Essays On Monetary Policy

A dissertation by

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DECLARATION

I declare that this thesis is my own original work and has not been submitted for any other degree or award to this or any other university or institution.

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THESIS ABSTRACT

This thesis presents a compilation of four essays under the broader theme of monetary economics. The first two essays focus on two Pacific Small Island Developing States or Pacific SIDS, namely Papua New Guinea and Fiji Islands; and the second two essays focus on Asia's two rising giants, China and India. We study three different, yet topical aspects of monetary policy. Firstly, we decompose and examine the impact of excess banking sector liquidity and its repercussions on the transmission mechanism of monetary policy in an operational setting. Secondly, we calculate the efficiency of monetary policy in China and India; and thirdly we estimate the neutral short run interest rates in China and India using statistical filters and semi-structural models.

In the first paper, we investigate the endogenous and exogenous drivers of excess liquidity in Papua New Guinea and Fiji using the Generalized Method of Moments specification. These two economies have been hoarding excessively increasing levels of reserves over the past several years and our analyses finds that commercial banks in Papua New Guinea (PNG) are highly risk averse and keep precautionary levels of liquidity over and above the statutorily required minimum. On the other hand, Fijian banks, maintain involuntary levels of excess liquidity. The factors influencing this behaviour are varied. PNG is a resource rich country, with a significant petro-chemicals industry, high economic growth, and experiences commodity price fluctuations. The Central Bank also monetizes fiscal deficits. Fiji's endowments are rather limited and it has moderate levels of economic activity. Investable opportunities are rather limited with high cost of doing business and complicated investment procedures. There are exchange control limitations and a possibility of *keeping up with the Jones* behaviour in hoarding reserves. We highlight some avenues through which these excess could be drained and the monetary policy indicator rate realigned so that monetary efficiency is achieved.

The presence of excess reserves makes monetary policy weak, and ex ante by implication, impedes the strength of the interest rate channel. The second paper examines the i) two stage pass-through process by focusing on the inter-bank and the retail market; and ii) interest rate transmission to the ultimate macroeconomic targets of stable prices and growth in two Pacific SIDS; Fiji and PNG using SVAR model. For Fiji, we find that that a shock to policy interest rate (that is, an increase in policy rate decreases the inter-bank rate, while a shock to policy and inter-bank rates decreases the monthly change in excess liquidity. This is complemented by prolonged response from the lending and savings rate due to a shock to policy and inter-bank rate, and excess reserves. For PNG, a shock to policy interest rate initially decreases the interbank rate but causes a non-dissipating response of the interbank rate after the second month. On the other hand, the policy impact on change in excess liquidity causes an undulating response with its effects total disappearing in the sixth period. Additionally, a shock to policy and inter-bank rate, tend receive a prolonged positive response from the

lending and savings rate, whereas, the lending and savings rate, with respect to excess liquidity, has a prolonged negative impact.

The third paper assesses the efficiency of monetary policy in Asia's two largest and emerging economies, namely China and India. This paper improves the baseline techniques developed by Li et al. (2010) and Cecchetti et al. (2006) and assesses monetary policy efficiency. Using the stochastic frontier model we directly estimate the time varying efficiency of achieving the primary and secondary targets of monetary policy with the modified version of the model presented by Li et al., (2010). Results suggest a high level of efficiency in management of output gap (over 97 percent for China and above 95 percent for India) compared to inflation gap (which has an undulating trend averaging around 50 percent for China and ranging from 30 to 70 percent for India based). These results are mirrored by greater weighting of policymaker preference to output gap and according to our results, this is around 92 percent for China and around 70 percent for India, compared to inflation gap indicated by the GMM estimates of Taylor rule for both countries. The dynamic accounting analysis following Cecchetti et al., (2006) based on estimates from the Generalised Method of Moments for China and India, assessed on split sample ratios shows i) an overall decrease in macroeconomic weighted monetary policy efficiency by almost 113 percent, which can potentially be due to the high impact of supply shock variability and relatively high macroeconomic performance loss with respect to inflation in China; and ii) and overall deterioration in macroeconomic weighted monetary policy efficiency by around 73 percent, underpinned by a decrease in macroeconomic performance, variability of supply shock and an increase in monetary policy inefficiency with respect to inflation in India.

The final paper looks at time-varying neutral interest rates for China and India using semi-structural models built on the Taylor Rule (Taylor 1993) – Dynamic and Augmented Taylor Rules – supplemented by similar estimates of neutral interest rates using the common stochastic trends (with and without interest parity conditions) and pure statistical filters (HP, CF and Kalman filter) to determine the underlying trend as proxy for neutral interest rates. We also apply a two-sided varying coefficient estimator based on Generalized Methods of Moment, which yields time-varying neutral interest rates as low as just below 2% to just over 6% for China, while time-varying neutral interest rates has fluctuated from 4% to 10% in India. Overall, we find that output gap, inflation gap and inflationary expectation contemporaneously and negatively relate to a tightening real monetary policy stance and vice versa. This proves that the estimated time-varying neutral rates have provided quite reasonable indicator for assessing monetary policy stance against its objectives and supports the case for prudent response of monetary policy to achieve its objectives in China and India.

……To my mum; and my late father, may his soul rest in peace …

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THESIS INTRODUCTION

This compilation of essays under the broader theme of monetary economics, aims to study monetary policy's topical issues in contemporary settings. This thesis contains a collection of empirical essays on Monetary Policy focusing on the pertinent issues of monetary policy in two Small Island Developing States (SIDS) (Fiji and Papua New Guinea) and two emerging economies (China and India). For small open economies with managed exchange rate regimes, liquidity management and overhang is a critical issue. Thus, we model the nature of excess liquidity in Fiji and PNG and outline their overall impact on monetary policy. The choice of these two Pacific SIDS countries was made on data availability and noting role of these leading economies in the Pacific region. As for the emerging economies, we study the degree of monetary policy efficiency and estimation of neutral interest rate. China and India, the two largest emerging economies, are a natural choice for these empirical studies. In total, there are four essays in this thesis and we study three different, yet topical aspects of monetary policy. Firstly, we decompose and examine the impact of excess banking sector liquidity and its repercussions on the transmission mechanism of monetary policy in an operational setting using Generalized Method of Moments. Secondly, we calculate the efficiency of monetary policy in China and India using the Stochastic Frontier Model; and thirdly we estimate the neutral short run interest rates in China and India using statistical filters and semi-structural models estimated in a State-Space Framework.

Since the Global Financial Crisis; the introduction of United States' unconventional monetary policy; and the European banks' limited inter-bank trading fiasco, more emphasis is being placed on studying the hoarding of additional levels of banking sector liquidity that lies over and above the statutorily mandated amount. Risk averse banks, and lack of appropriate infrastructure and credit demand are two main reasons commercials banks keep precautionary and involuntary reserves. Our first two essays focus on excess liquidity. In our first paper, using the Generalized Method of Moments (GMM) framework, we find that in our sample set; Papua New Guinea keeps precautionary reserves due to the volatility in commodity prices, and therefore uncertainty associated with export receipts (tax and dividends from the petro-chemicals industry); monetization of fiscal deficits; high growth rate in the resources sector with decelerating non-resources sectors; low financial inclusion and lack of collateral for credit; high probability of civil unrest and security problems; amongst others.

Fiji, on the other hand, largely keeps stores of involuntary reserves due mainly to rigidities in investment climate; lack of avenues for channeling out foreign exchange reserves and investing them in viable projects; higher lending rates; exchange control limitations; and other similar restraints. While private and public sector deposits are high, they tend to sit idle in transactions accounts and are therefore parked in central bank demand deposit accounts, with a lower opportunity cost. All these impact the inter-bank trading, the primary focus of current-day monetary policy, and the primary cost of funds which is the conduit for monetary transmission.

Our study highlights some measures that can be undertaken by the Bank of Papua New Guinea and the Reserve Bank of Fiji to curb rising levels of liquidity that may pose inflationary pressures. Firstly, both central banks should relook at the their monetary policy framework and improve the interest rate structure. While Fiji operates in a corridor framework, the official monetary policy rate is ineffective in influencing the inter-bank market rate and consequently the retail rates. Monetary policy has been largely accommodative for a number of years, operating at almost the lower bound, and with excess liquidity in the system, the transmission of policy rates to the retail rates is incomplete. Investable opportunities are minimal and large inflows of foreign exchange are not converted into local currency, consequently a phenomenon *Keeping up with the Jones* is being exhibited. Papua New Guinea operates a reserve management framework without any quantitative targets for inflation, growth and exchange rate. Exchange rate is its de-facto nominal anchor and price stability is 'anchored' to exchange rate stability, which is *apparently* not a very well grounded shock absorber.

Secondly, net foreign assests need to be balanced with complete sterilization, given PNG and Fiji's high mineral (resources and water) receipts and an influx of foreign exchange reserves. In PNG's case, the government may also look at shifting its large trust fund accounts to the central bank. Other aspects of foreign asset transactions should be reviewed by both countries; and this should include causality analyses with aggregate demand, imports and consumption patterns, and the timing of import payments.

Addressing the money base and readjusting currency in circulation is vital and one of the simplest ways of withdrawing liquidity from the system. However, interest-bearing deposits tend to have a higher income elasticity of demand relative to currency and cash. For economies where deposits are invested in remunerative schemes, excess liquidity may be held for precautionary purposes like PNG, however, an absence of such schemes leads to involuntary hoarding such as the case in Fiji. The Fiji government, together with its various developments partners is trying to reduce impediments to investment so liquidity can be diverted into long-term capital projects.

More direct tools such as increasing the required reserve ratios, issuing more central bank papers, securities and treasury bills; and more prominent use of deposit and lending facilities will uplift the operational aspects of monetary policy in both countries and help address the problem of excess liquidity.

Having investigated the nature of excess reserves in Fiji and PNG, we examine the pass-through of policy rates to the market retail rates in two stages, firstly from the policy/target rate to the inter-bank rate, secondly from the inter-bank rate to the retail rates (commercial bank deposit and lending rates).

The policy interest rates set by the central banks affect the inter-bank rates, which underpins the process of defining the cost of funds lent by commercial banks, that ultimately influences

the behaviour of borrowers and subsequently the real economy. The role of the inter-bank market is therefore pivotal in the transmission of monetary policy. Moreover, the limited available literature on inter-bank markets looks at theoretical dynamics and its behaviour and ability to respond and transmit policy changes to the real economy during economic and financial stress.

Following on from the first essay, our second paper studies the implications of having excess reserves on the efficiency of monetary policy in transmitting signals to the inter-bank and the retail markets.

Chapter 1 explained how reserves are created through autonomous factors and the central bank's liquidity management decisions. However, if the economy is unable to fully absorb the reserves, then there is an inundation of excess reserves/liquidity[1] in the economy, which hinders the complete pass-through of policy rates to the inter-bank and retail rates; and in turn weakens the effectiveness of monetary policy. This suggests that the central bank's attempts to influence the market remains incomplete. Analyses in this Chapter are tied to the preceding one and the paper looks at the pass-through or transmission of the central bank's indicator rate to the other key rates in the retail market. The first stage looks at the inter-bank market; while the second stage investigates dynamics in the retail market. This is in fact the operational transmission of monetary policy for it to be an effective policy and stabilization tool in the economy. A common mistake in a number of studies is trying to regress excess liquidity or role of interest rate with excess liquidity with key macroeconomic variables. However, this is fundamentally flawed. If the operational transmission mechanism (that is impact of the central bank's policy rate to market rate) is not working or effective then using policy interest rate with other macroeconomic explains nothing and superficially assumes that policy interest rate affects the other macroeconomic variable when in reality it is not the case.

Therefore, this study is unique in the sense that research on developing countries thus far has focused only on macroeconomic variables, overlooking the operational aspect of monetary policy. That is, although, the ultimate goal is price stability and growth in aggregate demand, the channels via which this is attained is multi-fold and usually inter-related, the so-called "black box" of Bernanke and Gertler (1995). In an operational sense, the inter-bank market intuitively, carries a much larger weight since it is the behaviour of the money market that eventually decides the outcome of monetary policy. In other words, the inter-bank rate is the benchmark rate that identifies the magnitude of the private sector lending rates, both individual and corporate, given changes in the primary rates. When faced with liquidity imbalances, the inter-bank market allows commercial banks to reallocate liquid assets/reserves amongst themselves at a price allotted by the interplay of the market forces, steered by the central bank rates. However, despite the significant role it plays in maintaining financial stability, there is scant empirical research in the area.

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[1] Liquidity and reserves are used interchangeably in this chapter.

With regards to Fiji, the chronic levels of excess reserves have virtually left the inter-bank market in the "no-trade" zone for over 12 months (of our sample), while excess reserves has been a constant challenge for monetary policy in the last decade. This may stem from the fact that commercial banks have a perfectly elastic demand for free reserves, arising from the expansionary monetary policy stance (with a very low indicator rate ~ 0.5 percent as at June 2014, which has pumped an abundant level of liquidity in the market and, as Allen et al. (2009) suggest, the level is optimal given banks hoard reserves and stop trading with each other due to perceived liquidity risks. In line with studies that focused on the inter-bank hoarding of reserves due to the sub-prime crisis and given the political climate of the sovereign country, it is likely that commercial banks maintain an increasingly higher level of reserves[2], and willingly not engage in inter-bank trade. The situation in PNG is similar. The country has enjoyed robust levels of economic growth over the last 13 years and at times registering double digit rates. The growth is primarily being fueled by the resource based sectors, particularly, investment in and mining and exports of Liquefied Natural Gas (LNG). This has seen an influx of capital inflow and accumulated foreign reserves. Since most of the investment is internationally sourced, and despite the resources sector showing buoyant performance, the absorptive capacity of the economy is constrained, fueled also by the dwindling and at times, bullish, outcome in the non-resource sectors. This has flooded the economy with excessive levels of free reserves; which has made the inter-bank market defunct.

We use the Structural Vector Auto-Regression (SVAR) Model to examine the transmission of interest rates. Based on the results for Fiji, we find that that a shock to policy interest rate (that is, an increase in policy rate decreases the inter-bank rate, while a shock to policy and inter-bank rates decreases the monthly change in excess liquidity (Model 1). This is complemented by prolonged response from the lending and savings rate due to a shock to policy and inter-bank rate, and change in excess reserves (Model 2 & 3). For PNG a shock to policy interest rate initially decreases the interbank rate but causes a non-dissipating response of the interbank rate after the second month. On the other hand, the policy impact on change in excess liquidity causes an undulating response with its effects total disappearing in the sixth period (Model 1). Additionally, a shock to policy and inter-bank rate, tend receive a prolonged positive response from the lending and savings rate, whereas, the lending and savings rate, with respect to excess liquidity, has a prolonged negative impact (Model 2 & 3).

The final two essays focus on China and India. We firstly look at the efficiency of monetary policy in these two Asian giants; and then estimate the time varying neutral interest rate using the State-Space Framework. Monetary policy evolution in China and India has seen a

[2] In addition, the inter-bank interest rates are at extremely low levels. From an operational perspective, particularly in corridor frameworks where the returns on reserves (required and free reserves) are arithmetically linked to the policy rates, for instance, remuneration on reserves pinned at 75 basis points below the indicator rate, maintaining lower policy rates apparently, does not eat into the central bank margins. Saborowsk & Weber, 2013 quote studies that suggest that an economy's financial structure and the underlying regulatory and institutional quality underpin effective transmission.

wholesale reform of operational instruments, intermediate targets and overall goals of monetary policy facilitated by the deepening of economic reforms and structural adjustments. These shifts, have been dished out in a piecemeal and/or decisive manner and were rapid in nature producing varied results for the People's Bank of China (PBC) and Reserve Bank of India (RBI). They have been complemented by financial development, openness and rapid innovation of financial products and the changing structure of the economies, which dictate greater role of monetary policy as a stabilisation and demand management tool. In addition, international monetary policy coordination, in order to respond to changing underlying global economic forces and through lessons learnt from developed and mature economies has provided these selected Asian countries with a steep learning curve.

The evolution of monetary policy in these countries have provided a better arsenal of demand and stabilisation tools when combined with improved prudential supervision and financial system development; and real (gross domestic product), external, especially Balance of Payments (BoP) and fiscal sector reforms. Despite the current plethora of literature of the improvements in monetary policy and ensuing estimation of monetary reaction functions for these selected Asian economies, gaps in measuring the efficiency of monetary policy remains elusive. Therefore, the novelty of this study lies in the theoretical and particularly, empirical contribution to this under-researched domain of measuring efficiency of monetary policy in China and India. Exploring the potency of monetary policy in achieving the overall targets (with adopted instruments) can reveal and inform the utilised mechanism design and provide invaluable understanding to policymakers and academics in these two large Asian economies.

Based on the improved theoretical and empirical model centered on the framework provided by Li et al. (2010) and Cecchetti et al. (2006), the stochastic frontier efficiency analyses for China and India indicate a high level of efficiency in management of output gap compared to inflation gap. These results are mirrored by greater weighting of policymakers' preference to output gap compared to inflation gap, as indicated by the Generalized Methods of Moments estimates of the Taylor rule for China and India. Furthermore, the dynamic accounting analyses of macroeconomic performance weighted monetary policy efficiency analyses for China and India (based on split sample ratios) show a decrease in overall monetary policy efficiency, which is largely explained by the poor macroeconomic performance, variability of supply shock and monetary policy inefficiency with respect to inflation. On a positive note, the macroeconomic performance weighted cumulative impact of efficiency with respect to output is positive, indicating a marginal improvement for both China and India, generally re-enforcing (along with the Stochastic frontier efficiency results) that both PBC and RBI have been better at controlling the fluctuations in output gap and keeping output closer to its potential level.

The final essay estimates the time-varying neutral interest rate for China and India. We pose the question 'what is the right level of interest rates for emerging economies, like China and India? This is a pertinent question for emerging economies, that have undergone rapid structural changes overtime. The determination of the appropriate interest rates in emerging

economies can be a daunting task in economic policy implementation and management. It is something similar to pinning down a changing target. Such randomness in target interest rates can create significant degree of uncertainty for policymakers and can be difficult to deal with. Interest rates are crucial element in setting prices and returns for almost every economic asset and investment. For instance, interest rates determine exchange rate movements (including currency swaps), savings, credit and investment return rates in the economy, amongst others. Thus, policy interest rate is a key policy tool to manage and stimulate economic output.

The benchmark (or so called 'policy') interest rates are set by the central banks (or designated monetary authority with legislative power) in any economy. The policy interest rate are then utilised by the banking sector to price financial assets and returns, which is then transmitted to other economic sectors and agents in varied forms. For example, retails interest rate set by the commercial banks (that is, based on the policy interest rate set by the central bank) determines the cost of borrowing by the public and private sector, which in turn affects the pricing of similar financial products and services to recover cost of borrowing[3] and generate an adequate return on their investment and envisaged risk. Such is the impact of monetary policy stance on the economy. However, to determine the appropriate monetary policy stance with respect to interest rate in the economy it is important, that central banks have a good idea of their neutral or natural rate of interest. Generally, neutral interest rate is defined as an equilibrium monetary policy stance.

While complexities in the empirical estimation exists, appropriate estimates of neutral interest rate for emerging economies, like China and India, can provide significant policy insights, improvements and/or appropriate evaluation of the conduct of monetary policy and hence the management of the economy. In emerging markets, central banks have adopted more indirect form of monetary policy conduct, primarily based on the interest rates as policy indicator. Therefore, appropriateness of monetary policy stance also depends on the "neutral policy interest rate" stance to implement effective interest rate increases or decreases so as to efficiently influence financial markets, credit and capital costs and returns. However, a dominant feature of emerging market's monetary policy neutral stance is that it is subject to dynamic behaviour based on a number of factors. In large part, rapid structural changes in emerging economies, like China and India, drives the underlying changes in neutral interest rates. This is also contingent on the savings-investment patterns and domino effects of global or dominant trading partners' monetary policy stance.

Limited attention has been placed on the estimates for neutral (or natural) interest rates in China and India, especially with respect to time varying neutral interest rates. Most studies have focused on the estimation of fixed coefficient Taylor rule and invariably identify the constant as neutral interest rates. While such estimates do provide some direction on the magnitude of the neutral interest rates, they ignore its time varying dynamics and effects of

[3] Borrowing for the inter-bank market and/or from the Central Bank.

the change structure of the economy. Consequently, this research contributes to this policy space by estimating time varying neutral interest rates for China and India. From a policy perspective, understanding the dynamics of the neutral interest can tremendously help in the forward guidance of monetary policy if needed to do so, especially, in period of financial distress or crisis as in the case of developed countries. Nevertheless, forward guidance also helps in setting the interest rate path and adds some certainty to economic and financial decisions, as elaborated in the experience of New Zealand, Sweden and Norway.

We utilise numerous methods (using statistical filters and semi-structural models inspired by the literature on other emerging markets, like Brazil) to estimate neutral interest rates in China and India. Applying a two-sided varying coefficient estimator based on Generalized Methods of Moment yields time-varying neutral interest rates as low as just below 2% to just over 6% for China, while time-varying neutral interest rates has fluctuated from 4% to 10% in India. Accordingly, computing nominal and real monetary policy stance for these two economies, to analyse monetary policy performance. Overall, we find that output gap, inflation gap and inflationary expectation contemporaneously and negatively relate to a tightening real monetary policy stance and vice versa. This proves that the estimated time-varying neutral rates have provided quite reasonable indicator for assessing monetary policy stance against its objectives and supports the case for prudent response of monetary policy to achieve its objectives in China and India.

CHAPTER ONE

BANK RESERVES: PAPUA NEW GUINEA & FIJI

ABSTRACT

In this paper, we investigate the endogenous and exogenous drivers of excess liquidity in Papua New Guinea and Fiji using the Generalized Method of Moments specification. These two economies have been hoarding excessively increasing levels of reserves over the past several years and our analyses finds that commercial banks in Papua New Guinea (PNG) are highly risk averse and keep precautionary levels of liquidity over and above the statutorily required minimum. On the other hand, Fijian banks, maintain involuntary levels of excess liquidity. The factors influencing this behaviour are varied. PNG is a resource rich country, with a significant petro-chemicals industry, high economic growth, and experiences commodity price fluctuations. The Central Bank also monetizes fiscal deficits. Fiji's endowments are rather limited and it has moderate levels of economic activity. Investable opportunities are rather limited with high cost of doing business and complicated investment procedures. There are exchange control limitations and a possibility of *keeping up with the Joneses* behaviour in hoarding reserves. We highlight some avenues through which these excesses could be drained and the monetary policy indicator rate realigned so that monetary efficiency is achieved.

1.1 INTRODUCTION

The notion of excess reserves has been around for long and Edgeworth in 1888[4] was credited with popularizing thematic studies in banking sector reserves. The art of (central) banking has evolved significantly since then and this evolution has weaved greater complexities into reserve/liquidity management and demand models. While existing literature on banking and monetary economics is rife with studies on optimum monetary policy and profit maximization behaviour of commercial banks, very few studies have actually looked at this in context with the persistent hoarding of liquidity/reserves by commercial banks in small island developing states.

The first chapter of my thesis aims to examine the liquidity-reserving behaviour of commercial banks in two of the biggest Pacific Islands Countries, namely Papua New Guinea and the Republic of Fiji Islands, PNG and Fiji, respectively, hereafter, by decomposing liquidity into precautionary and involuntary reserves augmenting Saxegaard's (2006) framework.

The design and successful delivery of the reserve management system rests with the central banks as the 'suppliers/drainers' of liquidity. A sufficiently liquid market is necessary for effective monetary policy transmission, whereas a deficiency or excess may cause frictions. While different definitions of excess liquidity is offered in literature, today, nonetheless, there existence of clear excess liquidity because the money market real interest rate is too low for the current, increasing levels of inflation in our sample countries. In the presence of excess liquidity, the transmission mechanism becomes weak since commercial banks may not pass on interest rate changes to the consumer lending and deposit rates given they face lower opportunity costs and have no or very little competition in acquiring deposits. In a float system, it can impose down-ward pressure on the domestic currency and propel inflation.

Arguably, these and similar other problems mainly tend to inflict developing countries, due to capital market imperfections, size of commercial banks, inherent economic constraints and asymmetric information, amongst others. Where the increase in liquidity emanates from increased capital inflow, the domestic economy should be able to sufficiently soak up the influx, however, cyclical constraints and structural deficits plaguing many small developing states usually prevent this. Other sources of excess liquidity include, current account surpluses; increase in foreign aid; increased fiscal lending; structure of the financial market and financial instruments available; macroeconomic policies; and credit markets.

In order to understand the concept of excess liquidity better, it is imperative to clearly understand the operating framework of monetary policy; define the parameters of liquidity in

[4] See Edgeworth (1888).

our sample countries. Therefore, the first two sections of the paper look at the definition of excess liquidity and defines the monetary framework under which monetary policy operates.

For our empirical modeling, we utilize the Generalized Method of Moments framework and find that commercial banks in Fiji hoard liquidity purely for involuntary reasons while those in PNG park excess reserves for precautionary reasons. The structure of each economy is different however the operational aspects of monetary policy is quite similar. Additionally, the current excess liquidity situation is well understood in both countries**,** as is its impact on the effectiveness of monetary policy. For the central banks to manage excess liquidity that is consistent with the desired stance, an aggressive approach to withdraw liquidity (or inject in deficient conditions) is warranted.

The process to restore the effectiveness of monetary policy should primarily begin with focusing on the appropriate level of inflation (core objective) that the Reserve Bank of Fiji (RBF) and Bank of PNG (BPNG) need to achieve, and the optimal monetary policy stance that is consistent with that inflation objective. This will help determine the correct level of the Overnight Policy Rate (OPR) and the Kina Facility Rate (KFR) – the policy target rates for RBF and BPNG, respectively. Once a desired OPR/KFR is determined, a number of instruments are available to enable both central banks to drain enough liquidity to achieve equilibrium.

In PNG's case one of the least costly methods of sponging excess liquidity would be for the government to move its deposits from the commercial banks to the BPNG. If this is not sufficiently viable, then it can issue its own central bank paper (Central Bank Bills –CBBs). In Fiji's largely 'accommodative' case, a reassessment of the OPR is highly imperative. While some developed countries can effectively operate on or near the zero lower bound, Fiji cannot continue on this trajectory because excess liquidity is imposing inflationary pressures and increasing the cost of funds. Another option is to raise the required reserves ratio but may widen the interest rate spread.

Controlling foreign asset sales and purchases is desirable, however, adequacy of foreign reserves is essential. While this may be viable for PNG, given its large influx of international reserves due o petro-chemical export proceeds, it may not be an option for Fiji (one can argue accumulation of reserves and keeping up with the Joneses dilemma). Furthermore, the real effective exchange rate should stand ready to maintain external stability and competitiveness. However, given the effects of liquidity withdrawal on central bank capital, a long-term solution may require government bond issuance, with the issuance proceeds set aside and unavailable for financing expenditure.

Once short-term interest rates are in line with the policy interest rate, the RBF and BPNG will need to ensure that open market operations continue to support the OPR/KFR. Under the proposal of reinforcing OPR/KFR, the practical way to assess whether or not there is an excess liquidity is by asking if the current stance of monetary policy is consistent with

macroeconomic goals. Secondly, under a reinforced corridor system, there will be minimal demand for Bank Demand Deposits (BDDs) and Exchange Settlement Accounts (ESAs), so the level of the latter will not be relevant for the assessment of excess liquidity. It will also be important to ensure adequate information sharing between the Treasury and RBF/BPNG to support liquidity management operations.

The paper briefly suggests methods of controlling the central bank balance sheet items, such as net foreign assets, net public sector credit, net currency in circulation, open market operations and other policy instruments to catapult desired results and sponge-up excess liquidity that impedes proper functioning of the transmission mechanism.

The bottom line is that Fiji keeps excess reserves since its doesn't have enough viable channels to put the funds to productive use; while in PNG due to the socio-economic (and political) and structural drawbacks, banks are highly risk averse and tend to hold on to liquidity as a safety net against unexpected financial events. The results are as per our a-priori expectations; and indicate that the larger the level of demand deposits, the more precautionary reserves are kept by BPNG (a coefficient of 32 percent); and in Fiji's case the larger the private sector credit (17 percent) and international reserves (1 percent), the more involuntary levels are kept.

Saxegaard (2006) highlights two important aspects of excess reserves: i) precautionary reserves are less inflationary and more responsive to monetary policy; and ii) involuntary reserves are more inflationary and less responsive to monetary policy. We find similar results for Fiji and PNG.

At this juncture, it is worth noting that, excess liquidity is becoming a common phenomenon in most banking systems and one can assume a natural rate of excess to be always present at the equilibrium level. This concept and investigation of its presence is however beyond the scope of the current project.

The paper starts by studying and differentiating the different concepts of liquidity as used in central banking literature and sets the tone for defining excess liquidity. Section 1.3 describes the model and defends the use various parameters used in measuring excess liquidity and presents the Generalized Method of Moments methodology. Section 1.4 discusses the results while the final sections provides policy implications and sheds light on forward looking policies.

1.2 BANK RESERVES

Bank reserves or liquidity, although being the subject of discussions for many prolific writers and researchers such as Bagehot and Edgeworth in the late 1800's, have garnered a lot of attention recently due mainly to the banking sector turbulences of the last decade and as the behaviour of commercial banks to hoard increasingly higher levels of reserves becomes more problematic for monetary policy settings. We take a deeper look at the concept of reserves/liquidity and excess liquidity in this section.

1.2.1 LIQUIDITY DEFINED

In central banking literature, the concept of liquidity relates to the ease with which assets can be converted into cash. According to the BIS (2008) and the United States (US) Federal Reserve (2013), liquidity is simply the ability of the commercial banks (depository institutions) to satisfy obligations as they fall due. More frequently, the definitions assigned to monetary aggregates, for example M_0 and M_1 have been used, with the narrowest of the definitions implying liquidity to be high powered money[5] issued by the country's central bank, or in the widest of the definitions, broad money aggregates, more commonly referred to as *M3* (see Ganley, 2002; and Gray, 2008).

Ruffer and Stracca (2006) further explain that defining liquidity in a globalised financial system is immensely difficult and using the monetary aggregates measure is fraught with challenges, nonetheless, a more robust definition should also include endogenous money or inside money. Consequently, most financial and monetary analysts, (see Morgan Stanley, 2005) use a varying-mix of money measures in contemporary literature.

For the purposes of the present study, liquidity will consistently be defined as, and in line with general central banking definitions, cash-flows into the banking system, reflected by the holdings of domestic currency denominated liabilities on the central banks' balance sheets, consisting of reserves[6] - that the central banks make available to the commercial banks. This classification is one of the most fundamental of the definitions as it is the cost of this concisely defined liquidity that the central banks either directly or indirectly manage in order to implement and/or control monetary policy[7]. For instance, in excess liquidity conditions, the central banks may use various instruments at their disposal to mop-up the surplus from the economy, for instance, by increasing the overnight policy rates, that shadows the overnight lending and borrowing rates at the inter-bank market[8] which ultimately affects the bank

[5] High powered money is referred to as the monetary base or M_0 (Friedman M. , 1956; Tobin, 1969).
[6] This is a separate concept from foreign exchange reserves, which is typically known as *reserves*.
[7] See Tito et al. (2014) fore more.Both central banks in our sample set target the c ost of this liquidity to mamage monetray policy.
[8] Inter-bank market is the market where commercial banks and depository institutions trade reserve balances (held at the central banks) to maintain adequate liquidity and fulfil daily settlement obligations. Some popular inter-bank rates are the Federal Funds Rate, the EURIBOR (Euro Inter-bank Offered Rate) and the LIBOR (London Interbank Offered Rate).

lending rates, subsequently curbing any inflationary pressures (the interest rate channel of transmission).

Commercial banks are statutorily mandated to hold a certain portion of their portfolio specified by the Reserve-Ratio[9], and denominated in domestic currency, with the central bank (as liabilities on the central bank balance sheet[10]). These are known as the Statutory Reserve Requirements (SRR, RR). In Fiji, they are classified as statutory reserve deposits (SRD) and in PNG, they are called cash reserve requirements (CRR). RR is held either in the form of i) central bank currency[11]; and/or ii) reserve balance accounts.

If for example, the reserve ratio is 10 percent, then for a given calendar month, 10 percent of the preceding week's reservable base can be used as RR. This can be computed as 10 percent of the daily close-of-business level of reservable base then averaged at the end of the 7th day (or the net balance at the end of the 7th day). Commercial banks will then be required to hold 10 percent of the same on a weekly basis in the form of RR. At the end of the week, commercial banks should be holding the mandated amount of RR while on a day-to-day basis; they can either remain below or above this level. This 7-day window is the maintenance period of RR and the aforementioned practice represents the lagged system of RR calculation.

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[9] It can be argued that the base for the reserve ratio should be aligned to the monetary aggregate anchor (for example, M_0 to M_3) that the central bank elects to use as an operating target for monetary policy. This will consequently restrict the use of external liabilities (denominated in foreign currency) as an operational base, in some cases. In addition, liabilities with short maturity periods (especially two years and lower – see Gray, 2011) are considered more appropriate reservable bases.

[10] The central bank balance sheet is discussed further in the next section.

[11] This is held by a very small subset of IMF member countries in part fulfilment of the RR.

FIGURE 1.1 A: FIJI SDR

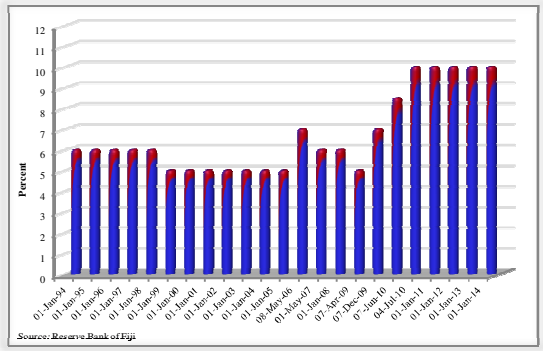
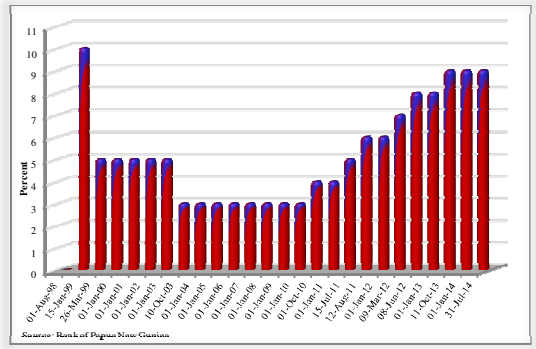


FIGURE 1.1 B: PNG CRR



Gray (2011) highlights that nearly 93 percent of the International Monetary Fund's (IMF) 121 member country central banks legally oblige commercial banks to maintain RR[12]. Countries can fix a single ratio like the prevailing rates in Fiji and PNG (see Figure 1.1 A/B) or set by the European Central Bank (ECB) of 1 percent or RR of €103,924m[13] (ECB, 2014). A range of rates is also mandated in some countries like the US, where a threshold of US$13 million has 0 percent rate (exemption tranche), while anything over US$89 million attracts a 10 percent rate, and liabilities lying in-between these extremes are allotted a 3 percent ratio (low reserve tranche).

The People's Bank of China (PBC) also uses a multi-layered framework. Since it is mandatory to keep reserves at the prescribed level, maintenance failures sometimes draw fines. Penalty rates are usually set at levels higher than the discount rates (ceiling rates) to prevent truancy and promote adherence to the RR[14]. Central banks prefer that the banks utilize the operational framework in place and borrow from the inter-bank market to meet shortfalls rather than be deficient at the end of the maintenance period.

Gray (2011) further addresses three reasons for imposing RR, namely; i) prudential; ii) monetary control; and iii) liquidity management. Under prudence, RR is an *insurance* against solvency or liquidity risks, allowing commercial banks to adequately meet their short run demand obligations, especially during unexpected turbulences, example bank runs. The IMF (1995) states that RR allows the central banks to effect changes in the money market interest rates. Therefore, it is an indirect instrument for controlling money supply and ultimately credit growth in the economy (see also Feinman, 1993; Montoro & Moreno, 2011 and Borio, 1997 & 2011). RR exerts influence through the money multiplier (which is the inverse of the

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[12] New Zealand, Canada, Sweden, Norway, Denmark, Mexico and Timor-Leste are the only exceptions, together with the Hong Kong Monetary Authority (IMF, 2014).

[13] For maintenance period 11/06/2014 to 08/07/2014 (https://www.ecb.europa.eu/mopo/implement/mr/html/index.en.html).

[14] The ECB imposes a 2.90 percent charge on deficient banks[14], while the RBF and BPNG impose minimal penalties.

reserve ratio, so the larger the ratio the smaller the money multiplier and therefore a larger constraint on credit growth); and the interest rate corridor, with the latter channel being more prominent of the two.

RR also facilitates the maintenance of adequate liquidity in the system, in that balances held at the central bank may earn interest at marginal rates and by changing these rates and/or the reserve ratios, central banks can take the reins and normalise any unwanted liquidity surges and stabilize the economy (Gray, 2011). A recent example is that of the US banking sector. Pre-GFC[15], the US Federal System did not pay any interest on reserve balances. With the enactment of the Financial Services Regulatory Relief Act of 2006 and the Emergency Economic Stabilization Act of 2008, the Federal Reserve began to pay interest on reserve balances beginning - October 01, 2008. Before October, total reserves amounted to US$45 billion (a trend held in the last 5 decades). However, during the first half of 2012, reserves averaged over US$1.5 trillion (see US Federal Reserve Bank of San Francisco, 2013; Labonte, 2014).

The PBC has also used increases in reserve ratios and reductions in the remuneration rates for required and free reserves as one of the main sterlisation tools to curb the increasingly large inflows of foreign exchange reserves (see Ma et al. 2011), totalling some US$4 trillion at the end of June, 2014[16], which is amongst the highest in the world. In terms of China's Gross Domestic Product (GDP), RR also tops the charts. The multi-layered RR framework gives the PBC more freedom to utilize this tool; and it also one of the most cost effective ways of addressing liquidity issues.

Furthermore, most commercial banks keep additional reserve accounts with the central banks. These take the form of Exchange Settlement Accounts (ESA-PNG), or Bank Demand Deposits (BDD-Fiji) commonly known as Free Reserves (FR), which contain exchange settlement balances and/or working balances; and short-term deposits.

In line with the Keynesian money demand models, Saxegaard (2006) explains that the demand for free reserves arise from risk aversion due to structural and cyclical instabilities/shocks that compel commercial banks to maintain, as a precaution or involuntarily, additional reserves to meet payment systems shortfalls. Borio (1997) suggests that the main reason for holding BDD is precautionary[17] - to avoid the risk of incurring penalties as a result of failing to meet obligations with its existing balances at the central bank. Holmstrom and Tirole (1998) and Stein (1998) suggest that excess liquidity is a buffer

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[15] Refers to Global Financial Crisis (GFC) of 2007-2008 emanating from the US financial sector.

[16] See http://www.bloomberg.com/news/2014-07-09/china-to-keep-intervening-on-yuan-finance-minister-says.html.

[17] Some studies highlight that the measure of precautionary reserves takes the form of square root of the scale of transactions (Olivera, 1979) – where reserves imply the holdings of any asset to meet unexpected deviations. Most studies have shown that stocking up/reserving assets are contingencies only.

against liquidity shocks. Risk neutral level of reserves are usually held involuntarily since there may not be enough viable investable projects to make productive use of liquidity.

Commercial banks in Fiji keep BDD accounts with the RBF, while those in PNG keep short tenured ESA to meet intra-day settlement needs. Countries without an RR system (for example, Australia and Canada) keep ESA accounts while some others (for example United Kingdom) maintain BDD (contractual) accounts. RR and BDD/ESA represent the pool of total reserves (TR) at the central banks and when central bankers refer to excess liquidity, they refer to this great ensemble! In a simple framework, TR is replenished via deposits and used-up via loans.

Around 70 percent of IMF member central banks do not pay any interest on the reserve balances, including PNG, and Fiji as of late. The remaining 30 percent which remunerate, either fix the rate at the policy target rate or below, in the form of a constant rate or in bands. This is to minimize distortionary effects and also use remuneration as a policy maneuvering tool. Unremunerated reserves (URR) are also effective. Changes in liquidity flows are brought about through the interest rate corridor/spread since the (implied) forgone interest from the absence of remuneration would be passed onto consumers in the form of higher/lower lending and deposit rates. The US, until 2008 did not remunerate reserves and monetary policy had been working as effectively. Arguments such as URR impose a deadweight burden on banks as they are unable to compete with their non-encumbered competitors led to the creation of deposit sweep programs, which effectively reduced the size of RR by classifying a proportion of the reservable base as non-reservable giving banks a competitive edge. Marginal URR - surplus reserves are temporarily accounted as RR and are used to rein in liquidity.

1.2.1.1 EXCESS LIQUIDITY

At cursory inspection, the concept of excess liquidity appears simple. Nonetheless, the finer workings of the commercial banks' settlement accounts and the reserve management system need to be examined to fully comprehend what excess liquidity is. Any level, over and above the RR is regarded as surplus, which suggests all free reserves are excess (Mishkin, 2012). In other words, BDD, ESA, and FR represent excess liquidity in the banking system. However, in central banks' liquidity/reserves forecasting models, it is imperative to make a distinction between free and excess reserves in relation to the reserve maintenance period.

Hypothetically, if RR is $2 million, and on day 1 of the maintenance period, free reserves are $3 million while daily clearing needs push settlement requirements to $6m, a shortfall of $1 million appears. Even though the TR of this commercial bank is above the RR almost twofold, the commercial bank will need to either borrow from the inter-bank market or the central bank using standing facilities to satisfy this shortage. Classifying this economy as having excess reserves on the basis of BDD alone is erroneous. If the scenario was to repeat

at the end of the maintenance period, then this shortage would attract penalties from the central bank. Furthermore, the use of BDD/ESA to represent excess liquidity, or lack thereof, at that juncture will then be acceptable.

Ideally commercial banks hold precautionary/involuntary reserves at a 25 to 50 basis points margin above the RR (see Gray, 2008; US Fed Reserve 2014). Factors like unpredictable banking climate, volatilities in deposit patterns, economic health of the country determine the level of buffer that banks are comfortable with. Given this dilemma, identifying excess liquidity becomes cumbersome. The task then becomes one of deciphering the level of desired reserves based on optimality conditions and the trend depicted by BDD/ESA; and then isolating the excess level, which is the primary focus of modern monetary policy.

Demanded reserves less the desired level should reveal excess liquidity in the system[18]. Indeed, for countries without an RR system, like the UK and Australia, liquidity forecasters at the central bank have the taxing task of determining the daily reserves needs of the banking system, as non-statutory reserves may have a volatile demand pattern (see Section 1.5). It is also important to note the magnitude and frequency with which commercial bank reserve balances fail to meet/surpass settlement requirements since this will have serious implications for the operating targets for monetary policy[19].

According to the IMF (2013), a second case of excess liquidity arises during a credit crunch when commercial banks are reluctant to provide loans[20]. In such cases there could be credit rationing. As a consequence, commercial banks could have a high share of liquid assets on their balance sheets. This situation typically occurs after a financial crisis. In Fiji and PNG, the ratio of credit to deposits is relatively and liquidity ratios are high. This situation reflects a low degree of credit market development, but also an increasing supply of T-bills/bonds for public finance purposes. The situation could change gradually in the future concomitant with the development of credit markets and strengthened fiscal accounts. It is pivotal for both central banks to follow this process as it should improve the effectiveness of monetary policy.

A third case of excess liquidity is a macroeconomic one - there is an excess liquidity if the monetary conditions are not consistent with the control of inflation. The existence of excesses depends on macroeconomic conditions, that is, the level of liquidity that induced low levels

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[18] This has been empirically tested by many researchers (see Agénor & Aynaoui, 2010). They show that commercial banks continuously adjust their actual holdings of excess reserves (*FR*) towards their target or desired levels (FR^*). With beginning of period actual level of excess reserves denoted as FR^0, and the adjustment process, as $\gamma \in (0,1)$; excess reserves (where the actual holdings exceed the desired level) can be shown as:

$$\frac{FR}{FR^*} = \left(\frac{\gamma FR^* + FR^0(1-\gamma)}{FR^*}\right) = \gamma + (1-\gamma)\left(\frac{FR^0}{FR^*}\right)$$

[19] It is usually argued that RR can help forecasters accurately predict the actual demand levels, provided it is fixed at sufficiently comfortable levels. Reserve balances can assist in determining the level of excess in the economy and guide the direction/magnitude of monetary instruments.

[20] Refer to footnote 28.

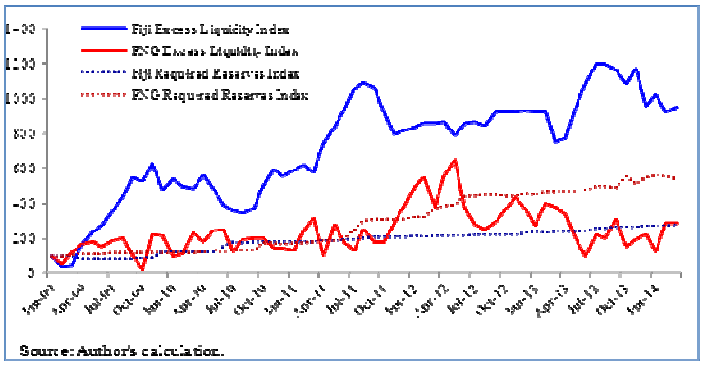
of real interest rates could be considered an excess when the rate of inflation is above the level considered desirable by the central bank. But if macroeconomic climate changes to deflationary pressures, the same level of liquidity may be considered appropriate rather than excess.

The price of reserves is also important in considering BDD and ESA levels. The price of liquidity is the interest rate or the opportunity cost of holding that liquidity. In PNG's, the closest opportunity cost for holding ESAs for a commercial bank is the yield of the 28-day Central Bank Bills (CBBs). Presently, the 28-day CBB yield is 1.9 percent. In Fiji, the closest proxy is the interest rate on the 91-day Treasury Bill, which currently stands at 0.39 percent However, while considering the price attached to these, one has to be mindful of the inflation rates, which effectively gives the real opportunity cost of holding large BDD and ESA balances.

Remunerated excess liquidity if priced below the money market rates signal greater opportunity cost of holding reserves in central banks - incentive to allocate additional deposits as insurance against liquidity risk is comparatively lower. Remuneration is usually set within the range of 100 basis points south of the rate paid on RR. However, some central banks, like the Federal Reserve, keep the rate at par with the RR remuneration rate[21]. RBF and BPNG remunerate at a level below the policy rates, but from recently the remuneration has been temporarily ceased, mainly to cut down costs and mop-up liquidity. Despite this, liquidity is still being hoarded by commercial banks, consequently, excess liquidity has become a permanent feature of the RBF and BPNG balance sheets (Figure 1.2). If the existing framework is unable to curtail this rise, then studying the micro-components of the cause-effect bin is vital to better the monetary policy operation. This will also aid in the forward guidance policies of the two central banks (for example, the implication on growth in new lending in the presence of excess reserves: would the economy overheat?)

[21] The UK uses the remuneration of reserves as their policy target rate.

FIGURE 1.2: RESERVES INDICES



Most empirical studies on excess reserves have focused on macroeconomic shocks, which increase the banking sector's risk aversion leading to the accumulation of more than the required level of reserves. For instance, liquidity hoarding was rampant during the GFC and US banks were frequently found unwilling to lend in the interbank market arising from the need to self- insure. Ashcraft et al. (2011) find that in the US intra-day and overnight settlement systems, most banks held onto interbank funds as a precaution only, especially during the day, and would sometimes lend overnight. This was due to the large fluctuations in the federal funds rate which frequently overshot the discount (ceiling rates) and crashed at zero during most trading days.

Agénor et al. (2004) investigate demand and supply factors for the credit crunch in Thailand post 1997 East Asian Crisis by analysing the empirical excess reserves demand model and conclude that the accumulation of the liquidity was primarily a result of supply side impediments. The authors highlight that build-up of liquidity due to subdued credit demand are involuntary in nature in that they are beyond the commercial bank's control, however, increase in reserves due to supply side constraints are construed as evidence of voluntary hoarding (this finding has implications for PNG – see Section 1.5).

On the other hand, an earlier study by Dollar and Hallward-Driemeier (2000) find results to the contrary and suggest that the rise in FR during the Asian Crisis was due to involuntary sources stemming from demand side constraints of credit growth as a result of weaker aggregate demand conditions. Mohanty et al. (2006) also find demand driven sources of excess reserves in selected developing and emerging economies. A similar conclusion is also offered by Wyplosz (2005) for the Euro-Zone that the lacklustre growth outlook post 2000 (involuntary nature) was the primary cause for the liquidity build-up since the Union had entered a cyclical slowdown with an expansionary yet ineffective course of monetary policy (this finding has implications for Fiji as well – see Section 1.4).

In a similar vein, Saxegaard (2006) examines the excess reserves dynamics of the Sub-Saharan African region by quantifying the extent by which it exceeds the level needed for precautionary purposes. The decomposition is vital in that monetary policy decisions effected in the presence of involuntary and precautionary reserves may lead to varied results. He

highlights that some countries hold precautionary levels while others hold involuntary reserves, and further concludes that involuntary reserves are more inflationary and less responsive to monetary policy. He uses instrumental variables and threshold vector autoregressive and impulses responses for the estimation and concludes incomplete transmission in the presence of excess reserves.

Agénor & Aynaoui (2010) study excess reserves in the presence of credit market asymmetries, without disaggregating reserves into precautionary and involuntary components and conclude that in a contractionary phase, deposit rate does not fall quickly enough which eases collateral requirement on borrowers resulting in lower risk premiums and lower lending rates. Consequently, excess reserves impede monetary policy in curtailing inflation. In order to fully understand the causes of excess reserves, it is imperative that we get the picture the current monetary policy setting in our sample set.

The following section gives a brief theoretical background.

1.2.2 MONETARY FRAMEWORK

The fluent operation of monetary policy depends on the existing framework and efficiency of operational instruments. Fiji has a corridor system in place while PNG is moving towards a corridor. PNG's monetary framework is fully discretionary with an informal nominal anchor - the exchange rate. BPNG does not have clear quantitative targets on inflation, money supply and exchange rates and operates under a loose excess liquidity management framework whereby the central bank announces a monthly target on the Kina Facility Rate (KFR – the policy indicator rate) and uses open market operations, mainly using the Central Bank Bills (CBBs) and treasury bills. The KFR was introduced in 2001 as a monthly benchmark to signal monetary policy stance and set the rate for inter-bank transactions. The range for CBB maturities is from 28-182 days while that of T-Bills is 6-12 months.

In Fiji, corridor system hinges on three rates of interest: i) Overnight Policy Rate or OPR; ii) the discount rate (lending facility rate) and iii) the remuneration rate (deposit facility rate). The OPR like KFR is the interest rate of the choice instrument that that central banks use to signal policy intention (increases show a contractionary stance, and reduction spells an expansion).

Most central banks use the rate offered on open market instruments such as government-treasury or self-issued bills[22] to proxy the target rate (Fiji 91-day T-Bills), and some others may choose rates on Repurchase Agreements (REPOs) or Reverse REPOs (PNG); while others like Australia, the US and the UK may use the interest rate on overnight exchange

[22] The maturity of these securities may differ between countries.

settlements; and the interest rate on reserve balances, respectively. Once the policy stance is announced, the rates of the operational instruments are expected to gravitate towards the indicator rate, and in so doing influence the interbank rates. Figures 1.3 A/B show the operational framework in Fiji and PNG[23].

The discount rate/primary credit facility rate is the lending price imposed on commercial banks for collateralized loans. These standing facilities provide very-short term credit to commercial banks. The tenure for such instruments is overnight and are similar to the repo rate[24]. They also comprise a penalty price set above the policy rate to discourage commercial banks from borrowing from the central bank and encouraging them to utilize the inter-bank credit market instead. The interplay of demand and supply factors should ensure that the inter-bank market operates efficiently and is able to allocate a competitive price for new inter-bank credit. The discount rate usually acts as a ceiling rate for the inter-bank shadow prices.

Depending on the existing stance and efficiency of monetary policy, the prevalent inertbank rates can either be above or below the policy rate. In PNG's cse, the discount rate closely follows the REPO rate and sets the ceiling for all previaling rates. The presence of excess liquidity has rendered the primary credit facility ineffective in both countries.

[23] The charts clearly show that the transmission is ineffective since the operational instruments do no follow the target rates.
[24] This classification is central bank specific, as some may not categorise REPOS as standing facilities, rather as a discretionary tool.

FIGURE 1.3 A: RBF FRAMEWORK-INTEREST RATE STRUCTURE

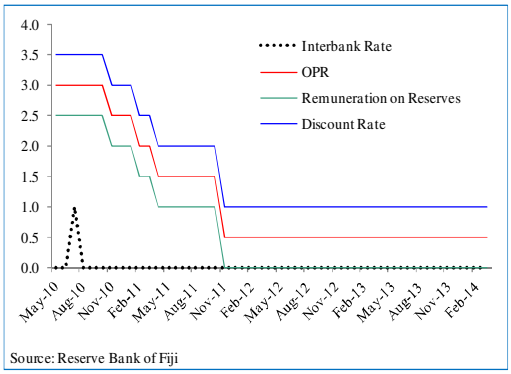
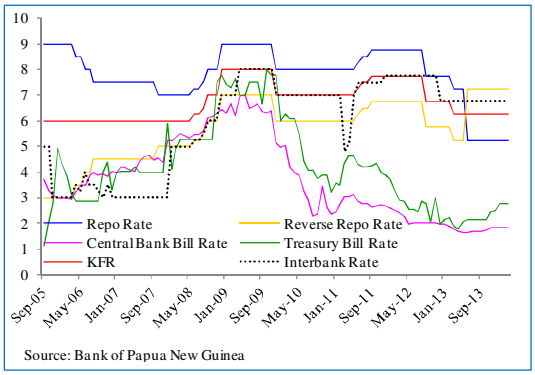


FIGURE 1.3 B: BPNG FRAMEWORK-INTEREST RATE STRUCTURE



Deposit facilities create the floor. Some central banks tend to reward commercial banks for maintaining reserve balances with them, since the opportunity cost for banks would be higher if they keep productive assets, idle, bearing no interest. With remuneration, TR tends to be higher due to lower implied tax. The remuneration rate is set below the policy indicator rate and creates a floor for the inter-bank rates. It is the interest paid to commercial banks by the central bank on selected deposits. It can also include interest on standing deposit facilities - either overnight or tenured. In the absence of interest rates on required and free reserves, these deposit facilities create the lower bound.

