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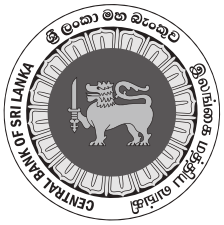

CENTRAL BANK OF SRI LANKA

Volume 48 No. 1 – 2018

The views presented in the papers are those of the authors and do not necessarily indicate the views of the Central Bank of Sri Lanka.

ISSN 1391 – 3743

Printed at the Central Bank Printing Press, 58, Sri Jayewardenepura Mawatha, Rajagiriya, Sri Lanka.
Published by the Central Bank of Sri Lanka, Colombo 01, Sri Lanka.

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Evolution of Monetary and Exchange Rate Policy in Sri Lanka and the Way Forward

Olcott Oration, 18 November 2017
at Ananda College – Kularatne Auditorium

P. Nandalal Weerasinghe [1]
Senior Deputy Governor, Central Bank of Sri Lanka

Preamble

I am deeply honoured to have been invited to deliver the Olcott Oration 2017 and to join a list of great Anandians who have delivered this Oration before. I cannot think of a greater honour that my school could confer on me. I accepted this invitation with humbleness, with gratitude and respect, and with great pride. Let me also take this opportunity to appreciate the support and guidance I received during my school career at Ananda College. The guidance our teachers gave us laid the foundation for any success later on in our lives.

My oration today, is on the rather technical topic of monetary and exchange rate policy. The biggest challenge that I have to face is to present such a topic to an audience with a majority who might not be familiar with the technical jargon involved. However, I will attempt to keep the discussion as simple as possible.

***Key Words**: Monetary Policy, Exchange Rate Policy, Central Banking, Sri Lanka*

***JEL Classification:** E5; N1*

[1] I would like to note that the views expressed in this oration are my own as an economist and do not necessarily reflect the views of the Central Bank of Sri Lanka. I also would like to acknowledge the technical support received in preparing the oration from Dr Chandranath Amarasekara and his team at the Economic Research Department of the Central Bank of Sri Lanka.

1. Central Banking and Price Stability

The prime responsibility of any central bank around the world is to maintain price stability by way of maintaining low and stable inflation on a sustainable basis. At the outset, I would like to discuss why low and stable inflation is important for growth and stability of the economy.

Based on experiences of many countries and different time periods, we have seen varying levels of inflation. When countries experience hyperinflation, domestic prices of goods and services will rise every minute. In such a situation, no one will want to hold the local currency, and people will rush straight from the bank to the shops to buy goods, fearing that their currency holding will lose value along the way. In fact, the banking system itself will collapse. As people lose faith in local currency, the barter system, or the exchange of goods for goods or services will become the norm, making transactions significantly more difficult. Hyperinflation will also cause adverse redistributive effects, destroying real value of middle class savings in local currency and real incomes of fixed income earners such as workers and pensioners. One can read horror stories of hyperinflation in Germany and Australia in the 1920s, and more recently in several Latin American countries and also in countries like Zimbabwe. The episode of hyperinflation in the inter-war Germany is said to have facilitated the rise of Hitler and the global destruction that followed. The famous economics author Neil Irwin, in his book titled "The Alchemists: Three Central Bankers and a World on Fire", called the Governor of the German Reichsbank at the time, the "worst central banker in history"!

Let us also look at the other extreme case of price movements, namely deflation. The example that will come to anyone's mind is Japan, which underwent what was known as the "lost decade". Now it is termed the "lost 20 years"! Since early 1990s Japan experienced deflation, a continued decline in prices of goods and services. One may think that this is great! But what could be considered good for a consumer in the short-term may not be good for the entire economy, as evidenced by the experience of Japan. Since then, the Japanese economy had experienced negative economic growth, a drop in nominal GDP, declining wages and negative interest rates! Some indications of sustained growth in Japan are seen only now.

Fortunately, Sri Lanka has never experienced such episodes in the past, and clearly we want neither hyperinflation nor deflation even in the future. But what about double-digit inflation hovering around 10-20 per cent, as experienced in Sri Lanka for several decades from 1970s? Empirical evidence clearly shows that this kind of double digit inflation is bad for sustained growth. High and volatile inflation causes lenders like banks and other financial institutions to demand a higher fixed interest rate on loans to compensate for the risk that inflation will move around, thus raising the cost of finance for investment. At the same time, financial institutions need to offer higher nominal and real interest rates to encourage savers to deposit their money to mitigate the risk of high and volatile inflation eroding the real value of their savings. High and volatile inflation increases the margin between lending rates and deposits, and this high cost of financial intermediation penalises both savers and borrowers. High and volatile

inflation encourages workers to bargain for higher wages. High and volatile inflation also prompts producers and sellers in the economy to add higher markups in pricing of goods and services. The combined result of this self-fulfilling cycle will be lower economic growth and higher current account deficits, depleting reserves and volatile exchange rates, and the country will end up with a commercial capitalist class of buyers and sellers of imported goods, or a class of middlemen!

Then the question is, what is the appropriate level of low and stable inflation, which will result in more desirable outcomes? Most advanced economies set their inflation target in the low single digits around 2 per cent. For example, the United States and the United Kingdom desire to maintain inflation at around 2 per cent, while in the Eurozone it is below but close to 2 per cent. Australia has an inflation target of 2-3 per cent, and in New Zealand it is 1-3 per cent. Within emerging market and developing economies, the targets are slightly higher. The Philippines and Chile target 2-4 per cent, Indonesia 2.5-4.5 per cent, Brazil 4.5 per cent, South Africa 3-6 per cent, while India targets 2-6 per cent of inflation.

It must be noted here that a central bank could only effectively control demand driven inflation. Central banks could do little to address short-term disruptions to prices due to adverse domestic supply developments or unexpected international commodity price movements. However, central bank responses will be required to contain demand driven inflation, usually identified by movements in core inflation indices.

2. Monetary Policy Frameworks

In order to maintain low and stable, single digit inflation, central banks around the world are entrusted with the task of conducting monetary policy with varying degrees of independence. Central banks use various monetary policy frameworks, as there needs to be a mechanism to operationalise the achievement of the end objective of price stability using the policy tools given to central banks to fulfil this task.

Monetary policy frameworks differ across countries depending on country-specific circumstances such as the level of financial market sophistication, openness of the economy, strengths, capacities and independence of institutions, etc. For example, monetary policy frameworks in some countries are based on currency board arrangements where the value of domestic currency is strictly pegged to an international currency. In currency board arrangements, domestic inflation is directly linked to inflation of the country of which its currency is pegged, and then the anchor for inflation will be the exchange rate. In such strict exchange rate targeting regimes, the country's business cycles in terms of growth and inflation would be fully synchronised with the other country's business cycles. In these countries, monetary authorities have very little leeway to use monetary policy as a countercyclical policy measure to stabilise growth and inflation in the domestic economy. In the other extreme end,

monetary policy frameworks are based on fully fledged inflation targeting regimes where inflation is directly anchored through inflation targets and interest rate policy, while maintaining fully floating exchange rates. Under this arrangement, the exchange rate acts as the shock absorber to minimise the impact of external shocks on the real economy. In such regimes, central banks have more autonomy to use interest rates as an instrument to counter any cyclical economic shocks. There are many central banks that have a combination of these two extremes, where some are closer to inflation targeting and others being closer to exchange rate targeting with soft pegs with some leeway to use interest rate as an instrument to manage inflation and growth. One cannot argue that one regime is superior to the other. It all depends on country circumstances, and even within one country, monetary policy frameworks move in different directions at different times. Monetary aggregate targeting frameworks fall between these two extreme regimes depending on the extent of exchange rate flexibility of such policy regimes.

3. Evolution of Monetary Policy Framework in Sri Lanka

Sri Lanka's monetary policy framework has also evolved from a currency board arrangement before the establishment of the Central Bank of Sri Lanka in 1950. This history has been well covered in the masterpiece, "From dependent currency to central banking in Ceylon" written by Professor H A de S Gunasekera, in whose honour my retired senior central bank colleague Sirimevan Colombage delivered an eloquent speech recently at the University of Peradeniya.

From 1950 to 1977 Sri Lanka's monetary policy framework was largely based on maintaining a fixed exchange rate regime in terms of fixing the value of Sri Lanka rupee first to the sterling pound and then to the US dollar. Under this fixed exchange rate regime, domestic inflation was directly linked to foreign inflation and therefore there was no need for an explicit monetary anchor to manage inflation. The Central Bank did not have much leeway to control domestic inflation as the fixed exchange rate was the anchor to manage inflation. Like many other things, inflation was also more or less imported from the United Kingdom those days!

This system worked well as long as Sri Lanka earned sufficient foreign exchange to meet expenditure on imports without any restriction. For example, during the periods of export booms particularly in the early 1950s, the fixed exchange rate regime worked well, as foreign exchange earnings, which arose due to external factors rather than domestic export promoting policies, were not only sufficient to meet current expenditure but also helped build up foreign reserves so that currency peg could be maintained without foreign grants or borrowings. The necessary condition for any country to maintain a currency peg with a strong reserve currency like sterling pound on a sustainable basis is the country's ability to earn sufficient foreign exchange. In other words, such a country would require a strong set of export oriented policies. In technical terminology, a country should run at least a balanced current account in the

balance of payments on a long-term basis for it to be able to maintain a peg with a strong foreign currency. Economies like Japan early on, and later Hong Kong, Singapore, Taiwan and even China, given their strong export oriented policies, were able not only to generate current account surpluses on sustainable basis, but as a result, also saw the value of their currencies appreciating against major currencies like the sterling pound and the US dollar.

During the period of Sri Lanka's fixed exchange rate regime, successive governments did not pursue export oriented policies continuously. There were short episodes where policies focused on export promotion, but there were more times of policy reversals towards encouraging import substitution and inward looking polices. From a long-term perspective, such polices were inconsistent with the need to maintain a fixed exchange rate regime. Under these circumstances, the key challenge the Central Bank had to face was how to defend the exchange rate peg amidst policies which did not promote exports. The only choice available for the Central Bank at the time was to restrict the use of available foreign reserves and impose severe exchange control restrictions. In a way, the Central Bank at the time was successful in maintaining low inflation, which is one of the key responsibilities of the Bank, but it failed to support the multiple objectives, which were often in conflict with each other, of the then Central Bank.

In addition to pursuing inward looking economic policies, successive governments also ran high budget deficits mainly to provide subsidies and various free entitlements. Such budget deficits, even at moderate levels, caused more demand for imports in the midst of weak export performance, creating continued current account deficits, while the Central Bank was required to maintain a fixed exchange rate regime. This was an impossible task for the Central Bank. As a result, the Central Bank, from time to time, either devalued the rupee or maintained a dual exchange rate along with severe restrictions on the use of foreign exchange. This monetary policy framework lacked credibility and created severe distortions to market pricing.

Meanwhile, on the global front, the collapse of the Bretton Woods system, with the United States declaring in 1971 that it would cease to redeem US dollars for gold from its reserves, challenged the system of fixed exchange rates that the global economy was used to operate in. In addition, the 1973 oil crisis caused inflation to escalate in all countries, including Sri Lanka, often resulting in a destructive wage-price spiral. In Sri Lanka, inflation increased to 14.4 per cent by December 1973, the highest level of inflation the country experienced until then during its post-independent history.

Elsewhere in the world, following the collapse of the Bretton Woods system of exchange rates, the international community was getting used to floating exchange rates, where each currency's value was determined by the international demand for the currency. This was a new normal, prior to which money has historically been based on a valuable commodity such as gold.

