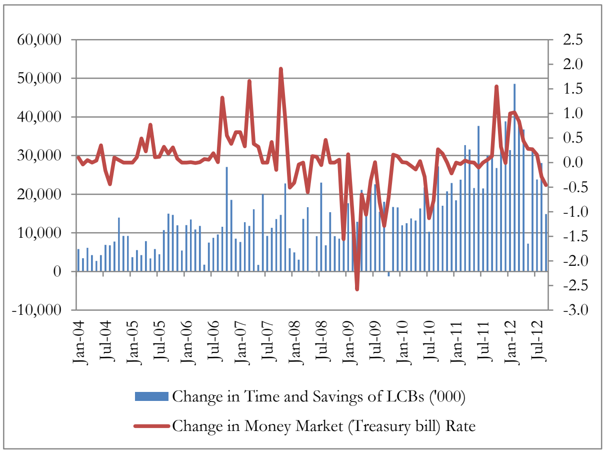


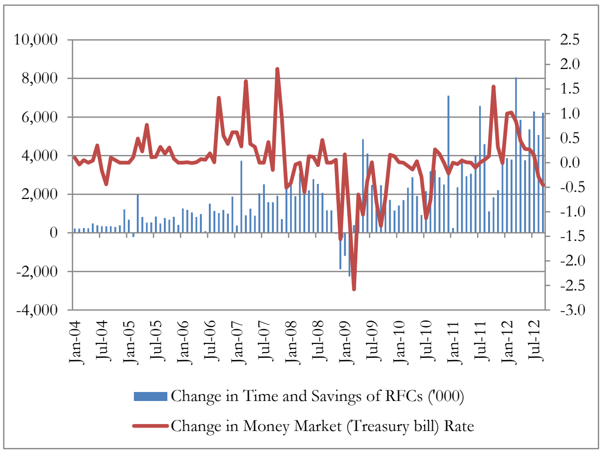
Figure C.4: Monthly Exchange Rate and Interest Rate Movements



Source: Authors calculation based on the research database and CBSL data

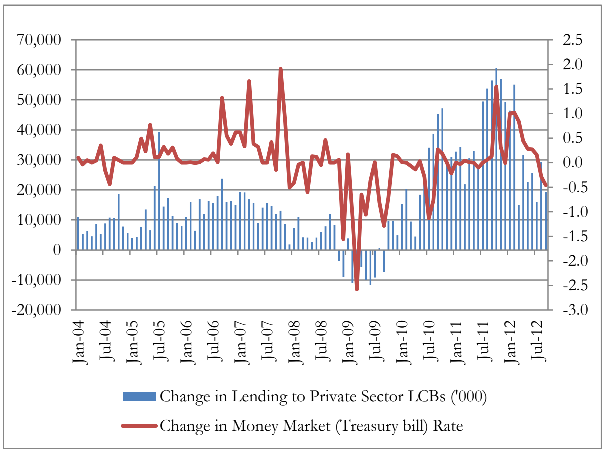
Figure C.5: Changes in Deposits of LCBs and RFCs and Money Market Rates

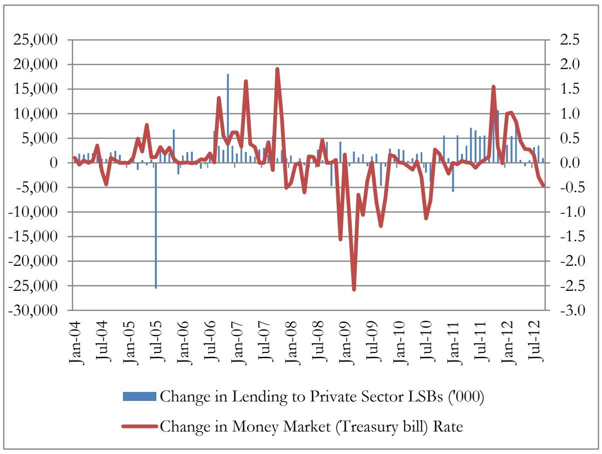




Source: Authors calculation based on the research database and CBSL data

Figure C.6: Changes in Private Sector Lending in LCBs and LSBs and Money Market Rates