According to the US Federal Reserve Bank of St. Loius (2008), the general practice has been to set the interest rate on free reserves at 25 basis points (¼ of a percent) below the policy indicator rate, and that of the REPO rate at 25 basis points above the target rate. The general pattern has been similar across most countries, while the rates of interest have widely differed.

FIGURE 1.4 A: FIJI INTEREST RATES & SPREADS

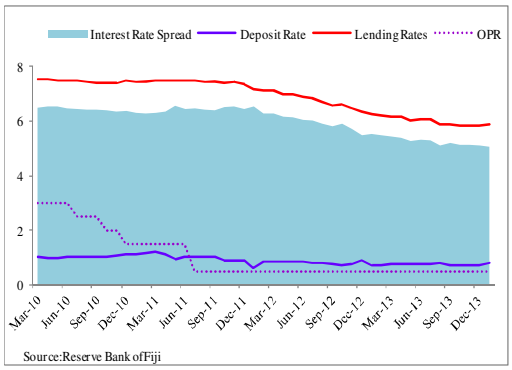
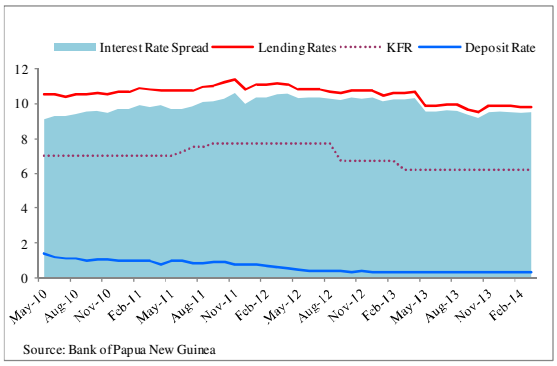


FIGURE 1.4 B: PNG INTEREST RATES & SPREADS



Remunerating reserves (inclining excess reserves) may sometimes appear paradoxical given an expansionary stance. Theoretically, if the central bank decreases the policy rate then remuneration will continue to allow banks to keep reserve balances (lower opportunity cost). These will earn interest while remaining in the transactions account, but will not add-on to the stock of reserves but will create a floor for the inter-bank market for credit, which will push down other rates, at least in theory, (see US Federal Reserve Bank of San Francisco, 2013; and Gray, 2011)[25]. The transactions' account assists central banks' in liquidity management initiatives.

The bottom line is that the discount rate ceiling and the remuneration rate floor create a corridor for the inter-bank market and policy indicator rates to co-move[26]. As for the consumer rates (commercial bank lending and deposits rates), empirical pattern suggests that the spread is quite substantial (see Figures 1.4 A/B). Again, this is due to the profit-maximising behaviour of commeercial banks. Tightening stance will see consumer rates increasing and vice versa.

1.2.3 DEMAND FOR RESERVES

As mentioned in the preceding section, commercial banks are not obliged to maintain BDD/ESA accounts but they voluntarily do to satisfy intra-day settlement needs, while leftovers are maintained in the same account and either traded in the inter-bank market or left idle. Therefore, demand for bank reserves, R^D is given as:

$$R^D = RR + FR \tag{1.1}$$

while the marginal level is:

$$\Delta R^D = \Delta RR + \Delta FR \tag{1.2}$$

where RR is the statutory required reserves and FR is the free reserves level consisting of BDD and/or ESA. These have been explained in Sections 1.2.1-1.2.2. RR is mandated by the central banks so it is taken as given *(required ratio* x *reservable deposit base)*. Where RR is not imposed, $R^D = FR$, i.e. demand for reserves is demand for settlement balances.

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[25] Using the US example once again, the emergency decrees in the aftermath of the GFC, saw the injections of large liquidity flows into the banking system, leading to surplus and pushing down the Fed Fund Rates below target. To combat this, reserve remuneration was introduced which was an, in effect, an opportunity cost to the commercial banks for providing inter-bank funds at lower rates, and encouraging them to increase BDD holdings, thereby absorbing the excess and diverting them to the non-bank sector to shore-up the economy.

[26] It is also likely that the targeted policy rate will hover at the floor, especially when the reserve remuneration rates are targeted. This is the floor operating system.

Furthermore, Borio (1997) outlines that RR and FR are dependent upon the design and structure of the RR regiment; the design, structure and workability of the real time gross settlement system (real time monetary payments systems); and the accessibility and penalty rates for standing facilities/collateralized loans. For example, inefficient payment systems would likely see central banks holding larger buffers to meet shortfalls. Additionally, lower accessibility or higher penalty rates may see higher *FR* balances leading to increases in reserves demand.

He further adds that for RR to influence the marginal reserves demand, satisfaction of two binding constraints is crucial, which include the ability of RR to meet settlement requirements; and the magnitude of RR surpassing that of settlement balances, whereby shortfalls in the latter can be covered by RR with a possibility of zero residual. This may however, not always hold in practice, therefore, the component influencing marginal demand then would be the working balances.

1.2.3.1 DETERMINANTS OF EXCESS RESERVES: EMPIRICS

This section looks at the determinants of FR from the reserves demand model: $R^D = RR + FR$.

Following (1.1), the identity for Total Reserves (TR) is equated to R^D, which is equivalent to supply, (R^s), in equilibrium:

$$TR = FR + RR = R^S \tag{1.3}$$

And consequently, excess reserves or excess liquidity can be re-written as:

$$\Delta FR = \Delta R^S - \Delta RR \tag{1.4}$$

which suggests that the excess reserves, FR, is a residual of the net autonomous and policy positions of the central bank while accounting for the statutorily required level of reserves. Identity (1.4) shows one way of calculating excess reserves and is consistent with the definition of FR from Section 1.2.1, which corresponds to commercial bank holdings of deposits at the central bank in excess of RR, and is comparable to identities used by Agénor et al. (2004); Saxegaard (2006) and Agénor and Aynaoui (2010), amongst others.

The authors point out that the determinants of excess liquidity can be broken down into i) precautionary; and ii) involuntary components. Precautionary reserves is the level above the minimum statutorily required balances needed to address payments system hiccups. Any level in addition to this is classified as involuntary. Consistently, the determinants of FR can be established by decomposing elements into these two explanatory matrices.

Precautionary factors explaining FR consist of several volatility measures. The level of *RR* (as a ratio of total commercial bank deposits) is assumed to be negatively related to FR , in line with the R^D dynamics. As the level of statutory required reserves increases, the overall risks associated with payments system shortfalls decreases leading to lower FR. Additionally, if surplus reserve sterilization is undertaken and RR[27] is increased, ceteris paribus, an increase in the domestic consumer rates is likely since the cost of keeping productive assets as RR will be pushed onto lending rates effectively subduing domestic demand (as there is clear causal relationship between new lending rates and domestic demand/expenditure – see Section 1.5). Higher lending rate will translate into larger interest rate spreads.

The penalty rate, (i^D) at which the commercial banks will be required to borrow to stabilize any shortfalls experienced in intra-day settlement balances, is also deemed relevant to FR . Handa (2008) states that this form of lending by the central bank is related to the notion of the *lender of last resort*[28]. i^D is assumed to be directly related to excess reserves in that a higher penalty rate increase costs associated with deficiencies, and induce banks to hoard up more reserves. Inclusion of i^D in the empirical model also serves an additional purpose.

The distinction between borrowed and non-borrowed reserves is imperative here. Replenishing of reserves stocks via borrowing from the central bank is usually classified as borrowed reserves and those acquired via customer deposits (deposit base) or sale of securities and commercial paper is deemed as non-borrowed reserves. Repeated and heavy borrowing can lead to the speculation that the commercial banks are unstable in managing liquidity needs, which can possibly lead to contagion fears in the economy.

The cyclical pattern of economic activity can also influence excess reserves level. If growth is bullish, then aggregate demand and consumption activity would increase, putting pressure on the holdings of currency in circulation and ultimately on money demand (discussed in detail in section 1.5). In turn, this would lead to an increase in the demand for excess reserves. Therefore, economic growth can be used as a proxy for currency demand. Nonetheless, a more robust measure would be output gap (Y^{GAP}), which shows the deviation of economic growth from its potential level. Y^{GAP} shows the cyclical position of the economy and is again directly correlated to FR .

In addition to this, volatility and liquidity risks can be explained using the output gap and cash/currency to deposits ratios (*C/D*). Based on Saxegaard (2006), the volatility in output gap, ($VOL^{Y^{GAP}}$), is used to denote the level of cyclical fluctuations in the economy, with a positive level indicating greater risk associated with FR^D . $VOL^{Y^{GAP}}$ is calculated using the

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[27] At the other extreme is open market operations and other policy tools together with reserve remuneration.

[28] He further states that the borrowing facility (discount window) and the ability of commercial banks to utilise it acts as a safety valve for the economy as a whole since most banks would initially resort to borrow from the interbank market but if the liquidity shortage is economy-wide plaguing most, if not all, banks, then the central bank will lend the additional reserves.

moving average of the standard deviation of output gap. Similarly, the *C/D* ratio is the preference of deposit holders to hold currency as opposed to maintaining deposit balances at banks. The higher the ratio, the greater the need for commercial banks to maintain sufficient reserves levels.

Additionally, volatilities in the ratio, increases the precautionary needs to keep such balances. The volatility in the *C/D* is denoted as $VOL^{C/D}$ and is measured as the moving average of the standard deviation of *C/D* weighted by the same period moving average of the *C/D* ratio (coefficient of variation).

The volatilities associated with the total deposit base and components of the deposit portfolio of the commercial bank also affect the demand for excess reserves. Firstly, if the degree of volatility of the deposit base is large, risks will be higher, and FR^{D} will be greater, since banks will insulate themselves from sudden bank runs. Decomposing the demand base into its varied components can provide a clearer picture, for example, commercial bank total deposits are made up of private and public sector deposits.

Therefore, VOL^{PS} and VOL^{G}, show the respective levels of deposits calculated as the moving average of the standard deviation of the private and public sector deposits, weighted against the same period moving average of the variables. Furthermore, the risks associated with the tenure of the deposit base also influence excess reserves demand. The higher the proportion of short tenured deposits (for example demand deposits), the greater the level of FR . The ratio of demand deposits to time and saving deposits is denoted as *DD* in the empirical model.

Involuntary hoarding of reserves may result either from risk taking behaviour of banks and can be due to structural; cyclical and political instabilities/shocks; and other similar restraints. Such impediments reduce the avenues for channeling-out accumulated funds to viable investments and commercial banks are compelled to maintain increasingly higher levels of reserves with the central banks.

Structural factors may include macroeconomic constraints, under-developed financial markets including an under-performing inter-bank market, sluggish credit/financial market mechanics and a poorly functioning capital market. These increase the demand for reserves for example a non-robust payments system or higher costs associated with project management and credit evaluation will see commercial banks keeping higher levels of working balances.

Political instabilities and similar crises will also increase reserves demand due to higher risks associated with lending in a volatile climate. Therefore, a higher risk premium[29] is usually attached to market lending rates (i^L), which ultimately dampens credit growth[30]. This can increase private sector (business and individuals) deposits (DEP^{PS}) which are maintained to cater for cash-flow requirements given credit constraints (including the high risk premium and associated costs) will hinder easy access to credit (CRE^{PS}).

A similar reasoning may also underscore deposits and borrowings from the public sector for example, a major component of government liabilities (assets on banks' side) are government securities, which can be converted into cash on demand using the standing facilities of the central bank– (see discussion in Section 1.5).

An under-developed financial system with low availability of financial instruments and other short-term investment schemes and similar savings facilities can also see private sector deposits increase. Given this scenario, commercial banks- faced with lower credit growth and high deposit rates, will inadvertently keep higher reserves.

If, however, some viable investments schemes are available, for example bonds and securities *(SEC)*, then the opportunity cost of keeping additional reserves increases (equivalent to the interest rate on the bonds/securities), therefore, demand for excess reserves would decrease. Furthermore, capital market constraints, for example the market is either under-developed or heavily regulated, can also limit commercial banks into diversifying their funds.

In an economy characterized with heavy inflow of external receipts, such as PNG which has a high inflow of LNG receipts or Fiji, with high foreign reserves *(IR)* coming from mineral-water/tourism exports, and other capital inflows; such capital market asymmetries together with other structural impediments leading to sluggish economic activity has resulted in the buildup of idle funds at the banks.

Ideally the buildup of liquidity should translate into domestic credit to finance domestic projects and activities, which is currently absent in Fiji and PNG (in PNG especially in the non-resource sectors, while resource sector capital funds are sourced off-shore in the petro-

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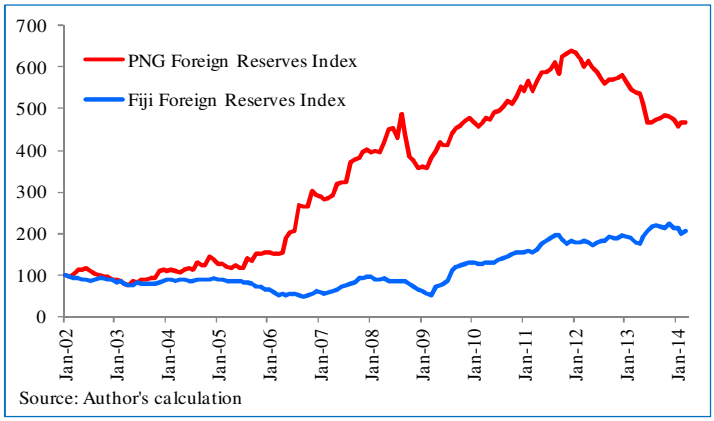
[29] Since a margin for credit and sovereign risks is attached to lending rates, and increasing deposit supply leads to low interest rate on deposits, (i^i), the interest rate spread (i^s) between (i^i) and (i^L) is reflective of excess liquidity conditions. Intuitively, for banks facing abundant liquidity, the marginal utility of an additional unit of deposit decreases, as a result, the interest rate offered on demand and tenured deposits will be relatively lower leading to larger spreads (see Figures 1.4 A/B).

[30] In a similar context, the Euro-Zone ccommercial banks exposed to the US sub-prime related assets during the start of the GFC built up precautionary levels of reserves in anticipation of potential liquidity needs. They were also unwillingly to lend inter-bank funds due to uncertainty about counterparty assets quality; as they were unable to distinguish between risky (exposed to the sub-prime) and non-risky assets. The restrained supply overshot the inter-bank rates as a larger premium was attached to the lending rates, translating into higher retail rates. The supply shortages was eventually matched by the ECB and Euro-area central banks (ECB, 2007). Similar findings are shown by Martin and Milas (2010).

chemicals industry). If external receipts and capital inflows follow a cyclical path, then commercial banks also end up with large stores of reserves (see Agénor and Aynaoui, 2010).

Our empirical model uses *(IR)* (central bank's level of international reserves) as it is the underlying position of balance of payments and encompasses all the inflows and outflows of external transactions (see Figure 1.5). Reiterating Saxegaard (2006), the reasons for involuntary accumulation of reserves are country-specific and the variables used to explain the phenomenon are crude proxies, which only attempt to describe the inherent structural, cyclical and political deficits in the model.

FIGURE 1.5: INTERNATIONAL RESERVES INDEX: FIJI & PNG



1.3 METHODOLOGY

In this section, we model the demand for excess reserves and split the components into precautionary and involuntary vectors, in line with discussions in preceding section.

1.3.1 EXCESS RESERVES MODEL

Consistent with the above, and following the models of Agénor, et al. (2004) and Saxegaard (2006), the excess reserves model takes the following form:

$$\varpi_1(L)FR_t = \varpi_2(L)\Omega_t^{PREC} + \varpi_3(L)\Omega_t^{INV} + \varepsilon_t \tag{1.8}$$

where the dependant variable, FR_t, is the ratio of excess reserves over commercial bank total deposits; Ω_t^{PREC} and Ω_t^{INV}, are the vectors of explanatory variables defining precautionary and involuntary levels of excess reserves, respectively; ε_t is the serially uncorrelated, homoskedastic and normally distributed error term; while $\varpi_k(L)$ are lag polynomials defined as $\varpi_1(L) = 1 - \varpi_{11}L$ and $\varpi_k(L) = \varpi_{ko} + \varpi_{k1}L,$ where $k \geq 2.$

The vector of explanatory variables includes the following:

$$\begin{aligned} \Omega^{PREC} &= \left\{RR, i^D, Y^{GAP}, VOL^{Y^{GAP}}, VOL^{C/D}, VOL^{PS}, VOL^G, DD\right\} \\ \Omega^{INV} &= \left\{i^L, DEP^{PS}, DEP^G, CRE^{PS}, CRE^G, IR, SEC, MIN\right\} \end{aligned} \tag{1.9}$$

Therefore, the precautionary (FR_t^{PREC}) and involuntary (FR_t^{INV}) levels of excess reserves can be modeled as follows:

$$FR_t^{PREC} = a\hat{c} + \hat{\varpi}_1^{PREC} FR_{t-1}^{PREC} + \hat{\varpi}_2(L)\Omega_t^{PREC} \tag{1.10}$$

$$FR_t^{INV} = (1 - a)\hat{c} + \hat{\varpi}_1^{INV} FR_{t-1}^{INV} + \hat{\varpi}_3(L)\Omega_t^{INV} \tag{1.11}$$

where the intercept term is denoted by $\hat{c}$, which incorporates a precautionary component represented by a and an involuntary component measured as $(1 - a)$. we identify this as the average minimum level of free reserves at the end of each period. For the equations to hold, $\hat{\varpi}_1 \neq 0$. (1.10) and (1.11) include a one period lagged estimator for the dependent variable in the dynamic forecasts. It should also be noted that: $FR^{PREC} + FR^{INV} = FR.$

Incorporating (1.10) and (1.11) with (1.8), and simplifying to get FR_t, and replacing FR_{t-1}^{PREC} and FR_{t-1}^{INV} with FR_{t-1} gives the following excess reserves demand model:

$$FR_t = \hat{c}\big(a + (1-a)\big) + \big(\hat{\varpi}_1^{PREC} + \hat{\varpi}_1^{INV}\big)FR_{t-1} + \varpi_2(L)\Omega_t^{PREC} + \varpi_3(L)\Omega_t^{INV} + \varepsilon_t \qquad (1.12)$$

which is simplified further to give:

$$FR_t = \hat{\varpi}_0 + \hat{\varpi}_1 FR_{t-1} + \varpi_2(L)\Omega_t^{PREC} + \varpi_3(L)\Omega_t^{INV} + \varepsilon_t \qquad (1.13)$$

where $\hat{\varpi}_0 = \hat{c}\big(a + (1-a)\big)$ and $\hat{\varpi}_1 = \big(\hat{\varpi}_1^{PREC} + \hat{\varpi}_1^{INV}\big)$.

Incorporating (1.9) with (1.13) and denoting the coefficients as α_i:

$$\begin{aligned} FR_t = {} & \alpha_0 + \alpha_1 FR_{t-1} + \alpha_2 RR_t + \alpha_3 i_t^D + \alpha_4 Y_t^{GAP} + \alpha_5 VOL_t^{Y^{GAP}} + \alpha_6 VOL_t^{C/D} + \\ & \alpha_7 VOL_t^{PS} + \alpha_8 VOL_t^{G} + \alpha_9 DD_t + \alpha_{10} i_t^L + \alpha_{11} DEP_t^{PS} + \alpha_{12} DEP_t^{G} + \\ & \alpha_{13} CRE_t^{PS} + \alpha_{14} CRE_t^{G} + \alpha_{15} IR_t + \alpha_{16} SEC + \varepsilon_t \end{aligned} \qquad (1.14)$$

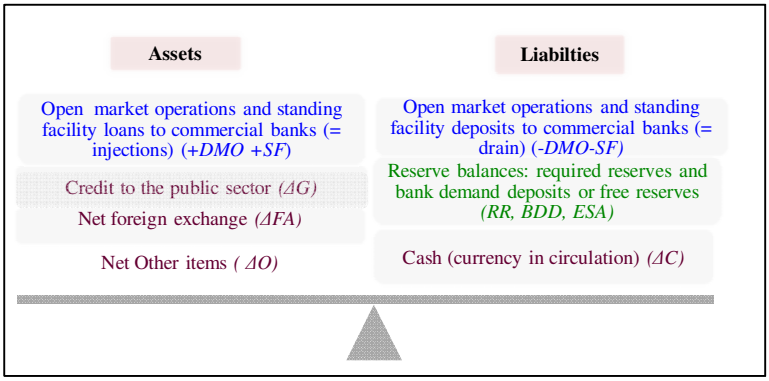
Additionally, using (1.10) and (1.11) and the underlying assumption for the value of *a*, we can decompose excess reserves into its precautionary and involuntary components. The decomposition is important, as Saxegaard (2006) highlights, the level of FR^{PREC} will likely influence inflationary pressures to a lesser extend as opposed to FR^{INV}.

1.3.2 LIQUIDITY SUPPLY

Although modeling the supply of liquidity is beyond the scope of this study, it is important to highlight factors that has policy implications from the findings of this paper. As custodians of monetary welfare, the responsibility of maintaining adequate liquidity rests with the central banks. Irrespective of the RR framework, all central banks need to predict the liquidity needs of the banking system in order to avoid supply fluctuations and distortions in short term market rates. Most liquidity is supplied via autonomous drivers - the net autonomous liquidity position (ΔA) in the ***short run*** while the remaining level is supplied through the central bank's policy decisions, such as open market - net policy decisions (ΔMO). The residual component is *reserves balances*. These transactions are a part of the representative central

bank's balance sheet[31] (refer to Figure 1.6), which is a powerful tool in controlling and correcting marginal liquidity.

FIGURE 1.6: REPRESENTATIVE CENTRAL BANK BALANCE SHEET



Intuitively, changes on the central bank balance sheet will correspond to changes in the commercial bank balance sheet. Ideally, $\Delta A + \Delta OM = \Delta Reservs$. Given this, changes in reserves demand is equivalent to changes in reserves supply, ex ante (Borio, 1997). The marginal supply of liquidity $\Delta R^s = \Delta A + \Delta MO$, where a positive net autonomous position, $+\Delta A = SURPLUS$, represents a net increase in liquidity supply, ceteris paribus. The net autonomous position, (ΔA) is reflected by changes in net foreign assets, (ΔFA); net government credit, (ΔG); cash/currency in circulation, (ΔC); and a minor component, other items (ΔO).[32] The bottom line is:

Net Autonomous Position= $(\Delta A : \overset{+}{Injections} / \overset{-}{Withdrawal\ s}) = \Delta FA + \Delta G + \Delta O - \Delta C.$

In a nutshell, reserves supply $R^S = A + MO$; and the marginal level: $\Delta R^S = \Delta FA + \Delta G + \Delta O - \Delta C + \Delta DMO + \Delta SF$.

The standard demand and supply for liquidity/reserves are presented in Figure 1.7.

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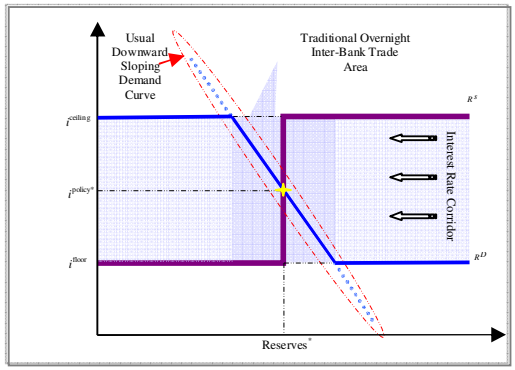
[31] Many have argued (see Durré and Pill, 2012) that by effectively controlling the size and the composition of their balance sheets, a number of central banks, particularly the Federal Reserve, the ECB and the Bank of England, were able to drastically shorten the effects of the GFC.

[32] These include retained profits and central bank reserves, together with chequing account floats and revaluation of assets. Central bank profits transferable to the government are also initially lumped in this account.

FIGURE 1.7: DEMAND & SUPPLY OF RESERVES UNDER A CORRIDOR FRAMEWORK



The floor and ceiling rates are depicted as i^{floor} and $i^{ceiling}$, with the indicator rate as $i^{policy*}$. In the absence of the floor and the ceiling rates, the demand for reserves, R^D, will conform to the conventional downward sloping format. R^D is however, constrained under the corridor framework, and is perfectly elastic at the ceiling rate - standing facility rate/discount rate/repo rate, since commercial banks will not incur the additional cost of borrowing at a rate higher than that charged by the central bank.

Similarly, R^D is also perfectly elastic at the floor rate – reserves remuneration rate/deposit facility rate, since profit maximizing commercial banks will not lend overnight funds at a rate lower than that offered by the central bank, and incur a loss. In-between the two constraints, R^D is downward sloping. Its responsiveness to interest rate will determine the degree of elasticity, with a vertical demand curve showing zero sensitivity to interest rate changes and so on. In the over-night trade area, commercial banks evaluate the cost of borrowing in the inter-bank market, against the opportunity cost associated with keeping free reserves. Given the inverse relationship, as the inter-bank market rate falls, the opportunity cost of excess reserves also falls. This implies higher holdings of free reserves, hence the downward sloping R^D.

R^S follows a similar pattern. The perfectly inelastic or the vertical portion at *Reserves*,* is predetermined by the central bank and does not play by the normal market mechanism rules. It is influenced by open market operations (under central bank control) which shifts the vertical segment sideways, given changes in *DMO*.

The perfectly elastic portion on the left is formed by the floor rate on deposit facility/remuneration of reserves. If R^D falls faced with reserve shortages, the floor rates put a cap on the inter-market rates irrespective of the magnitude of the fall, therefore, R^S takes on the horizontal path at i^{floor} as trade will not take place at an interest rate below the lower limit. The infinitely elastic portion on the right is influenced by the central bank's lending

facilities and discount windows/repos, hence the horizontal shape. Once the ceiling rate is struck, all market funding is catered for by the standing facilities/repurchase agreements, etc. The intersection of R^S and R^D shows the equilibrium point at $Reserves*$ and $i^{policy*}$. Irrespective of the degree of fluctuations in R^D (increases or decreases), the equilibrium interbank rate will hover inside the corridor[33].

1.3.3 ECONOMETRIC METHODOLOGY

All data have been sourced from the Reserve Bank of Fiji (spanning from January 2000 to March 2014) and Bank of Papua New Guinea (January 2002 to March 2014). Our modelling is based on the data stationarity, and from an economic perspective, all data included in the model are stationary, including the volatility components and also most variables are either in ratios or in percentages. We have utilised the Augmented Dickey Fuller (ADF) tests, as well as the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for variables that have low power of stationarity against the alternative of unit roots. All data used in the estimation are stationary at levels, based on the KPSS test, except for international reserves and indicator for stock market. These two variable were converted into first difference in logs to make it stationary. For brevity, we have omitted the results and proceed with the estimation.

The structure of the model in this paper is analogous to Saxegaard (2006). However, instead of a two stage least square (2SLS) we utilize a Generalized Methods of Moments (GMM) framework. The GMM framework is better and more efficient than the 2SLS Model, and also correct for endogeneity bias in the proposed model.

Having defined the structure of the model in Eq. 1.14, to estimate this using the Generalised Methods of Moments (GMM) framework, we identify the orthogonality condition given the set of instruments z_t[34]

$$E[(FR_t - \beta \mathrm{X_t})|\mathrm{z_t}] = 0 \qquad 1.15$$

where: $\boldsymbol{\beta}$ is the matrix of coefficients [i.e. $\alpha_0, \ldots, \alpha_{16}$] and $\mathbf{X_t}$ is the matrix of determinant variables as defined in Eq. 1.14 (including a constant).

Based on the orthogonality conditions defined in Equation 1.15 (above) and Eq. 1.14 under GMM framework, we overcome the inconsistencies of ordinary least square estimator as the respective error terms would be correlated with the endogenous regressors. As shown by

[33] Central banks can adequately predict demand behaviour and change liquidity supply accordingly. If the quantity of reserves demanded is expected to increase, central banks will supply sufficient reserves such that supply curve will intersect demand at its horizontal segment, which will see the policy rate fall to the floor level.

[34] A matrix containing 1 to 4 period lagged values of required reserves, discount rate, deposits, credit, lending rate and international reserves.

Hansen (1982), GMM estimators are strongly consistent and asymptotically normal provided that the instruments are correlated with the endogenous regressors and uncorrelated with the error term.

Furthermore, Jondeau et al. (2004) highlight that the GMM estimation technique needs to only identify relevant instruments and does not involve strong assumptions on the underlying model. This (as they argue) makes application of the GMM method very appealing The GMM technique requires the error terms in Eq. 1.14 to be orthogonal to the specified vector of instruments z_t. The results are presented and discussed in the next section.

Assuming an unknown form of heteroskedacticity and autocorrelation in the sample, we opt for a Heteroskedacticity and Autocorrelation Consistent (HAC) weighting matrix for the GMM estimation of Eq. 1.14. In addition, we use the Bartlett kernel with Newey-West bandwidth selection criteria of lags to weight the autocovariances in computing the weighting matrix[35].

[35] This procedure is simply executed utilising EViews 9.

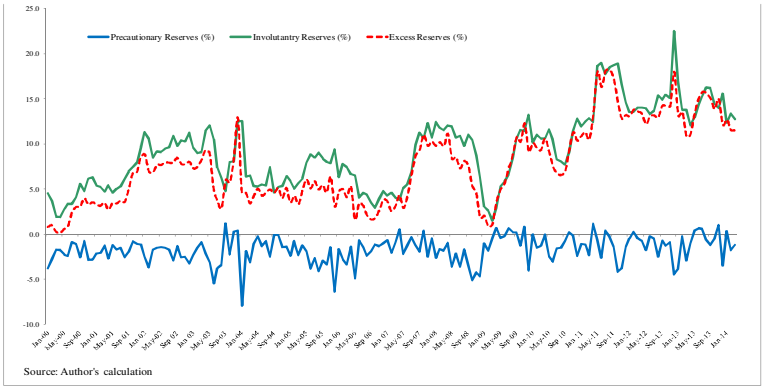
1.4 RESULTS

The estimation results are summarized in Figures 1.8 to 1.9 A-C and Table A.1 in the Appendix. Empirical results are indicative of the trend in Fiji (low GDP growth country) and PNG (high GDP growth country). On the outset, it important to note that the results for Fiji and PNG are also influenced by the nature of their exchange rate regimes. In particular, PNG has a de jure managed float regime for its currency (i.e. Kina) with a de facto crawl like arrangement while Fiji dollar is determined by a basket-peg weighted by trade flows with five major trading partners[36]. These institutional arrangements have a bearing on the management of excess reserves and economic policy options (discussed in Section 1.5 – Policy Implications).

In Fiji's case, we find high persistence of involuntary reserves (see Figure 1.8A), while very little is held as a precaution against unexpected events. Excess liquidity moves in tandem with involuntary reserves; and all explanatory variables: credit, deposits, international reserves and commercial bank lending rates are statistically significant. The behaviour of these variables are well depicted (see Figure 1.8B) and confirms our a-priori expectations:

1) A 1 percent increase in private sector deposits, increases FR by 3 percent;
2) A 1 percent increase in public sector deposits, increases FR by 2 percent;
3) A 1 percent increase in private sector credit, decreases FR by 1 percent;
4) A 1 percent increase in public sector credit, decreases FR by 17 percent;
5) A 1 percent increase in the *flow* of foreign reserves, increases FR by 12 percent; and
6) A 1 percent increase in lending rate, decreases FR by around 2 percent.

FIGURE 1.8A: FIJI PRECAUTIONARY, INVOLUNTARY AND TOTAL EXCESS RESERVES



[36] Exchange rate classification is based on IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) 2015.

FIGURE 1.8B: FIJI: INVOLUNTARY RESERVES

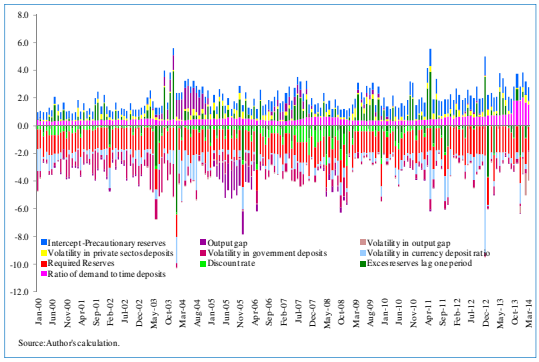


FIGURE 1.8C: FIJI: PRECAUTIONARY RESERVES

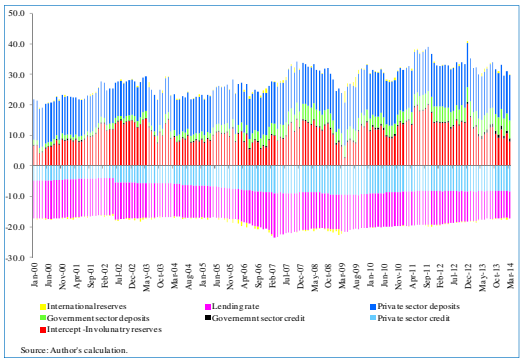


Figure 1.8C shows precautionary reserves. The behaviour of significant variables are contrary to expectations. A plausible explanation for the inverse causality is that Fijian banks hoard exceptionally large amounts of involuntary reserves and changes in aggregate demand conditions affect FR holding via credit and deposits rather than aggregate demand directly. Alternatively, the RBF's liquidity management practices may play a bigger role in cushioning the economy from such impacts. The ratio of demand to time deposits, however, has the expected sign and a 1 percent increase in DD increases FR by 0.8 percent.

It can be argued that in the presence of FR^{INV} during economic volatility, attempts by commercial banks to shore-up flagging credit demand by reducing the cost of borrowing or collateral requirements, etc, can be futile since the structural/macroeconomic/financial deficits causing the involuntary build-ups are not being remedied rather the auxiliary infrastructure for credit is being beefed up. A monetary contraction to sterilise the excess will likely erode excess reserves but the stance will only be effective if it is able to erode the FR^{INV} component, which can only be achieved if the macroeconomic climate is reinforced, and structural/financial impediments are corrected. Likewise, a monetary expansion will see excess reserves increasing which will not likely translate into new lending.

FIGURE 1.9A: PNG PRECAUTIONARY, INVOLUNTARY AND TOTAL EXCESS RESERVES

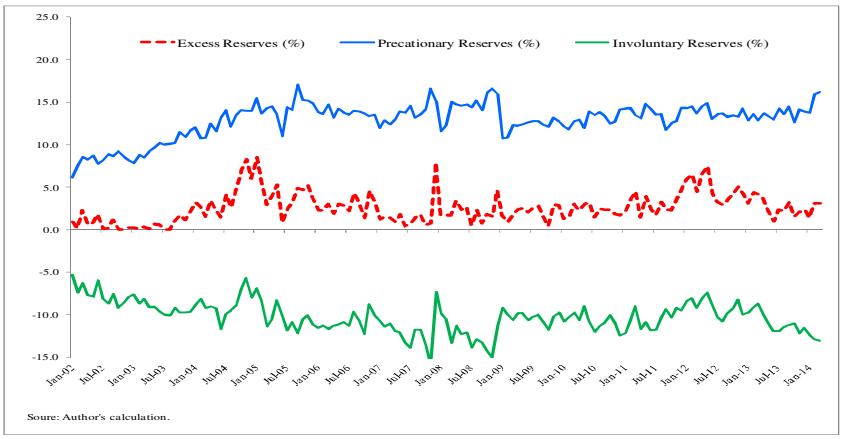


FIGURE 1.9B: PNG: PRECAUTIONARY RESERVES

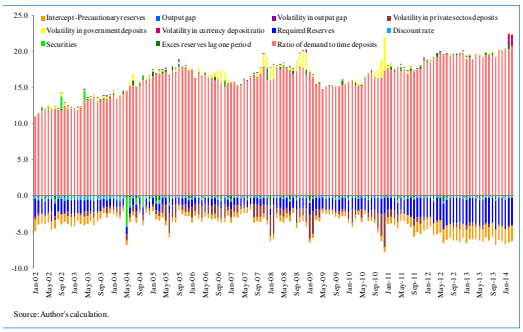
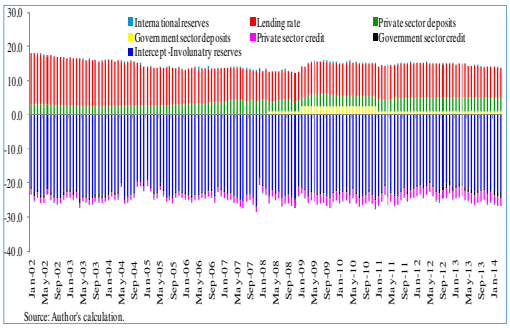


FIGURE 1.9C: PNG: INVOLUNTARY RESERVES



This is in line with interest rate pass through studies in the presence of excess reserves, which points to the ineffectiveness of monetary policy to fully correct imbalances. Additionally, if aggregate demand rises, given its causal relationship with new credit, FR^{INV} , as opposed to FR^{PREC}, will quickly be soaked up. Nonetheless, a rise in demand will likely give rise to inflation and the erosion of FR^{INV} (reserves will be diverted from central bank books into the economy) will further hasten these inflationary pressures.

Looking at the results for PNG (Figure 1.9 A-C), we find persistence of precautionary reserves. Commercial banks in PNG are highly risk averse and consequently hold increasingly higher levels of liquidity as a buffer. A-priori expectations are maintained and empirical analyses reveals:

1) A 1 percent increase in required reserves, decreases FR by 0.4 percent;
2) A 1 percent increase in the penalty rate, decreases FR by 0.04 percent;
3) A 1 percent increase in C/D volatility, increases FR by 0.002 percent;
4) A 1 percent increase in volatility in private sector deposits, decreases FR 0.3 percent;
5) A 1 percent increase in volatility in public sector deposits, decreases FR 0.06 percent; and
6) A 1 percent increase in demand to time deposit ratio, increases FR by 32 percent.

As opposed to FR^{INV}, FR^{PREC} tends be less inflationary, albeit partially. Given an expansionary monetary stance facilitated by a reduction in RR, the level of excess reserves will increase, and possibly grow beyond the precautionary requirements; hence credit growth can be facilitated via reduced lending rates. A portion of FR^{PREC} can likely be employed in meeting the potential rise in credit, however, only up to the point deemed less risky. All of the involuntary reserves indicators are statistically significant; however, commercial banks in PNG do not park funds for non-precautionary reasons.

1.5 POLICY IMPLICATIONS[37]

According to literature (Saxegaard, 2006), involuntary liquidity tends to be more inflationary than precautionary hoarding, however, despite the nature of hoarding, excess liquidity renders the monetary transmission mechanism ineffective. Therefore, in order to control inflation, both countries, particularly Fiji have stringent price controls in place, which does not let inflation shoot above a desired level. However, price controls also mean higher government subsidies and expenditure, which weighs heavily on macroeconomic stability. This section discusses selected measures that can address the phenomenon; and the central bank balance sheet becomes a powerful tool in catapulting the desired results.

The primary reason for involuntary liquidity hoarding in Fiji is the lack of investable projects and complicated investment procedures; lax economic infrastructure; and exchange control restrictions. In PNG's case risk aversive-ness is the prime factor. The economy is growing rapidly and there is high monetization of fiscal deficit. Moreover, there is high volatility in oil and LNG prices. In an environment like this, commercial banks hoard substantially high levels of precautionary liquidity to meet unexpected runs. The realignment of money market rates is essential for RBF and BPNG to make monetary policy more effective and erode excessive liquidity. The reinforcement of the interest channel and the removal of excess of liquidity should moderate pressure on the exchange rate. Under a de jure floating exchange rate regime (PNG) and sometimes under a managed peg (Fiji), the exchange rate is affected through the impact from policy rates on the differential between domestic interest rates and international rates and, in that way, on the nominal exchange rate. Changes in the nominal exchange rate have a direct effect on inflation through imported inflation, and, indirectly, through the impact of the real exchange rate (again given anchored inflation expectations) on net exports, and, therefore, aggregate demand. Excess liquidity when exchange rate is not realistic, directly feeds into import demand, which feeds back into pressures on the exchange rate.

Fiji and PNG have significant current accounts receipts. In PNG's case, the high commodity prices and high FDI in the petro-chemicals sector, led to higher US dollar denominated mining and petroleum inflows for the government. These were sold to BPNG at market rates in exchange for PNG Kina. This increased the liabilities but was counter matched by an increase in the BPNG's holdings of *FA*. When these were deposited into the commercial bank accounts, it led to excess liquidity. This could have been prevented if the government had engaged with the market to begin with; but currency volatility would have been a by-product, and also noting the precautionary behaviour of PNG banks, this may not have been fully viable.

[37] These policy implications hold true for the sample period.

In Fiji, large amounts are also transacted but rather than the RBF, commercial banks are heavily involved. Private entities are the bigger *FA* dealers rather than the government. While an inflow of foreign receipts has boosted the foreign exchange reserves in Fiji, the converted Fiji dollars have very few avenues of being put to productive use. A new theory being floated is *keeping with the Joneses,* whereby countries purposely hoard reserves to match-up with counterparts (See Cheung & Sengupta, 2011). In such instances, viable avenues will purposely be closed and funds will remian idle, thereby increasing the involunatry hoarding of liquidity in the system.

Consequently, attention should be paid on net foreign assets (see Figure 1.6), that is, purchases and sales of foreign currencies against the domestic (net foreign exchange intervention), and particularly on the level of sterilization. Sterilization is complete if intervention is fully offset by asset-side transactions leaving the monetary base unaffected (liabilities side). If the operational target and the nominal anchor is FX, then the central bank may be able to exert greater influence on *FA* transactions; however, this would require greater control over the volume of FX assets transacted[38]. In most instances, sterilization coefficient is not 100 percent. The timing of export receipts/payments is also important. If *FX* controls are in place, then this can have repercussions on the liquidity level. Predicting the pattern of FX earnings is therefore imperative.

Causality examination is vital. Export receipts may feed into import demand and propel domestic consumption driving up import demand. The lags and volume of future transactions can be predicted from past patterns and they form an integral part of FX demand and reserves management. Domestic consumption patterns also influence the level of FA bought and sold. In Fiji/PNG, in the absence of direct measurement tools, the Retail Sales data is the closest available proxy for consumption spending and as evident from anecdotal references, consumption expenditure peaks around major festivals, particularly during the last quarter of any calendar year.

The consumption basket is also import driven as the respective production bases are limited and 50-75 percent of the consumer price basket items are imported. Therefore, in line with some earlier studies which have examined the significance of new credit on expenditure (and reverse causality) (see Pontes & Murta, 2012; Biggs & Mayer, 2013; and Ermisoglu et al. 2013), it can be inferred that consumption pattern has significant implications for the liquidity minimization behaviour of commercial banks and inadvertently the reserve management models of central banks. Consequently, ceteris paribus, an increase in consumption following seasonal fluctuations would put upward pressure on foreign exchange prices, leading to short-term currency appreciation. Therefore, for the purposes of daily liquidity forecasting, this is vital; although, it will likely not warrant any policy actions from the central bank. It does

[38] This also warrants a stronger external position, with sufficient reserves. for example, the monetary policy framework in PNG, Singapore or Hong Kong SAR, not to mention mainland China.

have bearing on the daily liquidity needs of the banking industry therefore placing/reducing pressure on the reserve holdings.

Sometimes using direct-intervention armory is more practical. This can be decomposed, in terms of the degree of discretion: direct market operations initiated by the central banks and are the most widely used discretionary tool at their disposal; and standing facilities, which are activated by commercial banks' demand[39]. The use of required reserves is the easiest instrument and used widely around the world (PBC, 2014). An increase in RR will divert funds from FR^{INV} and FR^{PREC} to SRD and CRR at RBF and BPNG, respectively, although, it is plausible that FR^{INV} will likely see a larger fall due to a change in SRD than FR^{PREC}. FR^{INV} is risk averse and/or risk neutral in nature while FR^{PREC} is risk averse. A rise in RR will not necessarily compel PNG banks to divert funds most funds away from FR^{PREC} .

Furthermore, central banks and government treasuries, administer the sale and purchase of central bank bills, government securities, treasury bills, respectively, that is, outright trade in government and central bank backed notes and securities. These are more aligned to monetary policy preservation goals and tend to iron out liquidity imbalances. Most instruments deal in the trade of asset backed securities, and form a significant portion of open market operations. RBF and BPNG intervene in the secondary market via the sale and purchases of these assets, which are generally auctioned. They also issue their own security bills in the primary market. For example, both Fiji and PNG issue their own commercial notes, known as the RBF Note and the CBB, respectively. These usually have a short tenure. The OPR and KFR are aligned to these securities. However, the most pressing issue is the monetization of fiscal deficits by BPNG. PNG Treasury and BPNG issue securities and thus withdraw liquidity. However, BPNG buys all unsold T-Bills from the PNG Treasury and sells them as CBBs, crediting all public sector accounts – a double pronged problem.

Fiji's monetary policy is largely accommodative and the policy rate is at the lower bound. Little attempt has been made to mop-up the excess liquidity in large part due to price controls in Fiji; minimization of central bank costs; slower pace of economic growth, and due to the fact that any changes in the size of liquidity will require an interest rate hike, which may not bode well with economic growth objective of the RBF. The cost of the central bank would also rise.

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[39] Standing facilities are collateralized loans and advances granted by the central banks. These were used to signal policy rates by most central banks in the 19th century. However, deregulation of the banking sector and the advent of other more practical tools led to the shift away from the heavy dependence on standing facilities. Borio (1997) points out that standing facilities[39] are treated as *safety valves* for settlement imbalances and merely act as beacons, guiding market rates to corridor-ceiling rates rather than being the outright instrument of choice for the central banks to offset liquidity disequilibrium. Nonetheless, central banks still utilize lending and deposit facilities in varying degrees. RBF and BPNG have standing facility windows through which discounted lending and short term deposit options are provided to commercial banks.

RBF and BPNG engage in both repurchase facilities[40], which are collateralized advances entered into by selling securities with an agreement of procuring the same at a fixed price and date. In PNG's case a Repurchase Agreement Facility (RAF) was introduced with KFR in 2001. In Fiji's case, the minimum lending rate is used as the benchmark for repurchase facilities and is currently set at 100bp above the interbank rate. These facilities need to be strengthened for monetary policy to become more effective and to mop-up excess liquidity. Furthermore, despite considerable efforts by both central banks to sterilize foreign exchange inflows, excess liquidity has driven down short-term interest rates. Short term interest rates have become misaligned with the OPR and KFR. When market rates deviate from the operating target for long periods the signaling role of the target rate is diminished with consequent impact on the central bank's ability to implement sound monetary policy. Divergence between the OPR/KFR and T-Bill/CBB yields has been particularly evident for the last several years in both countries. A continuation of such trends precedes more liquidity hoarding by both central banks. A realignment, as mentioned before, is needed

Net government credit (net lending to the public sector) can also be used to steer liquidity outcomes. Government revenue collections through direct taxes and value added or goods and services taxes (VAT and GST), representing large inflows of funds directed to the central bank accounts; and welfare and pension payments, showing a drain of funds out of the accounts. This will obviously depend on whether the central bank is also the government's main banker, or whether the government keeps its accounts with the commercial banks, and handles a few transactions with its central bank. Government cash-flows can be volatile. With regards to expenditure, the annual budget forecasts from the government may provide sufficient data and assumptions to capture the liquidity needs of the government and the economy in the short term (since public expenditure depends on formal approval processes)[41].

Revenues, on the other hand, may present a challenge. The pattern of major receipts flowing in through income tax or VAT/GST collections can be useful in predicting future levels; and since the timing of tax receipts are usually known in advance, these may help reduce unexpected fluctuations. Keeping government's transactional account with central banks have drawbacks in that it limits market development and competition and most PIC central banks are not well-equipped to handle such transactional accounts. An alternative is *sweep accounts*, where government accounts will temporarily be parked at the central bank overnight.

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[40] These are domestic currency denominated repurchase agreements, repos and reverse repos (sale and purchases of domestic assets reversed at a pre-determined future date and foreign currency denominated repurchase agreements or foreign exchange swaps). Repos (purchases) inject liquidity while reverse repos (sales) tend to withdraw liquidity from the system.

[41] A separate liability account held on behalf of the government by the central bank is the transfer of part of its surplus or profits. Before the actual transfer takes place, these are reflected as general liabilities, however, once the central bank's governing board approves the transfers, the accounts are reflected as government deposits on the central bank balance sheets. This however, does not necessitate any changes in the reserve levels. It is only when the government draws-down on this additional deposits that an increase in bank reserves is actually seen.

Figures 1.10 A/B show that the net position of the Fiji and PNG governments, respectively from 2002-2013. A positive net position implies that the central bank has claims over the government, or in other words, the government is a net debtor to the central banks, a case depicted by Figure 1.9A. Fiji government's outlays are considerably larger than deposits with the central bank. This suggests a funneling of reserves into the economy. As for PNG, the net position has been in the negative territory - inflows are significantly higher than outlays, or government deposits with the central bank are higher than withdrawals, representing a drain of liquidity from the economy[42].

It should be noted that the PNG government holds numerous large-value trust fund accounts with domestic commercial banks. A possible solution would be to transfer trust fund accounts to the central bank. Depending on the tenure and use of such trust fund accounts, the cap on excess liquidity can either be permanent or temporary.

Another useful tool is currency in circulation. A withdrawal of currency/cash reduces bank reserves whereas deposits tend to augment reserve balances. Figures 1.10 A/B show the pattern in Fiji and PNG. While stock levels show a persistent upward trajectory, the rate of increase is volatile, although significantly positive. If the conversion of currency and cash balances is not sufficiently offset, then not only the level, but the composition of money supply can be affected. The demand for currency is underpinned by income levels, inflation or price levels, the use and availability of other mechanisms to meet transactional demand such as debit and credit cards, cash dispensing automated teller machines (ATM), and cheques; and the real cost associated with holding currency and cash. When real income per capita increases, the preference of holding cash as opposed to holding *deposits* may decline.

Considering substitutionability between these two, and assuming that these maybe preferred over other similar assets, the income elasticity of currency and cash holdings tends to be lower than that of holding interest bearing deposits. Suppose currency and deposits are two goods. With rising income, the level of deposits (either short or long term) will increase as more will be deposited with the banks – a transfer from the employers' to the employees' accounts. A portion, as is likely, will be held in the form of cash by the public, while an increasingly larger portion will be kept in the form of deposits, representing a fairly luxury-goods characteristic of deposits.

[42] Ceteris paribus, a situation like this would see the commercial banks bridging the liquidity gap via the inter-bank market or directly from the central bank (use of repos and other standing facilities). If commercial banks are able to sufficiently close the gap, then reserves and money supply balances would remain unaffected. On the contrary, if this does not happen then reserves would decline. Owing to the mis-match, the central bank will likely intervene to correct the disparity.

FIGURE 1.10 A:RBF'S NET POSITION WITH THE GOVERNMENT (2002-2013)

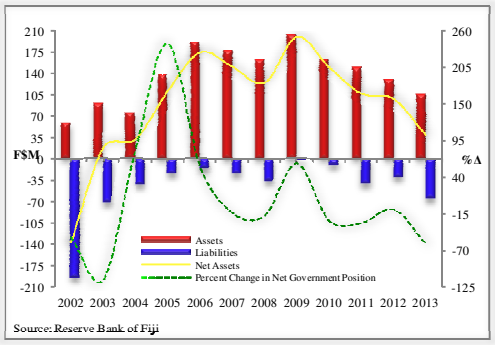


FIGURE 1.10 B: BPNG'S NET POSITION WITH THE GOVERNMENT

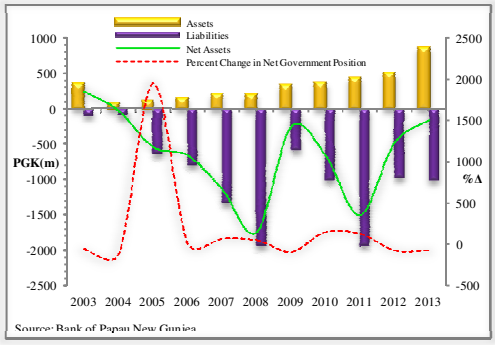


FIGURE 1.11 A CURRENCY IN CIRCULATION: FIJI (2000-2013)

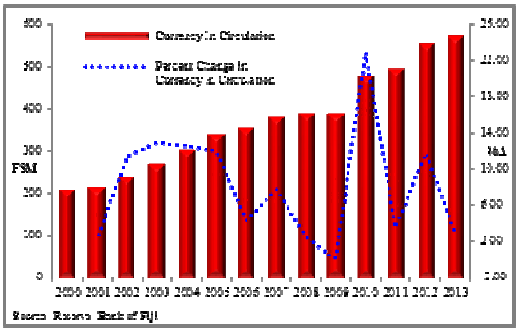
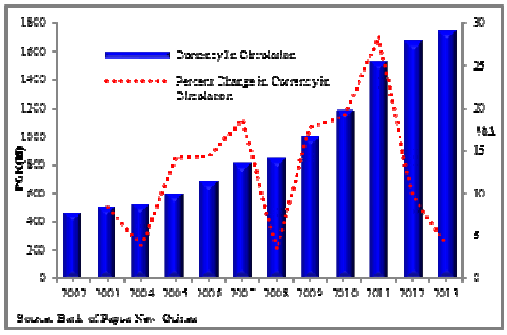


FIGURE 1.11 B CURRENCY IN CIRCULATION: PNG (2002-2013)



Therefore, deposits can be seen as normal goods, with income elasticity exceeding unity, whereas, currency and cash holdings can also be seen as normal goods, but with elasticity lower than one if cash and currency are kept only to meet necessary expenditure. In most instances, precautionary motives (for example the motives for holding excess bank reserves as discussed in the earlier sections), add onto the transactionary motives and hence, the income elasticity may exceed unity, yet lag behind that of interest bearing deposits. In other words, the marginal utility of a unit of currency is less than the marginal utility of an additional unit of deposit.