4. Post-liberalisation Monetary Policy Framework since 1977

In November 1977, Sri Lanka embarked on a major economic liberalisation move, marking paradigm shift from inward looking restrictive policies towards a liberal regime under which trade and payments were liberalised to a great extent. To be consistent with the new liberal regime, the Central Bank abandoned the fixed exchange rate regime and moved to a more market based system of exchange rate management. On 15th November 1977, the prevailing dual exchange rates were unified at an initial rate of Rs. 16 against the US dollar. This was an overnight devaluation of the basic exchange rate by 120 per cent! The rupee was then allowed to float under a managed exchange rate regime. Accordingly, compared to the end 1976 exchange rate of Rs. 8.83 per US dollar, the exchange rate was recorded at Rs. 15.56 at end 1977.

This sharp devaluation addressed the overvaluation of the rupee observed under the fixed regime. The subsequent managed exchange rate regime allowed some flexibility to determine the value of currency largely on the basis of market demand and supply, while attempting to prevent the overvaluation of the rupee by maintaining the real value of the rupee against movements of a basket of major currencies.

5. The Aftermath of the Managed Float

The introduction of the managed floating exchange rate was a welcome move from the perspective of a liberal macroeconomist. However, this resulted in new challenges to the conduct of monetary policy, particularly as the exchange rate was no longer available to anchor inflation expectations like in the past. The Central Bank also had to face a new challenge, as the government started to run extremely large fiscal deficits funded mainly by concessional external funding to develop public infrastructure such as the accelerated Mahaweli scheme. Annual fiscal deficits averaged 13.3 per cent of GDP between 1978 and 1983, External current account deficits averaged 10.8 per cent of GDP between 1979 and 1983. Year-on-year inflation averaged 15.6 per cent during February 1978 and January 1985, with a peak of 32.5 per cent in August 1980. It must be mentioned here that rising inflation was a main cause for the 1980 general strike, which resulted in over 40,000 public and private sector workers losing their jobs.

Little wonder that the Central Bank of Sri Lanka started looking for a new framework to contain inflation and inflation expectations in the absence of the pegged exchange rate system.

6. Beginning of Monetary Aggregate Targeting in Sri Lanka

The relationship between monetary expansion in terms of the amount of money held by the public and inflation has been well recognised in Sri Lanka from the beginning of central

banking in the country. However, the first mentioning of "desired monetary targets" in a Central Bank annual report in Sri Lanka could be found in 1982. The 1982 annual report states that "the National Credit Plan for 1982 was formulated against the perspective of the prevailing monetary and credit policies. It attempted to rationalise the use of private sector credit among different sectors of the economy as an instrument of selective credit policy. Having taken into consideration the real growth, estimated rate of price increase and increased monetisation of the economy, the desired monetary targets were set in the Plan with a view to maintaining the consistency between financial and real output flows in the economy. The monetary targets were then translated into a permissible level of credit to the private sector by commercial banks after allowing for the impact of the behaviour of the external sector and the credit requirements of the government."

This is a classic characterisation of an annual monetary programme, which is a crucial element in monetary aggregate targeting. Based on Irving Fisher's Quantity Theory of Money, monetary aggregate targeting seeks to explain the relationship between money growth and nominal economic growth (which is the combination of real economic growth and inflation). In this framework, as monetary policy instruments attempt to influence the final objective of inflation by first affecting monetary aggregates, broad money supply was considered the intermediate target. For operational purposes, reserve money or base money, which could be influenced and monitored by the Central Bank on a daily basis, was considered the operating target. The operating target and the intermediate target, both being monetary aggregates, were linked to each other through the money multiplier.

7. An Evolving Exchange Rate System

While monetary aggregate targeting remained the framework for the conduct of monetary policy in Sri Lanka, the exchange rate regime also underwent a gradual evolution. The managed floating exchange rate system broadly remained a crawling band arrangement as the margin associated with the foreign exchange transactions was increased from time to time. The degree of Central Bank intervention in the foreign exchange market varied over time with balance of payments developments and the view of the Central Bank on the direction of the exchange rate.

Under this monetary targeting framework with a crawling exchange rate, achieving price stability proved challenging, as successive governments continued to run high fiscal deficits even after the completion of the accelerated Mahaweli scheme to finance large scale housing and road development programmes. In addition, the three decades of ethnic conflict required successive governments to spend more money on defense expenditure. In order to maintain competitiveness of the rupee, the Central Bank had to let the currency depreciate to, at least partly, compensate for the inflation differential between Sri Lanka and its trading partners

under the crawling peg system. Even though this arrangement helped to alleviate the adverse impact on exports to some extent, higher domestic demand created through excessive fiscal deficits led to large current account deficits in the balance of payments, making it difficult to maintain the crawling peg without a sharp depreciation.

By the year 2000, Sri Lanka experienced a significant decline in its official international reserves, as a result of the considerable increase in expenditure on imports. The increased demand for foreign exchange placed tremendous pressure on the exchange rate. Within the managed floating exchange rate regime, this naturally resulted in increased pressure on international reserves. In order to defend the managed float, the Central Bank raised its policy interest rates to unprecedented levels, which later proved not only to be an unsuccessful exercise but also a costly experiment, which largely contributed to the only negative annual real GDP growth rate of the country's history of -1.5 per cent in 2001.

This prompted the Central Bank to revisit its exchange rate policy. On 23rd of January 2001, the Central Bank took the major step of allowing the commercial banks to determine the exchange rate depending on the supply and demand of foreign exchange in the domestic foreign exchange market. With this move, the Central Bank refrained from announcing daily buying and selling rates of foreign exchange, thus allowing freer foreign exchange transactions. The change in the exchange rate regime resulted in an overshooting effect with the rupee depreciating by Rs.13 from Rs. 98 per US dollar within the first three days, but a relatively quick stabilisation of the exchange rate followed.

As the use of monetary policy to defend the foreign exchange rate was no longer necessary under the floating exchange rate regime, the Central Bank of Sri Lanka was able to conduct monetary policy with an increased focus on achieving the Bank's objective of price stability. However, maintenance of price stability came under heavy pressure under this regime whenever aggregate demand was excessive as a result of expansionary fiscal policies.

Therefore, at times of such excessive domestic demand through fiscal dominance, the Central Bank of Sri Lanka intervened in the foreign exchange market to defend the exchange rate from depreciation. Although this was done with the good intention of maintaining macroeconomic stability in difficult times, experience repeatedly showed that managing the exchange rate extensively was always associated with a substantial loss of limited international reserves followed by a large depreciation. The most recent of such events were in 2011/2012 and 2015. During the 2011/2012 episode, the Central Bank supplied US dollars 4.2 billion to the market on a net basis, while the Central Bank supplied US dollars 3.2 billion to the market on a net basis during the year 2015. In spite of these considerable losses of reserves, the rupee depreciated against the US dollar by 13.5 per cent by the end of the 2011/2012 episode and by 9.0 per cent during 2015.

Since then, the Central Bank has explicitly announced that international reserves will not be used to defend an overvalued exchange rate. Instead, the Central Bank intervention in the foreign exchange market will aim to buildup international reserves. So far during 2017, the Central Bank has been able to purchase over US dollars 1.3 billion from the market on a net basis for this purpose, and improved market confidence is shown by the limited depreciation of the currency this year.

8. Gradual Modifications to the Monetary Policy Conduct

Returning to the previous discussion, it was clear by late 1990s and early 2000s, that a serious rethink of central banking in Sri Lanka was necessary. In addition to the increasingly popular view within international central banking and academic circles that price stability must be the overriding objective of a central bank, financial innovations, including the development of electronic payments and fund transfer systems, also prompted the Central Bank to upgrade its view on financial system stability. These factors, as well as many others which are beyond the purview of this speech, prompted the Central Bank of Sri Lanka Modernisation Project, resulting in legislative, procedural and operational changes in relation to central banking in Sri Lanka.

With regard to legislative changes, the amendments to the Monetary Law Act (MLA) in 2002 were the most important. Accordingly, the multiple objectives of the original MLA, which included stabilisation and development objectives as well as maintaining domestic and external value of the rupee, were streamlined to define the core objectives of the Central Bank as maintaining economic and price stability and financial system stability.

By this time, the Central Bank had gradually moved away from direct controls to market based tools of monetary policy, a process which started with the adoption of open economy policies since 1977. The significant advancement in monetary policy operations during this period was the introduction of the Repurchase rate and the Reverse Repurchase rate of the Central Bank. The Central Bank introduced its repurchase facility in 1993 to mop up overnight excess liquidity from the market, while introducing the reverse repurchase facility in 1995 to inject overnight liquidity to the market. These two rates served as the floor and the ceiling for movements of the interbank call money market rate. This policy interest rate corridor was used from early 2000s to signal changes in the monetary policy stance of the Central Bank. Today this policy corridor is called the Standing Rate Corridor with the floor and the ceiling rates being known, respectively, as the Standing Deposit Facility Rate (SDFR) and the Standing Lending Facility Rate (SLFR) of the Central Bank of Sri Lanka. Open market operations are conducted in a more active auction based framework with overnight, short-term and long-term operations to maintain market liquidity and thereby market interest rates in line with the announced monetary policy stance of the Central Bank.

The key operational changes to the conduct of monetary policy included the establishment of the Monetary Policy Committee (MPC) of the Central Bank in 2001 to strengthen monetary policy analysis and to improve the transparency of the decision making process. The Central Bank also began issuing regular press releases on monetary policy decisions to the public, based on an advance release calendar. This press release was often followed by a press conference chaired by the Governor and accompanied by the senior officials of the Central Bank. The Central Bank also introduced a Monetary Policy Consultative Committee (MPCC) comprising academics, professionals and private sector representatives, enabling the Central Bank to obtain views of the private sector to be used in the monetary policy formulation process. In addition, the Central Bank started to enunciate its monetary and financial policies for a medium-term horizon though a Road Map, which was unveiled at the beginning of each year.

9. 105 Consecutive Months of Single Digit Inflation

In spite of these modifications to the framework of conducting monetary policy over time, Sri Lanka continued to suffer from double digit inflation until 2009 as a combined outcome of high budget deficits and loose fiscal policy, reactive rather than proactive monetary policy, frequent domestic supply disruptions and international commodity price shocks. In June 2008, inflation increased to 28.2 per cent, the highest level of inflation since 1980s. In order to manage this situation within the monetary targeting framework, the Central Bank used strict quantitative monetary targets with increased policy interest rates while also imposing restrictions on access to the Central Bank reverse repurchase facility. In a display of validity of monetary targeting, the Central Bank was able to bring down inflation from the peak to near zero levels within a 12-month period. It was the sharpest disinflation the country has experienced in the history of Sri Lanka, but it must also be noted that the weak global commodity prices also contributed to this decline to some extent.

Nevertheless, the intent of the Central Bank to maintain inflation at mid-single digit levels, which was made clear through action as well as through communication, enabled the Central Bank to change the mindset of the people that Sri Lanka is typically an economy with double digit inflation. The change in the mindset was visible in improving inflation expectations. Since February 2009, inflation has remained in single digits, and 105 consecutive months of single digit inflation is considered an achievement in the recent history of Central Banking in Sri Lanka.