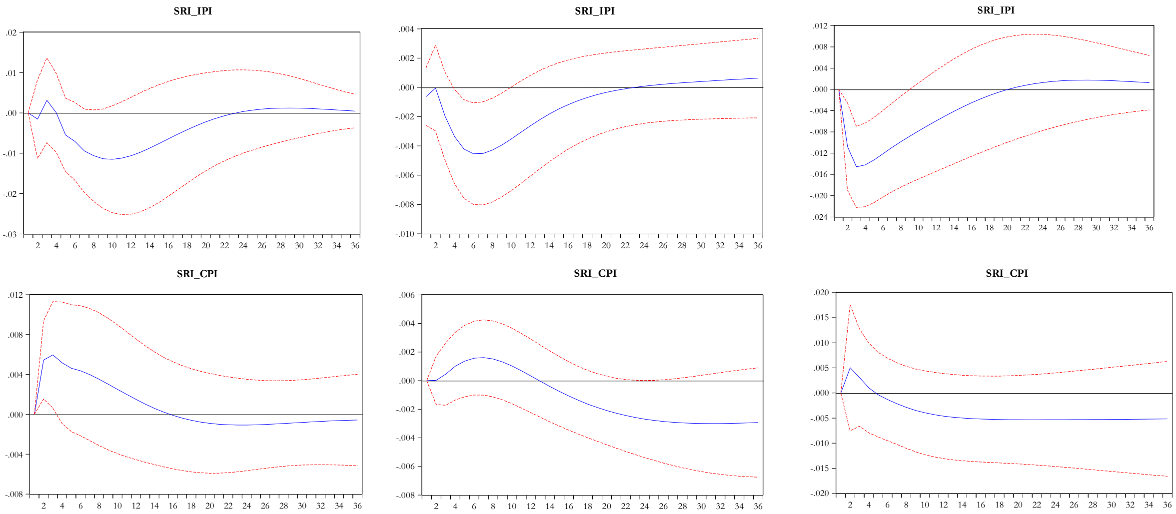


Source: Authors calculation based on the research database and CBSL data

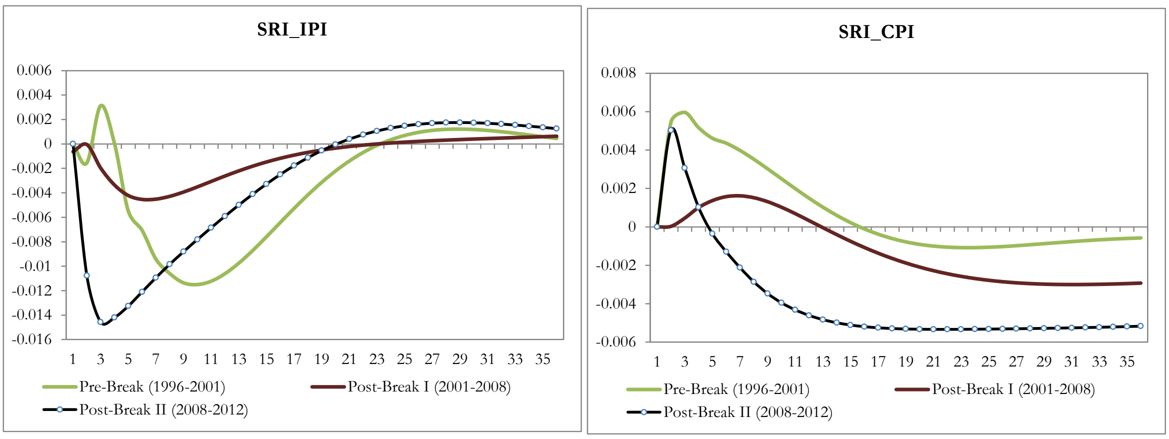
Figure C.7: Impulse Response Functions and Variance Decompositions over Different Sub-Samples (2001-2012)

Panel A: Separated IRFs

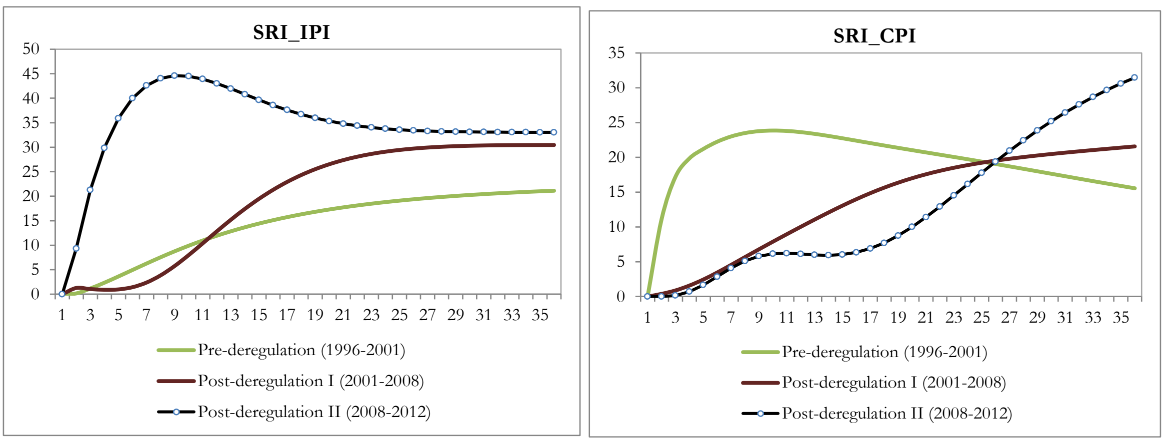
1996:01 – 2001:12	2001:12 – 2008: 12	2008:12 – 2012: 12



Panel B: Combined IRFs



Panel C: Variance Decompositions 1996:01 – 2001:12, 2001:12 – 2008: 12 and 2008:12 – 2012: 12



Source: Model Estimates