Similarly, general price levels may also influence the level of currency with the public. Higher prices indicate higher private sector cashflow. This may however be muted due to higher use of plastic money. Studies have shown that the demand for currency and cash holdings declines with the increase in the use of debit and credit cards; ATM and point-of-

sale transactions (see Carbó-Valverde and Rodríguez-Fernández, 2014; and Amoromin and Chakravorti, 2007).

Additionally, a rise in the cost of holding currency (which is the opportunity cost of holding cash proxied by the interest foregone on deposits had the cash been deposited or invested in a remunerative scheme) tends to reduce currency demand. It can be measured as the expected rate of return on deposits[43]. Interestingly, the larger size of the informal sector (a prominent feature in many SIDS including the Pacific Islands Countries) indicate the need for commercial banks to maintain more currency at hand to meet demand. Another element to consider is seasonality. This requires similar treatment to the spikes in expenditure portfolio associated with different seasons and festivals under FX intervention. Large scale festivals and key religious celebrations, and other holiday seasons – for example summer months may attract more foreign tourists – in Fiji and PNG's case these are the southern hemisphere winter months, see a large influx of visitors from Australia and New Zealand. Therefore, such times merit larger holdings of cash.

We highlighted factors that led to high levels of liquidity in PNG and Fiji and provided solutions to withdraw liquidity from the system, which include: i) reinforce the interest rate channel; ii) streamline foreign exchange market operations (align exchange rate with underlying fundamentals and shift to a less discretionary and more internal rules-based foreign exchange allocation regime); iii) transfer public sector deposits from commercial banks to the BPNG; iv) raise the SRD/CRR; v) establish a proper corridor for the interbank rate by using an overnight deposit and repo facility; vi) in PNG's case introduce a mechanism of recapitalization and transfer of profits from the BPNG to the Treasury and to prohibit direct BPNG financing of the government; vii) improve forecasting ability and have adequate causality analyses of treasury funds/consumption levels/currency in circulation to improve liquidity management by the RBF/BPNG; and viii) develop programs to increase the quality and frequency of macroeconomic data.

[43] Cagan (1958) lists some other interesting components of currency demand such distance, taxes on transactions and retail trade. It should also be noted that demand for currency/cash and demand for money are separate concepts. The former can be seen as a subset of the latter.

1.6. CONCLUSION

Our study finds that excess liquidity in Fiji is involuntarily held while in PNG the motives are purely precautionary. In Fiji's case, we find high persistence of involuntary reserves while very little is held as a precaution against unexpected events. Excess liquidity moves in tandem with involuntary reserves; and all explanatory variables: credit, deposits, international reserves and commercial bank lending rates are statistically significant. The behaviour of these variables are well depicted and confirms our a-priori expectations; a 1 percent increase in private sector deposits, increases FR by 3 percent; a 1 percent increase in public sector deposits, increases FR by 2 percent; a1 percent increase in private sector credit, decreases FR by 1 percent; a 1 percent increase in public sector credit, decreases FR by 17 percent; a 1 percent increase in the *flow* of foreign reserves, increases FR by 12 percent; and a 1 percent increase in lending rate, decreases FR by around 2 percent.

Looking at the results for PNG, we find persistence of precautionary reserves. Commercial banks in PNG are highly risk averse and consequently hold increasingly higher levels of liquidity as a buffer. A-priori expectations are maintained and empiricl analyses reveals; a 1 percent increase in required reserves, decreases FR by 0.4 percent; a 1 percent increase in the penalty rate, decreases FR by 0.04 percent; a 1 percent increase in C/D volatility, increases FR by 0.002 percent; a 1 percent increase in volatility in private sector deposits, decreases FR 0.3 percent; a 1 percent increase in volatility in public sector deposits, decreases FR 0.06 percent; and a 1 percent increase in demand to time deposit ratio, increases FR by 32 percent.

Some underlying reasons includes: risk averse nature of banks; the design and structure of the RR regiment; the design, structure and workability of the real time gross settlement system; the accessibility and penalty rates for standing facilities/collateralized loans; (inefficient payment systems would likely see central banks holding larger buffers to meet shortfalls); cyclical economic activity; aggregate demand conditions; consumption activity; structural; cyclical and political instabilities/shocks; commodity price fluctuations and other similar restraints.

The primary reason for involuntary liquidity hoarding in Fiji is the lack of investable projects and complicated investment procedures; lax economic infrastructure; and exchange control restrictions.

In PNG's case risk aversive-ness is the prime factor. The economy is growing rapidly and there is high monetization of fiscal deficit. Moreover, there is high volatility in oil and LNG prices. In an environment like this, commercial banks hoard substantially high levels of precautionary liquidity to meet unexpected runs.

An arsenal of tools is available to both central banks to deflate the excess liquidity bubble. From BPNG's perspective, a transfer of government's trust accounts to the central bank and

sweeping accounts could be given a trial. Governments' commercial bank balances could be parked at BPNG overnight and this could influence the market rates. If sweep accounts fail, then more CBBs or other securities could be issued to realign KFR to market rates. A sustainable and viable option for both central banks is to reduce liquidity through government bond sales or increase the SRD/CRR but this would place financial burden on commercial banks due to unremunerated reserves.

The realignment of money market rates is essential for RBF and BPNG to make monetary policy more effective and erode excessive liquidity. The reinforcement of the interest channel and the removal of excess of liquidity should moderate pressure on the exchange rate. Under a de jure floating exchange rate regime (PNG) and sometimes under a managed peg (Fiji), the exchange rate is affected through the impact from policy rates on the differential between domestic interest rates and international rates and, in that way, on the nominal exchange rate.

Changes in the nominal exchange rate have a direct effect on inflation through imported inflation, and, indirectly, through the impact of the real exchange rate (again given anchored inflation expectations) on net exports, and, therefore, aggregate demand. Excess liquidity when exchange rate is not realistic, directly feeds into import demand, which feeds back into pressures on the exchange rate.

As forward guidance, both central banks could look at enhancing their inter-bank trading. In the presence of excess liquidity, interbank trading is quite infrequent since the banks do not see a need to trade amongst themselves or with the central bank rendering the corridor system as well as the liquidity management system rather obsolete. Excess liquidity is associated with high inflation but both banks are reporting adequate levels of inflation, PNG at 5.8 percent and Fiji at 3.5 percent in 2014. However, stringent price controls are in place plus commodity, fuel and food prices are down, with a 40 and 75 percent import component in the consumer price basket of PNG and Fiji, respectively.

Exchange rate alignment (bands) should also be examined (PNG: crawling peg system although classified as a de jure floating arrangement; and Fiji - basket peg). A gradual flexibility of the foreign exchange rate intervention would allow more flexibility of the exchange rate and will assist market participants to anchor inflationary expectations based on expected policy rates rather than expected changes in FX. This will improve economic resilience in both countries and aid in absorbing external sector shocks.

Donor support, particularly in Fiji's case, where we have identified the lack of viable avenues to channel out liquidity and international reserves, the World Bank Group, Asian Development Bank, Japan International Corporation Agency, European Union, IMF and neighbouring developed countries (this is not an exhaustive list) can assist with financial and technical aid to streamline the investment climate and re-look at the monetary policy framework. Fiji's latest Development Strategy (post-the 2014 Elections) promises improvement in economic structure and infrastructure that may hopefully enhance

commercial viability and reduce cost of business in Fiji. This will help reduce involuntary excess reserves.

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APPENDIX 1.1

TABLE A.1.1: GENERALISED METHOD OF MOMENTS RESULTS FOR FIJI AND PNG

Results: Fiji and Papua New Guinea

Variable	Fiji	Papua New Guinea
Constant	10.2307	-23.9836
	(8.057319)	(6.00952)
	[0.2061]	[0.0001]***
$FR\text{-}_1$	0.7549	0.2357
	(0.079253)	(0.094865)
	[0.0000]***	[0.0145]***

TABLE A.1.1: GMM RESULTS FOR FIJI AND PNG: PRECAUTIONARY RESERVES

Ω^{PREC}

Variable	Fiji	Papua New Guinea
RR	-10.7347	-0.3447
	(24.99895)	(0.131866)
	[0.6682]	[0.0102]***
i^D	-0.1316	-0.0349
	(0.121214)	(0.015334)
	[0.2792]	[0.0248]**
Y^{GAP}	-0.0404	1.0810
	(0.019775)	(13.31728)
	[0.0429]**	[0.9355]
VOL^Y	-0.0083	0.0002
	(0.00449)	-0.0004
	[0.067]*	[0.6300]
VOL^{CD}	-0.2783	0.0002
	(0.16437)	-0.0001
	[0.0925]*	[0.0087]***
VOL^{PS}	0.1953	-0.3007
	(0.37187)	(0.075481)
	[0.6002]	[0.0001]***
VOL^G	-0.1167	0.0621
	(0.048889)	(0.022178)
	[0.0182]**	[0.006]***
DD	0.7747	31.1888
	(0.395059)	(6.063886)
	[0.0517]*	[0.0000]***

TABLE A.1.1: GMM RESULTS FOR FIJI AND PNG: INVOLUNTARY RESERVES

	Ω^{INV}	
DEP^{PS}	3.0011	0.8453
	(1.107651)	(0.392681)
	[0.0075]***	[0.0335]**
DEP^{G}	2.1759	0.6490
	(0.928044)	(0.264126)
	[0.0204]**	[0.0156]**
CRE^{PS}	-1.1983	-0.9842
	(0.360061)	(0.656253)
	[0.0011]***	[0.1366]`*
CRE^{G}	-16.9453	-8.7624
	(4.795435)	(5.36598)
	[0.0005]***	[0.1053]*
DLIR	12.3586	3.3846
	(4.133362)	(2.395009)
	[0.0033]***	[0.1604]`*
i^{l}	-1.4822	0.9199
	(0.479156)	(0.244481)
	[0.0024]***	[0.0003]***
DLSEC	-	-1.1327
	-	(0.74917)
	-	[0.1334]`*

R-squared	0.840	0.464
Adjusted R-squared	0.824	0.386
Durbin-Watson stat	1.910	2.042
J-statistic	15.865	17.277
Prob (J-statistic)	0.777	0.837

1. Stanadrd errors are give in paranthesis and probabilities in brackets.
2. *** significant at 1 percent, ** at 5 percent, * at 10 percent
3. Etimation weighting matrix:
   HAC (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)
4. Standard errors & covariance computed using HAC weighting matrix (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)
5. Instrument specification:
   RR(-1 TO -4) R_D(-1 TO -4) DD(-1 TO -4) DEP_PS(-1 TO -4) DEP_G(-1 TO -4) CRE_PS(-1 TO -4) CRE_G(-1 TO-4) R_L(-1 TO-4) LIR(-1 TO-4)
4. Constant added to instrument list.

CHAPTER TWO

EXCESS RESERVES & MONETARY TRANSMISSION: FIJI & PNG

ABSTRACT

The presence of excess reserves makes monetary policy weak, and ex ante by implication, impedes the strength of the interest rate channel. This paper examines the i) two stage pass-through process by focusing on the inter-bank and the retail market; and ii) interest rate transmission to the ultimate macroeconomic targets of stable prices and growth in two Pacific SIDS; Fiji and PNG using SVAR model. For Fiji, we find that that a shock to policy interest rate (that is, an increase in policy rate decreases the inter-bank rate, while a shock to policy and inter-bank rates decreases the monthly change in excess liquidity. This is complemented by prolonged response from the lending and savings rate due to a shock to policy and inter-bank rate, and excess reserves. For PNG, a shock to policy interest rate initially decreases the interbank rate but causes a non-dissipating response of the interbank rate after the second month. On the other hand, the policy impact on change in excess liquidity causes an undulating response with its effects total disappearing in the sixth period. Additionally, a shock to policy and inter-bank rate, tend to receive a prolonged positive response from the lending and savings rate, whereas, the lending and savings rate, with respect to excess liquidity, has a prolonged negative impact.

2.1 INTRODUCTION

Chapter 1 explained how reserves are created through autonomous factors and the central bank's liquidity management decisions. However, if the economy is unable to fully absorb the reserves, then there is an inundation of excess reserves/liquidity[44] in the economy, which hinders the complete pass-through of policy rates to the inter-bank and retail rates; and in turn weakens the effectiveness of monetary policy. This suggests that the central bank's attempts to influence the market remains incomplete (see Nissanke and Aryeetey, 1998; Saxegaard, 2006; Ulrich et al. 2006; Khemraj, 2007; Agénor and Aynaoui, 2010; Bathaluddin et al. 2012; Primus et al. 2014).

Analyses in this Chapter are tied to the preceding one. The set of countries investigated is the same, Fiji Islands and Papua New Guinea, which are two of the biggest economies in the Pacific Small Island Developing States (Pacific SIDS) group. Given that 2014 was the United Nations year of the SIDS; and due to the lack of studies focusing on Pacific SIDS, this paper looks at the pass-through or transmission of the central bank's indicator rate to the other key rates in the retail market. The first stage looks at the inter-bank market; while the second stage investigates dynamics in the retail market (following de Bondt, 2005). This is infact the operational transmission of monetary policy for it to be an effective policy and stabilization tool in the economy. A common mistake in a number of studies is trying to regress excess liquidity or role of interest rate with excess liquidity with key macroeconomic variables. However, this is fundamentally flawed. This is reasoned by the simple analogy that if the operational transmission mechanism (that is impact of the central bank's policy rate to market rate) is not working or effective then using policy interest rate with other macroeconomic explains nothing and superficially assumes that policy interest rate affects the other macroeconomic variable when in reality it is not the case.

Therefore, this study is unique in the sense that research on developing countries thus far has focused only on macroeconomic variables, overlooking the operational aspect of monetary policy. That is, although, the ultimate goal is price stability and growth in aggregate demand, the channels via which this is attained is multi-fold and usually inter-related, the so-called "black box" of Bernanke and Gertler (1995). In an operational sense, the inter-bank market intuitively, carries a much larger weight since it is the behaviour of the money market that eventually decides the outcome of monetary policy. In other words, the inter-bank rate is the benchmark rate that identifies the magnitude of the private sector lending rates, both individual and corporate, given changes in the primary rates[45] (see Borio and Fritz, 1995 and Martin and Milas, 2010). Furthermore, Freixas et al. (2011) highlight the importance of the policy and money market rates in redistributing reserves in the banking system. When faced with liquidity imbalances, the inter-bank market allows commercial banks to reallocate liquid

[44] Liquidity and reserves are used interchangeably in this chapter
[45] Primary rates, indicator rates and policy rates are used interchangeably.

assets/reserves amongst themselves at a price allotted by the interplay of the market forces, steered by the central bank rates. However, despite the significant role it plays in maintaining financial stability, there is scant empirical research in the area.

As for the retail market rates (commercial bank deposit and lending rates), policy rate conveyance has been investigated for developed and emerging market economies alike (for instance, see Espinosa-Vega & Alessandro, 2003; de Bondt, 2005; and BIS, 2008). Earlier studies have assumed competitive inter-bank markets with complete and immediate pass-through to the inter-bank and retail markets (see Bernanke and Gertler, 1995; Bernanke and Gilchrist, 1999; and Kashyap and Stein, 2000). Some empirical studies have nonetheless presented evidence to the contrary (see Borio and Fritz, 1995; BIS, 2008; and Martin and Milas, 2010). Similarly, the final lag of the transmission mechanism has also been tested Evidence presented suggests muted transmission in the presence of excess liquidity.

With regards to Fiji, the chronic levels of excess reserves have virtually left the inter-market in the "no-trade" zone for over 12 months (in our sample), while excess reserves have been a constant challenge for monetary policy in the last decade. This may stem from the fact that commercial banks have a perfectly elastic demand for free reserves, arising from the expansionary monetary policy stance (with a very low indicator rate ~ 0.5 percent as at June 2014 –RBF), which has pumped an abundant level of liquidity in the market and, as Allen et al. (2009) suggest, the level is optimal given banks hoard reserves and stop trading with each other due to perceived liquidity risks. In line with studies that focused on the inter-bank hoarding of reserves due to the sub-prime crisis (see ECB, 2007; and Martin and Milas, 2010) and given the political climate of the sovereign country, it is likely that commercial banks maintain an increasingly higher level of reserves[46], and willingly not engage in inter-bank trade.

The situation in PNG is rather similar. The country has enjoyed robust levels of economic growth over the last 13 years and at times registering double digit rates. The growth is primarily being fueled by the resource based sectors, particularly, investment in and mining and exports of Liquefied Natural Gas (LNG). This has seen an influx of capital inflow and accumulated foreign reserves. Since most of the investment is internationally sourced, and despite the resources sector showing buoyant performance, the absorptive capacity of the economy is constrained, fueled also by the dwindling and at times, bullish, outcome in the non-resource sectors. This has flooded the economy with excessive levels of free reserves; which has made the inter-bank market defunct. An excerpt from BPNG's March 2014 monetary policy statement:

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[46] In addition, the inter-bank interest rates are at extremely low levels. From an operational perspective, particularly in corridor frameworks where the returns on reserves (required and free reserves) are arithmetically linked to the policy rates, for instance, remuneration on reserves pinned at 75 basis points below the indicator rate, maintaining lower policy rates apparently, does not eat into the central bank margins. Saborowsk & Weber, 2013 quote studies that suggest that an economy's financial structure and the underlying regulatory and institutional quality underpin effective transmission.

"review of the KFR as the policy signaling rate conducted by the Bank ascertained …the KFR being ineffective in transmitting monetary policy signals to the market rates. This has become more prominent since early 2010, when liquidity increased significantly due to high foreign exchange inflows and deposits by government in trust accounts at commercial banks. In such a high liquidity environment, the interbank trading is limited or non-existent, thus, a change in the policy signaling rate does not translate into changes in market interest rates. As a result, an easing monetary policy, for example, might not be effective in stimulating economic activity through private sector credit growth, as lower (interbank) borrowing costs might not result in lower interest rates to businesses and consumers"

Our study uses the Structural Vector Auto-Regression (SVAR) Model to examine the transmission of interest rate in Fiji and PNG. A number of papers surveyed in literature have applied single equation models such as the Autoregressive-Distributed Lag (ARDL) approach. However, such methods are imperfect when policy analyses are drawn from multiple single equations but are estimated separately. The SVAR approach corrects such flaws in single equation analyses, improves on the methodology by estimating systems of equation with rather than multiple single equations, which ignores correlation of error terms generated by the single equations, and runs into the problem of identification (Gottschalk, 2001). By placing the appropriate structure in the SVAR model, it becomes useful tools to analyse the dynamics of a systems of equation and their inter-relationship by subjecting it to an unexpected shock. These qualities enhance the ability of SVAR as a better policy model for policy analysis, as the results of the impulse response analysis are often more informative than the structural parameter estimates themselves (Lutkepohl & Kratzig, 2004).

Based on the results for Fiji, we find that that a shock to policy interest rate (that is, an increase in policy rate decreases the inter-bank rate, while a shock to policy and inter-bank rates decreases the monthly change in excess liquidity (Model 1). This is complemented by prolonged response from the lending and savings rate due to a shock to policy and inter-bank rate, and change in excess reserves (Model 2 & 3). For PNG a shock to policy interest rate initially decreases the interbank rate but causes a non-dissipating response of the interbank rate after the second month. On the other hand, the policy impact on change in excess liquidity causes an undulating response with its effects total disappearing in the sixth period (Model 1). Additionally, a shock to policy and inter-bank rate, tend receive a prolonged positive response from the lending and savings rate, whereas, the lending and savings rate, with respect to excess liquidity, has a prolonged negative impact (Model 2 & 3).

Therefore, to study these complex interactions, the paper is organized as follows. The next two sections provide a brief over of the stages of pass through (operational and retail). The forth section explains our empirical model, while the Section 5 discusses the results and final section provides some concluding remarks.

2.2 PASS-THROUGH TO THE INTER-BANK RATE

The initial stage includes the inter-bank market, which is essentially one of the most important in the financial circuit. It is where depository institutions trade reserve balances (held at the central banks) to maintain adequate liquidity and fulfil daily settlement obligations. The investment of funds from the deposit base to viable projects is intermediated mostly via the inter-bank market given unexpected liquidity needs or due to the heterogeneous nature of some commercial banks (see Freixas and Jorge, 2008 and Freixas et al., 2011). In an operational sense, the inter-bank market, intuitively, carries a much larger weight since it is the behaviour of this market that eventually decides the outcome of monetary policy[47].

In other words, the inter-bank rate is the benchmark rate that identifies the magnitude of the private sector lending rates, both individual and corporate, given changes in the primary rates[48] (see Borio and Fritz, 1995 and Martin and Milas, 2010). A well-functioning interbank market is therefore supportive of monetary policy and is the key channel for financial intermediation (Smaghi, 2008). However, despite the pivotal role it plays, there is scant empirical research in the area. To this end, Becker et al. (2012) emphasize the sub-prime crisis has drawn to the fore the lack of sufficient research on pass-through of the official interest rates to the inter-bank market.

Looking at the operational aspect of liquidity management, a fundamental way in which central banks conduct monetary policy is by influencing the price of an intermediate target, which can be a selected financial variable in the primary (that is between the Central Bank and Commercial Banks) and secondary market (that is, the inter-bank market and secondary bond market), for example the interest rate on self-issued commercial papers/notes; government securities; over-night inter-bank funds; non-borrowed reserves; or a monetary aggregate. The prices attached to the intermediate targets help attain or effect changes in the central banks' key objectives; namely, stable inflation and growth in aggregate demand.

Theoretically, a feedback measure such as the Taylor rule (which is typically called a reaction function - aims at reducing inflation and output gap given interest rate changes by the central bank) is used to fix target rates. The transmission mechanism of monetary policy is therefore the channel via which policy changes affect price levels and aggregate demand.

Without delving deeper into Bernanke and Gertler's (1995) infamous "black box", the transmission channel can be broken down into several distinct pathways. Assuming a

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[47] This is similar to Friedman's (1968) seminal work which provides insights on how monetary policy should be conducted, specifically, central banks need to i) guide itself by magnitudes that it can control (such as, the rate on money growth), not by ones it cannot control (for example, unemployment rate); ii) avoid sharp swings in policy to promote economic stability; and iii) allow for the delay between their actions and the subsequent effects on the economy.

[48] Primary rates, indicator rates and policy rates are used interchangeably.

contractionary stance (open market operations, or change in required ratio, etc), the first destination, en-route to aggregate demand, is the interbank market via the intermediate interest rate channel[49]. Suppose the central bank sells self-issued notes at the secondary market to the commercial banks. This action injects securities/notes and financial assets in the accounts of economic agents and withdraws funds from the market, hence this infusion represents a decrease in free reserves, and ceteris paribus, causes the inter-bank market interest rates to rise. This market rate is not fixed by the central bank or the commercial banks in a competitive setting, rather determined by the interplay of demand and supply factors, however, it eventually approaches the indicator rate, particularly in a corridor framework, steered by the central bank's policy rate.

This subsequently leads to portfolio reallocation by commercial banks towards excess reserves from other short term securities, which ultimately establishes an equilibrium between the faring interbank and short term security rates (see Freixas et al., 2011). The central bank then is able to use the policy rate and fix the supply of reserves at an equilibrium rate, and is able to mop up the excess liquidity floating in the economy, which can potentially induce accelerated inflationary pressures if converted into credit.

This, however, is the usual order of business in theory. Empirically, with excess reserves, it is assumed that the inter-bank market is lax and unwilling to fully pass-on the drop in target interest rates. The market mechanism fails. For various reasons, the inundation of free reserves impedes a full transmission of the primary interest (or policy interest rate) to secondary and retail market rates, specifically the interbank rates, lending and deposit rates.

Empirical studies find similar results. Martin and Milas (2010) find that in the presence of liquidity and significant counterparty risk emanating from sub-prime related assets, there has been a large differential between the Bank of England's (BOE) policy rate and the LIBOR rates[50]. Changes in the policy rates have not effectively been passed onto the LIBOR rates due to the unwillingness on the part of banks to enter the inter-bank market as a result of solvency fears of their counterparties. This is similar to the findings by the ECB (2007).

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[49] Refers to the liquidity channel or the interest rate channel as far as the inter-bank market only (policy rate to inter-bank rate). This is also sometimes referred to as the short-term interest rate channel in literature.

[50] LIBOR (London Interbank Offered Rate) is the inter-bank market rate in the United Kingdom (UK). Some other popular inter-bank market rates are the Federal Funds Rate of the US and the EURIBOR (Euro Inter-bank Offered Rate) of the Euro-Zone.

2.3 TRANSMISSION TO THE RETAIL RATES

The second stage of the pass-through process involves the retail market rates, which are the commercial bank deposit and lending rates offered to non-financial institutions and individuals, indexed to the inter-bank rates (following the general definition by de Bondt, 2005; and Becker et al., 2012). de Bondt (2005) argues that the inter-bank and/or money market rates most accurately reflect the marginal funding costs incurred by banks in setting prices for their retail portfolios, namely, loans and deposits. For example; following de Bondt (2005), $i^b = \omega\_0 + \omega\_1\ (i^{mc})$, where i^b is the respective interest rate set by the commercial bank; ω_0 is a constant markup; ω_1 is the variable markup consisting of demand elasticities for loans and deposits, market power, adjustment costs, amongst other factors; and i^{mc} is the inter-bank market lending rate, which is equated to the marginal funding cost under the marginal cost pricing rules ($i^{mc} = marginal\ funding\ cost$).

Current literature on the intermediate interest rate channel has mainly looked at pass-through dynamics without augmenting the models with excess reserves. For instance, in a model without excess liquidity, Chirleşan and Apostoaie (2011) find that transmission of policy rates to the inter-bank market rates in Romania are slow, however, after the sub-prime crisis the degree of pass-through has been substantial. Mahasi and Pokhariyal (2013) utilise the two stage interest rate pass-through model and conclude incomplete transmission with a sluggish speed of adjustment with Kenyan data in the inter-bank market.

Additionally, extant literature focusing on retail interest rate pass-through has ignored the liquidity channel under the assumption that the inter-bank and money markets transmit policy rate changes quickly and to the full effect. On the contrary, studies by Borio and Fritz (1995); Espinosa-Vega & Alessandro (2003); de Bond (2005); BIS (2008); Martin and Milas (2010); and Becker et al. (2012) investigate the pass-through speed and magnitude for developed and emerging market economies and find evidence of sluggish and incomplete policy rate transmission to retail rates.

Espinosa-Vega & Alessandro (2003) classify retail interest rates (both lending and deposit) separately into three maturity baskets, short, medium and long term, and using a simple error correction model establish that pass through is incomplete even in the long run. Additionally, the maturity of the financial instruments also influences the short and long run coefficients. Shorter tenured instruments tend have a larger magnitude and speed relative to other counterparts.

de Bandt (2005) was one of the first to look at Euro level data and estimate transmission coefficients of commercial bank deposit and lending rates. His results suggest varying degrees of pass-through for lending and deposit rates. Kwapil and Scharler (2010) find that for the US, deposit rates experience a full conveyance while lending rates have sluggish and incomplete pass-through. Becker et al. (2012) analyse the interest rate transmission mechanism in the UK by exploring the pass-through of the policy rates in a two stage set-up,

to the LIBOR rate and then to the mortgage rates in a non-linear context by employing a threshold cointegration process. Their results indicate a complete transmission to money market rates of an expansionary stance but find evidence of stickiness in a contractionary set-up.

The retail (lending or saving rates) are the channels through which typically the monetary policy transmission or the central bank's policy decisions are conveyed to objective of price stabilization and economic growth. Nisanke and Aryeetey (1998) show that the presence of bank liquidity impedes the central bank's ability to control money supply effectively. Similarly, Agénor and Aynaoui (2010) study the effectiveness of monetary policy in the presence of excess reserves with credit market imperfections. Their results indicate asymmetric pricing behaviour in that deposit rates present greater stickiness which obstructs a full pass-through of the policy changes to the inflationary pressure.

In a similar vein, Kashyap and Stein's (2000) liquidity effect illustrates that monetary policy tends to be more effective on lending behaviour of banks with relatively less liquid balance sheets. Analogous to the theory of reserves, this indicates that banks facing higher liquidity (reserves) would see an incomplete pass-through of policy rates to the lending rate. Primus et al. (2014) highlight that chronic excess reserves, together with other financial market frictions reduce the strength of the policy interest rate pass-through in Trinidad and Tobago. Similalry, Saxegaard (2006) highlights that involunatry reserves tend to more un-responsive to monetary polciy than precautionary reserves.

2.4 EMPIRICAL MODEL

This paper utilises the Structural Vector Auto-Regression (SVAR) Model to study the transmission of interest rate transmission in Fiji and PNG. A number of papers surveyed in literature have applied single equation models such as the ARDL approach. However, such methods are imperfect when policy analyses are drawn from multiple single equations but are estimated separately. The SVAR approach corrects such flaws in single equation analyses, improves on the methodology by estimating systems of equation with rather than multiple single equation, which ignores correlation of error terms generated by this single equation, and runs into the problem of identification (Gottschalk, 2001). By placing the appropriate structure in the SVAR model, it becomes useful tools to analyse the dynamics of a systems of equation and their inter-relationship by subjecting it to an unexpected shock. These qualities enhance the ability of SVAR as a better policy model for policy analysis, as the results of the impulse response analysis are often more informative than the structural parameter estimates themselves (Lutkepohl & Kratzig, 2004).

The discussion on excess liquidity and its implication had been discussed at the length (in the earlier chapter). Therefore, we now define the models in SVAR framework to estimate and interpret the results. Based on the theoretical model specification (see Becketti, 2013; Lutkepohl, 2005; Lutkepohl & Kratzig, 2004), we set-up SVAR(p) models for Fiji and PNG, respectively, as:

$$y_t = A_1^* y_{t-1} + \cdots + A_p^* y_{t-p} + B\varepsilon_t \qquad 2.1$$

where y_t vector of observed endogenous variables. It is assumed that the structural errors, ε_t, are white noise and coefficient matrices A^* for $i = 1, \ldots, p$ are structural coefficients. Now multiplying the equation by inverse of A (A^{-1}) yields and then collecting the A matrices, as A_t, where $(t = 1, \ldots, p)$:

$$A^{-1}y_t = A^{-1}A_1^* y_{t-1} + \cdots + A^{-1}A_p^* y_{t-p} + A^{-1}B\varepsilon_t \qquad 2.2$$

$$y_t = A_1 A_1^* y_{t-1} + \cdots + A_p A_p^* y_{t-p} + u_t \qquad 2.3$$

The A and/or B matrices (as used as structural restrictions) in the SVAR model to identify shocks and trace these through the Impulse-Response Functions (IRF) and Forecast Error Variance Decomposition (FEVD)[51]. Furthermore, we define the structural innovations as $u_t = A^{-1}B\varepsilon_t$ and its variance-covariance matrix by $\Sigma_u = A^{-1}BB^T{A^{-1}}^T$. Consequently, the class of SVAR model we now estimate is termed the AB model , which can be written as:

[51] For details of the IRF and FEVD and restrictions (see Becketti, 2013; Lutkepohl, 2005; Lutkepohl & Kratzig, 2004).

$$Au_t = Be_t \qquad 2.4$$

where u_t (the observed or reduced form errors) and e_t (unobserved structural innovations and assumed to orthonormal, that is, $E[e_t e_t'] = I$) are vectors of length k and A and B are $k \times k$ matrices to be estimated. Having defined the broad modelling framework of the estimation technique, we fill-in this framework with the variables for estimated of IRF and FEVD for Fiji and PNG. With respect to the surveyed literature and stylsied facts for these economies, we estimate the structural relationships (through systems of equations) in a two-stage fashion:

1) **Immediate Pass through to Inter-bank Interest Rate (with excess liquidity)**
   In the first stage, we define, y_t, vector of observed endogenous variables, as $y_t = [i\_r, i\_b, dlFR]$ that contains the monthly data of policy interest rate (i_r), interbank rate (i_b) and first-difference in log of excess liquidity ($dlFR$)[52], where AB model is:

$$\begin{bmatrix} a_{11} & 0 & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} u^r \\ u^b \\ u^{FR} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 \\ 0 & b_{22} & 0 \\ 0 & 0 & b_{33} \end{bmatrix} \begin{bmatrix} \varepsilon^r \\ \varepsilon^b \\ \varepsilon^{FR} \end{bmatrix} \qquad 2.5$$

   The structure is placed on the A matrix by denoting that $a_{11}, a_{22}, a_{33} = 1$; a_{21}, a_{31}, a_{32} and diagonal elements of B matrix are estimated by the model and a_{13} & a_{23} are set one to indicate that central banks information set includes the consideration to liquidity and similarly commercial banks also take this into consideration when adjusting the interbank rate due to changes in policy rate. Placement of such restrictions provided an understanding of how observed errors and unobserved structural innovation interact, which defines the structural model as:

$$u^r = -u^{FR} + b_{11}\varepsilon^r \qquad 2.6$$
$$u^b = -a_{21}u^r - u^{FR} + b_{22}\varepsilon^b \qquad 2.7$$
$$u^{FR} = -a_{31}u^r - a_{32}u^b + b_{33}\varepsilon^{FR} \qquad 2.8$$

2) **Transmission to Retail Interest Rates (with excess liquidity)**
   In the second stage, we extend the above systems of equation to include the lending rate (i_L) and then separately the savings (or deposit) rate (i_i). Therefore, the AB Model is formulated as follows with:

[52] The first difference of log(FR) is taken to transform this into a stationary series.

i) Lending Rate

In the second stage (Part A), we define, y_t, vector of observed endogenous variables, as $y_t = [i\_r, i\_b, dlFR, i\_L]$ that contains the monthly data of policy interest rate (i_r), interbank rate (i_b) and first-difference in log of excess liquidity ($dlFR$) and lending rate (i_L), hence, its AB model is defined as:

$$\begin{bmatrix} a_{11} & 0 & a_{13} & 0 \\ a_{21} & a_{22} & a_{23} & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{bmatrix} u^r \\ u^b \\ u^{FR} \\ u^L \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 \\ 0 & 0 & b_{33} & 0 \\ 0 & 0 & 0 & b_{44} \end{bmatrix} \begin{bmatrix} \varepsilon^r \\ \varepsilon^b \\ \varepsilon^{FR} \\ \varepsilon^L \end{bmatrix} \qquad 2.9$$

Again, in the A matrix, $a_{11}, a_{22}, a_{33}, a_{44} = 1$; $a_{21}, a_{31}, a_{32}, a_{41}, a_{42}, a_{43}$ and diagonal elements of B matrix are estimated by the model and a_{13} & a_{23} are set one to indicate that central bank's and commercial bank's information set includes this, which defines the structural model as:

$$u^r = -u^{FR} + b_{11}\varepsilon^r \qquad 2.10$$
$$u^b = -a_{21}u^r - u^{FR} + b_{22}\varepsilon^b \qquad 2.11$$
$$u^{FR} = -a_{31}u^r - a_{32}u^b + b_{33}\varepsilon^{FR} \qquad 2.12$$
$$u^L = -a_{41}u^r - a_{42}u^b - a_{43}u^{FR} + b_{44}\varepsilon^L \qquad 2.13$$

ii) Savings Rate

In the second stage (Part B), we define, y_t, vector of observed endogenous variables, as $y_t = [i\_r, i\_b, dlFR, i\_i]$ that contains the monthly data of policy interest rate (i_r), interbank rate (i_b) and first-difference in log of excess liquidity ($dlFR$) and savings rate (i_i), similarly, its AB model is defined as:

$$\begin{bmatrix} a_{11} & 0 & a_{13} & 0 \\ a_{21} & a_{22} & a_{23} & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{bmatrix} u^r \\ u^b \\ u^{FR} \\ u^i \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 \\ 0 & 0 & b_{33} & 0 \\ 0 & 0 & 0 & b_{44} \end{bmatrix} \begin{bmatrix} \varepsilon^r \\ \varepsilon^b \\ \varepsilon^{FR} \\ \varepsilon^i \end{bmatrix} \qquad 2.14$$

The A matrix for this system outlines $a_{11}, a_{22}, a_{33}, a_{44} = 1$; $a_{21}, a_{31}, a_{32}, a_{41}, a_{42}, a_{43}$ and diagonal elements of B matrix are estimated by the model and a_{13} & a_{23} are set one to indicate that central bank's and commercial banks' information set includes this, which defines the structural model as:

$$u^r = -u^{FR} + b_{11}\varepsilon^r \qquad 2.15$$
$$u^b = -a_{21}u^r - u^{FR} + b_{22}\varepsilon^b \qquad 2.16$$
$$u^{FR} = -a_{31}u^r - a_{32}u^b + b_{33}\varepsilon^{FR} \qquad 2.17$$
$$u^i = -a_{41}u^r - a_{42}u^b - a_{43}u^{FR} + b_{44}\varepsilon^i \qquad 2.18$$

In both stages of transmission, the imposed structure emphasises a theoretically consistent method of identification. For instance, in both stages of interest rate transmission, we restrict the equations to show:

- **Equations 2.6; 2.10; 2.15** – That innovations in the level of excess reserves have a contemporaneous impact on setting of policy interest rates. More specifically, the monetary policy stance does take into account the level of liquidity to be mopped-up. This structure emphasises operational target to rein-in excess liquidity for overall interest rate transmission efficacy.

- **Equations 2.7; 2.11; 2.16 –** Indicates that innovations in the level of excess reserves and central bank policy interest rates have a contemporaneous impact on inter-bank interest rate. This is intuitive as the inter-bank market interest rate in reality reacts to both the cost of financing (based on the central bank interest rate) and available level of liquidity. Hence, any changes in the policy interest rate and excess liquidity will bring about changes in the inter-bank trading interest rate.

- **Equations 2.8; 2.12; 2.17** – There is causal link between the level of excess reserves, policy interest rate and interbank market trading interest rate (which is also explained it the model for excess reserves for Fiji and PNG in Chapter 1). Therefore, the level of excess reserves is contemporaneously influenced by the innovations in policy and inter-bank interest rates.

- **Equations 2.13; 2.18** – Finally, the market interest rates (that is savings and lending rate) are contemporaneously affected by the policy interest and inter-bank market interest rate and level of excess reserves (or liquidity) in the system. However, these retail rates do not influence the policy interest rate, interbank market interest rate and level of accumulated excess liquidity.

Such theoretically consistent structure allows for tracing the shocks through the IRF and FEVD. However, if we remove these imposed restrictions, the model will be a simple VAR and tracing the specific dynamics of excess liquidity and its contemporaneous impact on inter-bank rate, savings and lending rates will be quite generic and puzzling. As outlined by Enders (2010) that VAR approach is devoid of any economic content and thus forms its' major criticism, as Choleski decomposition do not have a direct economic interpretation. Such an approach, as argued by Enders (2010), improperly identifies the underlying shocks which results in misleading IRF and FEVD.

2.5 RESULTS & POLICY DISCUSSION

The estimation closely follows the defined systems of model in Section 2.4. We present the impulse response and variance decomposition result from the AB model identified SVAR for Fiji and PNG. Other auxiliary, results such as lag selection test, stability analysis of the model (using Cumulative Sum of Square – CUMSUM), etc., are presented in the Appendices to keep the discussion focused on the key results.

2.5.1 Fiji

The estimated lag structure of the three systems of equations indicate one (1) lag model (based on the Schwarz and Hannan-Quinn Criterion) for immediate transmission model, the lending rate and saving rate pass-through, accordingly. Using this formulation, we estimate a simple VAR and then define structural A and B matrices and embed this structure in the VAR model, as SVAR.

The lag structure, estimated VAR coefficients, A and B matrices and stability analyses are presented in Appendix 2.1 to 2.3. Given intuitive two-stage analyses, we outline the impulse response (with their 90% confidence interval) of:

1. **Model 1** ($y_t = [i\_r, i\_b, dlFR]$): $\boldsymbol{i_r \rightarrow i_b; i_r \rightarrow dlFR;\ i_b \rightarrow dlFR}$ in Figure 2.1 illustrates that a shock to policy interest rate (that is, an increase in i_r) decreases the interbank rate, while a shock to policy and inter-bank rates decreases the monthly change in excess liquidity. This impact on $dlFR$ is intuitive and consistent with theory noting that increases in policy and hence interbank rate are used to drive down the holdings of excess liquidity.

   To this end, it is also important to note that the impulse response of policy rate to interbank rate strengthens the case for observed stylized fact for the Fiji inter-bank market – that is – it remains largely insulated by the changes in policy rate. The variance decomposition[53] results presented Appendix 2.4 (across all models presented) attest to this stylized result for Fiji, as the FEVD for i_b shows minimal influence of policy interest rate on the inter-bank rate setting. In fact, inter-bank rate is substantially influenced by the changes in the quantity of excess liquidity than policy interest rate.

   As discussed in the earlier (in Chapter 1 results and policy discussion) the accumulation of involuntary free reserves have insulated the inter-bank rate from the increase in the policy interest rate. Such weak pass-through from the policy interest rate to inter-bank rate implies that traditional monetary policy transmission for Fiji is limited in influencing the commercial banks through the price for liquidity, noting relatively large accumulation of involuntary free reserves in the banking system.

[53] Variance decomposition indicates the amount of information each variable contributes to the other variables in the SVAR model and determines how much of the forecast error variance of a variable can be explained by exogenous shocks to the other variables.

Hence, to make this immediate pass-through channel effective in such a situation, the RBF needs to look at effective mobbing-up of excess liquidity in the banking system to improve the policy interest rate transmission to inter-bank interest rate. Nevertheless, it is vital to note that an oligopoly bank structure dominated by two (Australian) banks impedes meaningful competition in the banking sector, and strict exchange controls on outflows of funds from Fiji is biased towards a liquidity build-up through constant sterilisation of foreign exchange inflows by the central bank.

This result is also somewhat consistent with the impulse response of i_r & i_b on $dlFR$ (this is consistent with the FEVD of $dlFR$ presented in Appendix 2.4), which indicates an increase in policy interest rate and inter-bank rate decreases holding of free reserves (in case of Fiji it is largely the involuntary reserves which is reduced). The transmission of interbank rate to free reserves is easily established, while the policy rates tends to have a broader impact on the commercial banks' ability to borrow from the other sources such as the central banks overnight facility (where the penal interest rate charges is aligned to the central bank's policy rate plus a premium for such short-term borrowing).

However, in both cases, impact of policy and inter-bank rates shock on $dlFR$ dissipates with one month. This illustrates weakness in the overall effectiveness of (1) interest rate based monetary policy in controlling the liquidity in the banking system and (2) transmission of policy interest rate to immediate/intermediate operational targets to influence the overall macroeconomic variables and as a tool for economic stabilization in the short-medium term.

2. **Model 2** ($y_t = [i\_r, i\_b, dlFR, i\_L]$): $\boldsymbol{i_r \rightarrow i_b; i_r \rightarrow dlFR; i_r \rightarrow i_L;\ i_b \rightarrow dlFR;\ i_b \rightarrow i_L;\ dlFR \rightarrow i_L}$ in Figure 2.2. Model 2 expands Model 1 SVAR system by adding the lending rate (i_L). The (impulse–response) results of Model 1 still holds for the impact of: (1) policy rates on the inter-bank rate and change in free reserves; and (2) inter-bank rate on change in free reserves.

   Hence, we only focus on the results obtained for the lending rate and its interaction in this model. We find that a shock to policy (i_r) and inter-bank (i_b) rate, and $dlFR$ tend receive a prolonged response from the lending rate. This is perhaps more psychological response by the commercial banks, noting that policy rate a signal to increase the cost of borrowing for commercial bank and hence this is pass immediately to the lending rates. Observing the most commercial banks' lending in Fiji are contracted on fixed rates, thus policy shock impact continues to remain weight on lending rate rather than vanishing with time.

   Furthermore, the case of heterogeneous impact of central bank on banking lending condition cannot be ruled-out, noting that two other smaller commercial banking may not be flushed with liquidity as other two major Australian banks. Consequently, this would

translate into an immediate and prolonged impact of lending rates to larger extend for these smaller market players which is pacified by the larger commercial banks holding significant free reserves. Additionally, the $dlFr$ impact on lending rate is consistent with expectations, that is, an increase (positive shock) on excess reserves accumulation decreases the lending rates overtime.

3. **Model 3** ($y_t = [i\_r, i\_b, dlFR, i\_i]$): $\boldsymbol{i_r \rightarrow i_b; i_r \rightarrow dlFR; i_r \rightarrow i_i;\ i_b \rightarrow dlFR;\ i_b \rightarrow i_i;\ dlFR \rightarrow i_i}$ in Figure 2.3. Similar to the discussion on Model 2 above, we focus on the results for the savings rate and its interaction in this model. We find that a shock to policy (i_r) and inter-bank (i_b) rate, and $dlFR$ tend receive a prolonged response from the savings rate.

   As discussed results for Model 2 (above), this is more a signaling effect whereby the commercial banks increase savings rate to increase liquidity. This behavior systematically corresponds to an increasing in the lending rate, and could be an attempt to encouraged increased savings in the banking sector (from non-banks), from the public and/or institutions, to beef-up liquidity in addition to the central bank discount window borrowing, when needed.

FIGURE 2.1: FIJI – SVAR IMPULSE RESPONSE OF MODEL 1

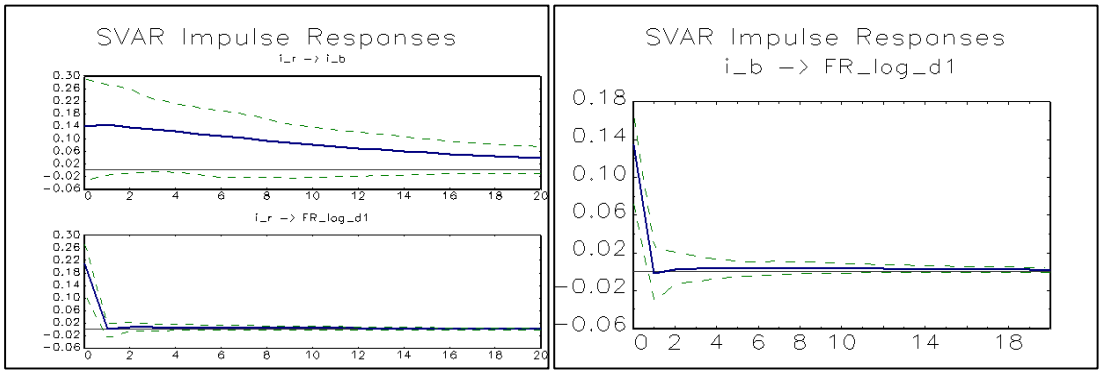


FIGURE 2.2: FIJI – SVAR IMPULSE RESPONSE OF MODEL 2

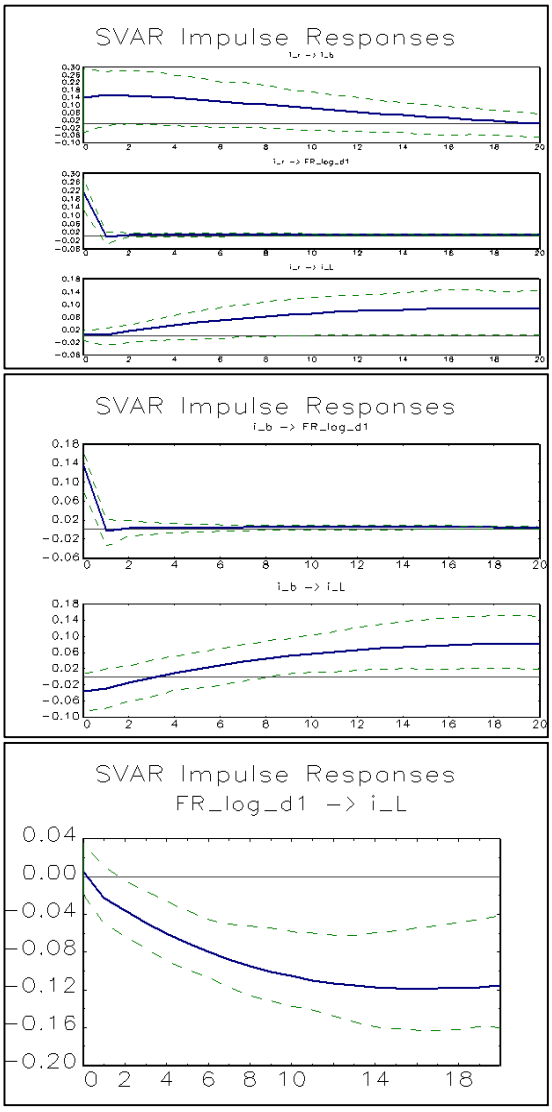
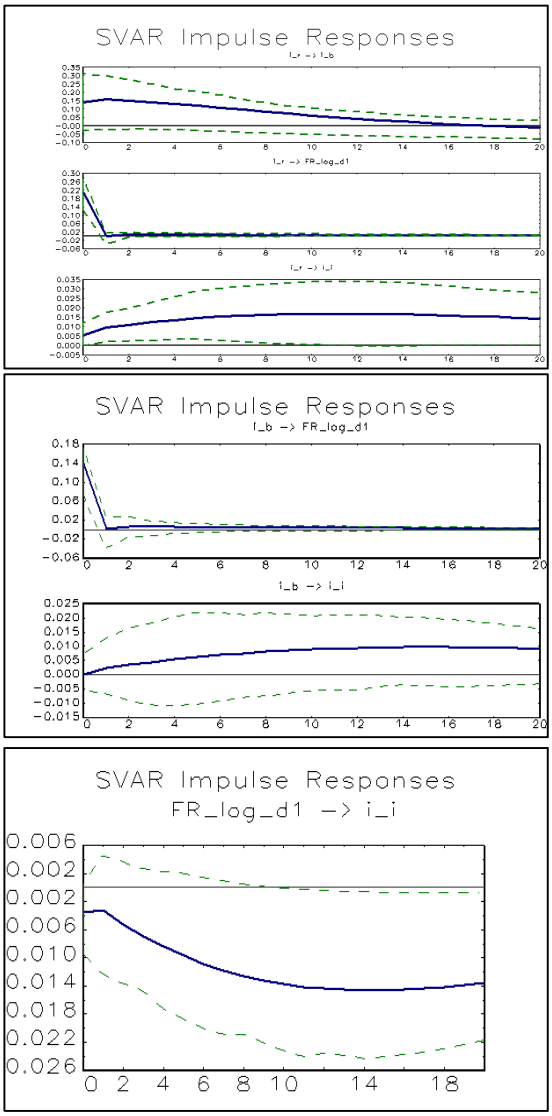


FIGURE 2.3: FIJI – SVAR IMPULSE RESPONSE OF MODEL 3



2.5.2 PNG

The estimated lag structure of the three systems of equations indicate two (2) lag model based on the Schwarz Criterion (for Model 1) and Hannan-Quinn Criterion (for Model 2 & 3). Using this formulation, we estimate a simple VAR and then define structural A and B matrices and embed this structure in the VAR model, as SVAR. However, in the case of PNG, the restrictions placed on the matrix A is slightly modified, as the model fails to convergence in case to two restrictions above the diagonal elements (i.e. where a_{13} & a_{23} are set one).

Therefore, we now identify Matrix A in Equations 2.5, 2.9 & 2.14 with element $a_{23} = 0$ and $a_{13} = 1$, which supports the stylised fact Bank PNG's interest rate policy setting is influenced by the level of liquidity. The approach and definition of element a_{23} is utilised across the structural restrictions utilised for SVAR estimation for PNG. The lag structure, estimated VAR coefficients, A and B matrices and stability analyses are presented in Appendix 2.5 to 2.7. Based on the estimated impulse response (with their 90% confidence interval), we analyse each of structural models below:

1) **Model 1** ($y_t = [i\_r, i\_b, dlFR]$): $\boldsymbol{i_r \rightarrow i_b; i_r \rightarrow dlFR;\ i_b \rightarrow dlFR}$ in Figure 2.4 illustrates that a shock to policy interest rate (that is, an increase in i_r) initially decreases the interbank rate (i.e. in the first month) but causes a non-dissipating response of the interbank rate after the second month. On the other hand, the policy impact on change in excess liquidity (denoted by $dlFR$) causes an undulating response and all effects of this policy interest rate shock disappears by the sixth month. The impact of i_r on $dlFR$ is consistent with theory and results obtained in the variance decomposition graphs of i_r (where around 60% of its forecast variance is explained by $dlFR$) and $dlFR$ (where around 80% of its' forecast variance is explained by i_r). Consequently, the increases in policy and associated positive response of inter-bank rate tends to drive down the changes in excess liquidity holding by commercial banks. The increase in policy rates invariably signals increases in the returns for central bank bills and treasury bills rates as a form short-term investment of excess liquidity by the commercial banks instead of keep its as idle funds. Therefore, it appears that monetary policy is primarily designed and biased towards dealing with excess liquidity rather than regulating liquidity in the banking system.

   This also explains the lasting impact on the inter-bank market, as we determined earlier (in the previous chapter) that commercial banks primary purpose for holding excess liquidity is driven by precautionary attributes given the strong economic growth observed (during the sample period) and thus the demands placed on banking sector liquidity. Furthermore, the $dlFR$ temporary increases in response to inter-bank interest rate shock to stock-up precautionary reserves. This could be attributed to the inter-bank

market not having a clear view about the future monetary policy stance[54] and hence unable to appropriately correlate with the financial and/or balance sheet decisions.