10. Infeasibility of Monetary Aggregate Targeting

However, Sri Lanka's achievement of single digit inflation for 105 consecutive months had little to do with monetary aggregate targeting. From July 2009 to September 2017, the year-

on-year broad money growth was, on average, 17.1 per cent. Year-on-year inflation during the same period averaged 5.2 per cent. Based on the earlier discussed Fisher's Quantity Theory of Money, the gap between these two figures, that is 11.9 per cent, must reflect average real economic growth during this period. However, real economic growth averaged only 6.0 per cent during this period. If the argument is reversed, there is a gap of 11.1 per cent between broad money growth and real economic growth. According to the Quantity Theory, this should reflect average inflation during the period, which was not the case. Even if some allowance is made for changes in velocity of money or money demand due to possible behavioral changes and financial sector development, the growth of money vs. the real growth of the economy and inflation cannot be explained for this period.

This was sufficient evidence that the strong and reliable relationship between the goal of price stability and the nominal anchor of money growth, which was essential for the success of the monetary aggregate targeting framework, has significantly weakened over time. This phenomenon was not limited to Sri Lanka, but was observed over time in many other economies as well. With the ending of monetary aggregate targeting in Canada in as early as 1982, Gerald Bouey, Bank of Canada Governor at the time famously stated "we did not abandon monetary aggregates. Monetary aggregates abandoned us." Even the recent experience with quantitative easing in many advanced economies yet again proved that the tremendous expansion of central bank balance sheets that these countries undertook was insufficient to raise either growth or inflation.

Earlier it was argued that Sri Lanka's achievement of single digit inflation for 105 consecutive months had little to do with monetary aggregate targeting. Instead, it was a result of the Central Bank's ability to anchor inflation expectations, by repeatedly emphasising its utmost desire to maintain inflation at mid-single digit levels. The behaviour of the Central Bank during the 2008-2009 episode of disinflation would have raised credibility of monetary policy. Improved communication also would have played a key role in this achievement. It must be noted that the neighbouring economies struggled with double digit inflation during some parts of the same period. For example, India was unable to tame inflation until 2014. One might argue that international commodity prices were in our favour. However, this was not always true, as global crude oil prices remained, on average, above US dollars 100 per barrel during the period from February 2011 to September 2014.

11. Inflation Targeting as an Alternative: Lessons from Other Countries

Therefore, without a formal announcement, the Central Bank of Sri Lanka, similar to many other central banks in the world, has moved to a monetary policy framework governed by expectations and credibility, rather than by monetary aggregates or exchange rates.

In the global economy, such a monetary policy framework that emphasised the role of expectations and credibility existed, and it was known as "inflation targeting" that I briefly referred to at the beginning. First adopted by New Zealand in 1990, inflation targeting was chosen as the monetary policy framework in Canada, the United Kingdom, Australia, and Sweden in quick succession. Encouraged by the success of inflation targeting, a number of other advanced economies as well as emerging market economies adopted this framework thereafter. These countries used inflation targeting either to bring down inflation from stubbornly high levels or to maintain inflation at low and stable levels on a sustained basis.

Inflation targeting is generally characterised by an announced inflation target; an inflation forecast, which facilitates forward looking monetary policy decision making; and a high degree of transparency and accountability. According to Lars Svensson, the Swedish economist who later served as Deputy Governor of the Riksbank, this policy framework encompasses a trinity of a mandate for price stability, independence, and accountability for the central bank, which enables anchoring of inflation expectations effectively.

In practice, inflation targeting is flexible rather than strict. According to Svensson, flexible inflation targeting means that monetary policy aims at stabilising both inflation around the inflation target and the real economy, whereas strict inflation targeting aims at stabilising inflation only, with little regard to the stability of the real economy. A strict inflation targeter would be who Mervyn King, the former Governor of Bank of England, called an "inflation nutter". Most of the central banks do not only aim at stabilising inflation around an inflation target, but also put an effort into stabilising real economic variables. This effort is described by the time horizon in achieving the inflation target, which dampens the adverse impact of policies on the real economy. Therefore, an important feature of flexible inflation targeting is that the inflation rate will be on average at target, but perhaps not every month.

A key advantage of inflation targeting is that it is easier for the general public to relate to. Since inflation is well understood by the public, the inflation forecast will serve as an ideal anchor and, with improved communication, will help bridge the information gap between the central bank and the public. Reference to such a straightforward target, rather than to an elusive monetary target, will ensure increased transparency and accountability while enabling the public to understand policy shortcomings.

Global experience has also shown that in adopting inflation targeting, a country needs to fulfill several prerequisites, particularly in terms of the legal and institutional framework. These include central bank independence and strong mandate for price stability, strong fiscal position with freedom from fiscal dominance, a flexible exchange rate regime, a well-developed financial system, a sound technical infrastructure for inflation forecasting, and transparent policies to build accountability and credibility of the central bank. In particular, with regard to fiscal dominance, other countries had developed mechanisms to stop monetary financing of fiscal deficits, particularly through subscribing to government securities auctions and the

provision of interest free funds to the government through an advance account as observed in Sri Lanka. Instead, other central banks would purchase government securities from the secondary market to influence monetary conditions as and when necessary.

12. Road to Flexible Inflation Targeting: Where We Stand

Considering the success of flexible inflation targeting in advanced and emerging markets, the Central Bank of Sri Lanka also considered this as the best framework to be adopted in the medium-term. A number of prerequisites for the new framework have already been fulfilled by the Central Bank and the government during the past few years with the view of moving towards flexible inflation targeting in the medium-term.

At present, as an interim arrangement, the Central Bank conducts its monetary policy within an enhanced framework with features of both monetary aggregate targeting and flexible inflation targeting frameworks. Under this enhanced monetary policy framework, the Central Bank focuses on stabilising inflation in mid-single digits over the medium-term, while supporting the growth objectives and flexibility in exchange rate management. Although the Central Bank does not announce any monetary targets explicitly, broad money aggregates remain a key indicative intermediate variable to guide the conduct of monetary policy. Moreover, instead of reserve money, the Central Bank currently uses the average weighted call money rate (AWCMR) as its operating target and increasingly relies on its market based policy instruments, namely policy interest rates and OMO.

As accurate forecasts of inflation and other key variables are essential for the success of flexible inflation targeting, macroeconomic projection capabilities of the Central Bank are currently being strengthened. As an important step toward building technical infrastructure for the successful implementation of flexible inflation targeting, a Forecasting and Policy Analysis System (FPAS) using short-term forecasting tools and medium-term dynamic stochastic general equilibrium (DSGE) techniques, has been developed by the Central Bank with the assistance of the International Monetary Fund (IMF). This system is currently being integrated into the monetary policy formulation process of the Central Bank. Following the best practices among inflation targeters, the number of Monetary Policy Committee (MPC) meetings has been reduced to eight meetings per year in order to provide technical staff sufficient time for deeper macroeconomic analysis.

Several other recent policy changes will also support the implementation of flexible inflation targeting in the medium-term. The Central Bank has implemented a more market based exchange rate policy during recent times, with limited intervention in the foreign exchange market. There has been a build-up of international reserves with minimal impact on the exchange rate. In tandem, the financial system has continued to expand whilst exhibiting resilience amidst challenging market conditions both globally and domestically. The

implementation of the Basel III framework will further enhance the resilience of the financial system.

A deeper and more liquid government securities market is also a prerequisite for a smoother transmission of the Central Bank policy rate signals to market interest rates, as yields on government securities form benchmark medium to long-term interest rates. In this regard, the recently introduced system of rule based and more transparent Treasury bond auctions, has not only reduced sharp volatility in yields on government securities, but also corrected the distortion between Central Bank policy rates and market interest rates that existed earlier. This mechanism has also helped reduce monetisation of the fiscal deficit through purchasing Treasury bills by the Central Bank at primary auctions. For example, the Central Bank holdings of Treasury bills have declined drastically this year from more than Rs 300 billion at end 2016 to around Rs 40 billion by now, as the new system ensures full market subscription through the auction system without creating adverse volatility in interest rates. The proposed Liability Management Act allows the Treasury to create a buffer fund to meet the expenditure in the following year, eliminating the necessity for the Central Bank to provide advances to the Treasury at the beginning of each year as per the current provisions of the MLA. These two measures would, in future, insulate monetary policy from fiscal dominance. These reforms are expected to create a win-win situation for both the Central Bank and the Treasury, as they would facilitate the Treasury to raise the required funds at the least possible cost from a more sophisticated government securities market at competitive rates, while helping the Central Bank to achieve its primary objective of maintaining price stability.

13. Looking towards the Future: Flexible Inflation Targeting as the New Monetary Policy Framework

In the "Road Map: Monetary and Financial Sector Policies for 2017 and Beyond" presented in January 2017, the Central Bank of Sri Lanka reiterated its intention to move to flexible inflation targeting in the medium-term as its new monetary policy framework. The government has endorsed this move since then, and stated in its recently released Vision 2025 policy document that "for medium to long-term price stability, the Central Bank will move towards a flexible inflation targeting regime. They will aim at continuously maintaining low inflation while supporting economic activity and competitiveness. The government will implement the legislative and operational changes necessary."

While it is heartening to note that the Central Bank and the government have agreed in principle that flexible inflation targeting is the way forward in the conduct of monetary policy, the full implementation of flexible inflation targeting by the year 2020 will require increased efforts to fulfil the remaining prerequisites for the success of inflation targeting.

It is also expected that comprehensive amendments will be made to the MLA to facilitate the transition to flexible inflation targeting, to redefine monetary policy objectives, eliminate monetary financing of fiscal deficits, and ensure Central Bank autonomy and public accountability. Amendments to the MLA are also expected to streamline the monetary policy decision making process.

Within the Central Bank, the ongoing upgrade of technical forecasting and analytical capabilities will continue, and it is expected that by 2020, the Central Bank will commence the publication of comprehensive Inflation Reports. The Inflation Report will explain inflation developments, inflation expectations, projections for inflation and other key macroeconomic variables, the assumptions behind such projections, reasons for any deviation of actual inflation developments from targeted levels, and remedial actions to be taken in the case of deviations. Such transparency and accountability is likely to enhance the credibility of the Central Bank and well anchor inflation expectations, resulting in increased economic stability and supporting high economic growth and increased international competitiveness of Sri Lanka.

Meanwhile continued commitment by the government towards greater fiscal discipline and stronger fiscal position remains key to the successful adoption of flexible inflation targeting. Therefore, the Central Bank will continue to support government's efforts to reduce the debt to GDP ratio to 70 per cent by 2020 and curtail budget deficits at 3.5 per cent of GDP from 2020. The government's intention to strengthen the Fiscal Management (Responsibility) Act is very encouraging in this regard.

In conclusion, I would like to take you back to the beginning of Central Banking in Sri Lanka. In 1949, John Exter, the founder of the Central Bank of Sri Lanka, in his "Report on the Establishment of a Central Bank for Ceylon" stated as follows:

> "The decision of the government of Ceylon to establish a central bank was a decision with far reaching implications for the people of Ceylon. One implication already stands out very clearly: in taking steps to establish an independent monetary system to be administered by a central bank the government has demonstrated unmistakably its intention to achieve genuine economic freedom as a corollary of the political freedom achieved a year and a half ago. It has been the endeavour of this report to propose a type of central bank which, with proper skill and understanding in its management, will establish monetary conditions in Ceylon that may make possible, as never before, the fuller use of the nation's human and material resources and a rising standard of comfort for all."

History has judged us before! I will leave it up to you to judge us in future as well!