2) **Model 2** ($y_t = [i\_r, i\_b, dlFR, i\_L]$): $\boldsymbol{i_r \rightarrow i_b; i_r \rightarrow dlFR; i_r \rightarrow i_L;\ i_b \rightarrow dlFR;\ i_b \rightarrow i_L;\ dlFR \rightarrow i_L}$ in Figure 2.5. Model 2 of PNG builds on Model 1 SVAR system by adding the lending rate (i_L). Given that the impulse–response results of Model 1 still hold for the impact of: (1) policy rates on the inter-bank rate and change in free reserves; and (2) inter-bank rate on change in free reserves, we only focus on the results obtained for the lending rate and its interaction in this model.

   A shock to policy (i_r) and inter-bank (i_b) rate, tend receive a prolonged positive response from the lending rate, whereas, the lending rate, with respect to $dlFR$, has a prolonged negative impact. These relationships are consistent with envisaged theoretical relationships, as higher policy and inter-bank rate, which determine the cost of raising funds for banks, relates positively to the lending rate. On the contrary, the accumulation of excess liquidity, as expected, decreases the lending rate.

3) **Model 3** ($y_t = [i\_r, i\_b, dlFR, i\_i]$): $\boldsymbol{i_r \rightarrow i_b; i_r \rightarrow dlFR; i_r \rightarrow i_i;\ i_b \rightarrow dlFR;\ i_b \rightarrow i_i;\ dlFR \rightarrow i_i}$. In Figure 2.6, we find a slightly different response of interbank rate to a shock in policy rate, compared the results obtained in Models 1 & 2. The other results remain the same. Hence, we focus on interaction of the savings rate in this model. We find that a shock to policy (i_r) and inter-bank (i_b) rate, and $dlFR$ tend receive a prolonged response from the savings rate. The results are quite mixed. The savings rate response negatively to a shock in policy rate, whereas, savings rate reacts positively to interbank rate initially (i.e. in the first month) and the declines rapidly changing to a negative impact around 10 months. This sort of independence structure of savings rate is also depicted in its' variance decomposition, where majority (i.e. around 90% in the first month) is determined by its own shocks. However, the relationship with *dlFR* is expected – an accumulation of excess liquidity decreases the savings rate, as is the case of lending rate (outlined in Model 2).

[54] Assessment of various BPNG monetary policy statements has shown that they do not have a clear view of the desired rate of inflation or manageable inflation rate. This increases uncertainty in determining the nominal anchor for monetary policy in PNG.

FIGURE 2.4: PNG – SVAR IMPULSE RESPONSE OF MODEL 1

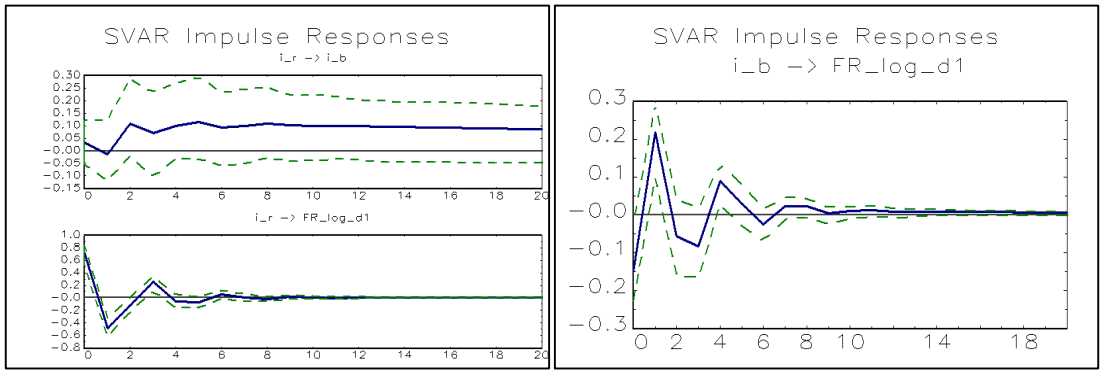


FIGURE 2.5: PNG – SVAR IMPULSE RESPONSE OF MODEL 2

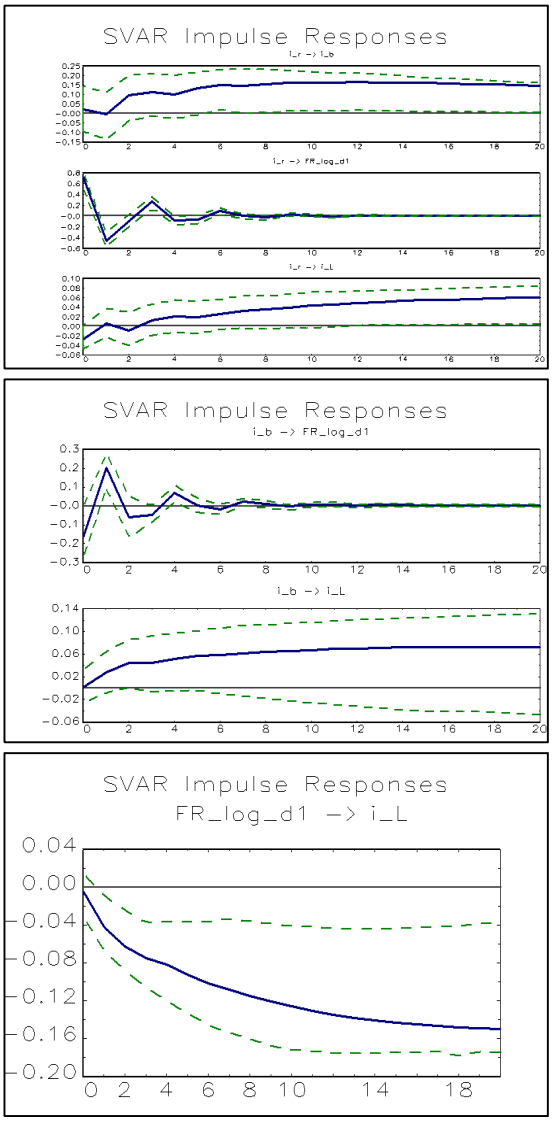
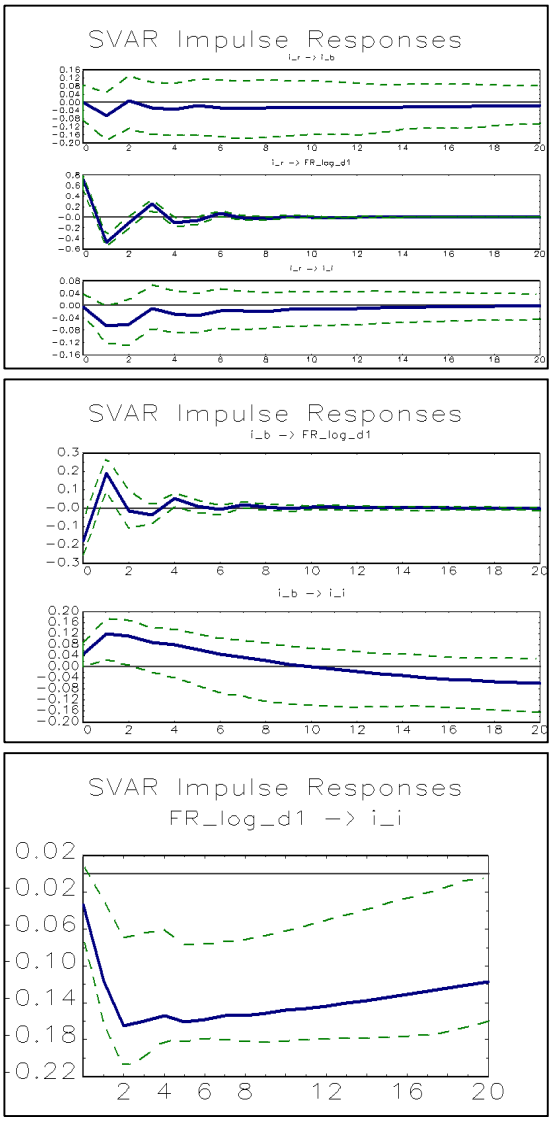


FIGURE 2.6: PNG – SVAR IMPULSE RESPONSE OF MODEL 3



2.6 CONCLUSION

The aim of this research was to isolate the impact of policy interest rate on the operational interbank interest rate (first stage of monetary policy transmission) and then the pass-through to retail lending and savings rate (second stage of monetary policy transmission). Using a SVAR framework with well-thought and stylized structural restrictions, we study interactions between policy interest rate, inter-bank rate and retail interest rates with excess liquidity. Hence, we estimate three models to study these interactions in detail using the impulse response and forecast error variance decomposition.

Based on the results for Fiji, we find that that a shock to policy interest rate (that is, an increase in policy rate decreases the inter-bank rate, while a shock to policy and inter-bank rates decreases the monthly change in excess liquidity (Model 1). This is complemented by prolonged response from the lending and savings rate due to a shock to policy and inter-bank rate, and change in excess reserves (Model 2 & 3). For PNG a shock to policy interest rate initially decreases the interbank rate but causes a non-dissipating response of the interbank rate after the second month. On the other hand, the policy impact on change in excess liquidity causes an undulating response with its effects total disappearing in the sixth period (Model 1). Additionally, a shock to policy and inter-bank rate, tend receive a prolonged positive response from the lending and savings rate, whereas, the lending and savings rate, with respect to excess liquidity, has a prolonged negative impact (Model 2 & 3).

Given Fiji and PNG's excess reserves conditions[55] – that is – predominantly involuntary free reserves in case of Fiji and precautionary excess reserves in PNG's case – commercial banks are able to manage their liquidity needs without frequent inter-bank trading. In PNG, overnight borrowing is done at the KFR, but as this is considered expensive such borrowing is limited. In Fiji, due to the large amount of involuntary reserves, trading has been inactive especially in recent years noting that such an exercise will be futile. Therefore, while the RBF and BPNG set interest rate on overnight funds, there is an absence of a properly functioning inter-bank money market, and the OPR largely has no impact on the interbank rate, while KFR has positive yet muted impact on inter-bank rates.

In addition, mopping up excess liquidity from the banking system is a costly affair for the central banks in these two countries. It is also important to note that an oligopoly bank structure dominated by two or three large banks impedes meaningful competition in the banking sector in both economies. Additionally, strict exchange controls on outflows of funds from Fiji and PNG,

[55] In the reference sample period.

to defend their exchange rate peg, is biased towards a liquidity build-up through constant sterilisation of foreign exchange inflows by the central banks.

Lack of credible monetary policy target (such as a specific target or range for the inflation rate) to anchor market expectations, confuses market players and impedes development of appropriate competition amongst commercial banks. In Fiji, over the last decade, generally depressed economic growth has placed no pressure on converting liquidity into domestic credit. Such lack of bankable projects in the economy with high probability of delinquencies and high country risk perception (as result of political instability), aggravate the already weak monetary policy transmission to primary (operational) and secondary (retail) money markets. This also limits monetary policy's economic stabilization role in the short-term. This, in fact, is proven when the RBF adopted direct quantitative restrictions (through administration of domestic credit ceiling for commercial banks after the 2006 Military Coup) rather than indirect mechanisms to influence the economy.

For BPNG it appears the monetary policy framework is designed to deal with excess liquidity but not flexible enough to manage liquidity properly. There is stark difference in these two roles. A muted interest rate channel may reduce excess liquidity but with limited success. Commercial banks will continue to build precautionary excess reserves, as a form of self-insurance against large project demands from the economy (such as, continued focus and impetus of the minerals and LNG sectors during the sample period). At the same time, however, other structural factors that impede the interest rate channel, such as limited financial sector participation, will need to be addressed over the longer term, in line with the BPNG's work agenda on financial inclusion.

Over time, with an improved interest channel, BPNG will be in a stronger position to signal its monetary stance using the KFR. The pace of liquidity withdrawal should also take account of risks associated with the potential for reserve outflows and depreciation pressure on the kina. Excess reserves held by the commercial banks at their respective central banks could potentially be sold for foreign exchange and precipitate a sharp fall in the value of the currency, which could lead to financial instability. Pressure for the kina to depreciate has been driven by the completion of the major LNG projects recently. The economy is sensitive to movements in the exchange rate, which research has shown has a greater impact on inflation and output than interest rates (David and Nants, 2006). The BPNG's desired stance for the KFR is fundamental to liquidity management and any further liquidity withdrawal.

Having studied this transmission mechanism in an excess liquidity framework, we have ascertained that modelling the heterogeneous channel, that is, transmission channel through individual banks can be an intriguing topic for future research and will require significant individual bank data, capital positions, etc., which may not be readily available.

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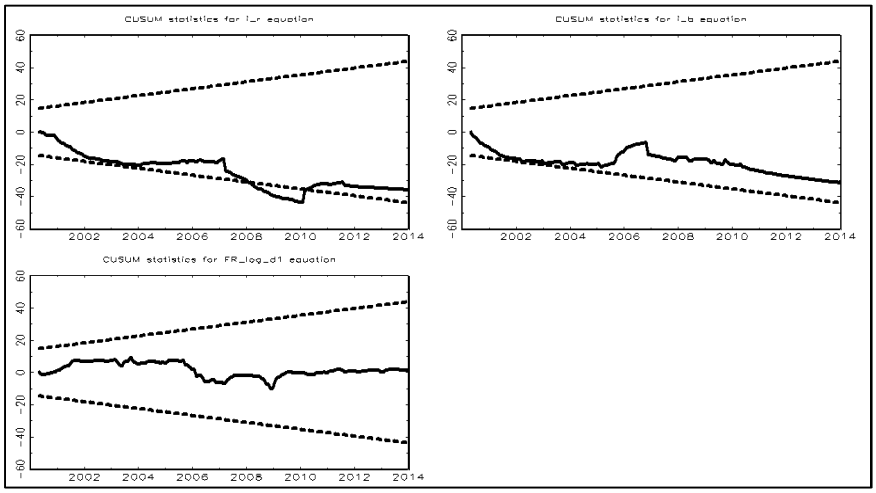
APPENDIX 2.1

TABLE A.2.1: FIJI –MODEL 1: VAR COEFFICIENTS, DIAGNOSTICS & AB MODEL

FIJI: MODEL 1 (OPTIMAL LAG STRUCTURE)

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA	
endogenous variables:	i_r i_b FR_log_d1
deterministic variables:	CONST
sample range:	[2000 M12, 2014 M3], T =160
optimal number of lags (searched up to 10 lags of levels):	
Akaike Info Criterion:	1
Final Prediction Error:	1
Hannan-Quinn Criterion:	1
Schwarz Criterion:	1

FIJI: MODEL 1 (CUMSUM STABILITY TEST)



VAR ESTIMATION RESULTS

endogenous variables: i_r i_b FR_log_d1

exogenous variables:

deterministic variables: CONST

endogenous lags: 1

exogenous lags: 0

sample range: [2000 M3, 2014 M3], T = 169

modulus of the eigenvalues of the reverse characteristic polynomial :

|z| = (1.2509 1.0867 34.8776)

Legend:

Equation 1 Equation 2
...
Variable 1 | Coefficient ...
| (Std. Dev.)
| {p - Value}
| [t - Value]
Variable 2 | ...

Lagged endogenous term:	i_r	i_b	FR_log_d1
i_r (t-1)	**0.853**	**0.033**	**0.015**
	(0.037)	(0.053)	(0.025)
	{0.000}	{0.532}	{0.547}
	[23.160]	[0.626]	[0.603]
i_b (t-1)	**0.107**	**0.866**	**0.007**
	(0.033)	(0.047)	(0.022)
	{0.001}	{0.000}	{0.746}
	[3.242]	[18.436]	[0.324]
FR_log_d1(t-1)	**-0.032**	**0.054**	**-0.029**
	(0.114)	(0.164)	(0.078)
	{0.782}	{0.741}	{0.711}
	[-0.277]	[0.330]	[-0.370]
Deterministic term:	**i_r**	**i_b**	**FR_log_d1**
CONST	**0.105**	**0.077**	**-0.008**
	(0.057)	(0.082)	(0.039)
	{0.066}	{0.347}	{0.843}
	[1.835]	[0.941]	[-0.198]

FIJI: MODEL 1 (AB MATRICES)

Estimated A matrix:			Estimated B matrix:		
1	0	**1**	**0.62**	0	0
-0.84	1	**1**	0	**0.80**	0
-0.39	**-0.34**	1	0	0	**0.45**
Estimated standard errors for A matrix:			Estimated standard errors for B matrix		
0	0	0	**0.03**	0	0
0.15	0	0	0	**0.05**	0
0.08	**0.07**	0	0	0	**0.04**
A^-1*B			SigmaU~*100		
0.41	-0.14	-0.23	24.10	7.64	1.75
0.14	0.55	-0.41	7.64	49.28	1.01
0.21	0.14	0.23	1.75	1.01	11.23

TABLE A.2.2: FIJI –MODEL 2: VAR COEFFICIENTS, DIAGNOSTICS & AB MODEL

FIJI: MODEL 2 (OPTIMAL LAG STRUCTURE)

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA	
endogenous variables:	i_r i_b FR_log_d1 i_L
deterministic variables:	CONST
sample range:	[2000 M12, 2014 M3], T = 160
optimal number of lags (se	arched up to 10 lags of levels):
Akaike Info Criterion:	5
Final Prediction Error:	5
Hannan-Quinn Criterion:	1
Schwarz Criterion:	1

VAR ESTIMATION RESULTS

endogenous variables: i_r i_b FR_log_d1 i_L
exogenous variables:
deterministic variables: CONST
endogenous lags: 1
exogenous lags: 0
sample range: [2000 M3, 2014 M3], T = 169

modulus of the eigenvalues of the reverse characteristic polynomial :
|z| = (1.2595 1.0426 1.0426 28.5101)

Legend:
Equation 1 Equation 2 ...
Variable 1 | Coefficient ...
| (Std. Dev.)
| {p - Value}
| [t - Value]
Variable 2 | ...

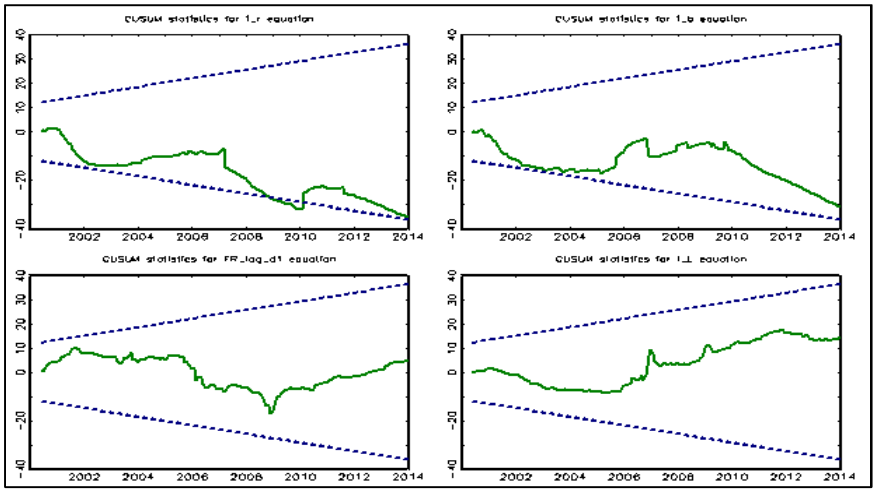
Lagged endogenous term:

	i_r	i_b	FR_log_d1	i_L
i_r (t-1)	**0.864**	**0.047**	**0.008**	**0.018**
	(0.038)	(0.054)	(0.026)	(0.010)
	{0.000}	{0.388}	{0.771}	{0.065}
	[22.845]	[0.864]	[0.291]	[1.848]
i_b (t-1)	**0.103**	**0.862**	**0.01**	**0.03**
	(0.033)	(0.047)	(0.022)	(0.008)
	{0.002}	{0.000}	{0.660}	{0.000}
	[3.119]	[18.268]	[0.440]	[3.535]
FR_log_d1(t-1)	**-0.02**	**0.069**	**-0.037**	**-0.053**
	(0.115)	(0.164)	(0.078)	(0.029)
	{0.861}	{0.676}	{0.636}	{0.071}
	[-0.175]	[0.418]	[-0.473]	[-1.807]
i_L (t-1)	**-0.063**	**-0.08**	**0.044**	**0.985**
	(0.051)	(0.073)	(0.035)	(0.013)
	{0.214}	{0.276}	{0.206}	{0.000}
	[-1.243]	[-1.090]	[1.265]	[75.344]

Deterministic term:

	i_r	i_b	FR_log_d1	i_L
CONST	**0.573**	**0.664**	**-0.333**	**0.042**
	(0.381)	(0.545)	(0.260)	(0.098)
	{0.133}	{0.223}	{0.200}	{0.667}
	[1.503]	[1.218]	[-1.281]	[0.430]

FIJI: MODEL 2 (CUMSUM STABILITY TEST)



FIJI: MODEL 2 (AB MATRICES)

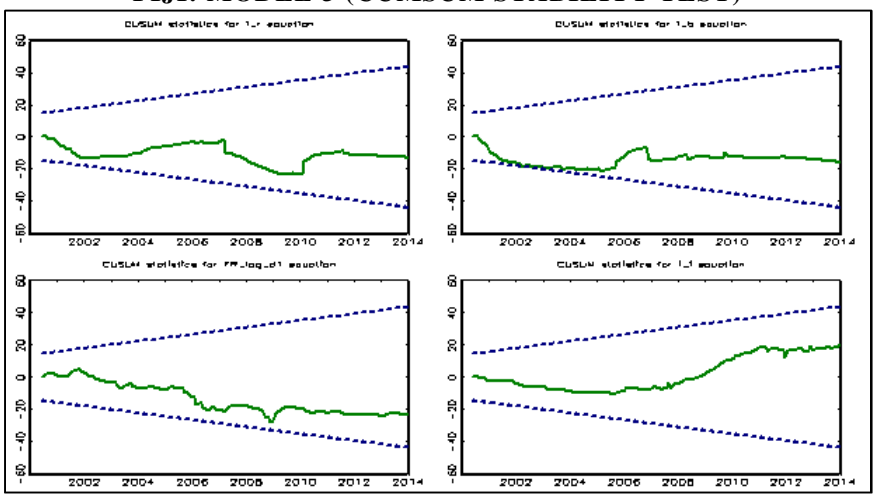
Estimated A matrix:				Estimated B matrix:			
1	0	1	0	0.62	0	0	0
-0.84	1	1	0	0	0.80	0	0
-0.39	-0.34	1	0	0	0	0.45	0
-0.04	0.05	0.03	1	0	0	0	0.12
Estimated standard errors for A matrix:				Estimated standard errors for B matrix			
0	0	0	0	0.03	0	0	0
0.15	0	0	0	0	0.05	0	0
0.08	0.07	0	0	0	0	0.04	0
0.02	0.01	0.03	0	0	0	0	0.01
A^-1*B				SigmaU~*100			
0.42	-0.13	-0.22	0.00	24.02	7.40	1.92	0.49
0.14	0.55	-0.41	0.00	7.40	49.22	1.21	-2.17
0.21	0.13	0.22	0.00	1.92	1.21	11.19	-0.31
0.00	-0.04	0.01	0.12	0.49	-2.17	-0.31	1.58

TABLE A.2.3: FIJI –MODEL 3: VAR COEFFICIENTS, DIAGNOSTICS & AB MODEL

FIJI: MODEL 3 (OPTIMAL LAG STRUCTURE)

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA	
endogenous variables:	i_r i_b FR_log_d1 i_i
deterministic variables:	CONST
sample range:	[2000 M12, 2014 M3], T = 160
optimal number of lags (searched up to 10 lags of levels):	
Akaike Info Criterion:	1
Final Prediction Error:	1
Hannan-Quinn Criterion:	1
Schwarz Criterion:	**1**

FIJI: MODEL 3 (CUMSUM STABILITY TEST)



VAR ESTIMATION RESULTS

endogenous variables: i_r i_b FR_log_d1 i_i

exogenous variables:

deterministic variables: CONST

endogenous lags: 1

exogenous lags: 0

sample range: [2000 M3, 2014 M3], T = 169

modulus of the eigenvalues of the reverse characteristic polynomial :

|z| = (1.3088 1.0563 1.0563 26.3274)

Legend:

Equation 1 Equation 2 ...

Variable 1 | Coefficient ...

| (Std. Dev.)

| {p - Value}

| [t - Value]

Variable 2 | ...

Lagged endogenous term:

	i_r	i_b	FR_log_d1	i_i
i_r (t-1)	0.859	0.065	0.008	0.004
	(0.038)	(0.054)	(0.026)	(0.005)
	{0.000}	{0.226}	{0.771}	{0.377}
	[22.396]	[1.210]	[0.291]	[0.884]
i_b (t-1)	0.101	0.836	0.014	0.003
	(0.034)	(0.048)	(0.023)	(0.004)
	{0.003}	{0.000}	{0.540}	{0.479}
	[2.946]	[17.270]	[0.612]	[0.708]
FR_log_d1 (t-1)	-0.027	0.082	-0.035	0.01
	(0.115)	(0.162)	(0.078)	(0.014)
	{0.817}	{0.613}	{0.651}	{0.465}
	[-0.232]	[0.506]	[-0.453]	[0.731]
i_i (t-1)	-0.105	-0.591	0.137	0.957
	(0.189)	(0.267)	(0.129)	(0.023)
	{0.577}	{0.027}	{0.286}	{0.000}
	[-0.557]	[-2.215]	[1.067]	[42.082]

Deterministic term:

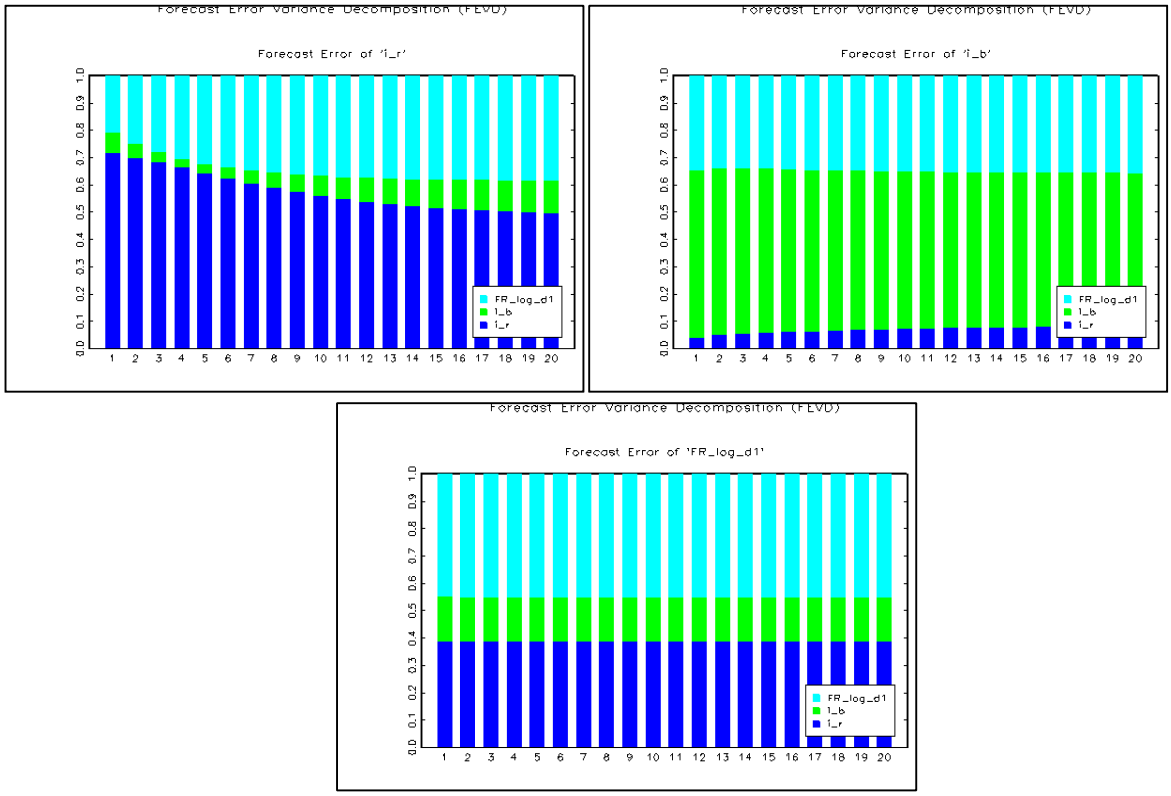
	i_r	i_b	FR_log_d1	i_i
CONST	**0.178**	**0.489**	**-0.104**	**0.022**
	(0.144)	(0.203)	(0.098)	(0.017)
	{0.215}	{0.016}	{0.290}	{0.209}
	[1.239]	[2.411]	[-1.058]	[1.257]

FIJI: MODEL 3 (AB MATRICES)

Estimated A matrix:				Estimated B matrix:			
1	0	1	0	0.63	0	0	0
-0.84	1	1	0	0	0.80	0	0
-0.38	-0.35	1	0	0	0	0.45	0
-0.01	-0.003	-0.001	1	0	0	0	0.06
Estimated standard errors for A matrix:				Estimated standard errors for B matrix			
0	0	0	0	0.03	0	0	0
0.15	0	0	0	0	0.05	0	0
0.08	0.07	0	0	0	0	0.04	0
0.01	0.01	0.01	0	0	0	0	0.003
A^-1*B				SigmaU~*100			
0.42	-0.14	-0.22	0.0	24.21	7.43	1.82	0.30
0.14	0.54	-0.41	0.0	7.43	48.13	1.35	0.23
0.21	0.14	0.22	0.0	1.82	1.35	11.22	0.03
0.01	0.000	-0.004	0.06	0.30	0.23	0.03	0.35

FIGURE A.2.4 FIJI – VARIANCE DECOMPOSITION

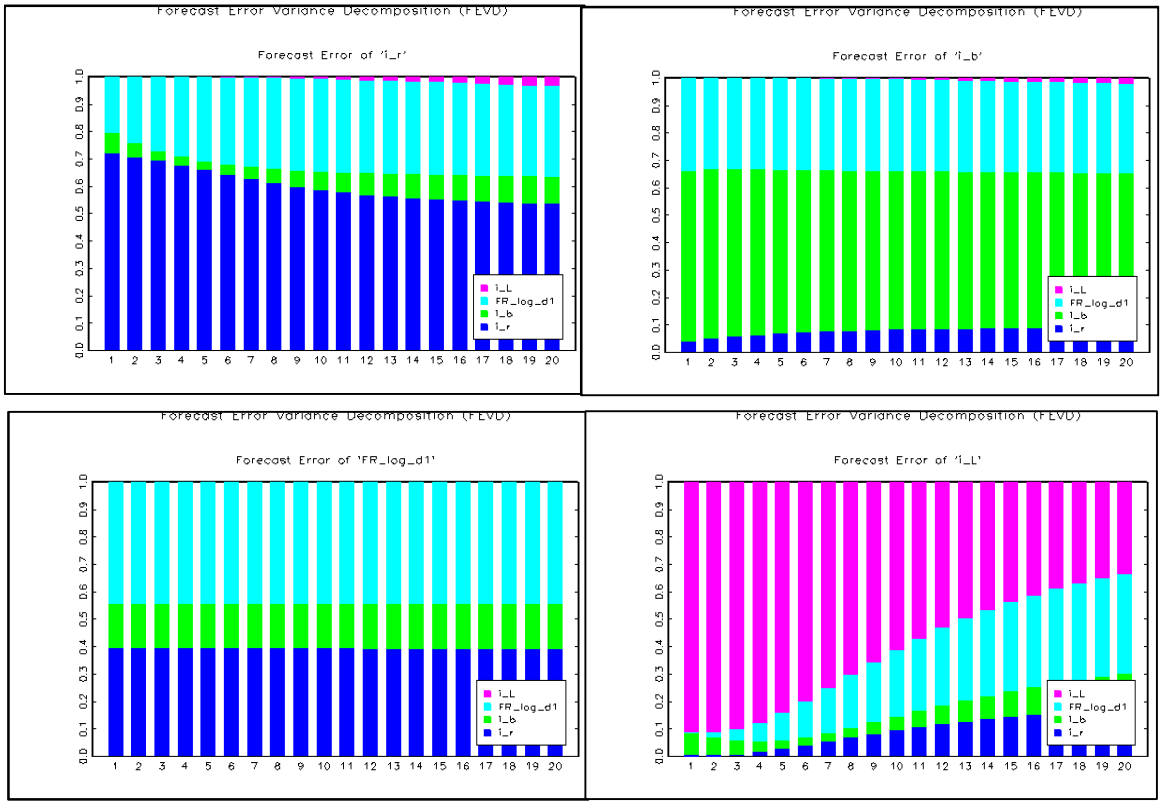
MODEL 1



SVAR FORECAST ERROR VARIANCE DECOMPOSITION

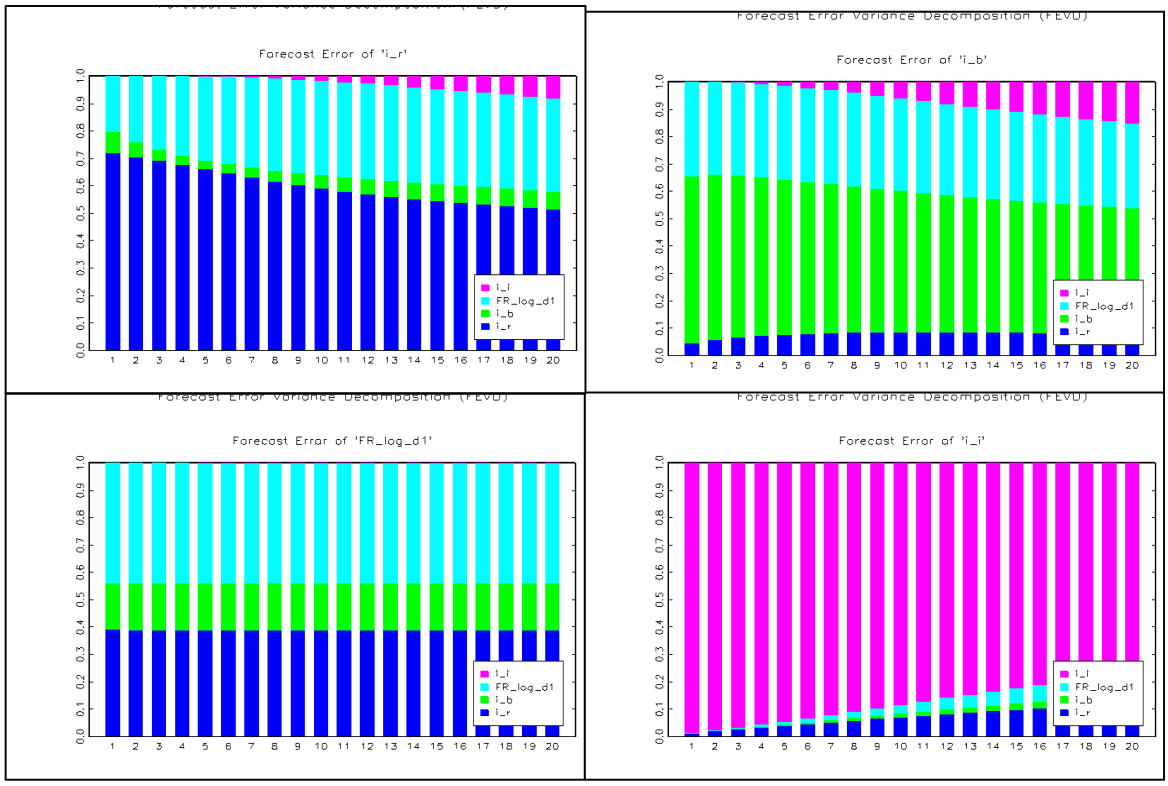
Forecast Horizon	Proportions of forecast error in "i_r" accounted for by:			Proportions of forecast error in "i_b" accounted for by:			Proportions of forecast error in "FR_log_d1" accounted for by:		
	i_r	i_b	FR_log_d1	i_r	i_b	FR_log_d1	i_r	i_b	FR_log_d1
1	0.71	0.08	0.21	0.04	0.61	0.35	0.39	0.16	0.45
3	0.68	0.04	0.28	0.05	0.61	0.34	0.39	0.16	0.45
6	0.62	0.04	0.34	0.06	0.59	0.35	0.39	0.16	0.45
12	0.54	0.09	0.38	0.07	0.57	0.35	0.39	0.16	0.45
18	0.5	0.11	0.38	0.08	0.56	0.36	0.39	0.16	0.45
24	0.49	0.12	0.39	0.08	0.56	0.36	0.39	0.16	0.45

MODEL 2



SVAR FORECAST ERROR VARIANCE DECOMPOSITION																
Forecast Horizon	Proportions of forecast error in "i_r" accounted for by:				Proportions of forecast error in "i_b" accounted for by:				Proportions of forecast error in "FR_log_d1" accounted for by:				Proportions of forecast error in "i_L" accounted for by:			
	i_r	i_b	FR_log _d1	i_L	i_r	i_b	FR_log _d1	i_L	i_r	i_b	FR_log _d1	i_L	i_r	i_b	FR_log_ d1	i_L
1	0.72	0.08	0.21	0.00	0.04	0.62	0.34	0.00	0.39	0.16	0.44	0.00	0.00	0.08	0.00	0.92
3	0.69	0.04	0.27	0.00	0.06	0.61	0.33	0.00	0.39	0.16	0.45	0.00	0.00	0.05	0.04	0.90
6	0.64	0.04	0.32	0.00	0.07	0.59	0.34	0.00	0.39	0.16	0.45	0.00	0.04	0.03	0.13	0.80
12	0.57	0.08	0.34	0.01	0.08	0.57	0.33	0.01	0.39	0.16	0.45	0.00	0.11	0.07	0.28	0.53
18	0.54	0.10	0.33	0.03	0.08	0.57	0.33	0.02	0.39	0.16	0.45	0.00	0.16	0.12	0.35	0.37
24	0.53	0.10	0.33	0.04	0.08	0.57	0.33	0.02	0.39	0.16	0.45	0.00	0.17	0.13	0.37	0.34

MODEL 3



SVAR FORECAST ERROR VARIANCE DECOMPOSITION																
Forecast Horizon	Proportions of forecast error in "i_r" accounted for by:				Proportions of forecast error in "i_b" accounted for by:				Proportions of forecast error in "FR_log_d1" accounted for by:				Proportions of forecast error in "i_i" accounted for by:			
	i_r	i_b	FR_log _d1	i_i	i_r	i_b	FR_log _d1	i_i	i_r	i_b	FR_log _d1	i_i	i_r	i_b	FR_log _d1	i_i
1	0.72	0.08	0.20	0.00	0.04	0.61	0.35	0.00	0.39	0.17	0.44	0.00	0.01	0.00	0.00	0.99
3	0.69	0.04	0.27	0.00	0.06	0.59	0.34	0.00	0.39	0.17	0.44	0.00	0.02	0.00	0.01	0.97
6	0.64	0.03	0.32	0.00	0.08	0.56	0.34	0.02	0.39	0.17	0.44	0.00	0.04	0.01	0.01	0.94
12	0.57	0.06	0.35	0.03	0.08	0.50	0.33	0.08	0.39	0.17	0.44	0.00	0.08	0.02	0.04	0.86
18	0.52	0.06	0.34	0.07	0.08	0.47	0.31	0.14	0.39	0.17	0.44	0.00	0.11	0.03	0.07	0.80
24	0.51	0.06	0.34	0.08	0.08	0.46	0.31	0.15	0.39	0.17	0.44	0.00	0.11	0.03	0.08	0.78

TABLE A.2.5: PNG –MODEL 1: VAR COEFFICIENTS, DIAGNOSTICS & AB MODEL

PNG: MODEL 1 (OPTIMAL LAG STRUCTURE)

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA

endogenous variables:	i_p i_b FR_log_d1
deterministic variables:	CONST
sample range:	[2002 M12, 2014 M3], T = 136

optimal number of lags (searched up to 10 lags of levels):

Akaike Info Criterion:	8
Final Prediction Error:	8
Hannan-Quinn Criterion:	3
Schwarz Criterion:	**2**

VAR ESTIMATION RESULTS

endogenous variables: i_r i_b FR_log_d1

exogenous variables:
deterministic variables:
CONST

endogenous lags: 3

exogenous lags: 0

sample range: [2002 M5, 2014 M3], T = 143

modulus of the eigenvalues of the reverse characteristic polynomial :

|z| = (1.5385 1.5385 1.6699 1.6699 1.7928 1.0230 3.7059 3.7059 1.0744)

Legend:

Equation 1 Equation 2 ...

Variable 1 | Coefficient ...

| (Std. Dev.)

| {p - Value}

| [t - Value]

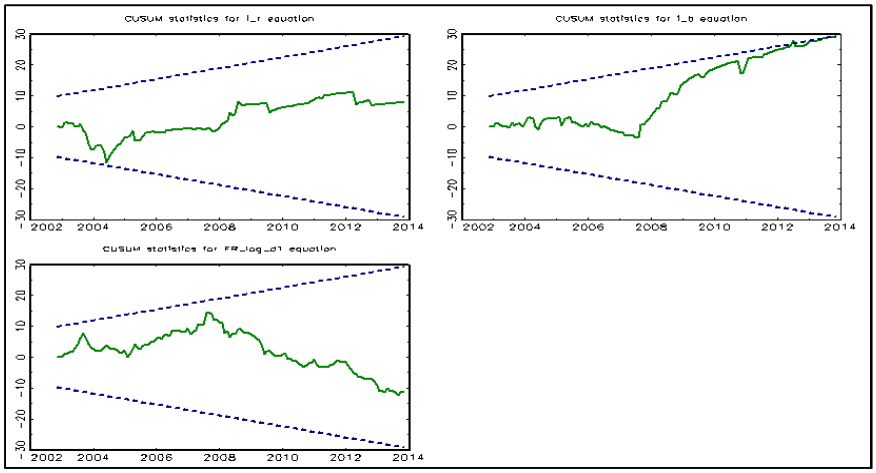
Variable 2 | ...

Lagged endogenous term:

		i_r	i_b	FR_log_d1
i_r	**(t-1)**	**1.113**	**0.25**	**-0.647**
		(0.100)	(0.177)	(0.223)
		{0.000}	{0.158}	{0.004}
		[11.136]	[1.411]	[-2.895]
i_b	**(t-1)**	**0.082**	**0.884**	**0.369**
		(0.056)	(0.099)	(0.124)

	{0.138}	{0.000}	{0.003}
	[1.482]	[8.960]	[2.968]
FR_log_d1(t-1)	**-0.066**	**-0.106**	**-0.57**
	(0.039)	(0.070)	(0.088)
	{0.092}	{0.126}	{0.000}
	[-1.683]	[-1.530]	[-6.511]
i_r (t-2)	**-0.106**	**0.344**	**0.363**
	(0.148)	(0.262)	(0.330)
	{0.474}	{0.189}	{0.272}
	[-0.715]	[1.313]	[1.099]
i_b (t-2)	**-0.009**	**-0.071**	**-0.222**
	(0.075)	(0.133)	(0.167)
	{0.906}	{0.592}	{0.186}
	[-0.118]	[-0.536]	[-1.324]
FR_log_d1(t-2)	**0.044**	**0.001**	**-0.514**
	(0.039)	(0.070)	(0.088)
	{0.266}	{0.990}	{0.000}
	[1.113]	[0.012]	[-5.847]
i_r (t-3)	**-0.018**	**-0.535**	**0.244**
	(0.100)	(0.177)	(0.223)
	{0.860}	{0.003}	{0.275}
	[-0.176]	[-3.013]	[1.092]
i_b (t-3)	**-0.081**	**0.11**	**-0.073**
	(0.057)	(0.101)	(0.127)
	{0.157}	{0.276}	{0.568}
	[-1.415]	[1.090]	[-0.572]
FR_log_d1(t-3)	**0.005**	**-0.065**	**-0.093**
	(0.037)	(0.066)	(0.083)
	{0.901}	{0.324}	{0.265}
	[0.124]	[-0.986]	[-1.115]
Deterministic term:			
	i_r	**i_b**	**FR_log_d1**
CONST	0.099	0.068	-0.168
	(0.094)	(0.166)	(0.210)
	{0.289}	{0.684}	{0.422}
	[1.060]	[0.407]	[-0.803]

PNG: MODEL 1 (CUMSUM STABILITY TEST)



PNG: MODEL 1 (AB MATRICES)

Estimated A matrix:			Estimated B matrix:		
1	0	**1**	**0.85**	0	0
-0.26	1	**0**	0	**0.59**	0
-5.93	**1.64**	1	0	0	**1.92**
Estimated standard errors for A matrix:			Estimated standard errors for B matrix		
0	0	0	**0.05**	0	0
0.37	0	0	0	**0.07**	0
1.31	**0.74**	0	0	0	**0.38**
A^-1*B			SigmaU~*100		
0.13	0.15	-0.29	12.60	11.98	-1.41
0.03	0.62	-0.08	11.98	39.70	-9.04
0.72	-0.15	0.29	-1.41	-9.04	62.93

TABLE A.2.6: PNG –MODEL 2: VAR COEFFICIENTS, DIAGNOSTICS & AB MODEL

PNG: MODEL 2 (OPTIMAL LAG STRUCTURE)

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA	
endogenous variables:	i_r i_b FR_log_d1 i_L
deterministic variables:	CONST
sample range:	[2002 M12, 2014 M3], T = 136
optimal number of lags (searched up to 10 lags of levels):	
Akaike Info Criterion:	3
Final Prediction Error:	3
Hannan-Quinn Criterion:	2
Schwarz Criterion:	1

VAR ESTIMATION RESULTS

endogenous variables: i_r i_b FR_log_d1 i_L
exogenous variables:
deterministic variables: CONST
endogenous lags: 2
exogenous lags: 0
sample range: [2002 M4, 2014 M3], T = 144
modulus of the eigenvalues of the reverse characteristic polynomial :
|z| = (1.4745 1.4745 6.1880 8.1054 1.0195 1.1036 1.1036 32.8032)

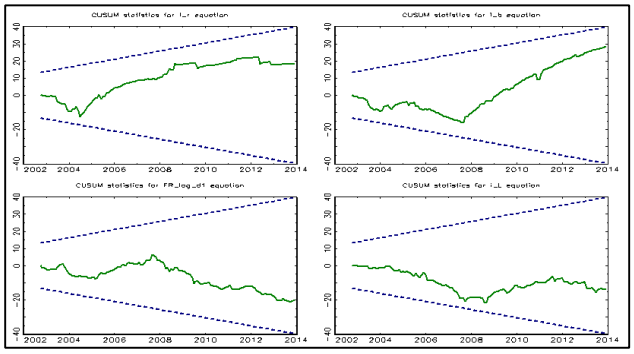
Legend:
Equation 1 Equation 2 ...
Variable 1 | Coefficient ...
| (Std. Dev.)
| {p - Value}
| [t - Value]
Variable 2 | ...

Lagged endogenous term:

	i_r	**i_b**	**FR_log_d1**	**i_L**
i_r (t-1)	**1.163**	**0.341**	**-0.681**	**0.144**
	(0.097)	(0.175)	(0.215)	(0.056)
	{0.000}	{0.052}	{0.002}	{0.010}
	[11.938]	[1.946]	[-3.162]	[2.576]
i_b (t-1)	**0.065**	**0.843**	**0.357**	**0.009**
	(0.056)	(0.102)	(0.125)	(0.033)
	{0.247}	{0.000}	{0.004}	{0.788}
	[1.157]	[8.299]	[2.864]	[0.269]
FR_log_d1(t-1)	**-0.052**	**-0.097**	**-0.518**	**0.010**

	(0.033)	(0.060)	(0.074)	(0.019)
	{0.118}	{0.105}	{0.000}	{0.592}
	[-1.564]	[-1.622]	[-7.044]	[0.536]
i_L (t-1)	**-0.042**	**-0.159**	**0.000**	**0.798**
	(0.145)	(0.261)	(0.320)	(0.083)
	{0.770}	{0.541}	{0.999}	{0.000}
	[-0.293]	[-0.611]	[0.001]	[9.559]
i_r (t-2)	**-0.165**	**-0.125**	**0.718**	**-0.095**
	(0.103)	(0.185)	(0.228)	(0.059)
	{0.109}	{0.501}	{0.002}	{0.108}
	[-1.601]	[-0.672]	[3.153]	[-1.609]
i_b (t-2)	**-0.072**	**0.010**	**-0.317**	**-0.010**
	(0.056)	(0.100)	(0.123)	(0.032)
	{0.197}	{0.925}	{0.010}	{0.744}
	[-1.291]	[0.095]	[-2.568]	[-0.327]
FR_log_d1(t-2)	**0.036**	**0.042**	**-0.470**	**-0.013**
	(0.033)	(0.059)	(0.073)	(0.019)
	{0.281}	{0.478}	{0.000}	{0.498}
	[1.078]	[0.710]	[-6.437]	[-0.677]
i_L (t-2)	**0.032**	**0.01**	**-0.084**	**0.121**
	(0.137)	(0.246)	(0.302)	(0.079)
	{0.814}	{0.967}	{0.782}	{0.123}
	[0.235]	[0.042]	[-0.277]	[1.540]
Deterministic term:				
	i_r	**i_b**	**FR_log_d1**	**i_L**
CONST	**0.149**	**0.967**	**0.396**	**0.5**
	(0.267)	(0.481)	(0.591)	(0.154)
	{0.577}	{0.044}	{0.503}	{0.001}

PNG: MODEL 2 (CUMSUM STABILITY TEST)



PNG: MODEL 2 (AB MATRICES)

Estimated A matrix:				Estimated B matrix:			
1	0	1	0	0.85	0	0	0
-0.16	1	0	0	0	0.62	0	0
-5.69	1.70	1	0	0	0	1.86	0
0.02	0.00	0.03	1	0	0	0	0.20
Estimated standard errors for A matrix:				Estimated standard errors for B matrix			
0	0	0	0	0.05	0	0	0
0.39	0	0	0	0	0.07	0	0
1.22	0.68	0	0	0	0	0.36	0
0.06	0.03	0.02	0	0	0	0	0.01
A^-1*B				SigmaU~*100			
0.13	0.16	-0.29	0.00	12.81	12.07	-1.54	-0.22
0.02	0.64	-0.05	0.00	12.07	41.49	-10.31	0.03
0.72	-0.16	0.29	0.00	-1.54	-10.31	62.61	-2.09
-0.03	0.00	0.00	0.20	-0.22	0.03	-2.09	4.25

TABLE A.2.7: PNG –MODEL 3: VAR COEFFICIENTS, DIAGNOSTICS & AB MODEL

PNG: MODEL 3 (OPTIMAL LAG STRUCTURE)

OPTIMAL ENDOGENOUS LAGS FROM INFORMATION CRITERIA	
endogenous variables:	i_r i_b FR_log_d1 i_i
deterministic variables:	CONST
sample range:	[2002 M12, 2014 M3], T = 136
optimal number of lags (searched up to 10 lags of levels):	
Akaike Info Criterion:	7
Final Prediction Error:	7
Hannan-Quinn Criterion:	2
Schwarz Criterion:	2

VAR ESTIMATION RESULTS

endogenous variables: i_r i_b FR_log_d1 i_i
exogenous variables:
deterministic variables: CONST
endogenous lags: 2
exogenous lags: 0
sample range: [2002 M4, 2014 M3], T = 144

modulus of the eigenvalues of the reverse characteristic polynomial :

|z| = (1.5238 1.5238 6.4792 6.4792 3.5741 1.0440 1.0440 1.1215)

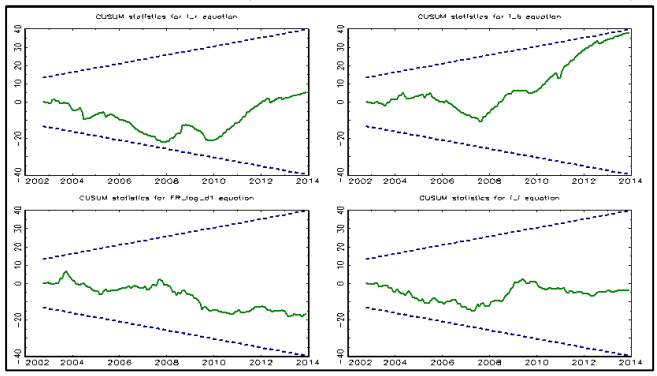
Legend:
Equation 1 Equation 2 ...
Variable 1 | Coefficient ...
| (Std. Dev.)
| {p - Value}
| [t - Value]
Variable 2 | ...

Lagged endogenous term:

	i_r	i_b	FR_log_d1	i_i
i_r (t-1)	1.083	0.187	-0.804	0.175
	(0.099)	(0.180)	(0.223)	(0.053)
	{0.000}	{0.297}	{0.000}	{0.001}
	[10.972]	[1.043]	[-3.606]	[3.336]
i_b (t-1)	0.049	0.835	0.354	0.029
	(0.054)	(0.099)	(0.123)	(0.029)
	{0.371}	{0.000}	{0.004}	{0.312}
	[0.894]	[8.453]	[2.890]	[1.010]
FR_log_d1(t-1)|	-0.069	-0.119	-0.542	-0.116
	(0.033)	(0.060)	(0.074)	(0.017)
	{0.035}	{0.047}	{0.000}	{0.000}
	[-2.108]	[-1.985]	[-7.315]	[-6.621]
i_i (t-1)	0.163	0.75	0.288	1.095
	(0.140)	(0.254)	(0.316)	(0.074)
	{0.244}	{0.003}	{0.361}	{0.000}
	[1.165]	[2.948]	[0.914]	[14.700]
i_r (t-2)	-0.16	-0.182	0.665	-0.144
	(0.095)	(0.173)	(0.215)	(0.051)
	{0.092}	{0.293}	{0.002}	{0.004}
	[-1.687]	[-1.051]	[3.098]	[-2.843]
i_b(t-2)	-0.043	0.094	-0.264	-0.054
	(0.055)	(0.101)	(0.125)	(0.030)

	{0.436}	{0.351}	{0.035}	{0.069}
	[-0.779]	[0.932]	[-2.111]	[-1.819]
FR_log_d1(t-2)	0.026	0.085	-0.472	-0.053
	(0.034)	(0.062)	(0.077)	(0.018)
	{0.438}	{0.168}	{0.000}	{0.004}
	[0.776]	[1.378]	[-6.145]	[-2.911]
i_i(t-2)	-0.011	-0.605	-0.078	-0.136
	(0.143)	(0.260)	(0.323)	(0.076)
	{0.940}	{0.020}	{0.810}	{0.074}
	[-0.076]	[-2.324]	[-0.241]	[-1.784]
Deterministic term:				
	i_r	i_b	FR_log_d1	i_i
CONST	0.326	0.236	0.2	-0.03
	(0.127)	(0.231)	(0.287)	(0.068)
	{0.010}	{0.307}	{0.485}	{0.661}
	[2.562]	[1.023]	[0.699]	[-0.439]

PNG: MODEL 3 (CUMSUM STABILITY TEST)

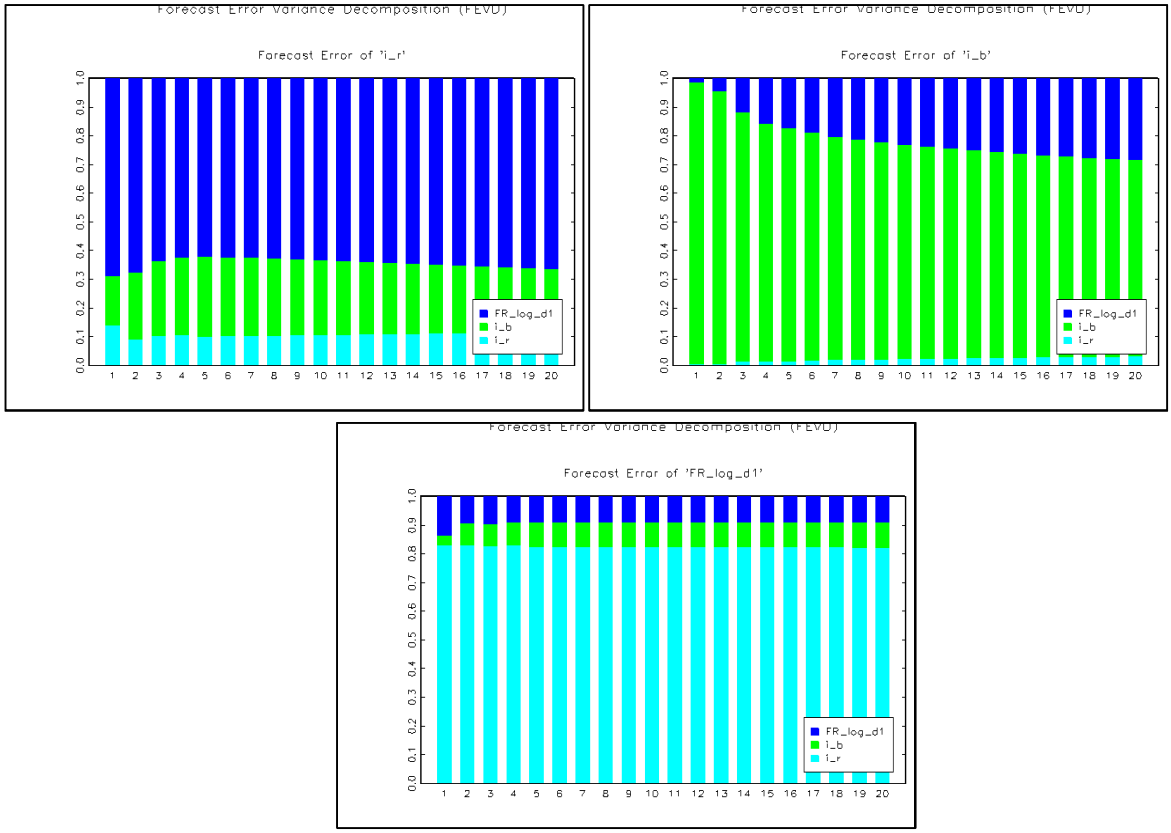


PNG: MODEL 3 (AB MATRICES)

Estimated A matrix:				Estimated B matrix:			
1	0	1	0	0.83	0	0	0
0.00	1	0	0	0	0.63	0	0
-6.20	2.01	1	0	0	0	1.99	0
-0.10	-0.038	0.022	1	0	0	0	0.18
Estimated standard errors for A matrix:				Estimated standard errors for B matrix			
0	0	0	0	0.05	0	0	0
0.46	0	0	0	0	0.09	0	0
1.44	0.79	0	0	0	0	0.42	0
0.05	0.03	0.02	0	0	0	0	0.010
A^-1*B				SigmaU~*100			
0.11	0.18	-0.28	0.0	12.08	11.14	-2.56	1.66
0.00	0.63	0.00	0.0	11.14	39.93	-11.16	2.86
0.71	-0.18	0.28	0.0	-2.56	-11.16	61.54	-2.03
0.00	0.045	-0.033	0.18	1.66	2.86	-2.03	3.43

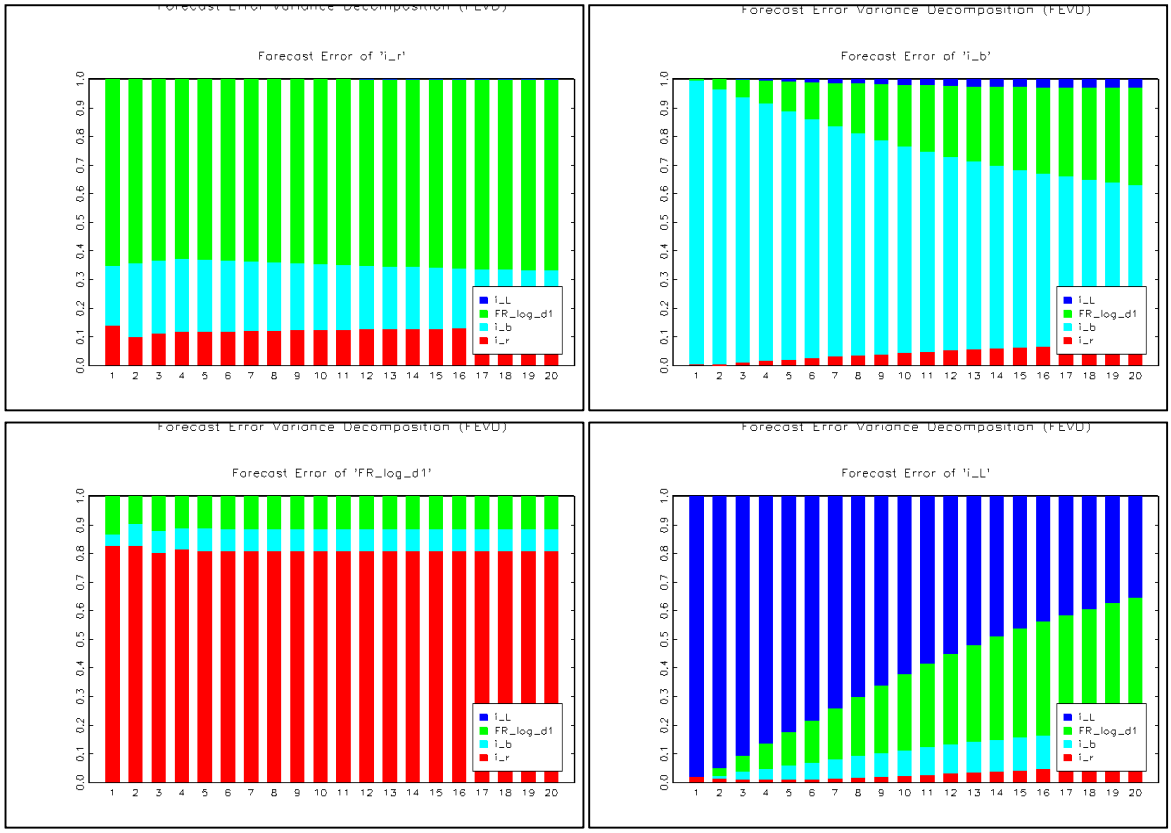
FIGURE A.2.8: PNG: VARIANCE DECOMPOSITION

MODEL 1



SVAR FORECAST ERROR VARIANCE DECOMPOSITION									
Forecast Horizon	Proportions of forecast error in "i_r" accounted for by:			Proportions of forecast error in "i_b" accounted for by:			Proportions of forecast error in "FR_log_d1" accounted for by:		
	i_r	i_b	FR_log_d1	i_r	i_b	FR_log_d1	i_r	i_b	FR_log_d1
1	0.14	0.17	0.69	0.00	0.98	0.02	0.83	0.03	0.14
3	0.10	0.26	0.64	0.01	0.87	0.12	0.82	0.08	0.10
6	0.10	0.27	0.63	0.02	0.79	0.19	0.82	0.09	0.09
12	0.11	0.25	0.64	0.02	0.73	0.25	0.82	0.09	0.09
18	0.11	0.23	0.66	0.03	0.69	0.28	0.82	0.09	0.09
24	0.11	0.22	0.67	0.03	0.68	0.29	0.82	0.09	0.09

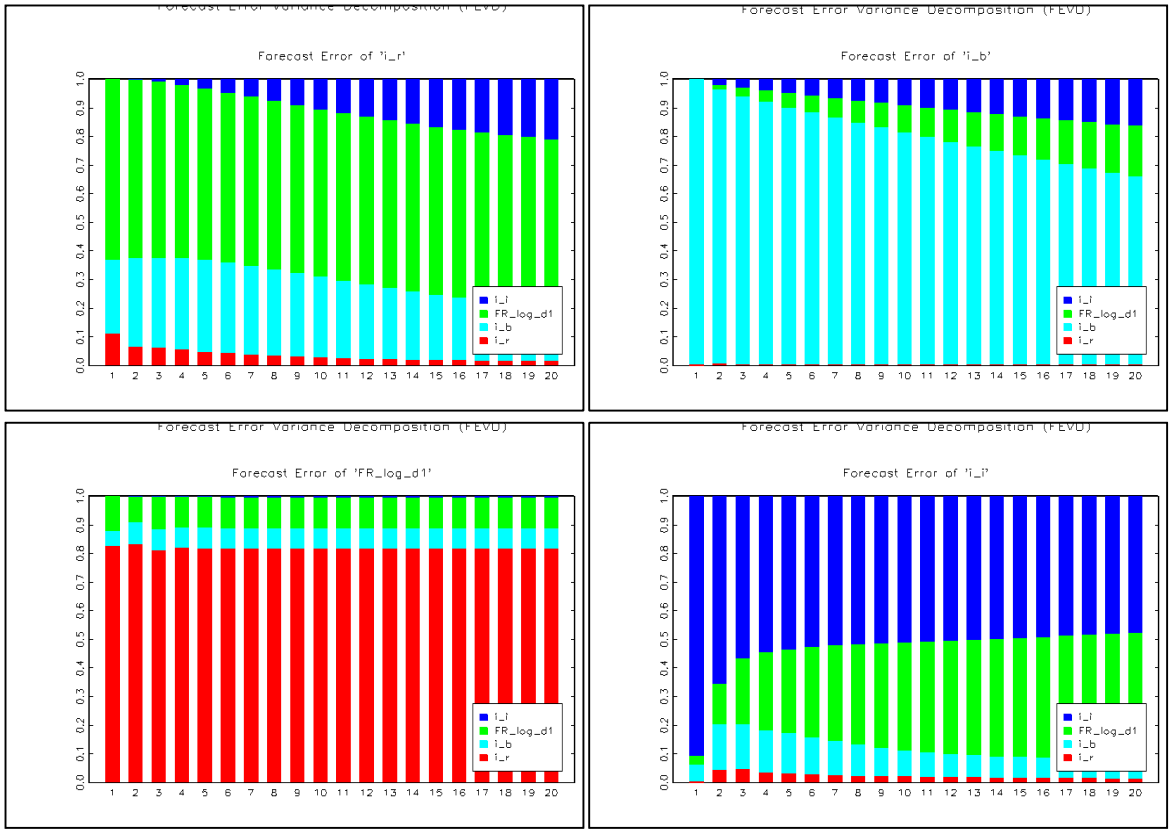
MODEL 2



SVAR FORECAST ERROR VARIANCE DECOMPOSITION

Forecast Horizon	Proportions of forecast error in "i_r" accounted for by:				Proportions of forecast error in "i_b" accounted for by:				Proportions of forecast error in "FR_log_d1" accounted for by:				Proportions of forecast error in "i_L" accounted for by:			
	i_r	i_b	FR_log _d1	i_L	i_r	i_b	FR_log _d1	i_L	i_r	i_b	FR_log _d1	i_L	i_r	i_b	FR_log _d1	i_L
1	0.14	0.21	0.65	0.00	0.00	0.99	0.00	0.00	0.82	0.04	0.13	0.00	0.02	0.00	0.00	0.98
3	0.11	0.26	0.64	0.00	0.01	0.93	0.06	0.00	0.80	0.08	0.12	0.00	0.01	0.03	0.06	0.91
6	0.12	0.25	0.63	0.00	0.02	0.84	0.13	0.01	0.81	0.08	0.12	0.00	0.01	0.06	0.15	0.79
12	0.12	0.22	0.65	0.00	0.05	0.68	0.25	0.02	0.81	0.08	0.12	0.00	0.03	0.10	0.32	0.55
18	0.13	0.21	0.66	0.00	0.07	0.58	0.32	0.03	0.81	0.08	0.12	0.00	0.05	0.12	0.43	0.39
24	0.13	0.20	0.67	0.00	0.07	0.56	0.34	0.03	0.80	0.08	0.12	0.00	0.06	0.13	0.46	0.36

MODEL 3



SVAR FORECAST ERROR VARIANCE DECOMPOSITION

Forecast Horizon	Proportions of forecast error in "i_r" accounted for by:				Proportions of forecast error in "i_b" accounted for by:				Proportions of forecast error in "FR_log_d1" accounted for by:				Proportions of forecast error in "i_i" accounted for by:			
	i_r	i_b	FR_log _d1	i_i	i_r	i_b	FR_log _d1	i_i	i_r	i_b	FR_log _d1	i_i	i_r	i_b	FR_log _d1	i_i
1	0.11	0.26	0.63	0.00	0.00	1.00	0.00	0.00	0.83	0.05	0.12	0.00	0.00	0.06	0.03	0.91
3	0.06	0.31	0.62	0.01	0.00	0.94	0.03	0.03	0.81	0.07	0.11	0.00	0.04	0.16	0.23	0.57
6	0.04	0.32	0.59	0.05	0.00	0.88	0.06	0.06	0.82	0.07	0.11	0.01	0.03	0.13	0.32	0.53
12	0.02	0.26	0.58	0.13	0.00	0.78	0.11	0.11	0.82	0.07	0.11	0.01	0.02	0.08	0.39	0.51
18	0.01	0.20	0.59	0.20	0.00	0.68	0.16	0.15	0.82	0.07	0.11	0.01	0.01	0.07	0.43	0.49
24	0.01	0.18	0.59	0.21	0.00	0.66	0.18	0.16	0.82	0.07	0.11	0.01	0.01	0.07	0.44	0.48

CHAPTER THREE

MEASURING MONETARY POLICY EFFICIENCY IN CHINA AND INDIA

ABSTRACT

This paper assesses the efficiency of monetary policy in Asia's two largest and emerging economies, namely China and India. This paper improves the baseline techniques developed by Li et al. (2010) and Cecchetti et al. (2006) and assesses monetary policy efficiency. Using the stochastic frontier model we directly estimate the time varying efficiency of achieving the primary and secondary targets of monetary policy with the modified version of the model presented by Li et al., (2010). Results suggest a high level of efficiency in management of output gap (over 97 percent for China and above 95 percent for India) compared to inflation gap (which has an undulating trend averaging around 50 percent for China and ranging from 30 to 70 percent for India based). These results are mirrored by greater weighting of policymaker preference to output gap and according to our results, this is around 92 percent for China and around 70 percent for India, compared to inflation gap indicated by the GMM estimates of Taylor rule for both countries. The dynamic accounting analysis following Cecchetti et al., (2006) based on estimates from the Generalised Method of Moments for China and India, assessed on split sample ratios shows i) an overall decrease in macroeconomic weighted monetary policy efficiency by almost 113 percent, which can potentially be due to the high impact of supply shock variability and relatively high macroeconomic performance loss with respect to inflation in China; and ii) and overall deterioration in macroeconomic weighted monetary policy efficiency by around 73 percent, underpinned by a decrease in macroeconomic performance, variability of supply shock and an increase in monetary policy inefficiency with respect to inflation in India.

3.1 INTRODUCTION

Monetary policy has evolved significantly in emerging Asian economies, particularly in China and India. This evolution has been a wholesale reform of operational instruments, intermediate targets and overall goals of monetary policy facilitated by the deepening of economic reforms and structural adjustments. As reported by Chen et al., (1992); Xie, (2004); Singh and Kalirajan (2006); Laurens and Maino (2007); Geiger, (2008); Mohanty (2011, 2013); Sun (2014); and Wang (2014) these shifts, depending mostly on the policy prescriptions, have been piecemeal and/or decisive and rapid in nature producing varied results for the People's Bank of China (PBC) and Reserve Bank of India (RBI).

Such changes have often been complemented by financial development, openness and rapid innovation of financial products and the changing structure of the economies, which dictate greater role of monetary policy as a stabilisation and demand management tool. In addition, international monetary policy coordination, in order to respond to changing underlying global economic forces and through lessons learnt from developed and mature economies has provided these selected Asian countries with a steep learning curve. Resemblance of these global policy coordination and learning can be selectively traced to the introduction of an implicit preference to a flexible inflation target by the PBC post 2002 (Goodfriend and Prasad, 2006; and Girardin et al., 2013), despite the key monetary policy objective of the PBC *"⋯ to maintain the stability of the value of the currency (RMB)*[56] *and thereby promote economic growth"* (PBC, 2015)[57]. India's monetary policy objective also alludes to monetary stability by regulating issue of bank notes and operating credit and currency to the country's advantage (Mohanty, 2011) and in a similar vein, flexible inflation targeting has been proposed by a special expert panel (RBI, 2014) with adoption of inflation as a nominal anchor being deliberated upon by the Finance Ministry and RBI.

China and India, have traditionally focused on credit quotas, monetary aggregates such as broad money, and exchange rates as intermediate targets, however, changing monetary architecture has forced the adoption of multiple indicators by both central banks, particularly by RBI, focusing on an array of *operating* targets, such as the interest rates (for example, overnight call rates) and required reserves without a specific intermediate target[58]. Financial liberalisation along with

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[56] The renminbi (RMB) is the official name for Chinese currency while the yuan is a unit of the renminbi currency.

[57] *Stabilising the currency* means smoothing domestic prices as well as the exchange rates. Nagai and Hong (2007) add that the operational focus of monetary policy explicitly included exchange rate stabilisation only after July 2005, when China initiated the managed float exchange rate system, based on a referential basket of currencies.

[58] Unlike RBI, PBC's intermediate target has been money supply (the nominal anchor), with the inclusion of M_1 and M_2 with M_3 and credit quotas.

institutional reforms and strengthening[59] at PBC and RBI saw monetary policy evolve from an interventionist mode to indirect but active market based controls. As highlighted by Mohanty (2013), Green (2005) and Sun (2014), both RBI and PBC shifted their focus to indirect market based instruments and using the central bank balance sheet as the active tool for monetary policy response and wider influence on economic agents[60].

Apart from the direct control of the money base (as shown in the Central Bank Balance sheet), RBI introduced a fully operational LAF in April 1999 after years of financing credit to preferred sectors while PBC introduced open market operations in October 1998, after the national bank credit quota was scrapped (Chen et al., 1992; Green, 2005; Singh and Kalirajan, 2006; Nagai and Hong, 2007; RBI (2011, 2014) and Mohanty, 2013). Both of these situations assisted in the development of interest rate based monetary transmission and signaling in the economy, amongst other methods of influencing economic agents.

The evolution of monetary policy in these countries have provided a better arsenal of demand and stabilisation tools when combined with improved prudential supervision and financial system development[61]; and real (gross domestic product), external, especially Balance of Payments (BoP) and fiscal sector reforms. Despite the current plethora of literature of the improvements in monetary policy and ensuing estimation of monetary reaction functions for these selected Asian economies, gaps in measuring the efficiency of monetary policy remains elusive.

Therefore, the novelty of this study lies in the theoretical and particularly, empirical contribution to this under-researched domain of measuring efficiency of monetary policy in China and India. Exploring the potency of monetary policy in achieving the overall targets (with adopted instruments) can reveal and inform the utilised mechanism design and provide invaluable understanding to policymakers and academics in these two large Asian economies. The choice of countries typically reflects – i) our geographical interest in these larger emerging economies of Asia and the need to make this a manageable and sustainable endeavour; and ii) limiting to few countries promotes our ability to seek deeper understanding and provide an in-depth analysis of results against the stylised facts from these selected economies.

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[59] This has been noticed in both economies as RBI's policy was able to move away from credit planning for preferred sectors and PBC was able to introduce 'floating rate' central bank rediscount lending without having to seek State Council permission each time (for additional details see Mohanty, 2013 and Green, 2005). Such examples allude to some degree of institutional strengthening and independence in the conduct of monetary policy.

[60] The significance of the central bank balance sheet has been highlighted in Chapter One.

[61] This has been highlighted by Mohanty (2014) for India and Sun (2014) and Wang (2014) for China.

Based on the improved theoretical and empirical model centered on the framework provided by Li et al. (2010) and Cecchetti et al. (2006), the stochastic frontier efficiency analyses for China and India indicate a high level of efficiency in management of output gap compared to inflation gap. These results are mirrored by greater weighting of policymakers' preference to output gap compared to inflation gap, as indicated by the generalised methods of moment estimates of the Taylor rule for China and India.

Furthermore, the dynamic accounting analyses of macroeconomic performance weighted monetary policy efficiency analyses for China and India (based on split sample ratios) show a decrease in overall monetary policy efficiency, which is largely explained by the poor macroeconomic performance, variability of supply shock and monetary policy inefficiency with respect to inflation. On a positive note, the macroeconomic performance weighted cumulative impact of efficiency with respect to output is positive, indicating a marginal improvement for both China and India, generally re-enforcing (along with the Stochastic frontier efficiency results) that both PBC and RBI have been better at controlling the fluctuations in output gap and keeping output closer to its potential level.

The rest of this essay is structured as follows. The following section (Section 3.2) briefly describes the monetary policy reforms and operational instruments, targets and ultimate (explicit and/or implicit) objectives. It also underpins the design of the theoretical and empirical model, and given that it has been widely discussed in numerous other papers on emerging and developing economies we limit our discussion in this section to key issues. In Section 3.3, current available literature on measuring efficiency of monetary policy, which focuses on two key studies on this area, namely, Cecchetti et al., (2006) and Li et al. (2010) are explored. Key improvements and modifications to these aforesaid models are identified and applied using monetary and macroeconomic data, on China and India, the countries of empirical interest in this study. Section 3.4 provides a brief run-down of the empirical techniques (based on the improvements identified in Section 3.3) and ensuing results. Section 3.5 concludes this essay with some policy analysis and recommendations.

3.2 MONETARY POLICY EVOLUTION: CHINA AND INDIA

Both China and India have experienced tumultuous economic performances during the years proceeding to, and just after, their respective fundamental economic reforms. The crux of the Chinese reforms was gradually carried-out in the mid-to-late 1980s with the aim of increasing

economic efficiency by removing bottlenecks (see Chen et al. 1992). However, in India, the 'big bang' approach to economic reforms was undertaken and introduced in the early 1990s in the wake of the BoP crisis[62] (see Singh, 1991). With regards to monetary policy, China and India had similar approaches before and after the adoption of modern central banking, although the choice of instruments, targets (operating and intermediate) and operating procedures were circumscribed by PBC's and RBI's respective institutional arrangements and the financial market setup in each country.

Sun (2014) documents that during 1984-1997[63], the PBC adopted a direct regulatory framework focused primarily on credit management via a quota based system to manage credit and cash[64]. During the 1998 restructuring, PBC's role as a central bank was further cemented as it moved closer to modern monetary policy by establishing an indirect[65] policy framework through phasing out credit quotas for commercial banks[66] and strengthening its price and quantity based instruments (Xie, 2004; Nagai and Hong, 2007; Geiger, 2008 and Sun, 2014), which included re-introduction of open market operations (OMO)[67]; revamping reserve requirements (RR)[68] (and establishing voluntary reserves); recalibrating the central bank rediscounting and lending/deposit rates and streamlining standing facilities; and deregulating the wholesale, including the interbank

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[62] Refers to the 1991 Indian Economic Crisis, when the foreign exchange reserves fell to around US$1 billion in January and a US$2.3 billion International Monetary Fund (IMF) standby arrangement (or compensatory and contingency financing facility (CCFF) was secured whereby India mobilised 67 tons of gold reserves to the Bank of England (47 tons) and the Union Bank of Switzerland (20 tons) with a repurchase option (Government of India, 1991).

[63] According to Chen et al., (1992), China's urban industrial and banking sector reforms formally began in 1984, although most were enacted years before. In 1983, the Chinese State Council, through a rigorous shake-up, separated the PBC's role away from a monobank (central and commercial banking conducted by one bank) to a multi-tiered one thereby isolating central banking functions. PBC's institutional design was further strengthened in 1995 with a new Charter detailing PBC's functions as i) monetary stability; ii) banking supervision; and iii) payments system oversight. It was/is still not independent of the State Council. The 1984-1997 period refers to the industrial reform era, pre-dating the central banking reforms.

[64] See De-Wulf and Goldsbrough (1986) for more on the Chinese cash and credit plans.

[65] Indirect tools include market oriented price mechanisms.

[66] The use of some *direct* credit controls have not been fully eliminated, for example, the stringent window guidance.

[67] OMOs were officially introduced in 1993 (see Mehran et al., 1996 and Nagai and Hong, 2007) mainly to inject liquidity. The absence of a healthy interbank market, regulated interest-rates environment and shortage of tradeable bonds with few market participants rendered its use ineffective. By 1997, OMOs were suspended but reintroduced in 1998 during PBC's restructuring. OMOs consisted of outright transactions on government and treasury bonds and other similar instruments. By mid-2000, the PBC took a tightening stance and treasury-bond repurchase agreements (repos) were activated, which was facilitated by the national interbank and unified interbank repo markets (see Imam, 2004) giving the process a robust foundation. By June 2002, China saw an influx of foreign exchange and market repos were increasingly used as a sterilisation tool to maintain the de facto RMB peg. However, owing to bond shortages, OMOs were supplemented with PBC Bills from April 2003.

[68] RR was introduced in 1984 at different deposit tranches at rates ranging between 20 to 40 percent, however, in 1985 they were unified and a 10 percent rate was set which slowly rose to 13 percent by 1988 and remained for the next decade. A separate reserve account for exchange settlements was established, while RR was maintained purely to sustain government's credit policy. PBC also began remunerating reserves at 4-6 percent. It was not until 1998 (at 8 percent) that a more robust design was introduced, with establishment of excess reserves account. Most studies have quoted a high degree of passivity in the use of RR pre 1998 (see Geiger, 2008; and Ma et al., 2011). Between 1999 and 2003, rates were reduced to 6-7 percent, which slowly crept up to 9 percent in 2006. Between 2007 and 2008, differentiated RR was reintroduced wherein the rates changed 16 times and aggregated to 17.5 percent. By September 2008, PBC adopted a formal two-tier system with different rates for small and large banks, and several rate adjustments have since followed. Currently RR for large and small banks are around 19.5 and 17.5 percent, respectively (China Premium Database, 2014).

market[69] rates (Xie, 2002; Imam, 2004 and Porter and Xu, 2009) followed by loosening up of the commercial bank interest rate margins.

Post 1998, OMOs were the preferred monetary policy instrument. However, since 2007, reserve requirements have actively been pursued since they are relatively more effective in sterilising foreign exchange interventions at minimal cost (see Green 2005 and Ma et al., 2011); and as of lately, they have become a viable credit and macro-prudential policy tool, with deeper level of complexity. China's level of RR is one of the highest averaging around 30 percent of GDP (around CNY 180 trillion in 2010) globally. Notwithstanding the gradual liberalization of depository institutions interest rates, the PBC intervenes by setting ceiling and floor levels on benchmark deposit and lending rates and through window guidance or moral suasion arguably to safeguard commercial bank intermediation margins and provide lending volume guidelines, respectively (see Laurens and Maino, 2007; and Fukumoto et al., 2010)[70] to avoid overheating and/or economic crunches. For instance, the periods immediately before and after the Global Financial Crisis (GFC) witnessed the efficacy of window guidance in avoiding credit fluctuations and sharp economic swings.

In addition, PBC's standing facilities such as the Automatic Collateralized Lending (ACL) and the recently launched Standing Lending Facility (SLF) and Short-Term Liquidity Operations (SLO), amongst others, have been actively pursued to shore-up liquidity levels as China's economic growth decelerates[71]. The PBC has adjusted these specific lending schemes in four categories, namely i) liquidity lending; ii) credit policy support lending; iii) financial stability lending; and iv) special purpose policy lending. Such tools have become pivotal and PBC has

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[69] Although informal presence can be dated back to the 1980s, interbank markets were officially introduced in January 1996 with the setup of the unified Shanghai-based national interbank lending market known as the China Interbank Offered Rate (CHIBOR) market. All trading was/is conducted electronically through the China Foreign Exchange Trading System (CFETS). In June 1996, interbank interest rates were liberalized and financial institutions were free to fix CHIBOR at a negotiated level. Imam (2004) adds that in 1995 interbank lending and borrowing amounted to CNY 1 trillion, however, with segmentation of the bond markets and consequential development of the *unified interbank bond and repo markets* in 1997, interbank trading rose to CNY 10 trillion by 2002. It should be noted that the Chinese bond markets were established on the Shanghai and Shenzhen stock exchanges in 1990 and 1991, respectively. To prevent commercial banks from flooding the exchange market, the PBC decreed that banks could only trade in the interbank market, and with the officiation of CHIBOR market, bond markets were segmented into i) wholesale bond; and ii) bond repo markets. The latter became a popular source of short term collateralised financing and a prominent PBC tool. In May 1998, foreign licensed banks were also permitted to participate in the interbank markets. In January 2007, PBC introduced the Shanghai Interbank Offered Rate (SHIBOR), the weighted average call rates of participating banks set as a benchmark short term rate for long-term derivatives. It is similar to the LIBOR. The key short term interbank market rates are the CHIBOR, SHIBOR and repo rates (see Xie, 2002, Imam, 2004 and Port and Xu, 2009 for more).

[70] Despite criticisms of slow interest rate liberalisation in China, He and Pauwels (2008) suggest that interest rate bands have widened and administrative controls reduced significantly in recent years providing greater flexibility and control to commercial banks. On the contrary, some studies allude (for instance, see Geiger, 2008; and Fukumoto et al., 2010) that window guidance is not as dormant as generally perceived and is an effective policy instrument with minimal non-compliance.

[71] According to the International Monetary Fund (2014, 2015), Chinese economy began showing signs of slowing down in 2013, although annual growth registered a 10 basis point higher level (7.8 percent) relative to 2012. 2014 is estimated to have posted a 7.4 percent growth while 2015 and 2016 will likely slow further down to 6.8 percent and 6.3 percent, respectively.

reinforced them steadily to cope with its double surplus dilemma[72], prevalent in recent years. Sun (2014) and Wang (2014) further add that the PBC's current framework encompasses a combination of quantitative, price-based, macro-prudential (more strenuous after the GFC) and capital-flow management tools.

Developments in Indian monetary policy have been similar, although targeting-frameworks underwent significant changes over the years. As noted in RBI (2011), India's monetary tools during its formative, modernisation and subsequent era included reserve requirements; credit controls, open market operations and standing facilities with the objectives ranging from regulation of demand-supply of credit to maintaining price stability and boosting investments. Post-1969 nationalization of commercial banks, monetary policy focused on credit planning[73] implemented using Statutory Liquidity Ratio (SLR) and Cash Reserve Ratio (CRR)[74]. Both tools focused at balancing government financing and inflationary pressures (see Singh and Kalirajan, 2006; RBI (2011); and Mohanty, 2013). Monetary policy framework hinged on monetary targeting, which was adopted in 1985 without an explicit ceiling, however, in the following years, RBI stipulated a baseline objective for the nominal anchor (M_3 growth to be contained below a predefined limit), with reserve money and CRR the operating target and primary instrument, respectively. Development of a money market was gradually gained prominence and several instruments were introduced[75].

During the next decade, owing to the financial liberalization led by recommendations of Narasimham-I Expert Panel (RBI 2011) and induced by the BoP crisis in 1991 resulting into the economic adjustment and stabilization programs, RBI moved away from direct to indirect market based instruments by introducing repos; reducing SLR and CRR rates; liberalizing the exchange rates; and phasing out the automatic monetization of deficits and credit controls[76]. In 1998, RBI formally adopted an augmented multiple indicators approach without explicitly defining a nominal anchor whereby a range of indicators is targeted including M_3, credit, GDP, current

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[72] Surpluses on the current and capital accounts (see Zhang and Tan, 2015 for more).

[73] Non-food credit was the indicator for monetary policy stance.

[74] SLR was mandated at 26 percent (1970) and raised to 37 percent (1985) with CRR at 3 percent (1971) and increased to 15 percent (1985).

[75] These were facilitated by two RBI committee recommendations: i) Committee to Review the Working of the Monetary Policy System – Chakravarty Committee; and ii) Working Group on Money Market – Vaghul Committee (RBI, 2011). Measures were taken to increase market participants (bank and non-bank entities and primary dealers) and the Discount and Finance House of India (DFHI) Ltd was established to flush more liquidity into short term instruments which included i) interbank participation certificate in 1988, ii) certificate of deposit in 1989; and commercial paper in 1990. By late 1980s and early 1990s, the money market was dominated by few large lenders and some chronic borrowers leaving liquidity heavily skewed while RBI had negligible influence on the call money market.

[76] This period witnessed a major realignment of India's financing paradigm away from the government to the commercial sectors. Facilitation of liquidity absorption through reverse repurchase agreements began with the auctioning of governments-market-borrowing paving way for an infant secondary market for government bonds, which supported further interest rate liberalisation. Reverse repos were initially introduced in 1992 to adjust short term liquidity and stabilise money market rates via a variable pricing system which later changed to a fixed-price system. While repo trading garnered depth, there was unprecedented growth in liquidity in the absence of an efficient delivery and settlements system in government securities/repos, prior to 1999. The SLR and CRR were reduced to 15 and 9.5 percent, respectively in 1997 (RBI, 1998, 2011).

account, capital flows, fiscal position, inflation (consumer and wholesale indices and expectations), exchange rate and money market interest rates supplemented by forward looking indicators. Emphasis was placed on money market as the best conduit for monetary policy transmission.

By the turn of millennium, deficiencies in the money market were noted and the *operating* framework underwent robust remodeling guided by Narasimham-II recommendations. Liquidity management policies came to the fore prompting the establishment of a well-functioning-pure interbank market and the need for RBI's operations to be more market oriented[77]. As a result, the *Interim* Liquidity Adjustment Facility (ILAF) was introduced in 1999 to minimize short-term interest rate volatility[78] and was later transformed into a permanent Liquidity Adjustment Facility (LAF) following technological upgradation (see RBI, 1998; 2004, 2005 and 2011). LAF was further improved and reinforced in 2004 and again in 2011, signaling corresponding changes in the operating framework (Mohanty, 2011; 2013)[79]. Recently, the efficacy of RBI's multiple-indicator approach was reviewed due to mounting censure as the framework allegedly lost credibility owing to consistently increasing inflation and weakening GDP. Consequently, the Patel Expert Panel (RBI, 2014) recommended a revamp of the framework and mandating a flexible inflation level nominal anchor. The on-set of these events provide in-depth understanding on the emerging techniques of economic management, stylized for economies in transition, especially the crucial role of monetary policy in aggregate demand management and preventing the economy from overheating, by stabilizing output near its potential and stabilizing prices to provide certainty in investment and consumptions spending. A snapshot of the developments in monetary policy, instruments and objectives is provided in Figures 3.1 and 3.2 for China and India, respectively.

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[77] Following Narasimham-II, the streamlining of the interbank market was synchronized with development of an efficient repo market and led to exclusion of non-bank participants. To neutralize chronic borrowers, prudent limits were set beyond which banks could not rely on money markets. Additionally, access to interbank market was moulded towards meeting unexpected swings rather than financing banks' lending needs (RBI, 1998).

[78] ILAF operated using a combination of repo, export credit refinance, collateralized lending facilities and OMOs and acted as a ceiling in the call market while the fixed rate repo was the floor between which the short-term rates moved.

[79] With LAF, the fixed repo floor was changed to a variable rate to respond to inter-day variability and as the implementation progressed, the variable repos were replaced with fixed repos. There was no formal or explicit targeting of the overnight call rates (no formal or explicit operating targets were set). During late-2004 to 2011, the RBI policy rate alternated between a fixed repo (deficit liquidity conditions) and fixed reverse repo rate (surplus liquidity conditions), providing a corridor for the overnight money market rates to settle. Again, there was no explicit operating target, however, the overnight call money rate was used as an implicit target. Following the 2011 Mohanty Report, the repo rate became the sole policy rate which unambiguously signaled the monetary policy stance, the weighted average overnight call money rate (also known as the interbank rate or the uncollateralized market rate) became the explicit operating target, with the operating objective of maintaining this rate around the repo rate/policy rate within the corridor.

FIGURE 3.1: MONETARY POLICY INFO-GRAPHIC – CHINA

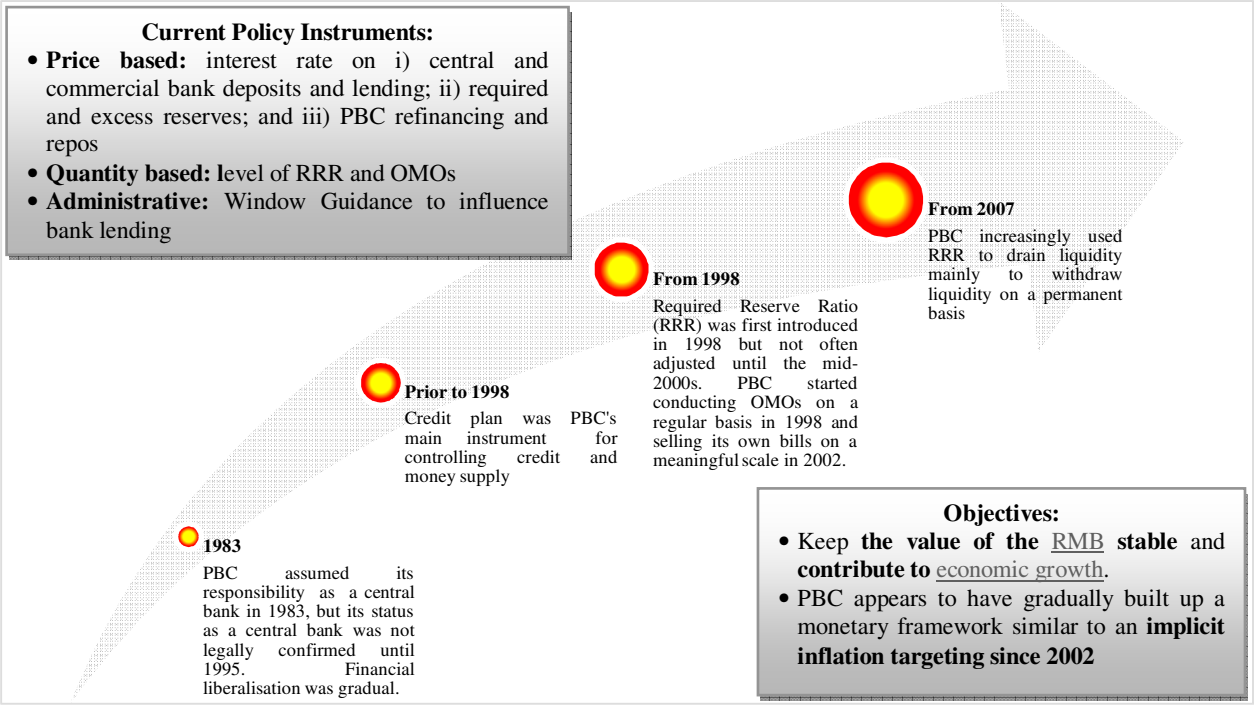


Illustration based on from Girardin et al. (2013).

FIGURE 3.2: MONETARY POLICY INFO-GRAPHIC – INDIA

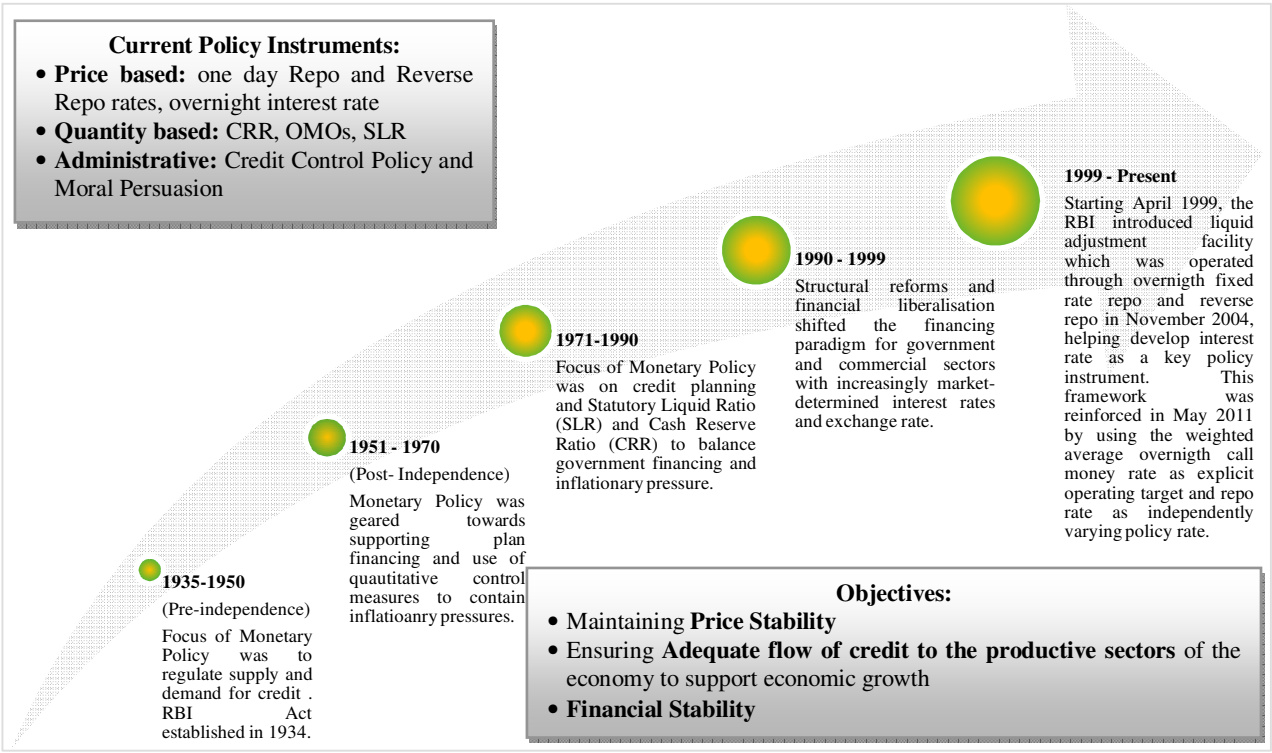


Illustration based on Mohanty (2011, 2013) & Singh and Kalirajan (2006)

3.3 MONETARY POLICY EFFICIENCY MODELS: REVIEW

In this section, the two key models on measuring monetary policy efficiency are discussed. The first model is an input-output function monetary model of Li et al. (2010), while the second model looks at macroeconomic policy weighted monetary policy loss efficiency frontier outlined by Cecchetti et al. (2006) and Krause (2004). The fundamentals of these techniques are highlighted and improvements are suggested based on theoretical and empirical developments; which are then incorporated into the baseline models; and applied to China and India.

3.3.1 MONETARY INPUT-OUTPUT FUNCTIONS (LI ET AL., 2010)

The first estimation model builds on the works of Li et al. (2010), which is an input-output type model of monetary policy transmission estimated using the Stochastic Frontier Analysis (SFA). Li et al. (2010) outline the efficiency of monetary policy in China from 2002:M09 to 2009:M10 using the SFA technique.

After dissecting the Li et al. (2010) model, the specific improvements, which can be applied on China and India, noting their monetary policy operational models and targets, are identified in this section.

The Li et al. (2010) model considers the initial and end stages of monetary policy transmission stylised to Chinese monetary policy operations and targets:

i. ***Efficiency with respect to influencing the monetary aggregate (M2) (or the controlling stage).*** Li et al. (2010) start by defining:

$$Theoretical\ Value\ of\ M2\ =\ f(monetary\ instruments) \qquad [3.1]$$

which is further refined as an input-output function based on the central bank balance sheet as this forms the basis for operational target for monetary policy:

$$M2 = f_M(B, s, R1, rr;\ \beta_n) \cdot \exp\{v\} \qquad [3.2]$$

where: *B* is the base money; *s* is summation of ratio of foreign assets to total assets and the ratio of bond issue to total liabilities; *R1* is one-year benchmark deposit rate; *rr* is the required reserve ratio of check deposits.

$$\textbf{Controlling Efficiency (CE)} = \frac{True\ Value\ of\ M2}{Theoretical\ Value\ of\ M2} = \frac{M2}{f(B,s,R1,rr;\ \beta_n)\cdot\exp\{v\}} \qquad [3.3]$$

If $M2 = f_M(B, s, R1, rr;\ \beta_n) \cdot \exp\{v\}$; the CE equals 1, that is, the highest level of efficiency; and when $M2 < f_M(B, s, R1, rr;\ \beta_n) \cdot \exp\{v\}$; the CE is below the ideal level, that is, some degree of inefficiency. While they denote $CE = exp\{-u\}$, where $u \geq 0$ and $u \sim N^+(m, \sigma_u^2)$, thus the expectation of u is described as

$$m = \delta_0 + \sum_{i=1}^{n} \delta_i X_{it} \qquad [3.4]$$

Equation 3.4 describes the inefficiency model and factors (denoted by *X*) that can influence the level of efficiency, such as financial innovation. Li et al. (2010) transform the Cobb-Douglas type input-output functions described in Equations 3.1 to 3.4 into log-linear inefficiency models that can be estimated using the Stochastic Frontier method with time varying inefficiency effects and given as:

$$\ln(M2) = \beta_0 + \beta_1 ln(B) + \beta_2\, ln(s) + \beta_3\, ln(R1) + \beta_4 \ln(rr) + v - u \qquad [3.5]$$

$$m = \delta_0 + \sum_{i=1}^{n} \delta_i X_{it} \qquad [3.6]$$

where: $n = 2$; X_1 is Shanghai Stock Index; $X_2 = \frac{M_2}{M_0}$; proxy measure of financial innovation taken as ratio of broad money to money base [Note, as highlighted by Li et al. (2010), these variables are specific to China].

ii. ***Efficiency with respect to influencing output (measured by the Real GDP) (or the Acting stage).*** To measure efficiency with respect to the overall objective of monetary policy, Li et al. (2010) highlight that:

$$Theoretical\ Value\ of\ Real\ GDP\ =\ f(monetary\ instruments) \qquad [3.7]$$

which is further refined as a input-output function describing the role of key monetary instruments in influencing the level of GDP as:

$$GDP = f_G(B, s, R1, rr;\ \beta_n) \cdot \exp\{v\} \qquad [3.8]$$

$$\textbf{Whole Efficiency (WE)} = \frac{True\ Value\ of\ Real\ GDP}{Theoretical\ Value\ of\ Real\ GDP} = \frac{GDP}{f_G(B,s,R1,rr;\ \beta_n) \cdot \exp\{v\}} \qquad [3.9]$$

If $GDP = f_G(B, s, R1, rr;\ \beta_n) \cdot \exp\{v\}$; the WE equals 1, that is, the highest level of efficiency; and when $GDP < f_G(B, s, R1, rr;\ \beta_n) \cdot \exp\{v\}$; the WE is below 1 the ideal

level, that is, some degree of inefficiency; which further defines $WE = exp\{-u\}$, where $u \geq 0$ and $u \sim N^{+}(m, \sigma_u^2)$, thus the expectation of u is described as:

$$m = \delta_0 + \sum_{i=1}^{n} \delta_i X_{it} \qquad [3.10]$$

Equation 3.10 describes the inefficiency model and factors (denoted by X) that can influence the level of efficiency. Similarly, transforming this as above into log-linear as inefficiency model with time varying inefficiency effects as:

$$\ln(gdp) = \beta_0 + \beta_1 ln(B) + \beta_2\, ln(s) + \beta_3\, ln(R1) + \beta_4 \ln(rr) + \ v - u \qquad [3.11]$$

$$m = \delta_0 + \sum_{i=1}^{n} \delta_i X_{it} \qquad [3.12]$$

where: $n = 4$; X_1 is Shanghai Stock Index; $X_2 = \frac{M_2}{M_0}$; proxy measure of financial innovation taken as ratio of broad money to money base; X_3 is the market interest rate (weighted average of national overnight interest rate in inter-bank market); X_4 ratio of all bank loans to GDP (an indicator of economic cycles and may influence efficiency the most).

3.3.2 MONETARY INPUT-OUTPUT FUNCTIONS (LI ET. AL, 2010): IMPROVEMENTS

While Li et al. (2010) provide a good platform and intuition to apply the input-output framework to measure monetary policy efficiency with respect to operational targets (that is, M2), their application of the same analogy to output (denoted by GDP) is flawed. Generally, output (GDP) per se is a combination of a number of factors and mostly driven by supply-side variables and total factor productivity. Therefore, monetary policy (or monetary aggregates) will partially influence output. Supply side policies, which encompass various combinations of factors of production, are much more effective in influencing long-term GDP.

Therefore, one of the key drawbacks in the Li et al. (2010) is the primary focus on output (that is, real GDP) rather than on output gap (that is, the difference between real and potential GDP). Monetary policy, by large, is a demand management tool and therefore may not be able stimulate long-term economic growth (or real GDP) by itself alone. Extensive research on monetary policy (see Taylor, 1993; Clarida et al., 1998 and 2000) shows that monetary policy can be used effectively to manage the output gap rather than long-term output trend (which largely depends on supply-side policies).

Furthermore, an obvious omission from the Li et al. (2010) is a similar efficiency analysis on inflation gap, reflected by the deviation of inflation from its trend or explicit target set by the central banks, a core, overall monetary policy target in developed and developing countries alike. Significant studies (see Taylor, 1993; Clarida et al., 1998 and 2000; Rudebusch and Svensson, 1999; Rudebusch, 2002 and 2006, Orphanides, 2001, 2002 and 2004; English et al., 2003 and Boivin, 2006) on monetary policy rules have shown the dual focus on output and inflation gap by most central banks.

As noted in Section 3.2 that whilst prices tend to be the core focus of monetary policy, aggregate demand stabilisation and management of the output provide a simultaneous feedback-effect in anchoring future prices, thus the dual focus (Cecchetti et al., 2006). Moreover, in China's case, a recent empirical study by Girardin et al. (2013) outline the role of PBC in managing this dual goal of stabilising output gap and managing inflation expectations. A similar case for India has been highlighted by Mohanty (2013) and Subbarao (2013) where they identify the focus on inflation (measured by wholesale price index) and output gap (also see RBI, 2014).

3.3.3 MODIFIED LI ET AL. (2010) MODEL: REDEFINED OBJECTIVE FUNCTIONS

Based on these specific-identified improvements, we redefine Li et al. (2010) model to measure the two specific efficiencies with respect to the fundamental monetary policy objectives*: i) inflation gap (difference between the current level of inflation and optimal level of inflation);* and *ii) output gap (difference between the potential and actual level of Real GDP)*. However, the efficiency measurement with respect to M2 presented in Li et al. (2010) is ignored here. The assessment of M2 is primarily omitted since our evaluation is focussed on measuring total efficiency with respect to ultimate goals of monetary policy as opposed to the intermediate targets. Furthermore, M2 is just one of the many intermediate targets contributing to efficiency with which the overall monetary policy objectives are achieved. Therefore, measuring the policy efficiency with respect to M2 undermines this process and narrows the focus from the overall transmission mechanism.

Additionally, other key intermediate instruments and targets, such as wholesale (repo rates, standing facilities, central bank lending and discounting rates) and retail interest rates and domestic credit also affect the efficiency levels in achieving the overall goal of monetary policy. Therefore, to avoid this narrow focus on the intermediate target, M2 efficiency assessment is excluded and focus is streamlined to the efficiency in policy management of inflation and output in comparison to their long-term trend for both China and India.

The basic determinants of the Li et al. (2010) model are also examined closely in light of the conduct of monetary policy in China and India. Some of the changes to the empirical model include redefining and replacing the:

i) Deposit Rate (DR) (in the initial model of Li et al.; 2010) with the Central Bank's Policy Indicator Rate (PR), which provides better policy signal for inter-bank rate, and retail lending and deposit rates;

ii) Required Reserve Ratio (RR) (in the initial model of Li et al.; 2010) with Effective Reserve Ratio (ER). ER provided the actual withdrawal from the money base in an economy rather than the minimum policy rate set by the Central Bank; and

iii) Market Interest Rate (R) in the inefficiency equation by better measure of the spread between the retail lending and deposit rate (SPREAD). The market interest rate utilised by Li et al. (2010) tends to narrow focus on lending activities, hence not a holistic measure of efficiency of transmission of monetary policy. On the other hand, our measure of SPREAD illustrates level of efficiency by noting the level of spread between the lending and deposit rates, that is, the price of demand for loanable funds against the price of supply of loanable funds.

In addition to these changes, output gap and inflation gap is included in the respective inflation and output equation given the contemporaneous feedback relationship between inflation and output, as highlighted by Svensson (1997), Rudebusch and Svensson (1999) and Cecchetti et al. (2006).