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Annexure

Chart 1: Real GDP Growth

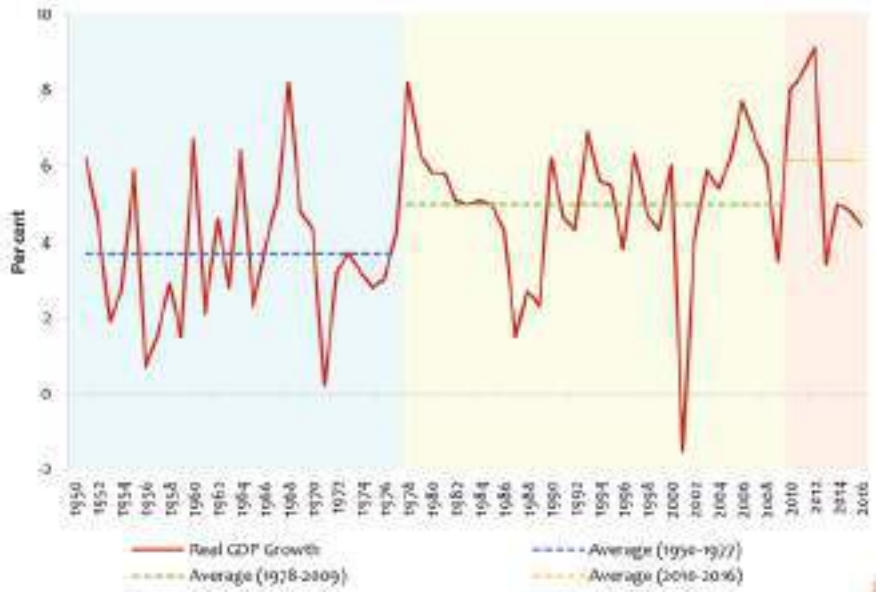


Chart 2: Annual Average Inflation

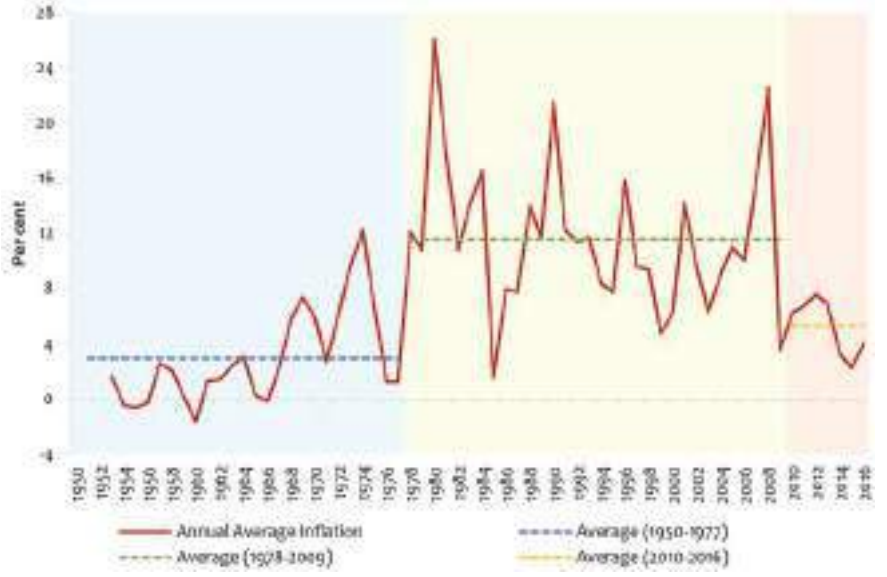


Chart 3: Budget Deficit

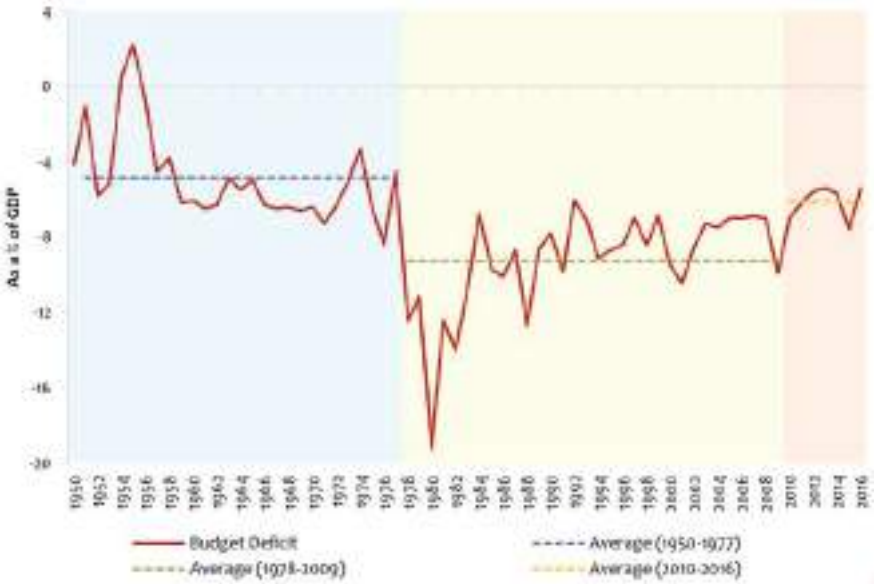
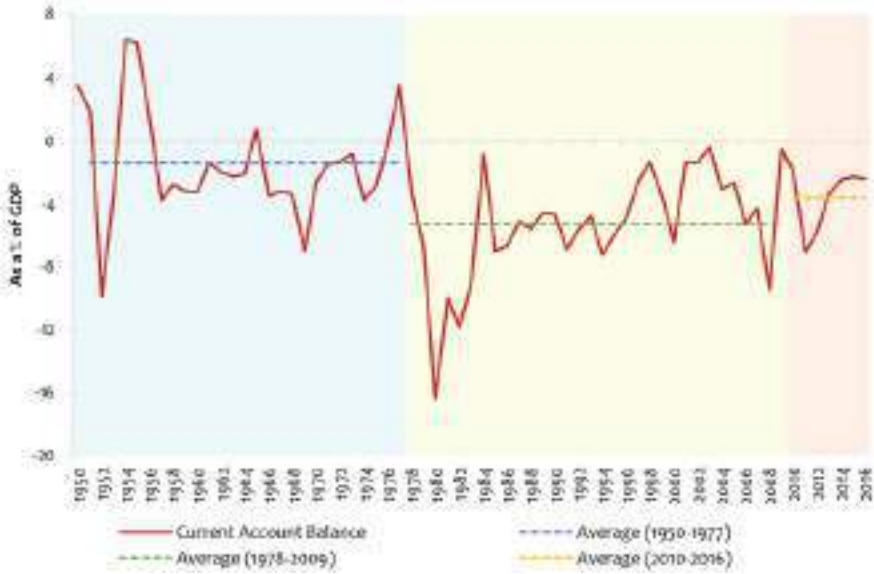


Chart 4: External Current Account Balance



An Open Economy Quarterly Projection Model for Sri Lanka[1]

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Abstract

This study documents a semi-structural model developed for Sri Lanka. This model, extended with a fiscal sector block, is expected to serve as a core forecasting model in the process of the Central Bank of Sri Lanka's move towards flexible inflation targeting. The model includes a forward-looking endogenous interest rate and foreign exchange rate policy rules allowing for flexible change in policy behavior. It is a gap model that allows for simultaneous identification of business cycle position and long-term equilibrium. The model was first calibrated and then its data-fit was improved using Bayesian estimation technique with relatively tight priors.

Key Words: *Sri Lanka, Quarterly Projection Model, Monetary Policy, Forecasting and Policy Analysis System, Flexible Inflation Targeting*

JEL Classification*: C15; C50; E17; E47; E52*

[1] This paper has been prepared as part of the joint capacity building project between the International Monetary Fund (IMF) and the Central Bank of Sri Lanka (CBSL) under the overall guidance of Mr. Andrew Berg of the IMF. The authors wish to thank Dr. P. Nandalal Weerasinghe, Mr. K.D. Ranasinghe, and Mr. K.M. Mahinda Siriwardana of the CBSL for their guidance. The authors are also grateful for valuable comments received from the Monetary and Capital Markets, Research, and Asian & Pacific Departments of the IMF. This paper has been published as IMF/WP/18/149.

1. Introduction

The Sri Lankan economy has undergone significant economic transformation since independence. The rapid pace of structural transformation, especially in the post-conflict era, alongside attempts to carve a niche for itself in the global economy as an exporter and an investment destination poses new challenges that warrant changes to the macroeconomic framework that guides the economy. While the economy has already successfully transitioned to a floating exchange regime since 2001, the transition of the monetary policy framework from a monetary targeting (MT) framework to a flexible inflation targeting (FIT) framework is still underway, with the Central Bank of Sri Lanka (CBSL) currently undertaking monetary policy under an 'enhanced' monetary policy framework that is a hybrid of the MT and FIT frameworks.

The evolution of the CBSL into an increasingly transparent and forward-looking institution is imperative to the successful transition to FIT. Accordingly, the use of structural models for medium-term projections and policy analysis is indispensable. Such models can provide forward-looking guidance on potential monetary policy actions required to align inflation with its medium-term objective while stabilizing real output at its potential level. The model outcomes can also structure the debate about underlying assumptions, risks, and policy issues, and will permit greater transparency in policy decisions and communication (Alichi et al., 2015). Further, it must also be discerned that the underlying role for monetary policy in such a rule-like framework is to serve as an anchor for inflation and inflation expectations while the central bank exercises its discretion in its reaction to shocks (Hammond, 2012). With due consideration to the importance of communication in the management of inflation expectations, the use of a simple structural model will also enable CBSL to bridge information gaps with the public regarding the rationale of the monetary policy stance.

In this paper, we describe a basic version of a new core forecasting model to be used at the CBSL for forecasting and monetary policy analysis. The work on this new core model has been part of a broader joint project of the CBSL and the International Monetary Fund (IMF) on developing a modern Forecasting and Policy Analysis System (FPAS) at the CBSL.[2]

The FPAS project draws on best-practices in the development of these frameworks in other central banks, described extensively in Laxton et al (2014). The FPAS consists of various elements: (i) a team fully dedicated to forecasting with clearly defined responsibilities, (ii) a database infrastructure, (iii) a set of near-term forecasting and nowcasting tools, (iv) a core quarterly projection model (QPM) which embodies policymakers' view about the transmission mechanisms and relevant shocks that affect the economy, (v) a regular schedule of meetings to update the forecast and interact with senior management, and (vi) a reporting process that

[2] A similar system has been recently adopted also at the Reserve Bank of India (Benes et al., 2016b).

presents the analysis in a clear and straightforward manner to the policy makers. As the above list makes clear, the FPAS combines quantitative tools to be used by central bank staff with a set of processes to use these tools efficiently in the policy decision-making.

The central banks which adopted (flexible) inflation targeting are known to capitalize on FPAS to disciple their policy analysis. This is because the FPAS framework is not just the forecasting model but it is a comprehensive framework which involves (i) collecting and organizing key set of macroeconomic variables; (ii) developing a consistent, model-based macroeconomic forecast including measures of uncertainty and alternative risk and policy scenarios, (iii) reporting and communicating the forecast to the Monetary Policy Committee and the Monetary Board (Andrle et al., 2013). In turn, it paves way for the formulation of forward-looking policies to achieve stabilization in the medium-term (CBSL, 2017).

The remainder of this paper is organized as follows, Section II provides insight about the progress of economic modelling in CBSL and contemporary motivation for the development of a semi-structural model. Section III describes the new QPM model and the theory and practical aspects underpinning the creation of this customized model. The means of calibration and fine-tuning of the QPM is described in Section IV, followed by an analysis of the dynamic properties of the model, and assessment of the model's performance using 'in-sample' simulations described in Section V. In Section VI, the paper proposes areas for future research and ends with concluding remarks in Section VII.