Apart from the above replacements and the addition of output and inflation gap in the respective equations, two slightly different equations are estimated to measure output and inflation gap efficiency. The first regression function denoted as *OG_1* and *IG_1* is estimated as $f(B, s, PR, ER; IG;\ \beta_n) \cdot \exp\{v\}$ while the second regression equation denoted as *OG_2* and *IG_2* is estimated as $f(M2, Credit, PR, ER; IG;\ \beta_n) \cdot \exp\{v\}$.

In the second regression equation, *B* and *s* are replaced with *M2* and *Credit* (where Credit is the ratio of Domestic credit to GDP). These changes in the secondary equation bring to the forefront the role of these intermediate targets in influencing output and inflation gap. The use of monetary aggregate in implementation of monetary policy in China and India coupled with developing and gradually deepening capital markets provide reasonable support to test the impact of these variables on the overall monetary policy objectives. This is also motivated by the fact that *M2* and domestic credit ratio to GDP are broad intermediate instruments and targets of monetary policy rather than $\ln(s)$ and $\ln(B)$ as defined by Li et al. (2010).

Empirically, primary instruments of monetary policy work through the operating targets, which inturn affects the intermediate targets to achieve the overall objectives, thus their direct influence on overall targets sometime is not as strong as envisaged. However, these primary instruments do play a key role in influencing the operating/intermediate instruments and targets.

Thus, the modified model is outlined as follows:

i. Efficiency with respect to influencing Output Gap (OG):

$$Theoretical\ Value\ of\ Output\ Gap\ =\ f(monetary\ instruments; Infaltion\ Gap) \quad [3.13]$$

which is further refined as a input-output function with Inflation Gap denoted as IG:

$$OG\_1 = f_{OG}(B, s, PR, ER; IG;\ \beta_n) \cdot \exp\{v\} \quad [3.14]$$

$$\textbf{Output Gap Efficiency (OGE\_1)} = \frac{True\ Value\ of\ Output\ Gap}{Theoretical\ Value\ of\ Output\ Gap}$$

$$= \frac{OG\_1}{f_{OG}(B,s,PR,ER,inf;\ \beta_n)\cdot\exp\{v\}} \quad [3.15]$$

If $OG\_1 = f_{OG\_1}(B, s, PR, ER, IG;\ \beta_n) \cdot \exp\{v\}$; then *OGE_1* equals 1, that is, the highest level of efficiency and if $OG\_1 < f_{OG}(B, s, PR, ER, IG;\ \beta_n) \cdot \exp\{v\}$; then *OGE_1* is below 1, that is, the ideal level, then some degree of inefficiency is observed.

This is supplemented by replacing s and B with M2 and Credit to GDP ratio in as:

$$OG\_2 = f_{OG\_2}(M2, Credit, PR, ER; IG;\ \beta_n) \cdot \exp\{v\} \quad [3.16]$$

$$\textbf{Output Gap Efficiency (OGE\_2)} = \frac{True\ Value\ of\ Output\ Gap}{Theoretical\ Value\ of\ Output\ Gap}$$

$$= \frac{OG\_2}{f_{OG}(M2,Credit,PR,ER,inf;\ \beta_n)\cdot\exp\{v\}} \quad [3.17]$$

If $OG\_2 = f_{OG\_2}(M2, Credit, PR, ER, IG;\ \beta_n) \cdot \exp\{v\}$; then *OGE_2* equals 1, that is, the highest level of efficiency and if $OG\_2 < f_{OG\_2}(M2, Credit, PR, ER, IG;\ \beta_n) \cdot \exp\{v\}$; then *OGE_2* is below 1, that is, the ideal level, then some degree of inefficiency is observed.

ii. Efficiency with respect to influencing Inflation Gap (IG) is represented by:

$$Theoretical\ Value\ of\ Inflation = f(monetary\ instruments; OG) \quad [3.18]$$

which is further refined as a input-output function as:

$$IG\_1 = f_{IG\_1}(B, s, PR, ER; OG;\ \beta_n) \cdot \exp\{v\} \quad [3.19]$$

$$\textbf{Inflation Gap Efficiency (IGE\_1)} = \frac{True\ Value\ of\ Inflation\ Gap}{Theoretical\ Value\ of\ Output\ Gap}$$

$$= \frac{IG\_1}{f_{IG\_1}(B,s,PR,ER,OG;\ \beta_n) \cdot \exp\{v\}} \quad [3.20]$$

If $IG\_1 = f_{IG\_1}(B, s, PR, ER, OG;\ \beta_n) \cdot \exp\{v\}$; then *IGE_1* equals 1, that is, the highest level of efficiency and if $IG < f_{IG}(B, s, PR, ER, OG;\ \beta_n) \cdot \exp\{v\}$; then *IG* is below 1, some degree of inefficiency is observed.

Similar to the Output Gap supplementary equation, we further modify the inflation gap efficiency equation by introducing *M2* and *Credit* to the regression equation as:

$$IG\_2 = f_{IG\_2}(M2, Credit, PR, ER; OG;\ \beta_n) \cdot \exp\{v\} \quad [3.21]$$

$$\textbf{Inflation Gap Efficiency (IGE\_2)} = \frac{True\ Value\ of\ Inflation\ Gap}{Theoretical\ Value\ of\ Output\ Gap}$$

$$= \frac{IG\_2}{f_{IG\_2}(M2,Credit,PR,ER,OG;\ \beta_n) \cdot \exp\{v\}} \quad [3.22]$$

If $IG\_2 = f_{IG\_2}(B, Credit, PR, ER, OG;\ \beta_n) \cdot \exp\{v\}$; then *IGE_1* equals 1, that is, the highest level of efficiency and if $IG\_2 < f_{IG\_2}(M2, Credit, PR, ER, OG;\ \beta_n) \cdot \exp\{v\}$; then *IG_2* is below 1, some degree of inefficiency is observed.

For Equations 3.13 through to 3.22, we define their respective efficiencies (*E*) as $E = exp\{-u\}$, where $u \geq 0$ and $u \sim N^+(m, \sigma_u^2)$ and where respective output and inflation gap is equal to $exp\{-u\}$, where $u \geq 0$ and $u \sim N^+(m, \sigma_u^2)$, thus the expectation of u is described for both as

$$m = \delta_0 + \sum_{i=1}^{n} \delta_i X_{it} \quad [3.23]$$

And where X_i has been specifically defined for each of the respective equations.

Based on Equations 3.13 to 3.23, we transform these into log-linear Stochastic Frontier Models with time varying inefficiency effects as:

Output Gap Models:

$$OG_1 = \beta_0 + \beta_1 ln(B) + \beta_2\, ln(s) - \beta_3\, ln(PR) - \beta_4\, ln(ER) + \beta_5\, IG + \ v - u \qquad [3.24]$$

$$m = \delta_0 + \sum_{i=1}^{n} \delta_i X_{it}\ ; \qquad [3.25]$$

where: $n = 4$; X_1 is the respective Country's key Stock Index (SPI) ; $X_2 = \frac{M_2}{M_0}$; is a proxy measure of financial innovation taken as ratio of broad money to money base (FI); X_3 is the difference between the retail lending and deposit interest rate (*SPREAD*); X_4 is the ratio of Domestic Credit to GDP (Credit).

$$OG_2 = \beta_0 + \beta_1 ln(M2) + \beta_2\, ln(Credit) - \beta_3\, ln(PR) - \beta_4\, ln(ER) + \beta_5\, IG + \ v - u \quad [3.26]$$

$$m = \delta_0 + \sum_{i=1}^{n} \delta_i X_i\ ; \qquad [3.27]$$

where: $n = 3$; X_1 is SPI ; X_2 is FI; X_3 is SPREAD.

Inflation Gap Models:

$$IG_1 = \beta_0 + \beta_1 ln(B) + \beta_2\, ln(s) - \beta_3\, ln(PR) - \beta_4\, ln(ER) + \beta_5 OG + \ v - u \qquad [3.28]$$

$$m = \delta_0 + \sum_{i=1}^{n} \delta_i X_{it}\ ; \qquad [3.29]$$

where: $n = 4$; X_1 is SPI ; X_2 is FI; X_3 is SPREAD; X_4 is Credit.

$$IG_1 = \beta_0 + \beta_1 ln(M2) + \beta_2\, ln(Credit) - \beta_3\, ln(PR) - \beta_4\, ln(ER) + \beta_5 OG + \ v - u \quad [3.30]$$

$$m = \delta_0 + \sum_{i=1}^{n} \delta_i X_{it}\ ; \qquad [3.31]$$

where: $n = 3$; X_1 is SPI ; X_2 is FI; X_3 is SPREAD.

Equation 3.24 to 3.31 are estimated for China and India and results are presented in sub-section 3.4.2.2.

3.3.4 MONETARY POLICY EFFICIENCY & PERFORMANCE: CECCHETTI ET AL. (2006)

Cecchetti et al. (2006) is one the first and probably the most influential studies on measuring monetary policy efficiency[80]. This study utilises the concept of Taylor Curve (inspired from the Taylor Rule) to model and estimate monetary policy frontiers (with variance in inflation and variance in output) for 24 countries[81] over two sample periods, namely, i) 1983:Q1 to 1990:Q4; and ii) 1991:Q1 to 1998:Q4. Using the two equation structural model of aggregate demand and aggregate supply, Cecchetti et al. (2006) estimate the policymaker's preference to quantify the macroeconomic performance and monetary policy efficiency frontier for 24 countries.

Cecchetti et al. (2006) set up the model using contemporary analyses of central bank's standard quadratic loss function:

$$Loss = \lambda[Var(\pi_i)] + (1 - \lambda)[Var(y_i)] \qquad [3.32]$$

where $0 \leq \lambda \geq 1$, π is inflation, y is output and λ is the policymaker's preference parameter. This is synonymously treated as actual macroeconomic performance and denoted as:

$$P_i = \lambda[Var(\pi_i)] + (1 - \lambda)[Var(y_i)] \qquad [3.33]$$

ΔP is interpreted as the measure of performance, that is, a positive change from one period to the next is identified as performance gain and vice versa. However, this change is measured against the variability of the efficiency frontier brought about by the variability of supply shock changes given as:

$$S_i = \lambda[Var(\pi_i)^*] + (1 - \lambda)[Var(y_i)^*] \qquad [3.34]$$

where $Var(\pi_i)^*$ and $Var(y_i)^*$ represent the variability of the optimal policy for inflation and output for period i and ΔS is change in the variability of supply shocks. The measure of actual

[80] This study builds on the earlier paper by Krause (2004) – one of the co-authors of the Cecchetti et al. (2006).
[81] Except for Mexico, all countries considered in this study are developed countries.

performance and performance under optimal policy conditions are utilised to construct an overall gauge of monetary policy efficiency for each period, defined as:

$$E_i = \lambda[Var(\pi_i) - Var(\pi_i)^*] + (1-\lambda)[Var(y_i) - Var(y_i)^*] \quad [3.35]$$

Therefore, a positive ΔE is denotes an increase in efficiency of monetary policy and vice versa. Cecchetti et al. (2006) further refine this efficiency as:

$$Q = \frac{\Delta E}{|\Delta P|} \quad [3.36]$$

which calculates the proportion of monetary policy efficiency that can be accounted for by improved policy, thus a positive value of Q implies improved monetary policy efficiency and negative value alludes to a less efficient monetary policy. The construction of efficiency frontier is derived by minimising an objective function subject to the constraints imposed by the dynamic structure of the economy as:

$$E(L) = E[\lambda(\pi_t - \pi^*)^2 + (1-\lambda)(y_t - y^*)^2] \quad [3.37]$$

Cecchetti et al. (2006) highlight that this objective function ignores the focus on interest rate and/or exchange rate, as the fundamental concern of a central bank is domestic macroeconomic performance which is measured by output and prices. In addition, a key assumption of their model is that optimal (or target) rate of inflation is assumed to be 2 percent for all countries.

Consequently, to obtain the quantitative estimates of the policymaker's preference parameter (λ), Cecchetti et al. (2006) introduce a structural two equation linear system of dynamic aggregate demand – aggregate supply model with three endogenous variables (inflation, industrial production and interest rate):

$$y_t = \sum_{l=1}^{2} \alpha_{1l} i_{t-l} + \sum_{l=1}^{2} \alpha_{1(l+2)} y_{t-l} + \sum_{l=1}^{2} \alpha_{1(l+4)} \pi_{t-l} + \alpha_{l7} x_{t-1} + \varepsilon_{1t} \quad [3.38]$$

$$\pi_t = \sum_{l=1}^{2} \alpha_{2l} y_{t-l} + \sum_{l=1}^{2} \alpha_{2(l+2)} \pi_{t-l} + \alpha_{25} x_{t-1} + \varepsilon_{2t} \quad [3.39]$$

y_t and π_t represent the aggregate demand and aggregate supply curves, with detrended log industrial production, y, nominal interest rate, i, demeaned inflation, π, demeaned external price inflation, x, and error terms ε_1 and ε_2 are assumed to be $N \sim (0, \sigma^2)$.

3.3.5 IMPROVED EMPIRICAL MODEL: TO ESTIMATE POLICY PREFERENCE

We utilise the efficiency and loss indicators derived by Cecchetti et al. (2006), however, we improve on their empirical estimation of central bank's preference parameter (λ) by defining them in the context of Taylor Rule estimated using a Generalised Methods of Moments (GMM) approach. The utilisation of Taylor rule (or commonly known as monetary reaction function) improves the current methodology by directly estimating the preference parameter of policymakers, that is, models the underlying behaviour of central banks in the conduct of forward-looking monetary policy.

Furthermore, as illustrated in a number of previous studies (see Jondeau et al., 2004) on forward-looking monetary policy reaction functions, the estimation by ordinary least squares using actual future realisations in place of expectation terms would provide inconsistent estimators as the respective error terms would be correlated with the endogenous regressors. Therefore, to overcome such estimation issues, the GMM technique is used, which makes the method appealing to the forward-looking Taylor rule estimations.

We define our empirical model to estimate the preference parameter based on the seminal work of Clarida et al. (1998 & 2000) as:

$$r_t^* = r^* + \lambda\left[E\left(\pi_{t,k}\middle|\Omega_{\mathrm{t}}\right) - \pi^*\right] + (1-\lambda)\left[E\left(y_{t,k}\middle|\Omega_{\mathrm{t}}\right) - y^*\right] \qquad [3.40]$$

Equation 3.40 denotes the forward-looking policy rule based on both theoretical and empirical grounds, as it incorporates the simple form of the quadratic loss function illustrated in the work of Cecchetti et al. (2006). In the equation, r_t^* denotes the central bank's policy interest rate in period *t* and is a function of the desired nominal rate (r^*) and gaps between expected and target inflation rate, and output and target output (i.e., the output gap) (based on the information set of the central bank). E is the expectation operator and Ω_t is the information set at time t. r^* is classified as the desired nominal rate when both the inflation and output gaps are zero.

3.4 EMPIRICAL ESTIMATION: RESULTS & DISCUSSION

3.4.1 DATA

Data for empirical estimation of both these models has been sourced primarily from the International Monetary Fund's (IMF) International Financial Statistics database except for the call interest rate sourced from the RBI online database. A detailed description of the data and manipulation of data to derive specific indicators are explained in Appendix 3.1. For the

estimation of output and inflation gap we applied the Hodrick-Prescott (HP) Filter with a smoothing parameter of 1600 to derive the trend data for RGDP (seasonally adjusted) and inflation. The output gap is calculated as the actual RGDP (seasonally adjusted using the Census X-12 methodology) less the trend of seasonally adjusted RGDP calculated using the HP Filter. Similarly, the inflation gap is estimated as the actual inflation rate (as year-on-year percentage change in Consumer Price index for China and Wholesale Price Index for India) less the trend inflation calculated using the HP Filter. All variables a converted to logs except for those already in percentages.

3.4.2 STOCHASTIC FRONTIER FRAMEWORK

This section firstly identifies the Stochastic Frontier Model then discusses the empirical results for China and India.

3.4.2.1 STOCHASTIC FRONTIER MODEL

Equations 3.24 to 3.31 are empirically estimated using the Stochastic Frontier Analytical models [which has been extensively discussed by Kalirajan and Shand (1994), Coelli (1996), Kumbhakar and Lovell (2003) and Belotti et al. (2013), amongst others] on time series data for China (1999Q1 to 2013Q3) and India 1997Q1 to 2013Q3). The Stochastic Frontier model used in estimation of these equations [3.24-3.31] includes exogenous inefficiency determinants which can be generally represented as:

$$y = f(X)e^{v-u}$$

As illustrated by Miljkovic and Shaik (2010) and Djokoto (2012) Kumbhakar, Ghosh and McGuckin (1991) and Huang and Liu (1994), Belotti (2013), applying natural logarithm to above equation yields a time series model as:

$$lny_t = Z_t\beta + \varepsilon_t$$

$$\varepsilon_t = v_t - u_t$$

$$v_t \sim_{iid} N(0, \sigma_v^2)$$

$$u_t \sim N^+(\mu, \sigma_u^2)$$

$$\mu_t = X_t\delta$$

where y_t denotes the Output Gap (Inflation Gap) for the quarter t $(t = 1, \ldots, T), Z_t$ is the vector of regressors of the Output Gap (Inflation Gap) as identified in Sub-section 3.3.3, β is the vector of parameters to be estimated, v_t is identically and independently distributed as $v_t \sim_{iid} N(0, \sigma_v^2)$, u_t is the non-neagtive error term independent of v_t and assumed to be identically and independently truncated in t instead of zero (half normal distributed when $\mu = 0$) as $u_t \sim N^+(\mu, \sigma_u^2)$ and $E[v_t] = 0$ for all $t, E[v_t v_j] = 0$ for all t and j (where $t \neq j), E[v_t^2] = \sigma_v^2, E[u_t u_j] = 0$ for all t , $E[u_t u_j] = 0$ for all t and j (where $t \neq j$), $E[u_t^2] = \sigma_u^2$, which indicates that v_t and $u_t$are uncorrelated. Furthermore, μ_t is a realisation from a truncated normal random variable, X_t is a vector of exogenous variables (including a constant term), and δ is the vector of unknown parameters to be estimated (the so-called inefficiency effects).

3.4.2.2 STOCHASTIC FRONTIER: EMPIRICAL ESTIMATES & DISCUSSION

Table 1 provides the results of the SFA estimates of the output gap equations (3.24 to 3.27) as illustrated in sub-section 3.3.3 and the calculated time varying efficiency for both models is presented in Figure 3. All models for China and India have been estimated with robust standard errors to account for any unknown heteroscedasticity included in the estimation and auxiliary bootstrap test based on 1000 replications have also been carried out to reconfirm the robustness of the estimates.

3.4.2.2.1 CHINA: OUTPUT GAP EQUATION RESULTS & DISCUSSION

The estimated SFA model results for China's output gap equations are presented in Table 3.1 and Figure 3.3. The Output Gap results show the expected signs denoted in Equations 3.24 through to 3.27. The initial equation (Eq. 3.24) based on Li et al. (2010) illustrates statistically significant role of the central bank balance sheet which affects the money base and the multiplier in the economy, policy interest rate set by the PBC to influence the money market and retail interest rates, and the role of effective reserve ratio in providing a monetary aggregate based approach to influence the level of liquidity in the banking system and its consequent impact on output.

As expected, the PBC's assets (represented by *s*) has a positive impact on output gap, that is an increase in foreign assets and liabilities with respect to total PBC's assets and liabilities tends to move the output away from its long-term trend and similarly a decrease in s moves the output closer to long-term trend. Both, the policy interest rate of PBC and the level of effective reserves kept by commercial banks (which is influenced by the required reserve ratio set by the PBC) negatively impacts China's output gap, that is, an increase in interest rates and effective reserves

by the PBC moves the current output closer to its long-term trend. This suggests that the policy tools of PBC seems to influence the output gap in the right direction as desired by policymakers.

TABLE 3.1: OUTPUT GAP RESULTS FOR CHINA

	Equation 3.24 -3.25 (OG_1)		Equation 3.26 -3.27 (OG_2)	
	$\boldsymbol{\beta}$	(z-stat)	$\boldsymbol{\beta}$	(z-stat)
bm	0.0322	(0.62)	...	...
s	0.0427^	(-1.61)	...	...
pr	-0.0113*	(-2.28)	-0.0108*	(-2.29)
er	-0.0137^	(-1.63)	-0.0210**	(-2.79)
inf_gap	-0.000276	(-0.28)	-0.000474	(-0.42)
M2	...	...	0.0288	(0.37)
Credit	...	...	0.00123	(0.22)
Constant	-0.00260	(-0.09)	0.0148	(0.63)
	lnsig2v (σ_v^2)			
Constant	-9.180***	(-36.77)	-9.139***	(-33.03)
	lnsig2u (σ_u^2)			
	$\boldsymbol{\delta}$	(z-stat)	$\boldsymbol{\delta}$	(z-stat)
SPI	-15.65*	(-2.23)	-11.55***	(-4.37)
FI	-16.04	(-0.13)	42.06	(0.30)
Spread	-32.17*	(-2.54)	-23.24**	(-3.14)
Credit	0.503	(0.79)	...	...
Constant	189.2	(1.01)	66.39	(0.33)
T (1999Q1-2013Q3)	**58**	**58**	**58**	**58**

^ p<0.10 * p<0.05 ** p<0.01 *** p<0.001

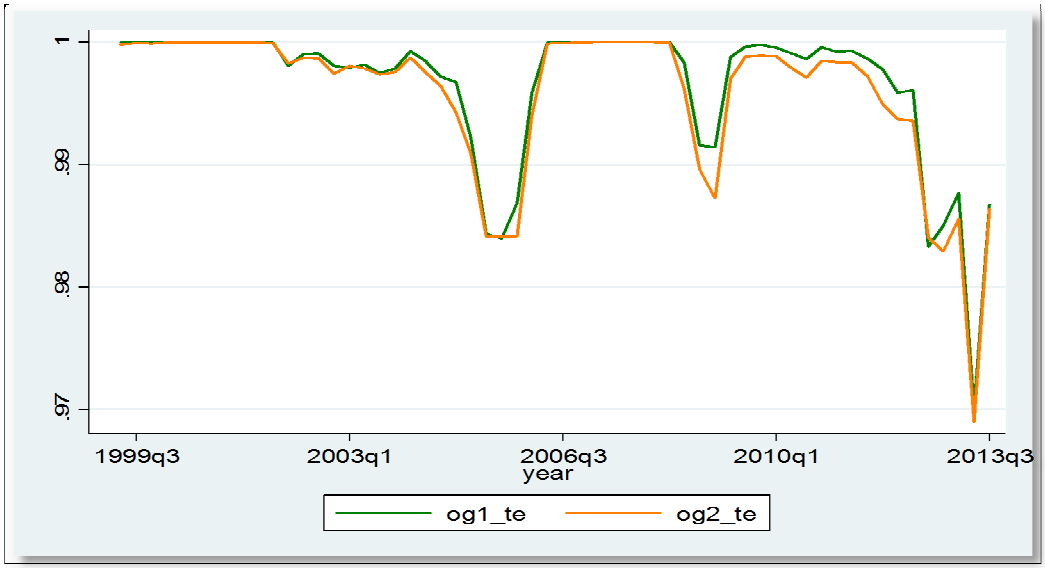
At the outset, the coefficients of policy interest rate (pr) and effective reserve ratio (er) which are -0.0113 and -0.0137, respectively, tend to allude to a weak impact of these policy variables on output gap. However, one key feature generally ignored in linking the estimated coefficients to policy analysis is the magnitude of impact of the policy variables like interest rates and effective reserve ratio on the output gap. These coefficients indicate that a combined impact of a one percent increase in policy interest rate and effective reserves ratio decreases GDP by around 0.025 (that is, -0.0113 plus -0.0137). It should be noted that a mere -0.025 percent impact of policy variables affects output gap by -0.025 percent which can be very large in terms of volume, or simply a 0.025 percent decline the GDP growth rate. This impact can be significant for a country like China.

Another important policy lesson that can be drawn from the results is that the PBC has not been aggressively pursuing adjustment of the output gap, but has taken a much more gradualist approach. This augurs well in terms of the current policy settings in China where the PBC's approach to output management is gradual noting the flow-on impact of lower GDP growth on other sectors of the economy.

The inefficiency equation (Eq. 3.25) illustrates a strong role of the interest rate spread and stock prices in decreasing the overall inefficiency with respect to PBC's ability to narrow the gap between the level of output and its' long-term trend, denoted by the relatively large coefficient values of interest rate spread and stock prices. A general conclusion from these results is that increases in interest rate spread (that is, price spread of supply and demand of loanable funds) and stock prices (a measure of financial activity) tends to reduce the inefficiency in the transmission effect of the PBC's monetary policy stance in influencing the level of output gap for China. This conclusion is supported by the trend growth in the Chinese economy since late 1990s as its pace of economic growth has been buoyant which seems to have assisted in easing financial frictions thus improving the transmission mechanism of monetary policy.

Overall the gist of these arguments are supported by the empirical values for efficiency generated for *OG_1* (or Output Gap regressed on determinants of Eq. 3.24-3.25) which illustrates that the average level of efficiency is close to 99 percent[82] for achieving the PBC's objective of narrowing the gap between the current and trend level of real GDP. The fall in efficiencies is also experienced during the global financial crisis when output was exogenously affected by the fall in demand for Chinese exports and the recent fall in efficiency reflects the adjustment cost of rebalancing the Chinese economy from an external sector focused economy to inward or domestic market driven economic growth.

FIGURE 3.3: CHINA – TIME VARYING EFFICIENCY OF OUTPUT GAP



[82] This corresponds to efficiency estimates of Li et al. (2010) which was around 90 percent in their study. It is important to note that Li et al. (2010) estimated their model on extrapolated data for Real GDP from 2002:M09 to 2009:M10 and their dependent variable was real GDP growth rather than output gap (which is estimated in this paper).

As indicated in Sub-Section 3.3.3, we re-estimate Equations 3.24-3.25 by replacing base money (bm) and composite of central bank's foreign assets and liabilities (s) with *M2* (Broad Money) and *Credit* (i.e. Credit to GDP ratio) as broader measure of intermediate monetary policy instruments and targets denoted by Eq. 3.26-3.27 as *OG_2*. The inclusion of M2 and Credit in the Eq. 3.26-3.27 increases the statistical significance of the policy interest rate and effective reserves ratio, and marginally increases the coefficient value of the effective reserve ratio (er), while the policy interest rate coefficient remains relatively unchanged at around -0.01. However, none of the other variables in the model are significant in Eq. 3.26 compared to Eq.3.24 (where s , a composite measure of central bank asset and liabilities, was significant). Nevertheless, Eq. 3.26 outlines a consistent policy message as discussed above, that is, policy interest rates and effective reserves ratio are key tools of managing the output gap[83].

In addition, as discussed in earlier paragraphs of this section, the PBC's gradualist approach in managing the output gap is confirmed by these estimates. The combined impact of policy interest rates and effective reserves ratio on output gap (under *OG_2*) is around -0.032 percent (for an increase in pr and er by 1 percent, respectively) compared to -0.025 percent under *OG_1*, an increase of around 70 basis points. This is supported by similar results for δ in the inefficiency equation, which shows a robust role of stock prices and interest rate spread in reducing the overall level of inefficiency. This is reflective of slightly lower efficiency values for Eq. 3.26-3.27 presented in Figure 3 (represented by the *OG_2* technical efficiency line) at around 97 percent compared to 99 percent for *OG_1*.

3.4.2.2.2 CHINA: INFLATION GAP EQUATION RESULTS & DISCUSSION

The inflation gap estimates (Eq. 3.28-3.31) and its efficiency analyses are presented in the Table 3.2 and Figure 3.4. The estimates for inflation gap for both the initial model (Eq. 3.28-3.29) and modified model (Eq. 3.30-3.31) indicate policy interest rate (pr) and effective reserves ratio (er) are the only potent policy tools of PBC in managing the current inflation around its long-term trend. In addition, the coefficients show a relatively robust or active policy response by the PBC in managing the inflation gap as in both equations the combined policy impact of pr and er are around -5.0 and -4.5 percent on inflation gap as result of 1 percent increase in pr and er, respectively. This alludes to a relatively strong policy response by the PBC to control the level of inflation gap in China.

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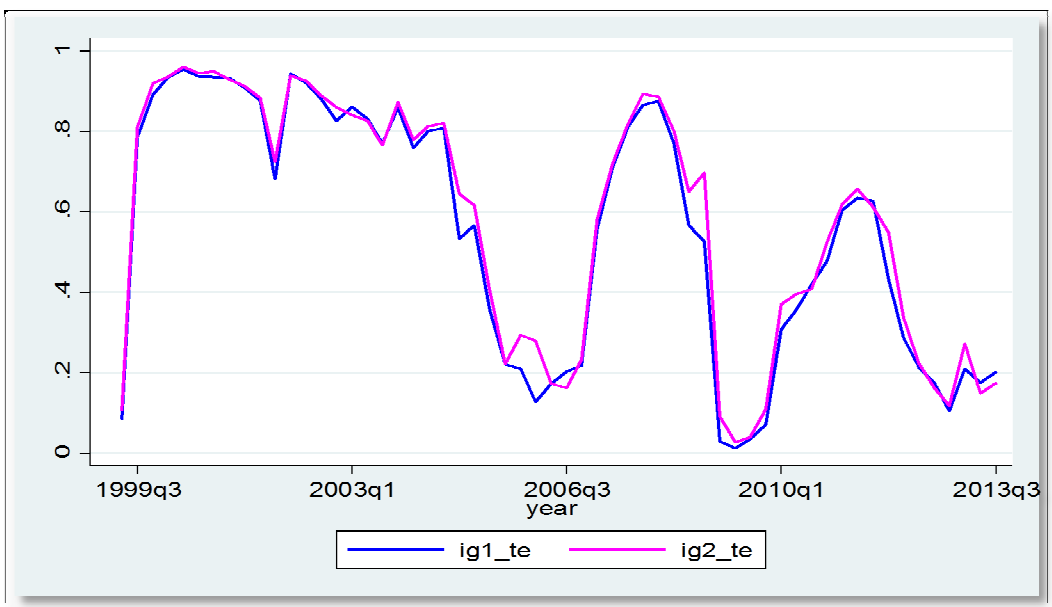
[83] Though not directly comparable to results of this study on China's output gap, Li et al. (2010) found s, bm and er to be statistically significant in influencing real GDP. Their interest rate variable was insignificant, as they used deposit rates as a measure of interest rate in the economy. The use of such a measure for prevailing interest rate in the economy is flawed as discussed in the sub-section 3.3.3 of this paper.

TABLE 3.2: INFLATION GAP RESULTS FOR CHINA

	Equation 3.28 -3.29 (IG_1)		Equation 3.30 -3.31 (IG_2)	
	β	(z-stat)	β	(z-stat)
bm	4.864	(1.21)	...	...
s	-2.709	(-0.52)	...	...
pr	-1.464*	(-2.13)	-1.575*	(-1.98)
er	-3.528*	(-2.18)	-2.887^	(-1.94)
output_gap	-0.648	(-0.02)	-4.635	(-0.16)
M2	...	...	-16.79	(-1.25)
Credit	...	...	0.122	(0.15)
Constant	4.220	(0.86)	3.025	(0.61)
	lnsig2v (σ_v^2)			
Constant	0.407*	(1.96)	0.472*	(2.53)
	lnsig2u (σ_u^2)			
	δ	(z-stat)	δ	(z-stat)
SPI	-3.603*	(-2.03)	-3.485^	(-1.93)
FI	424.0*	(2.23)	442.0**	(2.62)
Spread	5.937	(1.46)	7.084*	(2.06)
Credit	-0.336	(-1.16)	...	...
Constant	-562.6*	(-2.18)	-592.9**	(-2.60)
T (1999Q1-2013Q3)	**58**	**58**	**58**	**58**
^ p<0.10	* p<0.05	** p<0.01	*** p<0.001	

FIGURE 3.4: CHINA – TIME VARYING EFFICIENCY OF INFLATION GAP



The robust response to inflation gap to a larger extent could be in response to the limited success in controlling the domestic inflation rate (see Figure 3.4 on declining efficiency in managing inflation gap) due to a combination of factors, such consistent large influx of liquidity as result of

buoyant economic activity, increasing foreign direct investment (FDI) and foreign reserves with limited outflows due to capital controls[84], limited responsiveness of domestic supply side factors (experienced recently, largely led by domestic food prices[85]) and impact of international commodity prices (such as sharp rise in crude oil prices in 2008). Such idiosyncratic issues is compounded by the inefficiencies created by the financial innovation and impact of retail rate spreads in the Chinese market as estimated in Eq. 3.29 & 3.31.

The estimates of the inefficiency model (Eq. 3.29 & 3.31) indicate that while stock prices are relevant in reducing financial friction in the transmission of pr and er to inflation gap, this is significantly out-weighted by FI (a measure of financial deepening) and retail interest rate spread. This is duly reflected in the estimated values of time-varying efficiency calculated for both the initial and modified model, which indicate an undulating behaviour of the level of efficiency over the estimated period.

The estimated efficiency shows that in recent years PBC has limited success in influencing the level of inflation gap, as since December 2008 recording the lowest level of efficiency of close to 2 percent for both equations. Furthermore, the average efficiency has remained close to around 30 percent (on average) post-December 2008. This estimated lower efficiency also coincides with the recent experience of PBC in dealing with international price shock of commodities, just before the onset of the GFC in 2008, as the domestic inflation rate reached 8 percent in March 2008[86].

This was accompanied by another bout of inflationary pressures when inflation peaked again to just over 6 percent in September 2011, due to supply-side driven food prices underpinning the firm rise in domestic inflation. Furthermore, noting the explicit mandate and focus of PBC on managing the exchange rate and stability of real GDP as enshrined in their monetary policy objective, the results do indicate attempts to manage inflation but probably as a secondary objective and less weighting placed on it as a preferred policy outcome.

3.4.2.2.3 INDIA: UTPUT GAP EQUATION RESULTS & DISCUSSION

[84] http://www.eastasiaforum.org/2011/03/28/chinas-inflation-problem/
[85] http://qz.com/101859/chinas-short-term-inflation-problem-is-partly-a-long-term-food-supply-problem/
[86] Compared to an average of around 2% inflation rate based on the average of the CPI derived inflation values and its trend estimated by the HP filter in this study for the period from 1999Q1 to 2013Q3.

The output gap estimate and the estimated time varying efficiency for India is provided in Table 3.3 and Figure 3.5, respectively. The initial model (Eq. 3.24-3.25) indicates the statistical significance of all key policy variables, except for effective reserves ratio. In case of this model, the policy response from RBI seems to be largely conducted through the monetary aggregates (noting the significant and larger coefficient values for bm and s). The role of policy interest rate (measured by the call rate, RBI's key policy rate) remains relevant as denoted by the negative sign of the coefficient though the overall magnitude of the impact is around 0.01 percent (i.e. 1 percent increase in the call rate affects the real GDP growth by 0.01 percent, which is large in terms of volume impact).

TABLE 3.3: OUTPUT GAP RESULTS FOR INDIA

	Equation 3.24 -3.25 (OG_1)		**Equation 3.26 -3.27 (OG_2)**	
	β	**(z-stat)**	β	**(z-stat)**
bm	0.0562**	(3.23)	...	...
s	0.0331***	(4.25)	...	...
pr	-0.0133***	(-3.42)	-0.0133^	(-1.72)
er	-0.00790	(-0.45)	0.00320	(0.26)
inf_gap	0.00195***	(61.15)	0.000762	(1.21)
M2	...	...	0.199^	(1.88)
Credit	...	...	0.160*	(-2.16)
Constant	0.00335	(1.17)	-0.00779	(-1.11)
	lnsig2v (σ_v^2)			
Constant	-41.32***	(-520.26)	-9.362***	(-38.01)
	lnsig2u (σ_u^2)			
	δ	**(z-stat)**	δ	**(z-stat)**
SPI	-1.446**	(-3.12)	-2.112*	(-2.16)
FI	-1.798	(-1.10)	10.23	(0.33)
Spread	0.319	(1.18)	-0.946	(-1.53)
Credit	1.627^	(1.77)	...	...
Constant	3.744	(0.56)	3.706	(0.60)
T (1997Q1-2013Q3)	66	66	66	66

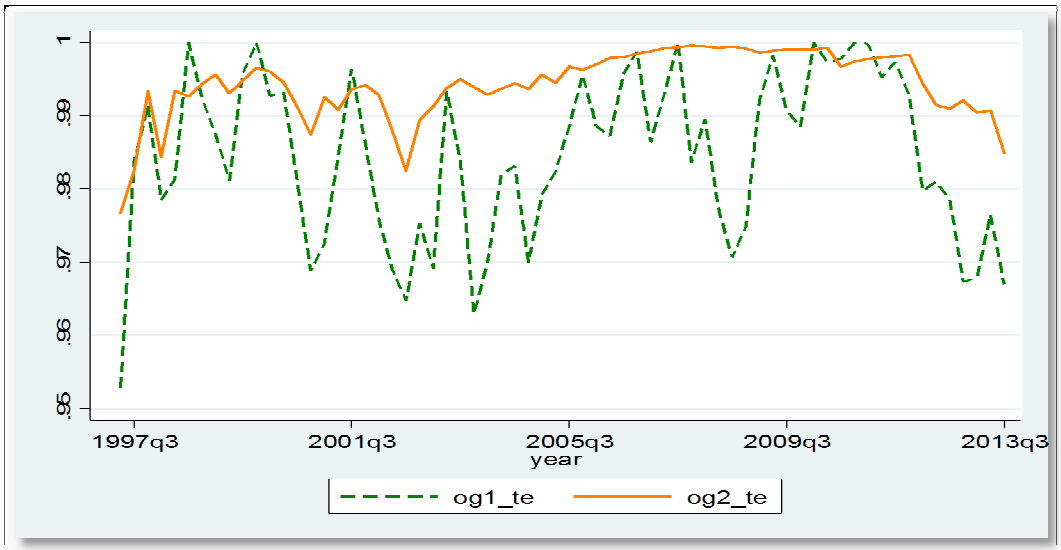
^ p<0.10 * p<0.05 ** p<0.01 *** p<0.001

Furthermore, the inflation gap seems to positively influence the output gap mirroring the theoretical correlation between the output and inflation gaps. The overall impact of policy variables (bm, s, pr) seems to be very potent in the management of output gap, as the combined effect of these policy variables is around +0.08 percent, thus a 1 percent respective decrease in these variables would decrease the output gap by 0.08 percent. Simultaneously, an increase in these by 1 percent will have the opposite impact.

The inefficiency equation (Eq. 3.25) shows an effective role of prices in decreasing the level of inefficiencies, while *Credit* (i.e. domestic credit) increases the inefficiencies. Overall, the time varying efficiency estimates (see *OG1_te* in Figure 3.5) show an average of around 98 percent in narrowing the gap between the current and the trend level of real GDP for India.

In the alternative or modified equation (of Eq. 3.30-3.31), only *M2, Credit* and policy interest rate (pr) are significant. As illustrated in Table 3.3, the coefficient for pr is unchanged from the previous estimation (Eq. 3.24), while the combined impact of policy variables ($M2, Credit, pr$) as a result of an increase by one percent in these respective variables is around +0.4 percent, considerably higher than the +0.08 percent estimated in the previous equation (Eq. 3.24). This is indicative of the fact that *M2* and *Credit* are better intermediate instruments in influencing the output gap in India than the money base and composite of central bank assets and liabilities. Nevertheless, a general conclusion drawn for these estimates is that monetary aggregates tend to be more effective in influencing output gap than policy interest rate. This is supported by the higher time varying efficiency estimates of over 95 percent (see *OG2_te* in Figure 3.5), with stock prices facilitating this by reducing the inefficiencies in the transmission mechanism.

FIGURE 3.5: INDIA – TIME VARYING EFFICIENCY OF OUTPUT GAP



3.4.2.2.3 INDIA: INFLATION GAP EQUATION RESULTS & DISCUSSION

Table 3.4 and Figure 3.6 provide the estimates of the inflation gap analysis for India. The initial equation (Eq. 3.24-3.25) indicate only effective reserves ratio (er) as only significant policy variable in managing inflation gap. The alternate estimation (Eq. 3.26-3.27) with $M2$ and $Credit$, also identify er along with $M2$ and $Credit$ as other policy tools to influence the inflation gap. The expected signs of the policy variables (i.e. of statistically significant variables) point towards a relatively robust approach to responding to inflation gap, a -3.2 percent impact on inflation due to a percent increase in the effective reserve ratio (Eq. 3.24) and a combined impact of around -6.6 percent of policy variables (er, $M2$ and $Credit$) due to one percent decrease in these respective variables (Eq. 3.26).

However, these results point to a monetary aggregate based policy response as policy interest rate is found to be insignificant and the relationship between er, $M2$ and $Credit$ in influencing the inflation gap is quite robust. These results are supported by the strong empirical relationship between monetary aggregates as presented in a recent study conducted by the RBI (see Ramachandran, 2010[87]), where divisia monetary indices derived from more micro-founded money models are considered as leading indicators and a good predictor of inflation in India. It also tied well with RBI's multiple indicator approach.

The results appear similar to those obtained for the inflation gap in China (in the previous sub-section), which shows a relatively robust monetary aggregate based policy response to inflation gap but the overall efficiency in the achieving the target is relatively low, supported by the positive contribution of *FI* and *Spread* in the inefficiency equation. Thus, the estimated time varying efficiency estimates (in Figure 3.6) depict considerable volatility in efficiency with respect to inflation gap for India (similar to China's results on inflation gap).

A recent article by the Financial Times[88] notes the willingness of the current RBI Governor Raghuram Rajan to introduce inflation targeting, particularly to respond to sharp volatility in prices and improve the RBI's ability to effectively rein-in inflationary pressures within a reasonable band. This has also been proposed by the recent special expert panel (RBI, 2014) and is currently being deliberated upon by the Finance Ministry and RBI.

India's effectiveness in improving the efficiency in controlling the inflation gap will ultimately depend on managing internal (largely for food price[89]) and external shocks (led by energy prices), reducing infrastructure bottlenecks, and limiting sudden bursts in government spending which drive the gusts of wage-price spirals in the economy. Furthermore, in the past two decades it is

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[87] http://www.rbi.org.in/scripts/BS_PressReleaseDisplay.aspx?prid=22576
[88] http://www.ft.com/cms/s/0/f0256d5c-8506-11e3-a793-00144feab7de.html#axzz3A8wRIAOz
[89] http://www.reuters.com/article/2013/12/26/us-india-economy-inflation-idUSBRE9BP0HG20131226

clearly evident that RBI's monetary policy response has also focused on adjustment of monetary aggregate in order to respond to capital flows and/or exchange rate volatility, which may not necessary augur well for controlling inflation in India[90].

Hence, this explains the volatile and low efficiency with respect to inflation gap as shown by the estimated models for India (see Figure 3.6), despite the strong correlation between monetary aggregates and inflation depicted by the estimated coefficient in Table 3.4.

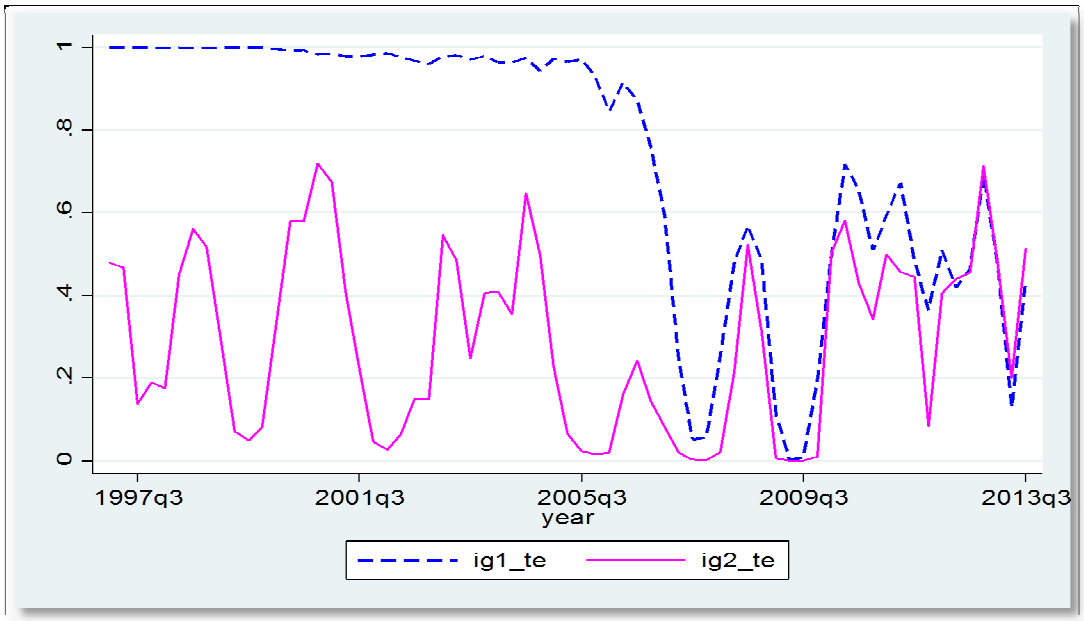
TABLE 3.4: INFLATION GAP RESULTS FOR INDIA

	Equation 3.24 -3.25 (OG_1)		**Equation 3.26 -3.27 (OG_2)**	
	β	**(z-stat)**	β	**(z-stat)**
bm	1.065	(1.72)	...	...
s	2.490	(1.54)	...	...
pr	0.105	(0.85)	0.117	(0.71)
er	-3.344*	(-2.13)	-2.319*	(-2.05)
output_gap	12.47	(0.63)	2.461	(0.16)
M2	...	...	5.771***	(5.16)
Credit	...	...	3.104***	(3.98)
Constant	1.255	(0.20)	-41.67***	(-4.80)
	lnsig2v (σ_v^2)			
Constant	0.932***	(4.74)	-0.105	(-0.12)
	lnsig2u (σ_u^2)			
	δ	**(z-stat)**	δ	**(z-stat)**
SPI	0.656	(0.27)	0.643	(1.42)
FI	15.12*	(1.98)	-0.263	(-0.36)
Spread	-0.406	(-0.46)	0.546**	(3.24)
Credit	-3.878	(-1.31)	...	...
Constant	-88.52*	(-2.10)	-2.135	(-0.49)
T (1997Q1-2013Q3)	66	66	66	66

^ p<0.10 * p<0.05 ** p<0.01 *** p<0.001

FIGURE 3.6: INDIA – TIME VARYING EFFICIENCY OF INFLATION GAP

[90] http://www.ft.com/cms/s/0/f0256d5c-8506-11e3-a793-00144feab7de.html#axzz3A8wRIAOz



3.4.3 GMM ESTIMATES OF THE POLICY PARAMETER AND MONETARY POLICY PERFORMANCE

3.4.3.1 GMM ESTIMATE OF POLICY PREFERENCE PARAMETER

As discussed in sub-sections 3.3.4 and 3.3.5, this section utilises the model developed by Cecchetti et al. (2006) to analyse monetary policy performance and efficiency. However, the first step is to compute an estimate for the policymaker's or central bank's preference parameter as highlighted it the seminal paper of Cecchetti et al. (2006). Therefore, based on the improvements in the empirical method identified in sub-section 3.3.5, the Generalised Methods of Moments (GMM) techniques applied the Eq. 3.40.

The interest rate smoothing aspect of the Taylor rule (in Eq. 3.40) has been ignored largely on the merit that the paper is specifically interested in the policy preference parameters with respect to inflation and output gap, and not with the monetary policy inertia. A detail discussion of monetary policy inertia is provided in Rudebusch (2002 & 2006). Generally, this omission of interest rate smoothing does not have a significant impact of the estimation of policy preference parameters as discussed in Clarida et al. (1998), Boivin (2006) and English et al.; (2003) and neither has this been accounted for in the estimation of policy preference parameters obtained by Cecchetti et al. (2010) for the 24 countries and Krause (2004) for European economies.

Based on the specifications of the model, as in Clarida et al. (1998) we generate an explicit target rate of output, y^*, and inflation, x^*, by employing the HP filter to extract the trend for seasonally adjusted real GDP and inflation rate. The instrument set which set the orthogonality condition for the GMM estimator includes 1 to 6 lags of year-on-year percent change in commodity price index (from IMF's IFS database), M2 growth rate, credit growth rate and the spread between the lending and deposit rate, as well as, 1 to 3 lags of the policy interest rate; and inflation and output gaps.

In addition, assuming an unknown form of heteroskedacticity and autocorrelation in the sample, the estimation is carried out using the Heteroskedacticity and Autocorrelation Consistent (HAC) weighting matrix for the GMM estimation of Eq. 3.40. As with previous studies on Taylor rules and application of GMM [see Clarida et al. (1998 & 2000), Orphanides (2001, 2002 & 2004), Rudebusch (2002 & 2006) and Jondeau et al. (2004)], policy interest rates, inflation gapand output gap are assumed to be stationary[91].

TABLE 3.5: GMM ESTIMATES OF POLICY PREFERENCE FOR CHINA AND INDIA

CHINA

$r_t^* = r^* + \lambda\left[E\left(\pi_{t,k}\middle|\Omega_t\right) - \pi^*\right] + (1-\lambda)\left[E\left(y_{t,k}\middle|\Omega_t\right) - y^*\right]$

Instrument specification: 1 to 6 lags percent change commodity price index, M2 growth rate, Interest rate Spread and 1 to 3 lags of policy interest rate, inflation gap and output gap

Dependent: Policy Interest Rate	Coefficient	Std. Error	t-statistic	Prob.
r^*	3.1546	0.0180	174.88	0.000***
λ	0.0811	0.0054	14.95	0.000***
Prob. (J-statistic) = 0.4413				***p<0.001

INDIA

$r_t^* = r^* + \lambda\left[E\left(\pi_{t,k}\middle|\Omega_t\right) - \pi^*\right] + (1-\lambda)\left[E\left(y_{t,k}\middle|\Omega_t\right) - y^*\right]$

Instrument specification: 1 to 6 lags percent change commodity price index, M2 growth rate, Interest rate Spread and 1 to 3 lags of policy interest rate, inflation gap and output gap

Dependent: Call Rate	Coefficient	Std. Error	t-statistic	Prob.
r^*	6.6646	0.1730	38.52	0.000***
λ	0.3023	0.0896	3.38	0.001**
Prob. (J-statistic) = 0.1460				**p<0.01 ; ***p<0.001

The GMM estimates for China and India are presented in Table 3.5. Estimates for both countries point towards a lower policy preference for managing inflation gap than output gap. This is more pronounced for China, where λ is just around 8 percent, therefore policy weighting for managing

[91] Numerous studies employing the Taylor rule have used this assumption due the low power of the conventional unit root test (such as, as the Augmented Dickey-Fuller test) and multiple breaks in the policy interest rate variables.

output gap is around 92 percent. This corresponds to the result obtained under SFA which illustrates a high efficiency with respect to output gap management as opposed to inflation gap which had a highly volatile efficiency, averaging around 30 percent. The policy preference reflects the strong focus of the PBC on growth and stability of output (or Real GDP), hence the strong reflection on these stylised policy facts in the results obtained in this paper.

The estimates for India also exhibit a lower λ, indicating a policy weighting to inflation gap at around 30 percent compared to a 70 percent weighting to output gap. The GMM estimates for India's policy preference is also consistent with the SFA efficiency analysis in the previous section and the focus of policy on output stabilisation and growth rather than inflation in the Indian case.

The standard post-estimation diagnostic for any GMM model is the Hansen's J-test statistic to check whether the instruments used in the model really satisfy the orthogonality condition — that is, whether the instruments are uncorrelated with the errors. The GMM estimates for China and India presented in Table 3.5, Hansen's *J* statistic p-values are more than Chi-square critical value probability of 0.1 (i.e. around 0.44 for China and 0.15 for India compared to the critical value probability), which indicates the validity of orthogonality condition of instruments used in these country estimates.

3.4.3.2 ACCOUNTING FOR MONETARY POLICY PERFORMANCE & EFFICIENCY

In this section, we utilise the accounting measures proposed by Cecchetti et al. (2000) and Krause (2004) to outline the improved macroeconomic performance and efficiency of monetary policy. To estimate some of these accounting or indicator measures as highlighted in sub-section 3.3.4, the data for China and India is divided into two samples, i) Sample 1 from 1999Q1 to 2005Q4 for China and 1997Q1 to 2005Q4 for India; and ii) Sample 2 from 2006Q1 to 2013Q3 for both China and India.

However, the policy parameter is only estimated for the full data set and assumed to be same over the two samples. The two samples are relatively small to generate any asymptotically significant results using the GMM estimator, noting that for each sample, six data points are lost due to the specification for orthogonal instruments. Hence, the policy parameter remains unchanged across samples. This approach (i.e. using the same policy parameter) also assists in isolating the impact of changing inflation and output gap variances on the macroeconomic performance and efficiency estimates across samples.

The measures of macroeconomic performance and efficiency accounting for China and India are presented in Table 3.6 and Table 3.7, respectively. The dynamic accounting analysis for China (based on the split sample ratios) shows an overall increase in the macroeconomic policy performance loss (of 23 percent) and monetary policy inefficiency (of 26 percent), translating into a decrease in overall monetary policy efficiency (weighted by macroeconomic performance) by around 113 percent. Some of the key factors that explain these results are: i) the high impact of supply shock variability on inflation, which mostly drives the monetary policy inefficiency between E_1 and E_2; and ii) relatively high macroeconomic performance loss with respect to inflation rate experienced in China.