2 Historical Background and Motivation

2.1 History of Economic Modelling at the CBSL

Sri Lanka gained independence in 1948, and since then, its economy has shown a gradual transformation from an agriculture based primary commodity producer into a predominantly service based light manufacturing economy. The country's per capita income has increased from around US dollars 100 at the time of independence to reach the upper threshold of the lower middle-income economy status. The CBSL, established in 1950, has been at the forefront of this gradual transformation, and contributed to maintaining economic stability while supporting economic growth. Broadly speaking, during the first 25 years of its existence, the CBSL's functions were less complex, with a fixed exchange rate system, strict capital controls, and underdeveloped domestic money and capital markets. The economy was hit by occasional external shocks, and stringent regulatory policies were introduced to mitigate the impact of such challenges. Supporting economic development, the CBSL continued to provide subsidized credit to selected sectors of the economy. However, the introduction of open economy policies in 1977 required an overhaul of the entire policymaking machinery. The CBSL key responses included the introduction of monetary targeting in the early 1980s, the

automation of the clearing house, and active facilitation of the development of domestic financial markets. Whether the CBSL was successful in achieving its multiple objectives is arguable. However, judging by the available macroeconomic statistics, it appears that the economy became more volatile, and inflation cycles became larger, shrouding the achievements of the economy in the post-1977 period.

From its inception, the CBSL has taken measures to train its staff in technical aspects of economic modelling. This has been facilitated by the Monetary Law Act No 58 of 1949, which established the Economic Research Department as a core department of the CBSL and empowered the CBSL to "promote and sponsor the training of technical personnel on the subjects of money, banking, statistics, finance, and other economic subjects". Accordingly, the staff of the CBSL has been able to introduce techniques, in line with global developments in theoretical and empirical economic modelling, to analyze the increasingly complex Sri Lankan economy.

Early efforts to formalize technical modelling of the Sri Lankan economy could be found in three studies by the staff of the CBSL. Sirisena (1976) developed a multisectoral model of production for Sri Lanka using input-output analysis and linear programming as production planning techniques. Karunasena's work on "A Macroeconometric Model for Sri Lanka (1986)", attempted to capture the functioning of the Sri Lankan economy by building a then-popular large scale macroeconometric model. Wijesinghe's thesis titled "Some Experiments with a Multisectoral Intertemporal Optimization Model for Sri Lanka (1986)" introduced intertemporal aspects to modelling of the Sri Lankan economy.

By late 1990s, a number of developments necessitated a serious rethinking of central banking in Sri Lanka. These included a) global developments in central banking, in particular, the view that price stability must be the overriding objective of a central bank, b) the managed floating exchange rate regime becoming unviable, c) the rapid development of financial markets and need to regulate hitherto unregulated sectors, d) financial innovation, including the development of electronic payments and fund transfer systems, together with the impending challenges from a possible "millennium bug", and e) exigencies caused by a terrorist attack in 1996 urging the CBSL to conduct its essential operations more efficiently. These developments prompted the CBSL Modernization Project, with technical and financial assistance from the IMF, the World Bank and the Sveriges Riksbank. In relation to the conduct of monetary policy, this process of modernization resulted in the establishment of the Monetary Policy Committee (MPC), floating of the Rupee, and the introduction of the system of active open market operations (active OMOs). The period that followed also saw the publication of a number of studies by the staff of the CBSL including Thenuwara (1998), Mahadeva and Thenuwara (2000), Jayamaha et al (2002), Amarasekara (2005), Weerasinghe et al (2005), Amarasekara (2008), Perera (2008 and 2009), Wimalasuriya (2009), Ratnasiri (2011), and Jayawickrema and Perera (2013). These studies focused on assessing the feasibility of inflation

targeting in Sri Lanka, analyzing the transmission channels of monetary policy, and assessing the impact of monetary policy on key macroeconomic variables in Sri Lanka.

Supported by the findings of these studies, the Economic Research Department and the Statistics Department of the CBSL continued to provide analysis and projections of inflation and economic activity to the Monetary Policy Committee (MPC) to support its recommendations on the monetary policy stance to the Monetary Board of the CBSL. The Economic Research Department has been providing Vector Error Correction (VEC) based headline and core inflation forecasts along with fan charts with a near term focus while the Statistics Department has been producing time series regression with ARIMA noise, missing values and outliers-signal extraction in ARIMA time series (TRAMO-SEATS) model combined with a moving average based method for near-term inflation forecasting. Both departments depend on indicator based nowcasting and near-term forecasting of economic activity, while Hodrick-Prescott (HP) and Band-Pass (BP) filter estimates of potential GDP have been provided to the MPC from time to time. Forward looking inputs to the MPC were introduced in mid-2000s with the commencement of the Inflation Expectations Survey, and a number of surveys, including the Business Outlook Survey and the Purchasing Managers' Index (PMI) Survey have been introduced recently. With the introduction of the core QPM outlined in this paper, these various sources of forward-looking information and results of the various near-term forecasting models will continue to feed into the process of forming a baseline medium-term outlook at the CBSL.

The latest developments in economic modelling in late 2000s, in particular, the introduction of DSGE modelling, have also attracted the attention of the CBSL, although the introduction of such models into the policymaking process has been slower than those observed in peer economies. Nevertheless, a number of recent studies authored by the staff of the CBSL as well as of the IMF have introduced DSGE techniques in the Sri Lankan context. These include Anand, Ding and Peiris (2011), who develop a model for inflation forecasting and evaluating policy trade-offs, Ehelepola (2014) provided welfare maximizing optimal monetary and fiscal policy rules for Sri Lanka in a DSGE framework, closely following Schmitt-Grohe and Uribe (2007), and Jegajeevan (2014) estimated a medium scale DSGE model using Bayesian technique to study Sri Lankan business cycles. Karunaratne and Pathberiya (2014) and Ehelepola (2015) estimated a New Keynesian Small Open Economy (SOE) DSGE model for Sri Lanka using Bayesian techniques.

The current study, which is a product of a joint project between the CBSL and the IMF attempts to build on the existing research on Sri Lanka, and produce a comprehensive small open economy quarterly projection model that can be used for practical monetary policy making in Sri Lanka.

2.2 Motivation for Building a Semi-Structural Model

The success of an inflation targeting (IT) regime mainly depends on anchoring inflation expectations at a desirable level while minimizing large fluctuations in the country's economic growth. In an IT framework, the underlying focus is on inflation. Therefore, in determining an appropriate policy stance, the most recent developments as well as probable future paths of inflation should be monitored, taking into account other numerous pressures and risks on achieving the target. Consequently, attention should be given to systematic components and other key indicators in the short term, in order to better comprehend linkages between various macro-economic variables and the impact of policy responses.

Until recently, the CBSL has been using Vector Auto Regression (VAR) and Vector Error Correction (VEC) models to assess future developments of key macroeconomic variables, and inform monetary policy decisions. They are flexible and simple models used in policy analysis which could be used for limited structural inference. However, in the move towards the adoption of a FIT regime, it is essential that a more structured approach is employed in analyzing policy trade-offs and macroeconomic dynamics for monetary policy decision purposes. Moreover, a clear logical and a practical policy framework should be in place to support the communication of policy to the public at large. In this context, small new Keynesian models, which are increasingly used in central banks for monetary policy analysis and forecasting purposes are known to improve the decision-making process.

Despite that FPAS at the central banks comprises always a suite of tools, models and processes that enable the conduct of comprehensive macroeconomic analysis and forecasting to feed into the decision-making process, it is usually built around one core (semi-)structural model. The unique benefits of the core model are its level of transparency and simplicity that it entails, while accommodating the analysis of the key features of an economy (Dizioli and Schmittmann, 2015). Laxton et al. (2009) identify at least six types of benefits that can be derived from a structured core model. It expresses variables in terms of gaps (deviation from their long-run trend) as well as trends, making the model tractable and intuitive for monetary policy analysis. These models, in addition to being a forecasting tool, can help provide economic interpretations to forecasts and related risks, and the appropriate responses to shocks, while providing a basis for exploring the monetary transmission mechanism and the dynamics of shocks to the economy.

The development of a (semi-)structural core forecasting model for the FPAS is therefore an essential ingredient to Sri Lanka's successful transition to FIT, and here we present a basic version of such customized semi-structural core forecasting model for the CBSL FPAS. This model will enable holistic analysis in the form of a baseline assessment, balance of risks to the baseline projections while allowing analysis of the nature of policy response to various kinds

of shocks.[3] To remain tractable, the model remains concise but has been designed in a structured manner to ensure that it sufficiently captures the dynamics of major macroeconomic variables and provides useful insights. Each equation in the model can be partially traced back to their theoretical underpinnings while certain aspects will strive to capture empirical traits. This will not only serve as an essential foundation to the policymakers' decision-making process but will also aid in Sri Lanka's long-term endeavor to construct a fully-fledged DSGE model. However, this model will continue to be refined and extended in a manner that will address the evolution of the economy and related challenges while ensuring that it remains agile.

3 Model Description

This section describes the QPM of the CBSL developed jointly by the CBSL staff and IMF. Our goal was to develop a coherent and consistent framework which is suitable for producing medium-term projections and simultaneously for analyzing macroeconomic risks thus contributing to formulation of monetary policy. As such, the model embodies the policymakers' view about the monetary transmission mechanism and incorporates all relevant information from macroeconomic data. A key aspect is to introduce monetary transmission channels in the model while using a transparent and tractable structure so we kept the model's structure relatively simple. These type of quarterly forecasting models were successfully used in many other central banks in their forward-looking policy making process.

It is also important to note that this model is one of many tools (including BVARs and leading indicator models) in CBSL's FPAS but as a core model it will play a significant role in the forecasting and decision-making process.

In the rest of this section we first discuss the main features of the Sri Lankan economy relevant for the model design, then we describe the structure and the monetary transmission mechanism in the model, and at the end of this section we provide more details about the key structural equations of the model (a complete list of model equations, a glossary of variables and the parameters can be found in Appendix A).

3.1 Stylized Facts of Sri Lankan Economy as Rationale for Model Design

The CBSL is vested with the responsibility of safeguarding the value of the local currency—the Sri Lankan rupee. Since its inception, CBSL has been consistently engaged in policy measures that focus on the preservation of the internal value of the domestic currency and the fact that there is not a single episode of hyper-inflation or of crises that are of a monetary

[3] See Berg, et al. 2006a for a thorough discussion on FPAS and role of QPM in the system.

nature in the history of the economy is testimony to the efficacy and level of prudence exercised in monetary management (Wijewardena, 2007).

For more than three decades, CBSL had pursued MT as its monetary policy framework wherein monetary aggregates served as the key nominal anchor in the conduct of monetary policy in Sri Lanka. Hence, the objective of economic and price stability was achieved by influencing an intermediate target that was defined based on broad money aggregates, which were in turn linked to reserve money through the money multiplier. Under this framework, reserve money was considered the operating target of monetary policy as outlined in the annual monetary program which is prepared based on the future path of key macroeconomic variables with due consideration to intersectoral linkages.

During this period, Sri Lanka's exchange rate policy has also gradually evolved from a fixed exchange rate regime to an independently floating regime. In 2001, the CBSL announced that it will halt trade of foreign exchange at preannounced rates, instead reserving the right to intervene in the market to buy and sell foreign exchange at or near market prices in order to curb undue volatilities in the short-term while enabling the country to build its international reserve position in the medium-term. Since then, the degree of the CBSL intervention in the foreign exchange market has varied from time to time. Nevertheless, throughout this period the exchange rate has played a key role in anchoring inflation expectations.