TABLE 3.6: MONETARY POLICY PERFORMANCE AND EFFICIENCY IN CHINA AND INDIA

CHINA

Macroeconomic Performance $P_i = \lambda[Var(\pi_i)] + (1-\lambda)[Var(y_i)]$	**P**	$\boldsymbol{\lambda}$	$\boldsymbol{\sigma_\pi}$	$\boldsymbol{\lambda(\sigma_\pi^2)}$	$\boldsymbol{\sigma_y}$	$\boldsymbol{(1-\lambda)(\sigma_y^2)}$
Sample 1 (1999q1-2005q4) $- P_1$	0.2838	0.0811	1.7687	0.2536	0.1814	0.0302
Sample 2 (2006q1-2013q3) $- P_2$	0.5154	0.0811	2.4159	0.4731	0.2145	0.0423
Change in Macro Performance $(P_1 - P_2)$	**-0.2316**			**-0.2195**		**-0.0120**
Supply Shock $S_i = \lambda[Var(\pi_i)^*] + (1-\lambda)[Var(y_i)^*]$	**S**	$\boldsymbol{\lambda}$	$\boldsymbol{\sigma_{\pi*}}$	$\boldsymbol{\lambda(\sigma_{\pi*}^2)}$	$\boldsymbol{\sigma_{y*}}$	$\boldsymbol{(1-\lambda)(\sigma_{y*}^2)}$
Sample 1 (1999q1-2005q4) $- S_1$	0.1013	0.0811	0.9212	0.0688	0.1881	0.0325
Sample 2 (2006q1-2013q3) $- S_2$	0.0467	0.0811	0.1813	0.0027	0.2188	0.0440
Variability of Supply Shock $(S_1 - S_2)$	**0.0547**			**0.0661**		**-0.0115**
Monetary Policy Inefficiency $E_i = \lambda[Var(\pi_i) - Var(\pi_i)^*] + (1-\lambda)[Var(y_i) - Var(y_i)^*]$	**E**	$\boldsymbol{\lambda}$	$\boldsymbol{\sigma_{\pi-\pi*}}$	$\boldsymbol{\lambda(\sigma_{\pi-\pi*}^2)}$	$\boldsymbol{\sigma_{y-y*}}$	$\boldsymbol{(1-\lambda)(\sigma_{y-y*}^2)}$
Sample 1 (1999q1-2005q4) $- E_1$	0.1859	0.0811	1.5139	0.1858	0.0130	0.0002
Sample 2 (2006q1-2013q3) $- E_2$	0.4474	0.0811	2.3489	0.4472	0.0125	0.0001
Change in Policy Efficiency $(E_1 - E_2)$	**-0.2615**			**-0.2615**		**0.0000**
Improved Monetary Policy Efficiency (if Q is $+ve$)	$\boldsymbol{Q}$		$\boldsymbol{Q_\pi}$		$\boldsymbol{Q_y}$	
$Q = \Delta E / \lvert\Delta P\rvert$	**-1.1291**		**-1.1911**		**0.0010**	

INDIA

Macroeconomic Performance $P_i = \lambda[Var(\pi_i)] + (1-\lambda)[Var(y_i)]$	**P**	$\boldsymbol{\lambda}$	$\boldsymbol{\sigma_\pi}$	$\boldsymbol{\lambda(\sigma_\pi^2)}$	$\boldsymbol{\sigma_y}$	$\boldsymbol{(1-\lambda)(\sigma_y^2)}$
Sample 1 (1999q1-2005q4) $- P_1$	0.8913	0.3023	1.7011	0.8749	0.1532	0.0164
Sample 2 (2006q1-2013q3) $- P_2$	2.2754	0.3023	2.7320	2.2565	0.1643	0.0188
Change in Macro Performance $(P_1 - P_2)$	**-1.3841**			**-1.3816**		**-0.0025**
Supply Shock $S_i = \lambda[Var(\pi_i)^*] + (1-\lambda)[Var(y_i)^*]$	**S**	$\boldsymbol{\lambda}$	$\boldsymbol{\sigma_{\pi*}}$	$\boldsymbol{\lambda(\sigma_{\pi*}^2)}$	$\boldsymbol{\sigma_{y*}}$	$\boldsymbol{(1-\lambda)(\sigma_{y*}^2)}$
Sample 1 (1999q1-2005q4) $- S_1$	0.0644	0.3023	0.3961	0.0474	0.1561	0.0170
Sample 2 (2006q1-2013q3) $- S_2$	0.2553	0.3023	0.8827	0.2356	0.1682	0.0197
Variability of Supply Shock $(S_1 - S_2)$	**-0.1909**			**-0.1882**		**-0.0027**
Monetary Policy Inefficiency $E_i = \lambda[Var(\pi_i) - Var(\pi_i)^*] + (1-\lambda)[Var(y_i) - Var(y_i)^*]$	**E**	$\boldsymbol{\lambda}$	$\boldsymbol{\sigma_{\pi-\pi*}}$	$\boldsymbol{\lambda(\sigma_{\pi-\pi*}^2)}$	$\boldsymbol{\sigma_{y-y*}}$	$\boldsymbol{(1-\lambda)(\sigma_{y-y*}^2)}$
Sample 1 (1999q1-2005q4) $- E_1$	0.8947	0.3023	1.7201	0.8946	0.0118	0.0001
Sample 2 (2006q1-2013q3) $- E_2$	1.9006	0.3023	2.5072	1.9005	0.0113	0.0001
Change in Policy Efficiency $(E_1 - E_2)$	**-1.0059**			**-1.0059**		**0.0000**
Improved Monetary Policy Efficiency (if Q is $+ve$)	$\boldsymbol{Q}$		$\boldsymbol{Q_\pi}$		$\boldsymbol{Q_y}$	
$Q = \Delta E / \lvert\Delta P\rvert$	**-0.7268**		**-0.7281**		**0.0030**	

In spite of these results, the inefficiency of monetary policy seems to be lower across the sample led by output gap. Although the findings from the stochastic frontier efficiency analysis and the GMM based indicator analysis are not directly comparable, the overall policy thrust is relatively same for China. As expected from the results derived under both scenarios, Q_y denotes an overall improvement in monetary policy with respect to output for China. On the hand, results for inflation (denoted by Q_π which primarily drives Q) is similar to the conclusions under the SFA efficiency analysis.

The overall macroeconomic weighted monetary policy efficiency results (Q) for India indicate an increase in inefficiency by around 73 percent across the selected samples, primarily influenced by the macroeconomic performance loss ($\lambda(\sigma_\pi^2)$ = 138 percent), variability of supply shock ($\lambda(\sigma_{\pi*}^2)$ = 19 percent) and monetary policy inefficiency ($\lambda(\sigma_{\pi-\pi*}^2)$ =100 percent) with respect to inflation. The weighted cumulative effects of these inefficiencies with respect to inflation presented in Q_π for India is around 73 percent (which drives weighted cumulative effects on India value for Q). Overall, the results on weighted cumulative effects with respect to output has been positive on Q . These conclusions based on the derived efficiency results for inflation and output here for India generally epitomize the stochastic frontier efficiency analysis for inflation and output in the previous sections.

Finally, to analyse the monetary policy efficiency for China and India, we plot the quadratic loss in inflation gap against the output gap weighted by their respective policy parameters. Figure 3.7 and Figure 3.7-3.8 illustrate the quarterly data points for the typical Taylor curve (see Eq. 3.37) in the first panel (on left) while the second panel (on right) outlines weighted loss in inflation and output by the total quadratic loss, the size of dots highlights higher weighted loss. These plots also support the SFA and GMM analyses, noting the high variance and quadratic losses in inflation gap (in case of weighted and unweighted data) compared to output gap. Except for some of the outliers (representative of the 1998 Asian Financial Crisis and 2007/2008 Global Financial Crisis), the variability in inflation (with variability of 0-2 percent for China and 0-4 percent for India) is significantly larger than output gap (of less than 0.0005 percent for both China and India). Likewise, the weighted quadratic losses for inflation gap are higher than output gap for China and India.

FIGURE 3.8: QUADRATIC LOSS PLOT - INFLATION AND OUTPUT FOR CHINA

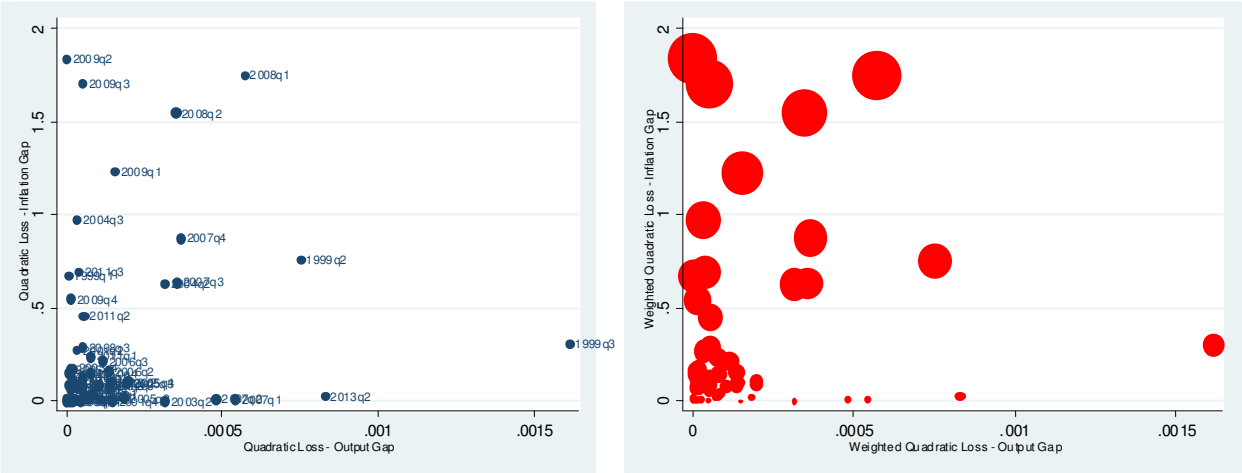
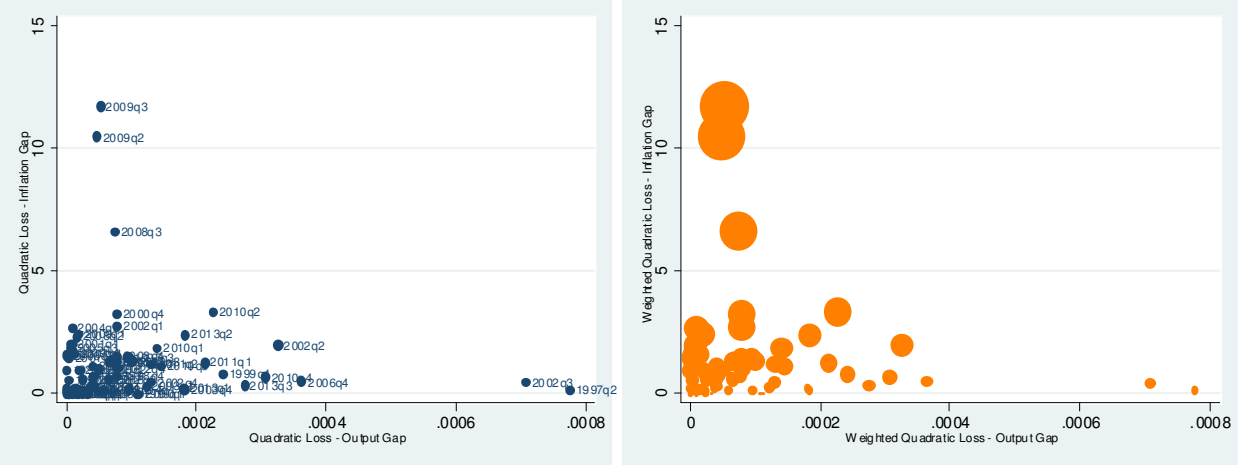


FIGURE 3.9: QUADRATIC LOSS PLOT - INFLATION AND OUTPUT FOR INDIA



3.5 CONCLUSION & POLICY IMPLICATIONS

This paper started with the simple objective of measuring monetary policy efficiency in two most important emerging economies, China and India. Utilising the basic framework Stochastic Frontier efficiency analysis of monetary policy provided by Li et al. (2010), the paper identifies specific theoretical gaps in the basic model of Li et al. (2010) and modifies these to align the theoretical model with existing theory and practice of monetary policy, with empirical applications to China and India.

Given that measuring monetary policy efficiency is not as straightforward as it seems, this paper also uses the empirical modelling techniques to account for macroeconomic performance weighted monetary policy efficiency used by Cecchetti et al. (2006) and Krause (2004). While key assessment indicators for performance and efficiency is adopted from the studies, this paper distinguishes the empirical techniques through direct estimates of policymaker preference parameters from Taylor rule using GMM instead of VAR approach. The GMM approach is better at dealing with expectation operator of independent variables and correcting for endogeneity basis by defining the orthogonal condition through a set of instrumental variables.

Stochastic frontier efficiency analyses for China and India indicate a high level of efficiency in management of output gap, which is clearly above 97 percent for China and above 95 percent for India, compared to inflation gap, which has an undulating trend averaging around 50 percent for China and ranging from 30 to 70 percent for India based on the defined equations. These results are mirrored by greater weighting of policymaker preference to output gap and according to our results, this is around 92 percent for China and around 70 percent for India, compared to inflation gap indicated by the GMM estimates of Taylor rule for both countries.

The dynamic accounting analyses of macroeconomic performance weighted monetary policy efficiency analyses for China and India (based on the split sample ratios) shows a decrease in overall monetary policy efficiency by around 113 and 73 percent, respectively. For both of these countries the overall decrease in efficiency under the Cecchetti et al. (2006) framework is primarily driven by the poor macroeconomic performance, variability of supply shocks and monetary policy inefficiency with respect to inflation. Overall, the macroeconomic performance weighted cumulative impact on efficiency with respect to output is positive, indicating a marginal improvement for both China and India, generally re-enforcing that both PBC and RBI have been better at controlling the fluctuations in output gap and keeping output closer to its potential level (along with the SFA results for output in these countries), thereby fulfilling their overall monetary policy mandate of output stability.

A key policy implication that can be deduced from this research is the need for greater focus on inflation while maintaining focus on output stabilisation and growth. Such a dual policy focus

will deliver better macroeconomic policy management and improve policy outcomes. In addition, the greater focus on inflation will enhance the role of monetary policy in taming inflation further. The current experience of both China and India (discussed in Section 3.4.2) attest to the challenge faced by the PBC and RBI in managing inflation pressures and changing inflationary expectations, largely attributed to the lack of explicit inflation targeting as the anchor for monetary policy. For instance, Sun (2014) highlights that PBC's current three pronged monetary policy regulation focuses on a mix of tools, including required reserves; open market operations such as repurchases, outright transaction in the secondary market and issuance of sterilised bonds or central bank bills; standing facilities such as the SLO and SLF; interest rate controls; window guidance and other administrative measures to manage i) aggregate liquidity; ii) guide economic re-structuring; iii) establish an interest rate corridor.

Notwithstanding, the role of direct policy instruments in managing inflation and output, placing greater emphasis on improving efficiency conduits in the economy are equally important, specifically promoting greater financial innovation and deepening of domestic financial markets will assist in improving the policymakers sphere of influence to achieve desired outcomes with respect to inflation and output, and providing appropriate policy signal to market and economic agents.

Finally, the thrust of this research is it's novelty in the use of suggested improvements to two key studies' [i.e. Li et al. (2010) and Cecchetti et al. (2006)] theoretical and empirical models to provide complementary and broad based analyses on quantitative estimates of monetary policy efficiency for China and India. This is probably the first research paper to provide broad-based empirical evidence on monetary policy efficiency analyses for China and India.

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APPENDIX 3.1 VARIABLE IDENTIFICATION

Variable (Indicator)	China (Quarterly from: 1999Q1 to 2013Q3)	India (Quarterly from: 1999Q1 to 2013Q3)
Nominal GDP	GDP at Factor Cost	GDP at Factor Cost
Real GDP	GDP at Factor Cost divided by the GDP Deflator and multiplied with 100 to derive the RGDP data	GDP at Factor Cost divided by the GDP Deflator and multiplied with 100 to derive the RGDP data
Inflation	Year-on-Year percent change in Consumer Price Index	Year-on-Year percent change in Consumer Price Index
GDP Deflator	GDP Deflator (as provided in IFS)	GDP Deflator (as provided in IFS)
GDP Gap	Calculated using HP Filter (current RGDP (seasonally adjusted using Census X-12) less calculated RGDP HP-Trend)	Calculated using HP Filter (current RGDP (seasonally adjusted using Census X-12) less calculated RGDP HP-Trend)
Inflation Gap	Calculated using HP Filter (current Inflation (seasonally adjusted) less calculated Inflation HP-Trend)	Calculated using HP Filter (current Inflation (seasonally adjusted) less calculated Inflation HP-Trend)
Central Bank Policy Interest Rate	PBC Policy Rate (as provided in IFS)	RBI Policy Rate (Call rate from the RBI database)
Money Base	M0 (IFS)	M0 (IFS)
Broad Money (M2)	Quasi Money plus seasonally adjusted Narrow Money	Quasi Money plus seasonally adjusted Narrow Money
Market Interest Rate	Market Rates (as provided in IFS)	Market Rates (as provided in IFS)
Deposit Interest Rates	Deposit Rate (as provided in IFS)	Deposit Rate (as provided in IFS)
Lending Rate	Lending Rate (as provided in IFS)	Lending Rate (as provided in IFS)
Stock Price Index	Country's key Share Price Index (as provided in IFS)	Country's key Share Price Index (as provided in IFS)
S	Calculated as the Monetary Authority's Foreign Assets over Total Liabilities plus Monetary Authority's Bond Liabilities divided by total Liabilities	Calculated as the Monetary Authority's Foreign Assets over Total Liabilities plus Monetary Authority's Bond Liabilities divided by total Liabilities
FI	Broad Money divided by Money Base (M2/M0)	Broad Money divided by Money Base (M2/M0)
Credit	Domestic Credit by Deposit Money Banks divided by Nominal GDP	Domestic Credit by Deposit Money Banks divided by Nominal GDP
Effective Reserve Ratio	Commercial Banks total reserves with the Central Bank over Commercial Bank's total assets (all data sourced from IFS)	Commercial Banks total reserves with the Central Bank over Commercial Bank's total assets (all data sourced from IFS)

CHAPTER FOUR

ESTIMATING TIME VARYING NEUTRAL INTEREST RATE FOR CHINA AND INDIA

ABSTRACT

This paper estimates the time-varying neutral interest rates using quarterly data for China (1999:Q1-2013:Q3) and India (1997:Q1-2013:Q3) using semi-structural models built on the Taylor Rule (Taylor 1993) – Dynamic and Augmented Taylor Rules – supplemented by similar estimates of neutral interest rates using the common stochastic trends (with and without interest parity conditions) and pure statistical filters (HP, CF and Kalman filter) to determine the underlying trend as proxy for neutral interest rates. We also apply a two-sided varying coefficient estimator based on Generalized Methods of Moment, which yields time-varying neutral interest rates as low as just below 2% to just over 6% for China, while time-varying neutral interest rates has fluctuated from 4% to 10% in India. Overall, we find that output gap, inflation gap and inflationary expectation contemporaneously and negatively relate to a tightening real monetary policy stance and vice versa. This proves that the estimated time-varying neutral rates have provided quite reasonable indicator for assessing monetary policy stance against its objectives and supports the case for prudent response of monetary policy to achieve its objectives in China and India.

4.1 INTRODUCTION

What is the right level of interest rates for emerging economies, like China and India? This is pertinent question for emerging economies, that have undergone rapid structural changes overtime. The determination of the appropriate interest rates in emerging economies can be a daunting task in economic policy implementation and management. It is something similar to pinning down a changing target. Such randomness in target interest rate can create significant degree of uncertainty for policymakers and can be difficult to deal with. Interest rates are crucial element in setting prices and returns for almost every economic asset and investment. For instance, interest rates determine exchange rate movements (including currency swaps), savings, credit and investment return rates in the economy, amongst others. Thus, policy interest rate is a key policy tool to manage and stimulate economic output.

The benchmark (or so called 'policy') interest rates are set by the central banks (or designated monetary authority with legislative power) in any economy. The policy interest rate are then utilised by the banking sector to price financial assets and returns, which is then transmitted to other economic sectors and agents in varied forms. For example, retails interest rate set by the commercial banks (that is, based on the policy interest rate set by the central bank) determines the cost of borrowing by the public and private sector, which in turn affects the pricing of similar financial products and services to recover cost of borrowing[92] and generate an adequate return on their investment and envisaged risk. Such is the impact of monetary policy stance on the economy. However, to determine the appropriate monetary policy stance with respect to interest rate in the economy it is important, that central banks have a good idea of their neutral (or natural) interest rates.

Generally, neutral interest rate is defined as an equilibrium monetary policy stance. In his influential work, Wicksell (1898)[93], characterises neutral interest rates as the real interest rate that yields price stability and thus equates the aggregate demand to potential output, which means that the output gap[94] is zero. Theoretically, this may sound simple and easy to determine, however the complexities are far greater than expected in practice. This is largely attributed to the fact that neutral interest rate is: (1) not a observable variable, thus has to be empirically estimated; (2) there is no reliable way to estimate it, as different assumptions and empirical models can yield different estimates; and (3) with the changing structure of the economy, neutral interest rates also change, that is, they exhibit a dynamic behaviour. The implications of market

[92] Borrowing for the inter-bank market and/or from the Central Bank.
[93] Cited in Woodford (2003) and Blanchard and Gali (2007).
[94] Output gap is quantitatively measured by the difference between the current and potential GDP.

interest over or below the neutral interest rate can either restrict or stimulate the economy, respectively.

Whilst complexities in the empirical estimation exists, appropriate estimates of neutral interest rate for emerging economies, like China and India, can provide significant policy insights, improvements and/or appropriate evaluation of the conduct of monetary policy and hence the management of the economy. In emerging markets, like China and India, central banks have adopted more indirect form of monetary policy conduct primarily based on the interest rates as policy indicator[95]. Therefore, appropriateness of monetary policy stance also depends on the "neutral policy interest rate" stance to implement effective interest rate increases or decreases so as to efficiently influence financial markets, credit and capital costs and returns. However, a dominant feature of emerging market's monetary policy neutral stance is that it is subject to dynamic behaviour based on a number of factors. In large part, rapid structural changes in emerging economies, like China and India, drives the underlying changes in neutral interest rates. This is also contingent on the savings-investment patterns and domino effects of global[96] or dominant trading partners' monetary policy stance.

Limited attention has been placed on the estimates for neutral (or natural) interest rates in China and India, especially time varying neutral interest rates. Recent studies [see Andres et. al., 2009; Basdevant et. al., 2004; Bernharden & Gerdrup, 2007; Djoudad et. al., 2004; Lam & Tkacz, 2004; Manrique & Marques, 2004, amongst others] have focused on the estimates of neutral interest rates for developed economies. On the other hand, literature on the emerging market economies is largely concentrated on the Latin American economies [for instance refer to: Ogunc & Batmaz, 2011 (Turkey); Magud & Tsounta, 2012 (on 10 Latin American countries); Pereda, 2010 (on Peru); Perrelli, 2012 and Perrelli & Roache, 2014 (on Brazil); Portugal & Barcellos, 2009 (on Brazil); Rossini & Rodriquez, 2011 (on Peru)]. Other studies have also focused on the Eastern European economies [Baksa et. al., 2013 (on Hungry); Horváth, 2009 (on Czech Republic)]. Perrelli & Roache (2014), using statistical filters find neutral interest rates ranging from 2.8% to 4.3% for China and -2.9% to 0.3% for India.

Thus, scant literature is present on China and India, which focus on estimating the neutral interest rates. Most studies are dedicated to estimating fixed coefficient Taylor rule and invariably identify the constant as neutral interest rates. While such estimates do provide some direction on the magnitude of the neutral interest rates, they ignore its time varying dynamics and

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[95] Note that both PRC and RBI set policy interest rates for the economy, which is used with a combination of other direct (and indirect) monetary policy instruments like the cash reserve ratio. All these instruments combine to deliver a comprehensive monetary policy management tool.

[96] For instance, the impact of the developed countries' Quantitative Easing (QE) on emerging economies and their financial markets. The advent of modern banking systems coupled with gradual liberalisation of domestic financial markets in emerging economies have seen significant leveraging of financing from developed markets to emerging economies.

effects of the change structure of the economy. Consequently, this research contributes to this policy space by estimating time varying neutral interest rates for China and India. From a policy perspective, understanding the dynamics of the neutral interest can tremendously help in the forward guidance of monetary policy if needed to do so, especially, in period of financial distress or crisis as in the case of developed countries (see Svensson, 2014). Nevertheless, forward guidance also helps in setting the interest rate path and adds some certainty to economic and financial decisions, as elaborated in the experience of New Zealand, Sweden and Norway (Svensson, 2014)

We utilise numerous methods (using statistical filters and semi-structural models inspired by the literature on other emerging markets, like Brazil) to estimate neutral interest rates in China and India. Applying a two-sided Generalised Methods of Moment based varying coefficient estimator on structural models yields time-varying neutral interest rates as low as just below 2% to just over 6% for China, while time-varying neutral interest rates has fluctuated from 4% to 10% in India. Accordingly, computing nominal and real monetary policy stance for these two economies, to analyse monetary policy performance. Overall, we find that output gap, inflation gap and inflationary expectation contemporaneously and negatively relate to a tightening real monetary policy stance and vice versa. This proves that the estimated time-varying neutral rates have provided quite reasonable indicator for assessing monetary policy stance against its objectives and supports the case for prudent response of monetary policy to achieve its objectives in China and India.

Moving on, next section (4.2) discusses the critical role of neutral interest rates in monetary policy. Following this, section 4.3 outlines the estimation methodology, various models to be estimated and ensuing results. Section 4.4 & 4.5, discuss the policy implications and conclude the paper, respectively.

4.2 NEUTRAL INTEREST RATES: USEFULNESS FOR MONETARY POLICY

The central banks in China and India have increasingly relied on interest rates both as a source of information for determining policy and as operating instrument for conducting policy. The use of interest rate in executing monetary policy, amongst other tools, has been spurred by the breakdown of traditional relationships between the money and economic activity, due to the burgeoning innovations in payments system and transactions technologies, and increasing sophistication of Chinese and Indian financial markets. These innovation and complexities have driven the enhanced role of central banks in these countries, which determine the financial policy direction and drive the embedded price of future financial instruments (such as currency futures,

inflation-indexed debt, etc.). Another key aspect of interest rate importance is the term structure relationship between the short-term and long-term interest rates and its impact on the economy. In large part, interest rates act as information indicators for broader economy and pricing financial instruments.

Monetary policy in China and India conducted through the control of short-term interest rates determines the movement and magnitude (with some premium placed by financial agents) of inter-bank interest rates at which the banks and/or financial institutions borrow and lend overnight balances. This, in turn, influences retail interest rates offered by the banks and financial institutions. The absolute or nominal policy interest rate, however, offers limited gauge of stance of monetary policy, noting (1) the ignorance of supply and demand conditions in the product and credit market; and (2) lack of comparison with an equilibrium or policy neutral interest rates to gauge effectiveness monetary policy stance – that is – monetary policy typically should move towards a tightening cycle if the nominal policy rate is above the neutral rate and accommodative cycle if the nominal policy rate is below the policy neutral rate.

Therefore, identification and measurement of unobservable equilibrium rates of macroeconomic aggregates is an essential input in the formulation of policy recommendations. In terms of monetary policy, neutral (or natural) interest rate is an important operational benchmark for measuring the stance of monetary policy, more importantly, playing a pivotal role in some rules-based monetary policy regimes (as described by Pencelli & Roache, 2014; Laubach & Williams, 2003). A number of studies (such as, Barsky et. al., 2014; Basdevant et. al., 2004; Svensson, 2001) define neutral interest rate[97] as the interest rate consistent with actual output at its potential level and stable inflation. Furthermore, neutral interest rate is normally derived from the ex-ante nominal policy interest rate and is expected to be invariant to cycles and factors (as explained by Perrelli & Roache, 2014) that do not affect or change the long-term savings and investment pattern.

In the recent study, Barsky et. al.(2014) have also very clearly articulated the role of neutral interest rate and its usefulness for monetary policy making, especially in regards to the forward guidance of monetary policy stance. Based on the New Keynesian (NK) model presented in Gali (2008), Barsky et. al. (2014) note neutral interest rate yield price stability and equates savings and investment in the economy. Therefore, based on their derivation (based on Gali's (2008) NK model), they outline two critical results:

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[97] Achibald & Hunter (2001) outline that neutral interest rate can be thought of as short-to-medium or long-run concept.

1. that output gap is the sum of all future real interest rate gaps as:

$$\widetilde{y_t} = -s \sum_{k=0}^{\infty} E_t(r_{t+k} - r_{t+k}^n) \tag{4.1}$$

   where: $\widetilde{y_t}$ is the difference between the actual and natural output; s is the inter-temporal elasticity of substitution; r is ex-ante real interest rate (derived as nominal interest rate minus expected inflation: $i_t - E_t\pi_{t+1}$); and r^n is the neutral interest rate; and

2. closing the output gap, $\widetilde{y_t}$, also stabilises inflation based on the NK Phillips curve as:

$$\pi_t = \beta E_t[\pi_{t+1}] + k\tilde{y}_t \tag{4.2}$$

   where: π_t is the inflation rate; $E_t[\pi_{t+1}]$ is the expected inflation rate; β and k are the relevant discount factors.

Consistent with the literature, Barsky et. al. (2014) indicate that both the output gap and inflation are zero when the central bank follows an interest rate path in which the actual real interest rate is always equal to the natural rate. Based on their analyses, Barsky et. al. (2014) argues that neutral interest rate can be an implementable target for monetary policy[98]. Furthermore, they also note that neutral interest rate could be a useful *"summary statistic"* or measure of forward guidance for monetary policy to stabilise the output and inefficient gaps while also decreasing the variability of price and wage inflation.

4.3 Estimating Neutral (or Natural) Interest Rates

Discussion the various methods to estimate the neutral interest rates have been extensively discussed by Araujo & Silva (2014), while Giammarioli & Valla (2004) provide a good synopsis of different studies in estimating neutral interest rates based on various theories and empirical methods. Based on the literature, three methods are used to estimate the neutral interest rates: (1) Dynamic Stochastic General Equilibrium (DSGE) Model (or micro-founded New Keynesian Model largely based on the work of Woodford, 2003; Neiss & Nelson, 2003; Smets & Wouters, 2003) which estimates neutral interest rates based on the assumption of fully flexible prices in the economy; (2) Semi-Structural models based work of Laubach & Williams (2003) on macro-monetary models are used with time varying statistical models (such as Kalman Filter approach) to estimate neutral rates, which has been utilised as the primary empirical method in a number of

[98] This was contextualised to the U.S. Federal Reserve.

subsequent studies [such as Basdevant et. al. (2004), Bernharden & Gerdrup (2007), Garnier & Wilhelmsen (2005), Mesonnier & Renne (2007), Ogunc & Batmaz (2011), Magud & Tsounta (2012), Perrelli & Roache (2014)]; and (3) application of standard single series statistical filters to approximate underlying trend of relevant interest rate series.

Therefore, after reviewing the extensive literature on the empirical methods of estimation, we utilise a combination semi-structural models as outlined by Laubach & Williams, 2003; Basdevant et. al. (2004), Magud & Tsounta (2012) and Pencelli & Roache (2014). This semi-structural models based on Kalman estimation approach which considers the relationship between neutral interest rate and different macroeconomic variables based on economic theory, has been very popular in number of developed and developing countries, as outlined in Araujo & Silva, 2014.

In addition, Humala et. al. (2009) drawing on the conclusions of Larsen and Mckeown (2004), Mesonnier & Renne (2007) and Berger & Kempa (2014) outlines that semi-structural models represent a convenient compromise between the costly full-fledged macroeconomic DSGE modelling and class of agnostic time series based on purely statistical approach. Furthermore, Humala et. al. (2009) and Berger & Kempa (2014) outline that purely statistical de-trending procedures are unable to incorporate any information from economic theory, while DSGE models are explicitly designed to identify transitory deviations of macroeconomic variables from their respective natural rates, and are not suited to trace the dynamic evolution of the natural rates. Therefore, it is important to use time varying models that can account for the variation and evolving nature of neutral interest rates keeping in tandem with the changing economic fundamentals which influence it. Furthermore, Horváth (2009) adds that joint estimation of equilibrium rates in DSGE models reduces the degrees of freedom which may be undesirable for countries where the underlying economic structure is in transition and small samples. In the next subsections, we start by estimating statistical filters as a simple estimate neutral interest rates for comparison purposes and then identify the different variants of the semi-structural models and accordingly estimate neutral interest rate for China and India.

4.3.1 STATISTICAL FILTERS

A simple technique used to estimate the neutral interest rates has been the use of statistical filters. Giammarioli & Valla (2004) note that real neutral interest rate can be estimated by the deflating the nominal interest rates by a suitable measure of inflation or inflation expectation and then taking away the cyclical component. Formally, statistical filters are used to decompose a time series data (such as that of a nominal or real interest rate) into trend and cyclical components. While there are a number of statistical filters with different focus and properties, we utilise the widely used Hodrick-Prescott (1997) filter (and for robustness we also use Christiano–Fitzgerald (2003) filter) to estimate the underlying trend of the nominal interest rates in China

and India as simple approach to estimating the nominal neutral interest rate (similar to Perrelli & Roache, 2014; Magud & Tsounta; 2012 Basdevant et. al., 2004). We also estimate the neutral interest rate for China and India using the state-space filter approach, which presented as part of the results on the semi-structural models (for secondary comparison).

4.3.2 SEMI-STRUCTURAL MODELS

Following initial (atheoretical) estimates of the neutral interest rates using various statistical methods (or filters) and we move onto the semi-structural model estimation. The semi-structural models have been a very popular method applied in number of papers given its intuitive appeal. State Space (S-S) framework has been extensively used to estimate neutral interest rates as they are able to explicitly account for the existence of latent (unobservable) variables. While we use a combination of semi-structural models, we define the novelty of our research in the improved empirical methodology. Most of the semi-structural models typically use the one-sided Kalman (or Bucy) filter approach to estimate time varying neutral interest rates, which suffers from problems in appropriate estimation of variances and therefore affects the estimated results of the model (see Schlicht, 2003). Consequently, to address this issue and improve the empirical estimation model, we utilise a two-sided Varying Coefficients (VC[99]) model developed by Schlicht (2006; 2003; 1988; 1985) instead of the Kalman Filter. Schlicht (2006; 2003) shows that the VC Model of is statistically more efficient and numerically more transparent and straightforward in defining difference is the estimation of variances. Furthermore, the maximum-likelihood estimation for Kalman filtering does not yield better results for smaller samples, as is the case in our study – noting our use of quarterly figures for China and India which limits the size of the observations[100]. In contrast, the VC estimation technique uses a Generalised Methods of Moment (GMM) estimator, which works efficiently in smaller samples at the same time it is intuitively and asymptotically equivalent to the maximum-likelihood estimator. Generally, the such time varying models has been consistently used in estimation of forward-looking Taylor rule (or variants of it) to study of time-varying monetary policy reaction functions recently [see Baxa, Horváth & Vašíček, 2013; Horváth, 2009;Boivin, 2006).

The structural models utilised to study neutral interest rates in China and India are adopted from the literature on emerging markets in Latin America (see Magud & Tsounta, 2012; Perrelli & Roache, 2014, amongst others), noting the similarities and evolving structure of their economies. It is important note that similar models and techniques have been also employed to study small developed open economies, such as New Zealand (Basdevant et. al., 2004). Hence, the structural

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[99] The program offers a statistically superior alternative to Kalman-Bucy filtering, is easy to use, and freely available (see http://www.semverteilung.vwl.unimuenchen.de/mitarbeiter/es/linkpages/linkpage-vc-package.htm)

[100] Since GDP data is produced quarterly we have to use other data in quarterly frequency as well.

models utilised in this paper are presented and discussed in the following subsections. We primarily focus on short-term nominal neutral interest rate estimates compared to long-run nominal neutral interest rates. This is done for three specific reasons:

1) the focus of this paper is draw policy implications for Monetary Policy in China and India which is dependent upon estimates of short-term neutral interest rates vis-à-vis current short term policy rates;
2) apart from the short-term interest rate and inflation expectations, long-term interest rates are more susceptible to changes from other myriad factors (including country risk perception, specific-asset risk[101], term structure premium[102] depending relative length of a financial asset, financial market stress, etc.) which makes data collation and thus reasonable estimates of it very difficult and practically superfluous to use for monetary policy analysis – that is – to draw some directions of monetary policy which is anchored on short-term policy rates; and
3) data on the long-term interest rates and its determinants for China and India are very limited, as normally used in the literature for emerging markets based survey of studies (mentioned above), as such estimates require Credit Default Swap Spread, amongst other data, which is only available for a few years (making quarterly estimates very weak).

4.3.2.1 IMPLICIT COMMON STOCHASTIC TREND & PARITY CONDITION

Implicit Common Stochastic Trend: Following, Basdevant et al. (2004) and Magud & Tsounta (2012), a common stochastic trend of the short-term nominal interest rates is proposed as follows:

TABLE 4.1: IMPLICIT COMMON STOCHASTIC TREND

State Equations: $$r_t^s = r_t^* + E_t[\pi_{t+12}] + \varepsilon_t^1 \quad (4.3)$$

Transition Equations: $$r_t^* = r_{t-1}^* + u_t^1 \quad (4.4)$$

where r_t^s is the nominal short-term rate on return, alternative the discount rate of central banks, (i.e. weighted 90-day inter-bank rate and 90-day call money rate for China and India,

[101] For instance, corporate bonds have different risks compared to government bonds.

[102] The determinants of long-term interest rate, such as term premium, itself can be a topic for an economic investigation and paper (see Ang & Piazzesi, 2003; Ang, Bekaert & Wei, 2008; Dai & Singleton, 2000; Durham, 2006; Hördahl, Tristani & Vestin, 2006; Kim & Orphanides, 2005), hence, we only focus on the short-term interest rates in this study.

respectively). The proxy is used as the policy interest rate (or discount rate set by the Central bank) is not changed in continuous fashion, hence it is not only discrete but also censored. Therefore, majority of studies cited in literature (see Clarida et. al., 1998) rely on 90-day interbank rate as an approximation of the censored policy rate (Horváth, 2009). $E_t[\pi_{t+12}]$ expected inflation rate (i.e. 12 month ahead inflation rate), r_t^* is the neutral interest rate and its transition equation represented by (Eq. 4.4) is assumed to follow a random walk.

Implicit Common Stochastic Trend with Interest Parity and Sovereign Risk: Perrelli & Roache (2014) expand on the determination of common unobservable time neutral interest rate beyond the inflation expectations to include output gap ($\tilde{y}_t$) and interest parity conditions using the 3-month and yield on US treasury securities (i.e. $US3m_t$) – Table 2.

TABLE 4.2: IMPLICIT COMMON STOCHASTIC TREND WITH INTEREST PARITY AND SOVEREIGN RISK

State Equations: $$r_t^s = r_t^* + \pi_{t+1}^e + \tilde{y}_t + US3m_t + \varepsilon_t^2 \quad (4.5)$$

Transition Equations: $$r_t^* = r_{t-1}^* + u_t^2 \quad (4.6)$$

All other variables, definitions and assumption for disturbance terms remain the same as in Sub-Section 3.2.1 (above).

4.3.2.2 TAYLOR RULE

Moving to more structural based equations, we employ theoretical Taylor rules to study the evolving nature of neutral interest rates for China and India. As highlighted in Laubach & Williams (2003), Taylor rules have been popular in the study of monetary reactions functions and neutral interest rates. Thus, in the spirit of Basdevant et al. (2004) and Magud & Tsounta (2012), we define two forms of the Taylor rule to estimate the short-term nominal neutral interest rates:

Dynamic Taylor Rule: The dynamic Taylor rule specification outline a monetary policy interest rates which responds to deviation of (1) inflation, π_t, from set target of the central bank, π_t^*; and (2) real output from its potential, that is, the output gap, $\tilde{y}_t$.

TABLE 4. 3: DYNAMIC TAYLOR RULE

State Equations: $$r_t = r_t^* + \beta(\pi_t - \pi_t^*) + \gamma\tilde{y}_t + \upsilon_t^1 \quad (4.7)$$

Transition Equations: $$r_t^* = r_{t-1}^* + e_t^1 \quad (4.8)$$

The stochastic disturbances are assumed to be zero mean with constant variances, while the transition process is for the neutral interest rate is a random walk with a growth rate (denoted as, μ_{t-1}) of the state variable.

Expected-Inflation Augmented Taylor Rule: Another variant of the Taylor rule is used to study the robustness of the estimates by using an augmented Taylor rule which now includes inflation expectation, $E_t[\pi_{t+12}]$ in the dynamic Taylor rule equation defined above.

TABLE 3: DYNAMIC TAYLOR RULE

State Equations: $$r_t = r_t^* + E_t[\pi_{t+12}] + \beta(\pi_t - \pi_t^*) + \gamma(y_t - y_t^*) + \nu_t^1 \quad (4.9)$$

Transition Equations: $$r_t^* = r_{t-1}^* + e_t^1 \quad (4.10)$$

4.3.3 RESULTS FOR CHINA AND INDIA

4.3.3.1 DATA

All quarterly data for analyses is sourced from the CEIC database[103] and Bloomberg® for China and India.

For China we obtain quarterly data spanning from 1999:Q1 to 2014:Q3 for Short-term nominal neutral interest rates estimation. However, only data from 1999:Q1 to 2013:Q3 is used for estimation, given that we are using 12 month expected inflation against other explanatory variables. The 90-day weighted interbank offered rate is used as a proxy for short-term policy

[103] This is accessible through the ANU Library secured login.

interest rate (given the policy interest rates set Peoples' Bank of China has significant structural breaks and used as indicator to affect the operational target – that is – inter-bank interest rate), output gap is calculated as the current real GDP growth rate less the potential real GDP rate (which is generated using a HP filter) and inflation gap is estimated using quarterly year-on-year percent change of the consumer prices index less expected inflation (4 quarters ahead). In addition, the 3-month U.S. Treasury bill rate is used to estimate Equation 4.5.

In the case of India data from 1997:Q1 to 2014:Q3 is collated, however, utilised sample is up to 2013:Q3 to allow for the use of 12month ahead inflation rate, as expected inflation. The call money rate, is used as the short-term nominal policy interest rate, output and inflation gap is estimated in the similar fashion (as described above for China) with one notable difference – use of Wholesale Price Index (WPI) as the measure of inflation than consumer prices[104]. The 3-month U.S. Treasury bill rate is also used to estimate the common trend with parity for India (Eq. 4.5).

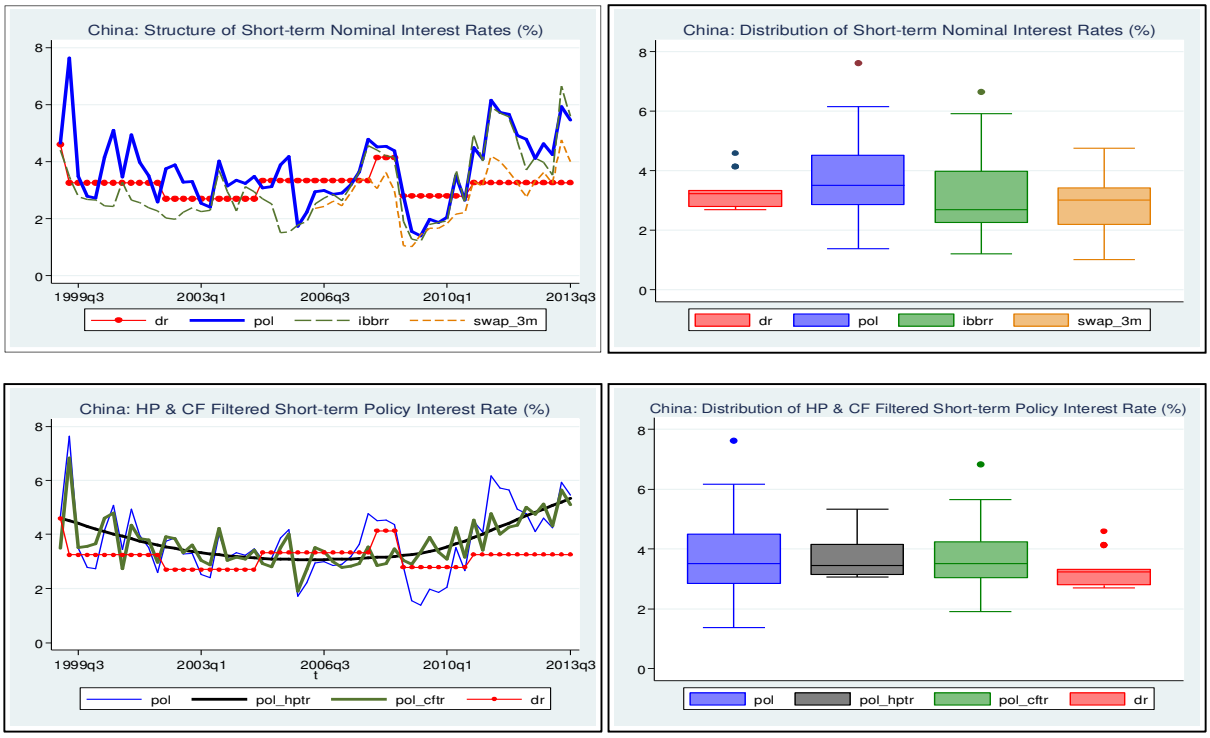
4.3.3.2 STRUCTURE OF INTEREST RATES & FILTERS

We start estimates of neutral interest rates by first outlining the structure of the interest rates in China and India. The structure of interest rate indicates the dynamics of key interest rates which can be important understanding economic correlation and headline policy inferences. Figures 4.1 & 4.2 illustrate the structure of nominal interest rates, that is, the relationship between the discount rate set by the Central Bank (dr) for China; repo (repor) and reverse repo (revrepor) rates for India[105]; money market rate or the key policy interest rate (pol); inter-bank market rates (3-month inter-bank bond rate (ibbrr for China) and 3-month currency-specific (i.e. for the Chinese RMB and Indian Rupee) swap interest rates (swap_3m), in China and India. The structure interest rates indicates a high correlation between policy and different market interest rates. In both countries the interest rates are relatively well anchored by the central bank discount rate and policy rate, proxied by the inter-bank weighted average rate.

[104] WPI is the monetary policy target of the Reserve Bank of India.

[105] Repo rate, also called the key short term lending rate with a 1-day maturity. If banks are short of funds they can borrow rupees from the Reserve Bank of India (RBI) at the repo rate. The reverse repo rate is the interest rate that banks receive if they deposit money with the central bank. This reverse repo rate is always lower than the repo rate.

FIGURE 4.1: CHINA – STRUCTURE & DISTRIBUTION OF SHORT-TERM NOMINAL INTEREST RATES AND HP & CF FILTER ESTIMATES

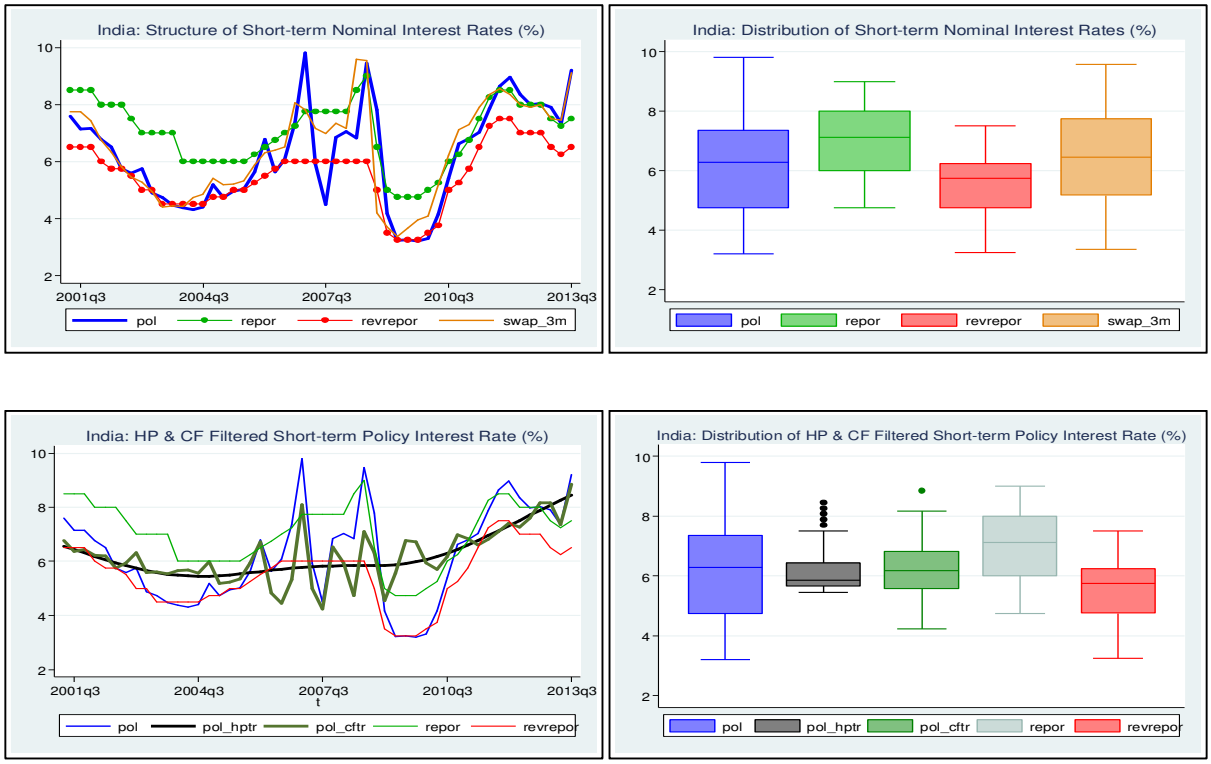


The HP and CF filters for China and India estimate the underlying trend (or the neutral interest rate) for the policy interest rate (pol). The trend based neutral interest for China indicates dip in the neutral interests during the mid-2000s, followed by a slight pick-up in late 2000s. On the hand the neutral interest rate (based on the underlying trend of pol) for India remained relatively stable until the 2008 before increasing by around 2 percent in 2009 to 2013. Numerically, the trend estimates of HP (CF) filter for:

1) China shows a mean value of 3.7% (3.7%) with standard deviation of +/- 1.0% (+/-0.9%) with 3.1% (1.9%) and 5.3% (6.8%) as the highest and lowest values, respectively; and

2) India shows a mean value of 6.2% (6.2%) with standard deviation of +/- 0.8% (+/- 1.0%) with 5.5% (4.2%) and 8.5% (8.9%) as the minimum and maximum values, respectively.

FIGURE 4.2: INDIA – STRUCTURE & DISTRIBUTION OF SHORT-TERM NOMINAL INTEREST RATES AND HP & CF FILTER ESTIMATES



4.3.3.3 IMPLICIT COMMON STOCHASTIC TREND & PARITY CONDITION AND TAYLOR RULE ESTIMATES

The results (see Figure 4.3 & 4.4) for time-varying short-term nominal neutral interest rates for the China and India are estimated in a state-space framework of Schlicht (2006; 2003; 1988; 1985) discussed in section 4.3.2 based on the structural models identified from literature and discussed in Eq. 4.3 to 4.10. In addition to these structural models, we also estimate state-space filtered nominal neutral interest rate to add robustness to our results.

FIGURE 4.3: CHINA - COMPARISON OF TIME-VARYING NEUTRAL INTEREST RATES (%)

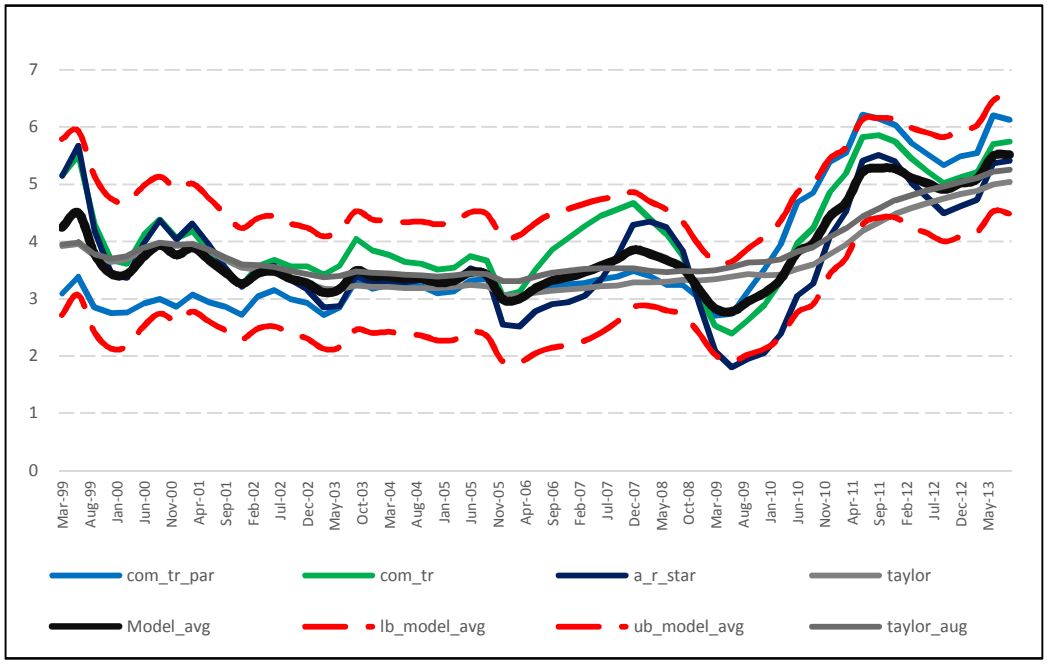
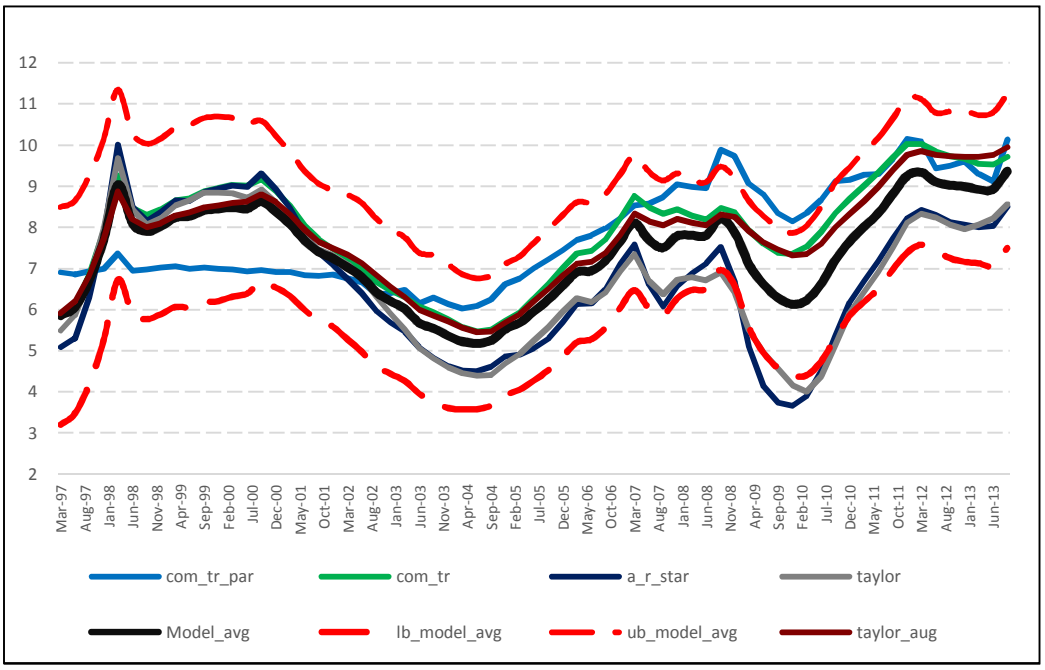


FIGURE 4.4: INDIA - COMPARISON OF TIME-VARYING NEUTRAL INTEREST RATES (%)



As described in Section 4.3.2.1, the structural models are based common trends (denoted as *com_tr*), common trends with interest rate parity condition (*com_tr_par*), taylor rule (*taylor*) and augmented Taylor rule (*taylor_aug*) supplemented by the trend estimated using the state space filter (*a_r_star*). Given that the results for each model is different due the different determinants to assess the time varying properties of the neutral interest rate, we estimate a simple model average of these estimated neutral interest rates to study average underlying time-varying neutral interest rate for China and India. The disaggregated results by specific model for China and India are presented in Appendix 4.1 – 4.2 (China) and Appendix 4.4 – 4.5 (India). Furthermore, we also analyse the numerical difference between the various nominal neutral interest rate models, presented in Appendix 4.3 & 4.6 for China and India. The calculated average differences between the neutral interest rates are at the maximum (+/-) 0.5% for China and (+/-) 1.2% for India.