Over the years there has been a breakdown in the relationship between monetary aggregates and variables such as inflation. There has also been notable volatility in the money multiplier and velocity which has exerted significant uncertainty on the role of monetary targets as a nominal anchor—a development experienced in other developing countries too (IMF, 2014). Instability of the relationship between money and inflation has led to the CBSL's conduct of monetary policy within an enhanced monetary policy framework that comprises features of both money targeting and flexible inflation targeting. Again, this evolution of the policy framework is not unique to Sri Lanka, but has been observed in many developing countries (IMF, 2015).

3.2 Main Mechanism and Model Structure

The CBSL's QPM is a semi-structural small open economy model of the monetary transmission. As based on the New-Keynesian paradigm the model incorporates nominal and real rigidities. The model is a so-called gap model, which means that it focuses on business cycle fluctuations around an exogenously given equilibrium. The main mechanism driving

inflation over the business cycle are the fluctuations of real variables (such as output and the real exchange rate) around their long-term trends.[4]

As a semi-structural model, the model is a short-cut for a full structural model derived from optimization (DSGE). The semi-structural model has good theoretical background but its structure is flexible enough to account for many empirical findings that would be hard to capture in a fully micro-founded DSGE model but are very important for monetary policy making in emerging markets.

The underlying mechanisms can be defined with the following four basic relationships.

- Aggregate demand depending negatively on the real interest rate and positively on real exchange rate (IS curve – Euler equation).
- Aggregate supply reacting in the short run on excess demand and prices of intermediary goods in production (New–Keynesian Phillips curve).
- The central bank which sets the path of the policy rate to achieve its inflation objective (and perhaps other objectives).
- The exchange rate determined by current and future interest rate differentials adjusted by the country risk premium (uncovered interest rate parity).

The monetary policy exerts its influence on the economy through the following channels:

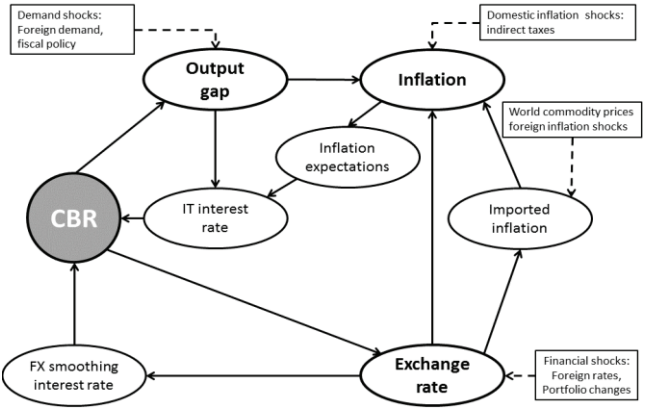
- *Interest rate channel:* In the short run, the change of real interest rates effects the agent's intertemporal substitution between today's demand and the future demand. If the real rates are higher, agents save more and postpone their spending (e.g. consumption, investment) which leads to the reduction of the demand-side inflationary pressure.
- *Exchange rate channel:* The lower the central bank's policy interest rate is the less attractive domestic instruments become, thus demand for the domestic currency falls, which leads to a depreciation. On one hand this improves the competitiveness of domestically produced tradable goods, which boost economic activity resulting in a demand side inflationary pressure. On the other hand, the weaker currency makes imported commodities and other imported production factors more expensive amplifying supply-side inflationary pressures.

[4] We construct a trend–cycle decomposition for the observed real variables in the model. The levels are defined as the sum of a cyclical and a trend component (i.e. for any real variable $x = \bar{x} + \hat{x}$ where $\hat{x}$ denotes the gap (cyclical) and $\bar{x}$ denotes the trend component). It is important to note that all variables are in logarithmic terms so cyclical components are thus expressed as a percentage of the trend. The long-term real trends in the economy (or their growth) are captured by autoregressive mean-reverting processes centered around the steady states of the respective long-run relationships.

- *Expectation channel:* Monetary policy decisions have also an effect on agents' expectations of economic growth, prices and future path of interest rates. Credible and transparent monetary policy makes agents of the economy aware what measures the central bank is likely to take to mute the effect of future shocks hitting the economy and they form their expectations about future economy growth, interest rates and prices based on this. These expectations affect decisions of firms and households about current saving and investment, and price setting.

The structure of the model and the most important channels of monetary transmission are presented in Figure 1.

Figure 1. Model Structure



3.3 Model Equations

3.3.1 Domestic Economy

Aggregate Demand

We use the overall production to reflect the business cycle position of the economy. The aggregate demand relationship corresponds to the open-economy version of the traditional IS curve which governs the intertemporal substitution between today's demand and the future demand. It takes the following form:

A general form of the equation is as follows:

$$\hat{y}_t = a_1 \cdot \hat{y}_{t-1} + a_2 \cdot \hat{y}_{t+1} - a_3 \cdot \hat{r}_t + a_4 \cdot \hat{y}_t^{foreign} - a_5 \cdot \hat{z}_t + \varepsilon_t^{\hat{y}} \qquad (1)$$

Where $\hat{y}_t$ is the deviation of the natural logarithm of output from its noninflationary level—the output gap. In this formulation, the output gap depends on its past value $\hat{y}_{t-1}$ (which reflects real rigidities e.g. habit formation) and model-consistent expectations of its future value $E_t(\hat{y}_{t+1})$. The dynamics are then driven by monetary policy through real interest rate gap, $\hat{r}_t$, (i.e., a deviation of the real interest rate, r_t, from the natural rate of interest $\bar{r}_t$). Since Sri Lanka is a small open economy its cyclical position does also depend on foreign demand, captured here by the foreign output gap, $\hat{y}_t^{foreign}$, and on the terms-of-trade approximated in the model by the real exchange rate gap $\hat{z}_t$ (i.e., a deviation of the real exchange rate, z_t, from its equilibrium level). The demand shock to the output gap is represented by $\varepsilon_t^{\hat{y}}$.

Equilibrium growth is modelled as an auto regressive process converging to the steady state growth rate:

$$\Delta\overline{y}_t = a_6 \cdot \Delta\overline{y}_{t-1} + (1 - a_6) \cdot \Delta\overline{y}_{ss} + \varepsilon_t^{\Delta\overline{y}} \qquad (2)$$

Aggregate Supply

The model disaggregates the aggregate supply into three parts: producers of core consumption goods and services (representing 68.8 percent of the CPI basket), producers of volatile food (15.2 percent) and producers of regulated transport and energy goods and services (treated as the residual).

The motivation for separate modelling of the inflation components is the different relevance of the corresponding inflationary shocks for the monetary policy. Incorporating inflation components in the QPM helps to distinguish various sources of inflation as well as different dynamic properties of its components and to capture better the dynamics of the overall inflation. Table 1 shows how the forecasting performance improved after adding the inflation components into the model.

Table 1. Comparison of RMSE for Headline Inflation with and without Inflation Components in the QPM

Quarters ahead	1Q	2Q	3Q	4Q	5Q	6Q
Headline Inflation, % YoY						
without inflation components in QPM	1.0	2.0	2.8	3.4	3.5	3.4
with inflation components in QPM	1.3	2.0	2.4	2.8	2.8	2.9

Aggregate supply in the model is represented by the Phillips-curve-type equations linking the real sector with nominal prices. Each inflation component (Core, Energy and Transportation,

and Volatile Food) has its own equation comprising different set of factors. The headline inflation is the weighted average of the three components plus a discrepancy term:

$$\pi_t = a_{14} \cdot \pi_t^c + a_{13} \cdot \pi_t^{vf} + (1 - a_{14} - a_{13}) \cdot \pi_t^{et} + \pi_t^{disc} \quad (3)$$

In line with the New Keynesian approach of the model, core inflation (modeled by equation (4)) is driven by the inflationary expectations $E_t[\pi_{t+1}^c]$. Since firms can't adjust prices in fully flexible way, we include backward-looking inflation π_{t-1}^c to match the observed rigidity of core prices.

$$\pi_t^c = a_{15} \cdot \hat{y}_t + a_{16} \cdot \pi_{t-1}^c + (1 - a_{16} - a_{19}) \cdot \pi_{t+1}^c - a_{17} \cdot (\hat{z}_t - a_{13} \cdot \hat{rp}_t^{vf/c} - (1 - a_{13} - a_{14}) \cdot \hat{rp}_t^{et/c}) + a_{18} \cdot \hat{rp}_t^{et/c} + a_{19} \cdot \Delta p_t^{food,imp,c} + \varepsilon_t^{\pi^c} \quad (4)$$

The costs of domestic production factors in core sector are captured by the output gap $\hat{y}_t$, while the costs of imported production factors are captured by sectoral effective real exchange rate gap (real exchange rate gap — $\hat{z}_t$ — adjusted by the differential between headline and core inflation). Since core basket includes food components too, and the production of core goods is energy intensive we introduced the direct effect of imported food inflation $p_t^{food,imp,c}$ (world food inflation in rupee adjusted by long term sectoral price dynamics) and the spillover effect from domestic energy and transport prices $\widehat{rp}_t^{et/c}$, where $\widehat{rp}_t^{et/c}$ is the relative price of energy and transport against the core price index.

We are calculating sectoral relative prices rp_t^j against the core price index. In order to better monitor changes in relative prices we construct a trend-gap decomposition. For all sectors, we assume that relative prices are converting back to their long-term trend (i.e. the cyclical components will close over the forecast horizon).

The relative price in sector j is defined as:

$$rp_t^j = p_t^j - p_t^c$$

where p_t^j is the log level of prices in sector j and p_t^c is the log level of prices in the core sector. The relative price is decomposed into a gap and trend components:

$$rp_t^j = \widehat{rp}_t^j + \overline{rp}_t^j$$

Where $\widehat{rp}_t^j$ refers to the cyclical component of relative prices and $\overline{rp}_t^j$ to its trend component which growth evolves according to an auto regressive process converging to its steady state growth

$$\Delta\overline{rp}_t^j = a \cdot \Delta\overline{rp}_t^j + (1-a) \cdot \Delta\overline{rp}^j + \varepsilon_t^{\overline{rp}_t^j}$$

Sri Lanka is an oil importer country, and thus administered energy and transport inflation depends on the world oil price dynamics. We capture this relationship by introducing the direct effect of imported oil price inflation $\Delta p_{t-1}^{oil,imp,et}$ (world oil inflation in rupee adjusted by long term sectoral price dynamics) in the Phillips curve of Energy and Transport inflation (equation (5)). Inflationary pressure from sectoral real costs are captured by the real oil price gap $\hat{q}_{t-1}^{oil,et}$. For each commodity sector we assume that sectoral relative prices (calculated against core prices) can't deviate permanently from a long-term trend thus we introduced the sectoral relative price gap $\widehat{rp}_{t-1}^{et/c}$ as a correction term in the Philips curve.

$$\pi_t^{et} = a_{22} \cdot \pi_{t-1}^{et} + (1 - a_{22} - a_{23}) \cdot \pi_{t+1}^{et} + a_{23} \cdot \Delta p_{t-1}^{oil,imp,et} + a_{24} \cdot \hat{q}_{t-1}^{oil,et} - a_{25} \cdot \hat{rp}_{t-1}^{et/c} + \varepsilon_t^{\pi^{et}} \quad (5)$$

Meanwhile volatile food inflation π_t^{vf} is modeled as a mean reverting process plus the adjustment with the sectoral relative price gap $\widehat{rp}_{t-1}^{vf/c}$:

$$\pi_t^{vf} = a_{20} \cdot \pi_{t-1}^{vf} + (1 - a_{20}) \cdot \overline{\pi}_t^{vf} - a_{21} \cdot \hat{rp}_{t-1}^{vf/c} + \varepsilon_t^{\pi^{vf}} \quad (6)$$

Monetary Policy Rule and the Uncovered Interest Rate Parity

Since the CBSL has multiple objectives the monetary policy in the model is described as combining two policy rules—an interest rate rule for inflation and growth objectives and an exchange rate rule for smoothing of the exchange rate.

Inflation and Output Objective

The first rule assumes that the CBSL's action is primarily aimed at stabilizing inflation and output. It's important to note that it does not mean that the CBSL follows an inflation-targeting regime in the strict sense of a monetary policy strategy. This type of monetary policy adjusts the nominal interest rate to influence credit conditions and exchange rate, with a view to bring inflation to desired range or target and output to its potential (non-inflationary) level.

The specification of the interest rate rule is following:

$$i_t^{pol} = a_7 \cdot i_{t-1} + (1 - a_7) \cdot (i_t^{neu} + a_8 \cdot \hat{\pi}_t + a_9 \cdot \hat{y}_t) + \varepsilon_t^i \quad (7)$$

$$\hat{\pi}_t = \pi_{t+4} - \overline{\pi}_t \quad (7a)$$

$$i_t^{neu} = \overline{r}_t + \pi_{t+1}^4 \quad (7b)$$

Where i_t^{pol} represents the (annualized) short term interest rate which is consistent with an inflation and output stabilization objective. We assume that the CBSL adjusts short term interest rates (i_{t-1}) smoothly and reacts on the expected deviation of CPI inflation from the inflation objective—$\widehat{\pi}_t$ is the difference between expected future inflation $E_t(\pi_{t+4})$ and the inflation objective $\overline{\pi}_t$ (see (7a)). The reason for including a forward–looking inflation term into the rule is to avoid excess volatility by ignoring short–term transitory inflationary shocks and to capture the transmission lag of monetary policy.

Furthermore, the CBSL stabilizes the output at its sustainable level. This is captured by the reaction of the interest rate on the current output gap $\hat{y}_t$.

The interest rate is also determined by the policy-neutral rate, i_t^{neu}, which is the rate of interest that does not cause any demand pressures. It is the sum of the real neutral rate of interest and model-consistent inflation expectations (7b).

The uncovered interest rate parity condition (UIP) describes the dynamics of the exchange rate consistent with the inflation-targeting interest rates:

$$i_t^{pol} = i_t^{foreign} + 4(s_t^e - s_t^{uip}) + \rho_t + \varepsilon_t^{\Delta s} \quad (8)$$

where s_t^{uip} is the nominal exchange rate consistent with the interest rate i_t^{pol}; s_t^e is the model-consistent expectation of the nominal exchange rate; $i_t^{foreign}$ is the (annualized) foreign nominal interest rate; ρ_t is the risk premium; and $\varepsilon_t^{\Delta s}$ is the exogenous innovation to the exchange rate. The UIP implies that the expected depreciation of the currency must equal the interest rate differential adjusted by risk premium so there is no arbitrage between investing money domestically or abroad.

Exchange Rate Smoothing Objective

The second policy rule assumes that the primary objective of the CBSL is to smooth exchange rate movements. This type of monetary policy adjusts the nominal interest rate to influence exchange rate with a view to smooth movements of the exchange rate.

The annualized short-term interest rate consistent with this regime is derived from the UIP condition:

$$i_t^{uip} = i_t^{foreign} + 4 \cdot (s_t^e - s_t^{pol}) + \rho_t + \varepsilon_t^{\Delta s} \quad (9)$$

$$\Delta s_t^{pol} = 4 \cdot (s_t^{pol} - s_{t-1}) \quad (9a)$$

Where i_t^{uip} and s_t^{pol} represent the (annualized) short term interest rate and the desired level of exchange rate respectively which are consistent with the exchange rate smoothing objective so the desired level of exchange rate is equal to the quarterly depreciation target (Δs_t^{pol}) plus the lagged level of exchange rate (9a).

The quarterly depreciation target is set by a simple exchange rate rule

$$\Delta s_t^{pol} = a_{10} \cdot \Delta s_{t-1}^{pol} + (1 - a_{10}) \cdot (-\Delta \overline{z}_t + \overline{\pi}_t - \pi_{ss}^{foreign} + a_{11} \cdot \hat{z}_{t-1}) + \varepsilon_t^{\Delta s^{pol}} \quad (9b)$$

As in the case of the interest rate we assume that the CBSL adjusts its depreciation target smoothly but in the long-term equilibrium it should be set consistently with the inflation target.

The Policy Rate

The actual short-term policy rate is then a combination of the two different rates defined above.

$$i_t = a_{12} \cdot i_t^{pol} + (1 - a_{12}) \cdot i_t^{uip} \quad (10)$$

This formula allows the policymaker to choose between its objectives in a flexible way. Parameter a_{12} reflects the relative importance of the inflation objective in the policymaker's preferences. In the extreme case when this parameter is equal to 1(0) the Central Bank follows a fully inflation targeting (exchange rate smoothing) regime.

It's easy to show that the current level of exchange rate is also a combination of the two exchanges rates under the two different regimes:

$$s_t = a_{12} \cdot s_t^{uip} + (1 - a_{12}) \cdot s_t^{pol} \quad (11)$$

Real Exchange Rate and Long run UIP

The real exchange rate is calculated against the US dollar and is defined as the nominal exchange rate adjusted for price level differential. Moreover, relative purchasing power parity relates domestic and foreign inflation rates to the change in the exchange rate.

$$z_t = p_t - s_t - p_t^{foreign} \quad (12)$$

The model also satisfies the long-run version of the UIP (Eq 13) expressed in real terms and equilibrium values of these variables:

$$\overline{r}_t = \overline{r}_t^{foreign} - \Delta \overline{z}_{t+1} + \rho_t \quad (13)$$

The equation determines the equilibrium level of the domestic neutral real interest rate $\overline{r}_t$ in relation to the foreign neutral rate $\overline{r}_t^{foreign}$, the equilibrium real exchange rate depreciation $\Delta\overline{z}_t$, and the risk premium, ρ_t , respectively.[5]

3.3.2 External Sector

As the purpose of the model is not to provide forecast of the external sector variables, we model the dynamics of the external variables very simply. Moreover, since Sri Lanka is a small price-taker economy, we consider external sector as fully exogenous. The block includes U.S. output gap, U.S. CPI inflation and U.S. interest rates as approximations to global demand, inflationary pressures and global liquidity conditions. It also includes world oil and food prices. The variables are assumed to be captured by autoregressive mean-reverting processes centered on the steady states of the respective long-run relationships. The complete list of external sector equations is shown in Appendix A.

4 Parameterization

4.1 Data Sources

The study uses data on key macroeconomic variables for Sri Lanka, namely real GDP, Colombo Consumer Price Index (CCPI) and its components, nominal interest rate (Average Weighted Call Market Rate), nominal exchange rate (US$/Rs). Foreign data include Fed Fund rate, Brent oil price, FAO world food price index, etc. Except for GDP and Inflation related data that are obtained from the DCS, all other domestic data are obtained from the CBSL. Foreign data are from sources as listed in Table 4. Forecasts of foreign variables were obtained from Mantis forecast database. All variables subject to seasonality are seasonally adjusted using X12 software package.

In the instances where data are available under different base years, a combined data series is generated using splicing technique. We extended available historical range of inflation components series using inflation data based on the previous methodology of the Department of Census and Statistics (DCS). DCS has from time to time changed the methodology and the base years of estimating key macroeconomic variables that it compiles without corresponding revisions to the previously compiled historical data. In the absence of officially published continuous data series for GDP and inflation, researchers are compelled to resort to various techniques to derive uninterrupted series largely in line with previously published data. We

[5] The variables on the right-hand side of equation (13) are modeled as autoregressive mean-reverting processes centered on the steady states.

have therefore implemented technical tools helping to overcome this issue of break in the data series and consistently calculated historical series reflecting the recent base year and the compilation methodology. Accordingly, continuous inflation series is obtained by rebasing the historical series. The combined observed GDP data series is obtained by rebasing GDP levels based on the base years 1996 and 2002 to the new base year 2010. In the meantime, noise in the combined series is treated by adding a measurement error component to the GDP equation. The model based GDP series, named as adjusted GDP, is obtained after removing measurement error from the observed combined GDP data series. This treatment is explained in detail in Box 1. Sri Lankan authorities are currently working with international agencies, including the IMF, to improve the quality of macroeconomic data compiled by DCS.

Table 2. Summary of the Data used in the Model

Variable	Notation in the Model	Data Source
Domestic Block		
Real Gross Domestic Product	l_y	DCS
Colombo Consumer Price Index	l_cpi	DCS
Core Inflation	l_cpi_core	DCS
Volatile Food Inflation	l_cpi_vfood	DCS
Energy and Transport Inflation	l_cpi_et	DCS
Average Weighted Call Money Rate	rn	CBSL
Nominal LKR per USD Exchange Rate	l_s	CBSL
Foreign Block		
Fed Funds Rate	rn_f	FRED Federal Reserve Bank of
U.S. Output Gap	l_y_gap_f	St. Louis
U.S. CPI	l_cpi_f	Mantis
Brent Oil Price	l_oil	OECD statistics
FAO Food Price Index	l_food	Bloomberg
		FAO

4.2 Calibration Techniques

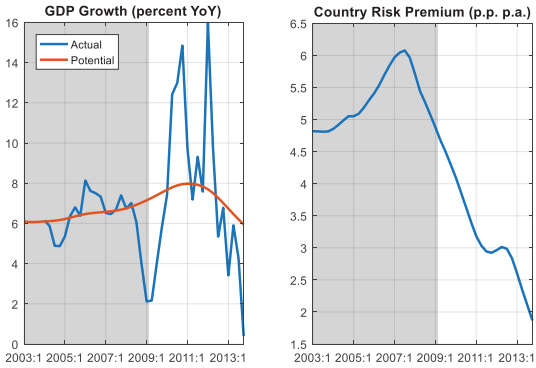
Instead of estimating the model parameters, similar to other central banks that adopted these type of models, we calibrate them because the estimation of small, semi-structural models for developing countries faces several limitations. In these countries, including Sri Lanka, the data samples are typically very short and noisy and include structural breaks making identification more difficult for even the small-scale QPM.[6] Thus estimating even our model which has

[6] For example, our sample consists of data for a period between 2001 and 2015. This means that we have about 14 years of quarterly data (56 data points), including the periods affected by the civil war in Sri Lanka which ended in May 2009, and the global financial crisis which emerged in 2007.

about 50 parameters (including standard deviations of shocks) and on the top of that consists of several unobserved variables that must be estimated would not be advisable.