For China, estimated time-varying neutral interest rates range from the as low as just below 2% (in late -2005 & mid-2009) to just over 6% (in mid-2013), as recorded by the simple average upper and lower confidence bands. Interestingly, neutral interest rates from the common stochastic trends and decomposed trend from state space framework exhibit relatively more volatility when compared to the theoretical rule based estimates of Taylor rule based models, which encompass a broader focus inflation and output gaps in addition to the inflationary expectations. However, all estimated neutral interest rates trended upwards in the final quartile of the sample period, consistent with the tightening bias stance of monetary policy in China given the follow-on effects of stimulus packages in the aftermath of the GFC to beef-up domestic demand. This contributed to the domestic demand led prices pressures in the form of higher consumer property rental and food prices, in particular[106].

In case of India, estimated time-varying neutral interest rates have fluctuated largely between 4%-10% and demonstrating a variable trend over time. Such mutable movements tend to reflect the changing underlying economic conditions that can provide insights in the design of appropriate monetary policy responses. In contrast to the results obtain for China, we find that for India that different common stochastic and Taylor rule-type models have very similar time—varying pattern. Nevertheless, the upward trend of neutral interest rates in the last quartile of the sample period is similar to China, noting the similar inflationary pressures experienced by India post-2009[107], which warranted a tightening monetary policy stance.

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[106] http://www.bloomberg.com/news/articles/2011-02-15/china-s-january-consumer-prices-increase-4-9-producer-prices-climb-6-6- & http://www.telegraph.co.uk/finance/economics/9794936/Food-price-rise-pushes-up-China-inflation.html

[107] http://www.economist.com/blogs/freeexchange/2011/01/indian_inflation & http://timesofindia.indiatimes.com/business/india-business/India-has-highest-inflation-rate-in-Asia/articleshow/27263603.cms

4.4 IMPLICATIONS FOR MONETARY POLICY (INTEREST RATE GAP ANALYSES)

As indicated earlier in this paper, neutral interest rates are an important indicator for stance of monetary policy and to study monetary policy responses. Hence, we expend on the results for China and India (in the previous section) to analyse the monetary policy stance over the sample period and coherently discuss the implications for monetary policy in China and India. As a first step to analyse monetary policy we compute the interest rate gap to ascertain the stance of monetary policy in these countries[108]. The monetary policy stance of China and India is then use to analyse the key monetary policy targets to assess whether the policy stance has been effective over time in achieving its objectives.

However, it is also vital to note here that there are many other unobservable variables that monetary policymakers in emerging markets take into account order to determine appropriate policy settings, for example, equilibrium real exchange rates, the responsiveness of exports to the exchange rate and financial stress in markets, etc. Moreover, central banks may not react to shocks which are sub-optimal, for instance, central banks may not react to cost-push inflationary shocks as such a policy reaction can destabilise the economy further.

Figure 4.5 & 4.8 outlines the stance of monetary policy in China and India using the Augmented Taylor rule estimates for nominal neutral interest rate. Augmented Taylor model provides a complete estimation of determinants that affect the central bank's policy setting and expectations, which is anchored in inflation and output gaps, as well as inflationary expectations. Furthermore, as argued by Taylor (1999), monetary policy rules provide a useful framework to evaluate monetary policy stance against its objectives.

We estimate both the nominal and real monetary policy stance to appropriately analyse the impact on key monetary policy objectives of inflation and output. The nominal monetary policy stance is computed as the proxy of monetary policy rate, that is, 90-day interbank rate, less the estimated nominal neutral (or so called 'equilibrium') interest rate obtained from the Augmented Taylor rule. As illustrated in the Figure 4.5 & 4.8, the nominal and real monetary policy stance depict similar movements in trend and difference between these is simple the inflation adjustment. Overall, the monetary policy stance (in nominal terms) has been generally expansionary (since computed nominal policy stance is mostly below zero), compared to the real monetary policy stance (which is largely positive).

[108] The gap between the current real interest rate and the neutral real interest rate can be thought of as a measure of the degree to which monetary policy is stimulating or contracting the economy.

Figure 4.6 & 4.9 assess the impact of monetary policy stance on output gap in these countries. A polynomial trend (of order 3) is added to sketch the directional responses of computed time-varying policy stance and to investigate any cause-effect relationship (or lead or lag effect). Similarly, Figure 4.7 & 4.10 outlines graphical analyses of monetary policy on the inflation gap and inflation expectations (with respective polynomial trend of order 3) in China and India, respectively.

In both countries, China and India, the real monetary policy stance and output gap show a contemporaneous cause-effect relationship. More specifically, tightening monetary policy seems to lower the output gap. Intuitively, real interest rate above their equilibrium (or neutral rate) will make consumption and investment more expensive as borrowing costs adjusted for inflation rises, which will contemporaneously lower real output (below its potential level), creating a negative output gap. This transmission channel of monetary policy shock is more pronounced for emerging economies, as China and India, noting strong dependence on business investment to propel domestic production for local consumptions and exports.

Analogously, in both China and India, the inflation gap and inflationary expectation seem to correspondingly move in opposite direction to real monetary policy stance. A tightening monetary policy depresses the inflation gap (indicating a decrease inflation) and inflation expectation. However, it can also be argued that inflation expectation drives the monetary policy stance, as central banks tend to tighten monetary policy in response to an envisaged inflationary pressure. Such mutual feedback mechanism is a basic forward-looking property of monetary policy stance in emerging market economies. Such results are consistent with literature on the expected relationship between monetary policy stance and expected inflation (Horváth, 2009; Amato, 2005; Neiss & Nelson, 2003).

FIGURE 4.5: CHINA - MONETARY POLICY STANCE (BASED ON NOMINAL (RHS) AND REAL (LHS) AUGMENTED TAYLOR RULE, %)

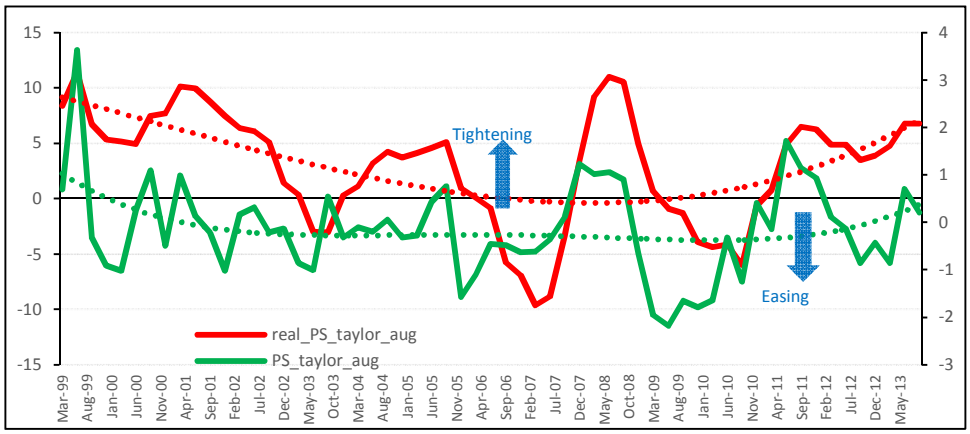


FIGURE 4.6: CHINA - MONETARY POLICY STANCE (REAL NEUTRAL INTEREST RATE) (LHS) & OUTPUT GAP (RHS) (%)

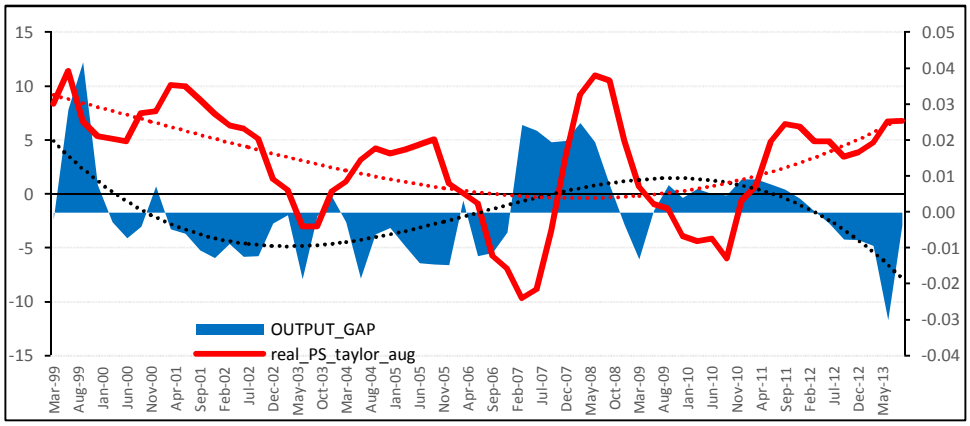


FIGURE 4.7: CHINA - MONETARY POLICY STANCE (REAL NEUTRAL INTEREST RATE) (LHS) AND INFLATION GAP (RHS) & EXPECTATION (RHS) (%)

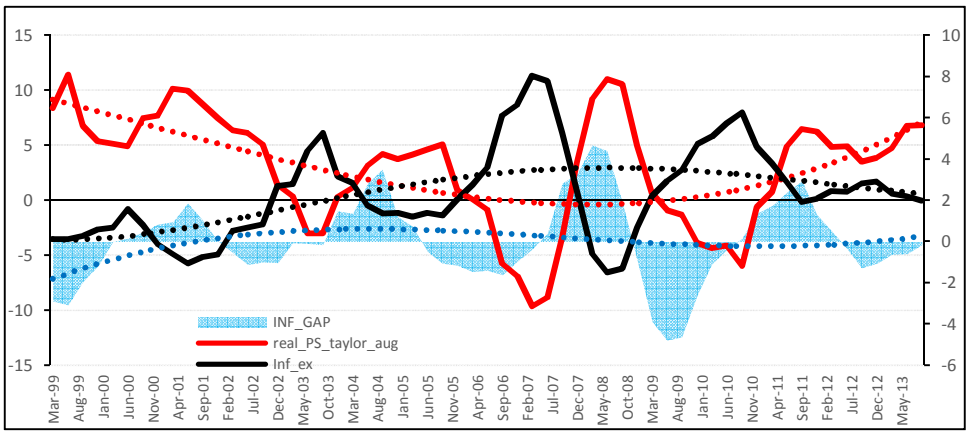


FIGURE 4.8: INDIA - MONETARY POLICY STANCE (BASED ON NOMINAL (RHS) AND REAL (LHS) AUGMENTED TAYLOR RULE, %)

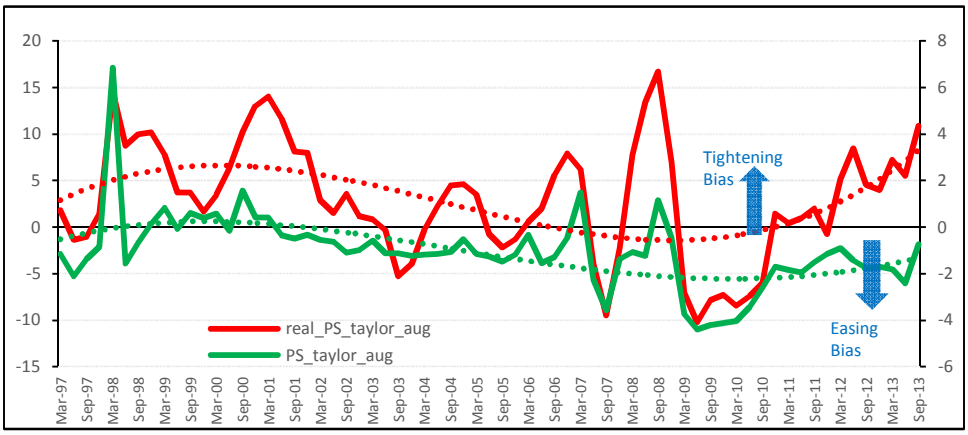


FIGURE 4.9: INDIA - MONETARY POLICY STANCE (REAL NEUTRAL INTEREST RATE) (LHS) & OUTPUT GAP (RHS) (%)

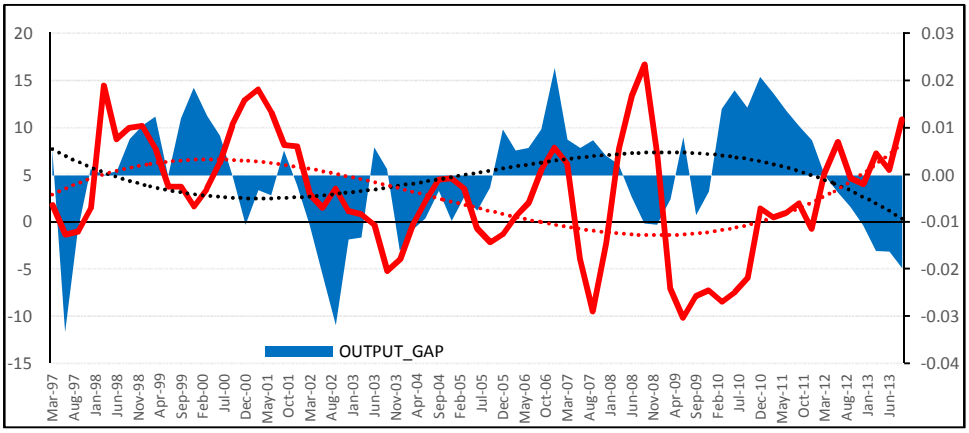
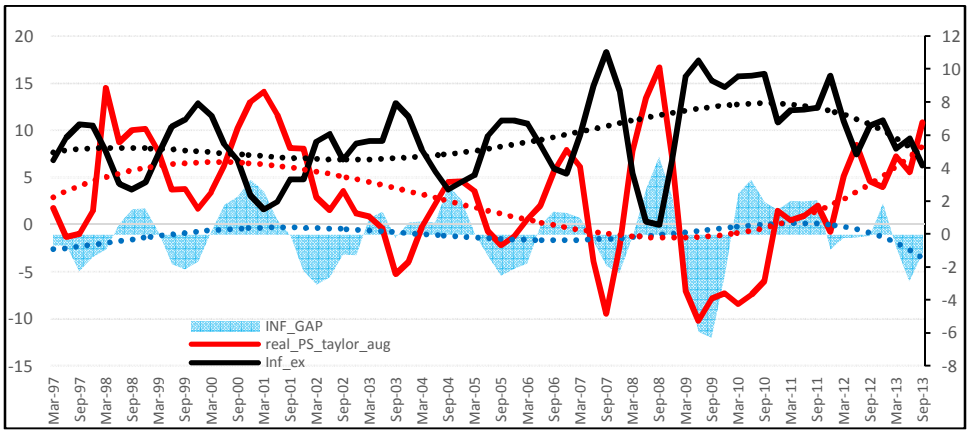


FIGURE 4.10: INDIA - MONETARY POLICY STANCE (REAL NEUTRAL INTEREST RATE) (LHS) AND INFLATION GAP (RHS) & EXPECTATION (RHS) (%)



4.5 CONCLUSION

The increasing reliance of the central banks in China and India on interest rates as a source of information for determining policy and as operating instrument for conducting policy requires an understanding of the appropriate monetary policy stance and its impact on the monetary policy objectives. Hence, this paper ventured to estimate and analyse the time-varying neutral interest rates using quarterly data for China (1999:Q1-2013:Q3) and India (1997:Q1-2013:Q3) in absence of any literature on this topic.

Based on popular methods applied to other emerging economies, such as Brazil and other Latin American economies, we utilise semi-structural models build on the Taylor rule (Taylor 1993) – Dynamic and Augmented Taylor Rules – supplemented by similar estimates of neutral interest rates using the common stochastic trends (with and without interest parity conditions) and pure statistical filters (HP, CF and Kalman filter) to determine the underlying trend as proxy for neutral interest rates. In doing so, we estimate the structural models with the two-sided VC (Schlicht, 2006; 2003; 1988; 1985), which is statistically more efficient and numerically more transparent and straightforward in defining difference is the estimation of variances than the one-sided Kalman filter. In addition, the VC estimation technique uses a GMM estimator, which works efficiently in smaller samples, as in our case, at the same time it is intuitively and asymptotically equivalent to the maximum-likelihood estimator for Kalman filter.

Applying the VC estimation technique on the identified structural models yields time-varying neutral interest rates as low as just below 2% (in late -2005 & mid-2009) to just over 6% (in mid-2013) for China, while time-varying neutral interest rates have fluctuated largely between 4%-10% and demonstrating a variable trend over time in India. Employing the estimates for neutral interest rates we compute the monetary policy stance for these tow economies (on nominal and real terms) and analyse the contemporaneous (and/or lead/lag) cause-effect relationship with output and inflation gap, and expected inflation. In both countries, as expected from theoretical perspective, the real monetary policy stance and output gap, inflation gap and inflationary expectation seem to correspond albeit in the opposite direction to real monetary policy stance.

Finally, the estimated time-varying neutral rates have provided quite reasonable indicator for assessing monetary policy stance against its objectives. The overall conclusion seems to support a prudent response of monetary policy to achieve its objectives in China and India. However, the efficiency with which monetary policy achieves its targets of set objectives is another pertinent study.

APPENDIX 4.1

FIGURE A.4.1 CHINA: COMPARISON OF TIME/VARYING CONFIDENCE INTERVALS

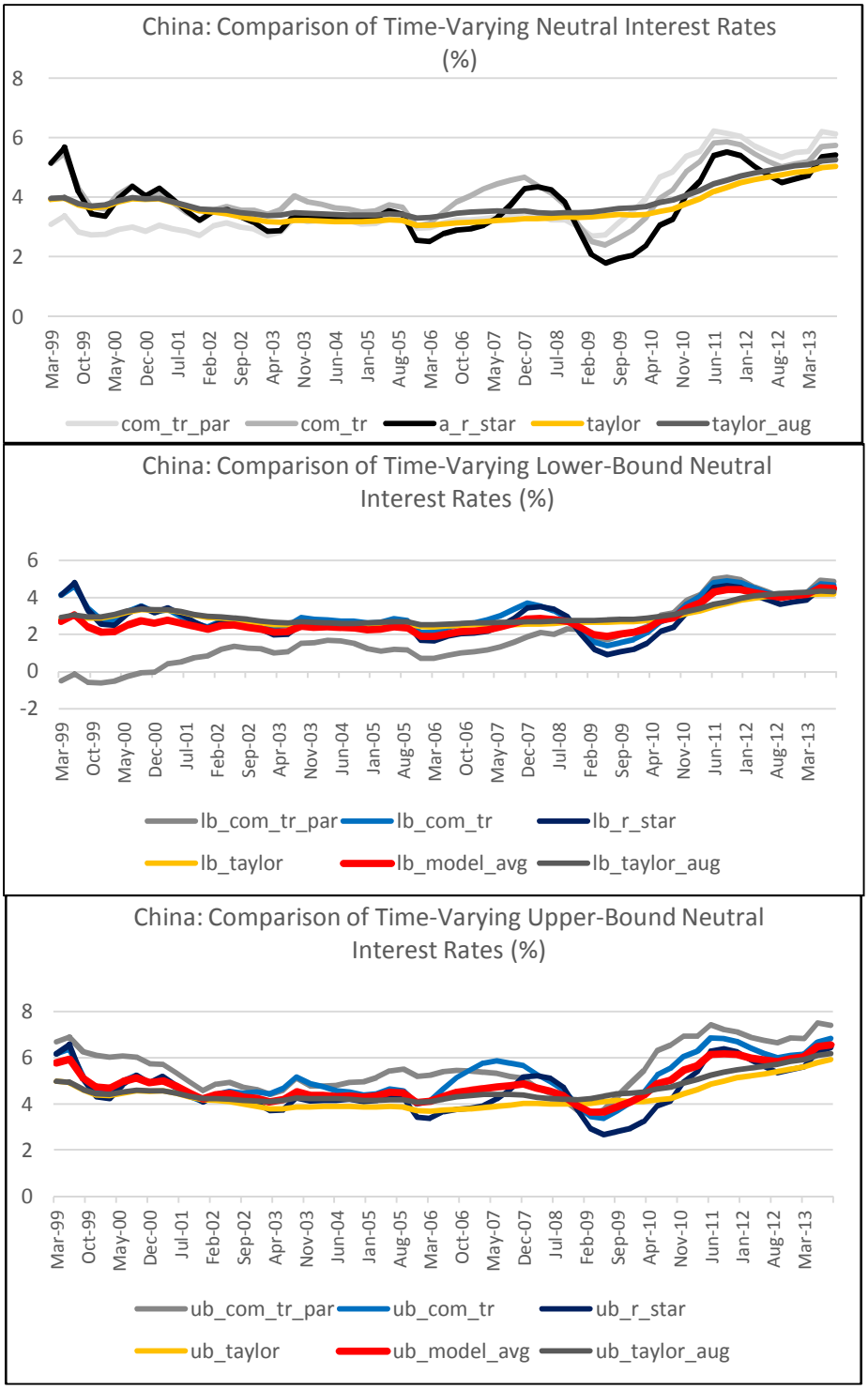
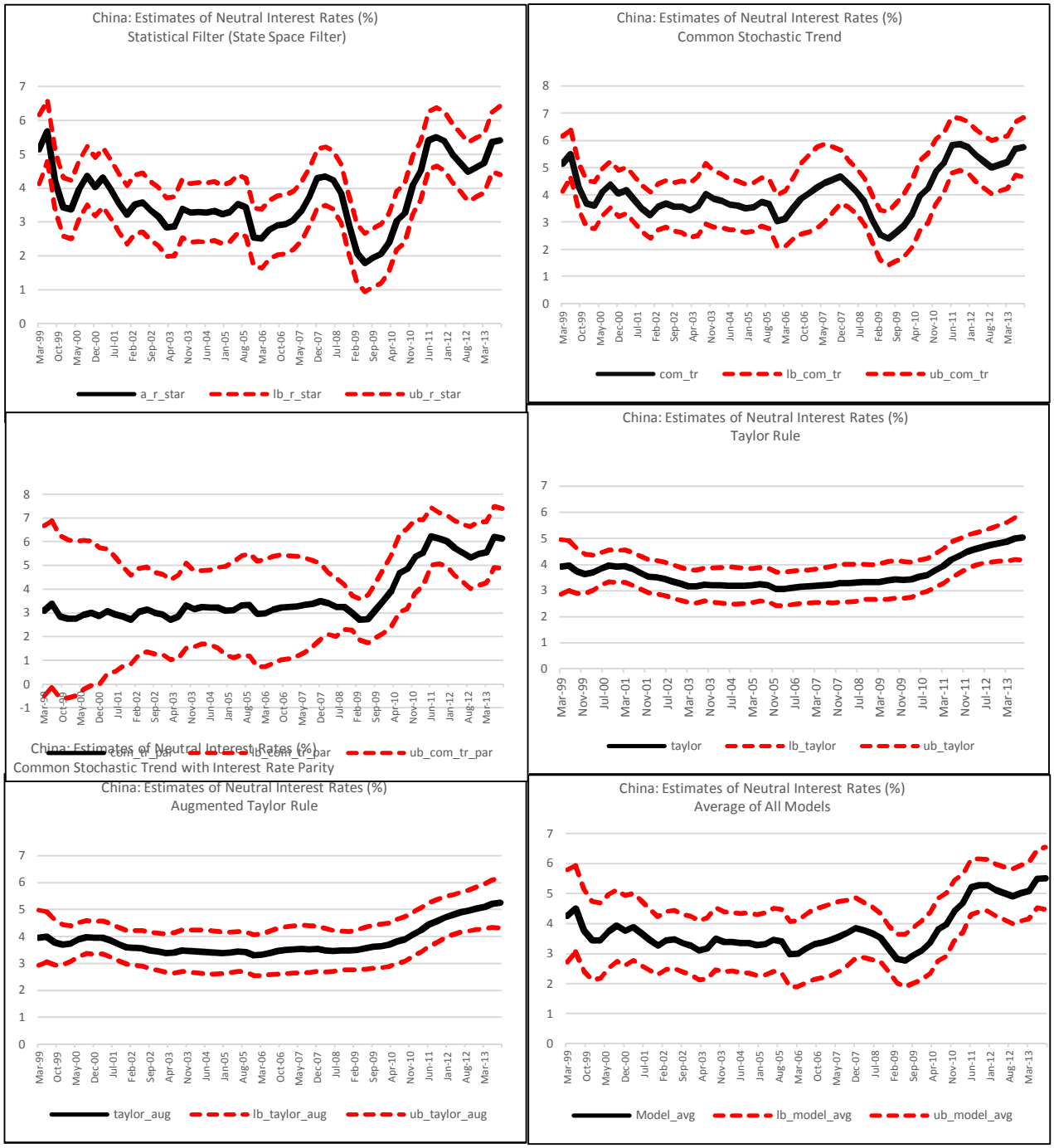


FIGURE A.4.2: CHINA –TIME-VARYING WITH CONFIDENCE INTERVALS



APPENDIX A.4.3: CHINA – NUMERICAL COMPARISON OF NEUTRAL INTEREST RATE ESTIMATES

		com_tr_par	lb_com_tr_par	ub_com_tr_par	com_tr	lb_com_tr	ub_com_tr	a_r_star	lb_r_star	ub_r_star	taylor	lb_taylor	ub_taylor	taylor_aug	lb_taylor_aug	ub_taylor_aug	Model_avg	lb_model_avg	ub_model_avg
		3.7	1.9	5.6	4.1	3.1	5.1	3.7	2.8	4.6	3.6	3.0	4.3	3.8	3.1	4.6	3.8	2.8	4.8
com_tr_par	3.7	0.0	1.9	1.9	0.4	-0.6	1.4	0.0	-0.9	0.9	-0.1	-0.7	0.6	0.1	-0.6	0.9	0.1	-0.9	1.1
lb_com_tr_par	1.9	-1.9	0.0	3.7	2.2	1.2	3.2	1.8	1.0	2.7	1.8	1.1	2.5	2.0	1.2	2.7	1.9	0.9	3.0
ub_com_tr_par	5.6	1.9	3.7	0.0	-1.5	-2.5	-0.5	-1.9	-2.7	-1.0	-1.9	-2.6	-1.2	-1.7	-2.5	-1.0	-1.8	-2.8	-0.7
com_tr	4.1	0.4	2.2	-1.5	0.0	-1.0	1.0	-0.4	-1.3	0.5	-0.5	-1.1	0.2	-0.3	-1.0	0.5	-0.3	-1.3	0.7
lb_com_tr	3.1	-0.6	1.2	-2.5	-1.0	0.0	2.0	0.6	-0.3	1.5	0.5	-0.1	1.2	0.7	0.0	1.5	0.7	-0.3	1.7
ub_com_tr	5.1	1.4	3.2	-0.5	1.0	2.0	0.0	-1.4	-2.3	-0.5	-1.5	-2.1	-0.8	-1.3	-2.0	-0.5	-1.3	-2.3	-0.3
a_r_star	3.7	0.0	1.8	-1.9	-0.4	0.6	-1.4	0.0	-0.9	0.9	-0.1	-0.7	0.6	0.1	-0.6	0.9	0.1	-0.9	1.1
lb_r_star	2.8	-0.9	1.0	-2.7	-1.3	-0.3	-2.3	-0.9	0.0	1.7	0.8	0.1	1.5	1.0	0.2	1.8	1.0	-0.1	2.0
ub_r_star	4.6	0.9	2.7	-1.0	0.5	1.5	-0.5	0.9	1.7	0.0	-0.9	-1.6	-0.2	-0.7	-1.5	0.0	-0.8	-1.8	0.3
taylor	3.6	-0.1	1.8	-1.9	-0.5	0.5	-1.5	-0.1	0.8	-0.9	0.0	-0.7	0.7	0.2	-0.6	1.0	0.2	-0.9	1.2
lb_taylor	3.0	-0.7	1.1	-2.6	-1.1	-0.1	-2.1	-0.7	0.1	-1.6	-0.7	0.0	1.4	0.9	0.1	1.6	0.8	-0.2	1.9
ub_taylor	4.3	0.6	2.5	-1.2	0.2	1.2	-0.8	0.6	1.5	-0.2	0.7	1.4	0.0	-0.5	-1.3	0.3	-0.5	-1.6	0.5
taylor_aug	3.8	0.1	2.0	-1.7	-0.3	0.7	-1.3	0.1	1.0	-0.7	0.2	0.9	-0.5	0.0	-0.8	0.8	0.0	-1.1	1.0
lb_taylor_aug	3.1	-0.6	1.2	-2.5	-1.0	0.0	-2.0	-0.6	0.2	-1.5	-0.6	0.1	-1.3	-0.8	0.0	1.5	0.7	-0.3	1.8
ub_taylor_aug	4.6	0.9	2.7	-1.0	0.5	1.5	-0.5	0.9	1.8	0.0	1.0	1.6	0.3	0.8	1.5	0.0	-0.8	-1.8	0.2
Model_avg	3.8	0.1	1.9	-1.8	-0.3	0.7	-1.3	0.1	1.0	-0.8	0.2	0.8	-0.5	0.0	0.7	-0.8	0.0	-1.0	1.0
lb_model_avg	2.8	-0.9	0.9	-2.8	-1.3	-0.3	-2.3	-0.9	-0.1	-1.8	-0.9	-0.2	-1.6	-1.1	-0.3	-1.8	-1.0	0.0	2.1
ub_model_avg	4.8	1.1	3.0	-0.7	0.7	1.7	-0.3	1.1	2.0	0.3	1.2	1.9	0.5	1.0	1.8	0.2	1.0	2.1	0.0

FIGURE A.4.4: INDIA – COMPARISON OF CONFIDENCE INTERVALS

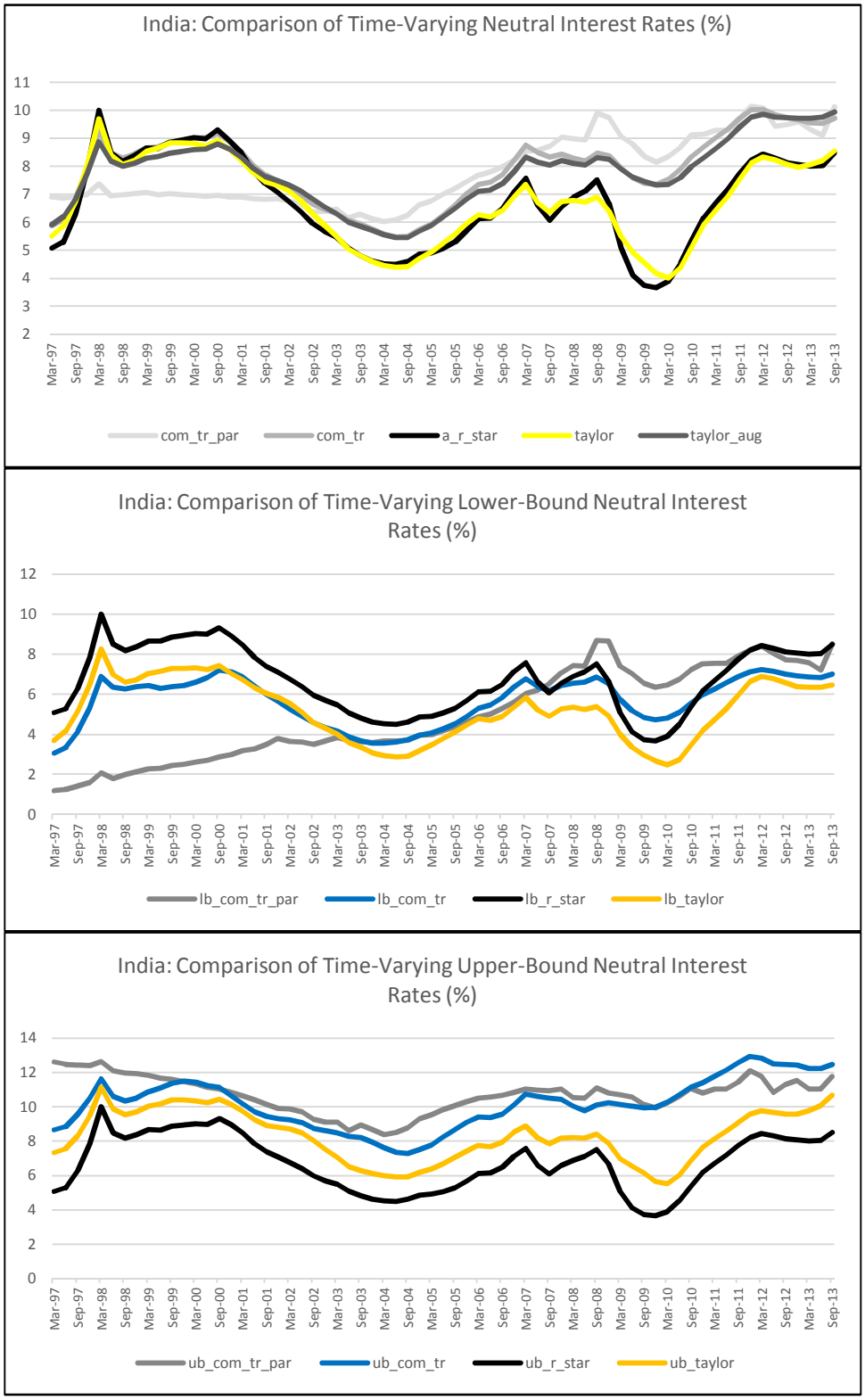
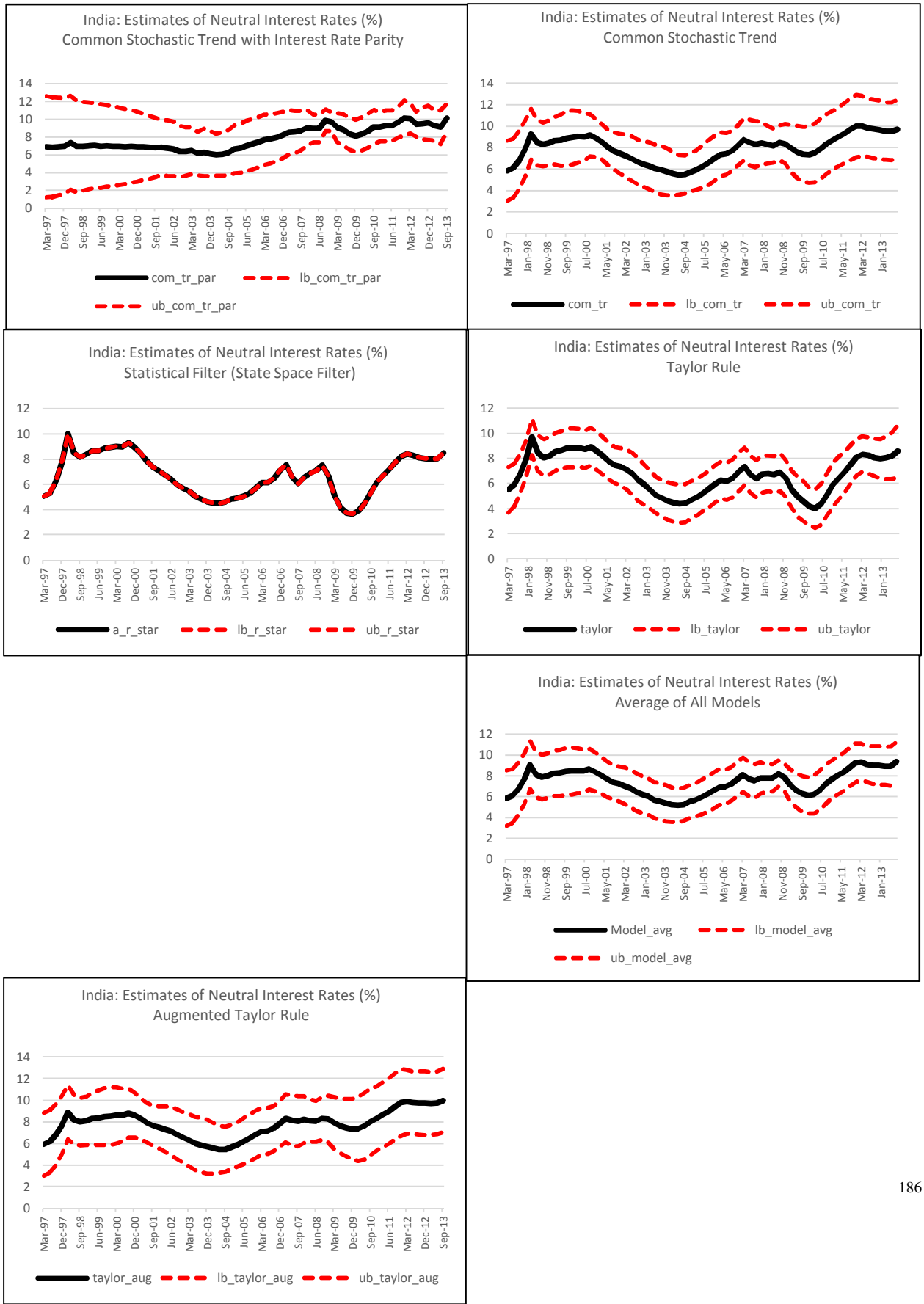


FIGURE A.4.5: INDIA –TIME-VARYING NEUTRAL INTEREST RATES WITH CONFIDENCE INTERVALS



APPENDIX A.4.6: INDIA – NUMERICAL COMPARISON OF NEUTRAL INTEREST RATE ESTIMATES

		com_tr_par	lb_com_tr_par	ub_com_tr_par	com_tr	lb_com_tr	ub_com_tr	a_r_star	lb_r_star	ub_r_star	taylor	lb_taylor	ub_taylor	taylor_aug	lb_taylor_aug	ub_taylor_aug	Model_avg	lb_model_avg	ub_model_avg
		7.8	4.9	10.7	7.9	5.7	10.2	6.7	6.7	6.7	6.7	5.2	8.3	7.8	5.3	10.2	7.4	5.6	9.2
com_tr_par	7.8	0.0	2.9	2.9	0.1	-2.1	2.4	-1.1	-1.1	-1.1	-1.1	-2.6	0.5	0.0	-2.5	2.4	-0.4	-2.2	1.4
lb_com_tr_par	4.9	-2.9	0.0	5.8	3.0	0.7	5.2	1.8	1.8	1.8	1.8	0.3	3.4	2.8	0.4	5.3	2.5	0.6	4.3
ub_com_tr_par	10.7	2.9	5.8	0.0	-2.8	-5.0	-0.5	-4.0	-4.0	-4.0	-4.0	-5.5	-2.4	-2.9	-5.4	-0.5	-3.3	-5.1	-1.5
com_tr	7.9	0.1	3.0	-2.8	0.0	-2.2	2.2	-1.2	-1.2	-1.2	-1.2	-2.7	0.4	-0.2	-2.6	2.3	-0.5	-2.4	1.3
lb_com_tr	5.7	-2.1	0.7	-5.0	-2.2	0.0	4.5	1.1	1.1	1.1	1.1	-0.5	2.6	2.1	-0.3	4.5	1.7	-0.1	3.5
ub_com_tr	10.2	2.4	5.2	-0.5	2.2	4.5	0.0	-3.4	-3.4	-3.4	-3.4	-5.0	-1.9	-2.4	-4.8	0.0	-2.8	-4.6	-1.0
a_r_star	6.7	-1.1	1.8	-4.0	-1.2	1.1	-3.4	0.0	0.0	0.0	0.0	-1.5	1.6	1.0	-1.4	3.5	0.7	-1.2	2.5
lb_r_star	6.7	-1.1	1.8	-4.0	-1.2	1.1	-3.4	0.0	0.0	0.0	0.0	-1.5	1.6	1.0	-1.4	3.5	0.7	-1.2	2.5
ub_r_star	6.7	-1.1	1.8	-4.0	-1.2	1.1	-3.4	0.0	0.0	0.0	0.0	-1.5	1.6	1.0	-1.4	3.5	0.7	-1.2	2.5
taylor	6.7	-1.1	1.8	-4.0	-1.2	1.1	-3.4	0.0	0.0	0.0	0.0	-1.5	1.5	1.0	-1.4	3.5	0.7	-1.2	2.5
lb_taylor	5.2	-2.6	0.3	-5.5	-2.7	-0.5	-5.0	-1.5	-1.5	-1.5	-1.5	0.0	3.1	2.6	0.1	5.0	2.2	0.4	4.0
ub_taylor	8.3	0.5	3.4	-2.4	0.4	2.6	-1.9	1.6	1.6	1.6	1.5	3.1	0.0	-0.5	-3.0	1.9	-0.9	-2.7	0.9
taylor_aug	7.8	0.0	2.8	-2.9	-0.2	2.1	-2.4	1.0	1.0	1.0	1.0	2.6	-0.5	0.0	-2.4	2.4	-0.4	-2.2	1.4
lb_taylor_aug	5.3	-2.5	0.4	-5.4	-2.6	-0.3	-4.8	-1.4	-1.4	-1.4	-1.4	0.1	-3.0	-2.4	0.0	4.9	2.1	0.2	3.9
ub_taylor_aug	10.2	2.4	5.3	-0.5	2.3	4.5	0.0	3.5	3.5	3.5	3.5	5.0	1.9	2.4	4.9	0.0	-2.8	-4.6	-1.0
Model_avg	7.4	-0.4	2.5	-3.3	-0.5	1.7	-2.8	0.7	0.7	0.7	0.7	2.2	-0.9	-0.4	2.1	-2.8	0.0	-1.8	1.8
lb_model_avg	5.6	-2.2	0.6	-5.1	-2.4	-0.1	-4.6	-1.2	-1.2	-1.2	-1.2	0.4	-2.7	-2.2	0.2	-4.6	-1.8	0.0	3.7
ub_model_avg	9.2	1.4	4.3	-1.5	1.3	3.5	-1.0	2.5	2.5	2.5	2.5	4.0	0.9	1.4	3.9	-1.0	1.8	3.7	0.0

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THESIS CONCLUSION

As highlighted in the introduction, this compilation of essays is under the broader theme of monetary economics, and aims to study monetary policy's topical issues in contemporary settings. There are four essays in this thesis, the first two essays focus on two Pacific Small Island Developing States or Pacific SIDS, namely Papua New Guinea and Fiji Islands; and the second two essays focus on Asia's two rising giants, China and India. We study three different, yet topical aspects of monetary policy. Firstly, we decompose and examine the impact of excess banking sector liquidity and its repercussions on the transmission mechanism of monetary policy in an operational setting using Generalized Method of Moments. Secondly, we calculate the efficiency of monetary policy in China and India using the Stochastic Frontier Model; and thirdly we estimate the neutral short run interest rates in China and India using statistical filters and semi-structural models estimated in a State-Space Framework.

In the first essay, we find that excess liquidity in Fiji is involuntarily held while in PNG the motives are purely precautionary. Some underlying reasons includes: risk averse nature of banks; the design and structure of the RR regiment; the design, structure and workability of the real time gross settlement system; the accessibility and penalty rates for standing facilities/collateralized loans; (inefficient payment systems would likely see central banks holding larger buffers to meet shortfalls); cyclical economic activity; aggregate demand conditions; consumption activity; structural; cyclical and political instabilities/shocks; commodity price fluctuations and other similar restraints. An arsenal of tools is available to both central banks to deflate the excess liquidity bubble. From BPNG's perspective, a transfer of government's large trust accounts to the central bank and sweeping accounts could be given a trial. Governments' commercial bank balances could be parked at BPNG overnight and this could influence the market rates. If sweep accounts fail, then more CBBs or other securities could be issued to realign KFR to market rates. A sustainable and viable option for both central banks is to reduce liquidity through government bond sales or increase the SRD/CRR but this would place financial burden on commercial banks due to unremunerated reserves.

The realignment of money market rates is essential for RBF and BPNG to make monetary policy more effective and erode excessive liquidity. The reinforcement of the interest channel and the removal of excess of liquidity should moderate pressure on the exchange rate. Under a de jure floating exchange rate regime (PNG) and sometimes under a managed peg (Fiji), the exchange rate is affected through the impact from policy rates on the differential between domestic interest rates and international rates and, in that way, on the nominal exchange rate.

Changes in the nominal exchange rate have a direct effect on inflation through imported inflation, and, indirectly, through the impact of the real exchange rate (again given anchored

inflation expectations) on net exports, and, therefore, aggregate demand. Excess liquidity when exchange rate is not realistic, directly feeds into import demand, which feeds back into pressures on the exchange rate.

As forward guidance, both central banks could look at enhancing their inter-bank trading. In the presence of excess liquidity, interbank trading is quite infrequent since the banks do not see a need to trade amongst themselves or with the central bank rendering the corridor system as well as the liquidity management system rather obsolete. Excess liquidity is associated with high inflation but both banks are reporting adequate levels of inflation, PNG at 5.8 percent and Fiji at 3.5 percent in 2014. However, stringent price controls are in place plus commodity, fuel and food prices are down, with a 40 and 75 percent import component in the consumer price basket of PNG and Fiji, respectively.

Having found what drives excess reserves; and the nature of excess reserves in Fiji and PNG, the second focuses on isolating the impact of policy interest rate of RBF and BPNG on the operational interbank interest rate (first stage of monetary policy transmission) and then the pass-through to retail lending and savings rate (second stage of monetary policy transmission). Using a SVAR framework with well-thought and stylized structural restrictions, we study interactions between policy interest rate, inter-bank rate and retail interest rates with excess liquidity. Hence, we estimate three models to study these interactions in detail using the impulse response and forecast error variance decomposition.

Based on the results for Fiji, we find that that a shock to policy interest rate (that is, an increase in policy rate decreases the inter-bank rate, while a shock to policy and inter-bank rates decreases the monthly change in excess liquidity (Model 1). This is complemented by prolonged response from the lending and savings rate due to a shock to policy and inter-bank rate, and change in excess reserves (Model 2 & 3). For PNG a shock to policy interest rate initially decreases the interbank rate but causes a non-dissipating response of the interbank rate after the second month. On the other hand, the policy impact on change in excess liquidity causes an undulating response with its effects total disappearing in the sixth period (Model 1). Additionally, a shock to policy and inter-bank rate, tend receive a prolonged positive response from the lending and savings rate, whereas, the lending and savings rate, with respect to excess liquidity, has a prolonged negative impact (Model 2 & 3). Given Fiji and PNG's excess reserves conditions, that is, predominantly involuntary free reserves in case of Fiji and precautionary excess reserves in PNG's case, commercial banks are able to manage their liquidity needs without frequent inter-bank trading. In PNG, overnight borrowing is done at the KFR, but as this is considered expensive such borrowing is limited. In Fiji, due to the large amount of involuntary reserves, trading has been inactive especially in recent years noting that such an exercise will be futile. Therefore, while the RBF and BPNG set interest rate on overnight funds, there is an absence of a properly functioning

inter-bank money market, and the OPR largely has no impact on the interbank rate, while KFR has positive yet muted impact on inter-bank rates.

The third essay started with the simple objective of measuring monetary policy efficiency in two most important emerging economies, China and India. Utilising the Stochastic Frontier efficiency analysis of monetary policy provided by Li et al. (2010), the paper identifies specific theoretical gaps in the basic model of Li et al. (2010) and modifies these to align the theoretical model with existing theory and practice of monetary policy, with empirical applications to China and India. Given that measuring monetary policy efficiency is not as straightforward as it seems, this paper also uses the empirical modeling techniques to account for macroeconomic performance weighted monetary policy efficiency used by Cecchetti et al. (2006) and Krause (2004). While key assessment indicators for performance and efficiency is adopted from the studies, this paper distinguishes the empirical techniques through direct estimates of policymaker preference parameters from Taylor rule using GMM instead of VAR approach. The GMM approach is better at dealing with the expectations operator of independent variables and correcting for endogeneity basis by defining the orthogonal condition through a set of instrumental variables.

Stochastic frontier efficiency analyses for China and India indicate a high level of efficiency in management of output gap, compared to inflation gap. These results are mirrored by greater weighting of policymaker preference to output gap and according to our results. The dynamic accounting analyses of macroeconomic performance weighted monetary policy efficiency analyses for China and India (based on the split sample ratios) shows a decrease in overall monetary policy efficiency. For both of these countries the overall decrease in efficiency under the Cecchetti et al. (2006) framework is primarily driven by the poor macroeconomic performance, variability of supply shocks and monetary policy inefficiency with respect to inflation. Overall, the macroeconomic performance weighted cumulative impact on efficiency with respect to output is positive, indicating a marginal improvement for both China and India, generally re-enforcing that both PBC and RBI have been better at controlling the fluctuations in output gap and keeping output closer to its potential level (along with the SFA results for output in these countries), thereby fulfilling their overall monetary policy mandate of output stability. A key policy implication is the need for greater focus on inflation while maintaining focus on output stabilisation and growth. Such a dual policy focus will deliver better macroeconomic policy management and improve policy outcomes. In addition, the greater focus on inflation will enhance the role of monetary policy in taming inflation further. The current experience of both China and India (discussed in Section 3.4.2) attest to the challenge faced by the PBC and RBI in managing inflation pressures and changing inflationary expectations, largely attributed to the lack of explicit inflation targeting as the anchor for monetary policy. Notwithstanding, the role of direct policy instruments in managing inflation and output, placing greater emphasis on improving efficiency conduits in the economy are equally important, specifically promoting

greater financial innovation and deepening of domestic financial markets will assist in improving the policymakers sphere of influence to achieve desired outcomes with respect to inflation and output, and providing appropriate policy signal to market and economic agents.

The final essay looks at the increasing reliance of the central banks in China and India on interest rates as a source of information for determining policy and as operating instrument for conducting policy requires an understanding of the appropriate monetary policy stance and its impact on the monetary policy objectives. Hence, this paper ventured to estimate and analyse the time-varying neutral interest rates using quarterly data for China (1999:Q1-2013:Q3) and India (1997:Q1-2013:Q3) in absence of any literature on this topic.Based on popular methods applied to other emerging economies, such as Brazil and other Latin American economies, we utilise semi-structural models build on the Taylor rule (Taylor 1993) – Dynamic and Augmented Taylor Rules – supplemented by similar estimates of neutral interest rates using the common stochastic trends (with and without interest parity conditions) and pure statistical filters (HP, CF and Kalman filter) to determine the underlying trend as proxy for neutral interest rates. In doing so, we estimate the structural models with the two-sided VC (Schlicht, 2006; 2003; 1988; 1985), which is statistically more efficient and numerically more transparent and straightforward in defining difference is the estimation of variances than the one-sided Kalman filter. In addition, the VC estimation technique uses a GMM estimator, which works efficiently in smaller samples, as in our case, at the same time it is intuitively and asymptotically equivalent to the maximum-likelihood estimator for Kalman filter.

Applying the VC estimation technique on the identified structural models yields time-varying neutral interest rates as low as just below 2% (in late -2005 & mid-2009) to just over 6% (in mid-2013) for China, while time-varying neutral interest rates have fluctuated largely between 4%-10% and demonstrating a variable trend over time in India. Employing the estimates for neutral interest rates we compute the monetary policy stance for these tow economies (on nominal and real terms) and analyse the contemporaneous (and/or lead/lag) cause-effect relationship with output and inflation gap, and expected inflation. In both countries, as expected from theoretical perspective, the real monetary policy stance and output gap, inflation gap and inflationary expectation seem to correspond albeit in the opposite direction to real monetary policy stance.

Finally, the estimated time-varying neutral rates have provided quite reasonable indicator for assessing monetary policy stance against its objectives. The overall conclusion seems to support a prudent response of monetary policy to achieve its objectives in China and India. However, the efficiency with which monetary policy achieves its targets of set objectives is another pertinent study.