In case of Sri Lanka, the civil war which ended in May 2009 represents a particularly distinctive structural break. Admittedly, the QPM is not capable of accounting for structural breaks explicitly, or of shedding a light on drivers and dynamic of structural changes in the Sri Lankan economy. Its relatively modest structure and focus on deviations (i.e. gaps) from long-term equilibria and linear nature of the model make it not directly suitable for capturing these structural changes. That being said, the QPM has been useful to identify an increase in potential output and decline in country risk premium (and subsequent real exchange rate appreciation) which we largely attribute to improving economic prospects following the peace. Figure 2 shows a temporary increase in potential output growth of about 1.5 percentage points right after the end of the war. At about the same time, the risk premium was trending down from its peak of 6 percentage points per annum in 2007 to around 2 percentage points per annum in 2013.

Figure 2. Model Structure



Despite the above-mentioned limitations of the QPM in capturing structural changes, we have been conscious of the civil war while calibrating the model. When assessing the model calibration using various tools mentioned below, we have been putting more emphasis on the model performance after the civil war than before 2009.

Despite of the fact that we did not estimate the model for the reasons mentioned above, calibration is still a long iterative process. In every iteration step the model's calibration is examined using several diagnostic tools until a satisfactory calibration is achieved.

These tools are:

- Impulse response functions for assessing dynamic properties of the model.
- In-sample historical forecast simulations for assessing model's forecasting performance.
- Filter decomposition to compare model's interpretation of the past events with experts' views and stylized facts.

The results of these diagnostic tools are discussed in Section 5.

4.3 Calibration of Main Behavioral Equations

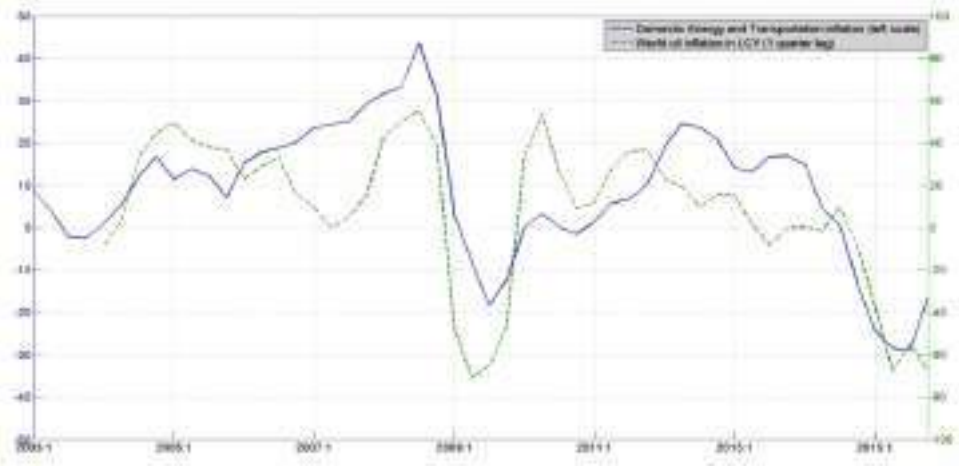
Modelling experience of other countries, particularly emerging markets, were analyzed to choose parameter values for Sri Lanka. However, characteristics of the Sri Lankan economy and policy-making were considered when adapting parameter values for the Sri Lankan context.

The coefficient on lagged output gap in the output gap equation depends to a large extent on the degree of output inertia in the economy, the effectiveness of monetary policy transmission, and the openness of the economy. Berg, Karam, and Laxton (2006) suggest that the value of the coefficient on lagged output lies between 0.5 and 0.9, with a lower value for less mature economies more susceptible to volatility. For Sri Lanka, we choose a value of 0.6 taking into account the emerging developments of the Sri Lankan economy. The coefficient on expected output gap is typically small, and we choose a value of 0.3 for Sri Lanka. The parameter of real interest rate gap depends on the effectiveness of the monetary transmission mechanism, while the parameters on real exchange rate gap and foreign output gap depend on the importance of the exchange rate channel and the degree of openness. We selected relatively low values for the above three parameters reflecting Sri Lanka's relatively weak interest rate channel, tightly managed exchange rate regime, and non-diversified export dependence.

Inflation dynamics in the economy were modelled using the three Phillips Curve equations, each of which individually tracks the movements in core inflation, volatile food inflation and energy and transport inflation, respectively. In the Phillips Curve equation for core inflation, the parameter on output gap depends on how much core inflation is influenced by real demand pressures, and affects the 'sacrifice ratio' of the economy. We selected a value of 0.27 for this parameter since price dynamics of core items are mainly driven by domestic excess demand. We set the parameter on backward component in the core inflation equation relatively small at 0.25, to match the high volatility of the observed data. As Sri Lanka is an open economy, the imported inflation components have strong effect on core prices too. We set the parameter of real exchange rate to 0.15 resulting in a strong pass-through of the exchange rate which is in line with the past experience. Furthermore, as an energy intensive sector we set the spillover

effect from energy prices to 0.06. Since the weight of non-volatile food prices is small in the core basket we set the direct effect of imported food price dynamics to 0.02.

Figure 3. Domestic Headline and World Commodity Inflation



Domestic administered energy inflation follows world oil price dynamics (see Figure 3) tightly thus we set relatively high parameters on the imported inflation components (0.25) and sectoral real marginal costs (0.5) in the Phillips Curve for Energy & Transport inflation. Consequently, we also observe a little price rigidity in this sector which is captured by a small parameter (0.1) on the backward component.

Volatile food inflation was parameterized to respond to its lagged value, however it is assumed that volatile food inflation reverts to its long-term trend fast and thus a higher weight was assigned for the respective parameter.

The parameters in the interest-rate monetary policy rule equation depend on the speed with which the central bank adjusts the nominal interest rate, and the relative importance of the inflation target versus the real economic activity target. We choose a value of 0.8 for the parameter on inflation gap, in line with the CBSL's gradual move towards a flexible inflation targeting regime (FIT), while a value of 0.1 was chosen for parameter on output gap. Reflecting the smooth path of the interest rate in the past, we set the interest rate smoothing parameter high to 0.8. This value is also in line with the estimates of this parameter for emerging markets by Mohanty and Klau (2004).

The weight on inflation-targeting interest rate rule as opposed to the exchange rate rule (parameter a_{12}) was set to 0.8. Thus, the calibrated value does still capture the CBSL's partial attention to the exchange rate volatility. Going forward, the parameter would be subject of

revision(s) along the progressing transition to FIT which will decrease and ultimately eliminate exchange rate rule. Moreover, as the CBSL adopts FIT and the new framework gains credibility, it would be realistic to expect stronger anchoring of inflation expectations around the medium-term inflation target. In such a case, the calibration of the Phillips curves driving inflation dynamics would need to be revisited potentially increasing weights on their forward-looking components. Similarly, a build-up in policy credibility, emphasis on interest rate operational target, and inflation as nominal anchor may require in the future recalibration which would strengthen interest rate channel and weaken exchange rate channel of monetary policy transmission (parameters at the real interest rate and real exchange rate gaps in the IS curve and parameters driving exchange rate pass-through in Phillips Curves and core Phillips Curve in particular).

4.4 Calibration of Steady States

The steady state of inflation rate is set to 5 percent which coincides with the recent medium term inflation targets of the CBSL. This rate is also consistent with stable inflationary periods (since 2009) of Sri Lankan economy. Since we are not expecting permanent differences in price dynamics of CPI components we set the same steady state inflation for all sectors.

The steady state of the real GDP growth rate is calibrated at 6.0 percent. The country achieved over 8 percent growth rates temporarily after the end of the internal conflict, but adverse weather conditions coupled with foreign economy contractions resulted in growth rates moderating around 3-5 percent. The economy grew at an average rate of 6.0 percent since 2003 which is also consistent with the stable growth rates observed in the early 2000's. The steady state value of real exchange rate appreciation was set to 2 percent. The real exchange rate appreciated by approximately 2.6 percent per annum on average, but we anticipate somewhat lower rate in long-term equilibrium based on the recently observed convergence. The real exchange rate appreciation (together with the 5 percent steady state for domestic inflation and 2 percent for foreign inflation) results in a 1 percent nominal depreciation in steady state. The country risk premium was calibrated at 5 percentage points per annum to match the historical levels of interest rate differential.

The steady states of the external sector variables were set consistently with figures in the DSGE literature or to the historical averages of the respective variables. Consequently, the steady state of foreign inflation was set to 2 percent, steady state of foreign real interest rate to 1 percent, and steady state of inflation of real oil and food prices to 7.5 percent and 7 percent, respectively.

Table 2. Summary of the Data used in the Model

Parameter†	Density	P(1)*	P(2)*	P(3)*	Calibrated Value*	ML Estimate
a_1 (c1_l_y_gap)	Beta	0.1	0.9	0.05	0.60	0.5480
a_2 (c2_l_y_gap)	Beta	0.1	0.9	0.05	0.30	0.2000
a_3 (c3_l_y_gap)	Beta	0.001	0.6	0.01	0.05	0.0354
a_4 (c4_l_y_gap)	Beta	0.001	0.6	0.01	0.10	0.0938
a_5 (c5_l_y_gap)	Beta	0.001	0.6	0.01	0.08	0.0637
a_7 (c1_rn)	Normal	0.2	0.99	0.01	0.80	0.8133
a_8 (c2_rn)	Beta	0.01	0.9	0.07	0.80	0.7744
a_9 (c3_rn)	Beta	0.0	0.9	0.01	0.10	0.0988
a_{11} (c2_dl_s_pol)	Normal	0.1	3	0.07	1.00	0.8220
a_{12} (w_rn_rule)	Normal	0.1	0.99	0.03	0.80	0.8066
a_{26} (c1_dl_cpi_disc)	Uniform	0.0	0.99	1/12	0.50	0.0787
a_{15} (c1_dl_cpi_core)	Beta	0.1	0.99	0.02	0.27	0.2509
a_{16} (c2_dl_cpi_core)	Beta	0.0	0.99	0.02	0.25	0.2743
a_{17} (c3_dl_cpi_core)	Beta	0.001	0.99	0.01	0.15	0.1366
a_{18} (c4_dl_cpi_core)	Beta	0.001	0.6	0.01	0.06	0.0435
a_{19} (c5_dl_cpi_core)	Beta	0.001	0.6	0.01	0.02	0.0288
a_{20} (c1_dl_cpi_vfood)	Normal	0.0	0.99	0.1	0.10	0.2680
a_{21} (c2_dl_cpi_vfood)	Normal	0.0	4	0.2	2.00	1.2902
a_{22} (c1_dl_cpi_et)	Normal	0.0	0.99	0.1	0.10	0.2089
a_{23} (c2_dl_cpi_et)	Beta	0.0	0.9	0.05	0.25	0.1807
a_{24} (c3_dl_cpi_et)	Normal	0.0	2	0.1	0.50	0.1664
a_{25} (c4_dl_cpi_et)	Normal	0.0	4	0.1	0.50	0.4487
a_{31} (c1_e_l_s)	Beta	0.2	0.999	0.01	0.90	0.8722

† All model equations and the parameters' descriptions are reported in Appendix A. Parameter names in parenthesis follow the notation adopted in the actual model code.

* Note: P(1), P(2) and P(3) indicate the lower bound, upper bound and the standard deviation of the prior distributions. Means of the prior distributions were set to the calibrated values.

4.5 Fine tuning calibration using Bayesian Maximum Likelihood Estimation

Application of Bayesian methods in DSGE models became very popular during the last two decades owing to the main desirable attributes they possess.[7] Bayesian approach uses the likelihood function generated by the solution of the DSGE model in estimation and additional information can be incorporated into the parameter estimation by using prior distributions. That way, Bayesian technique falls in between calibration and maximum likelihood estimation. Providing a prior value is related to calibration practice while maximum likelihood method is connected to estimating the model with data. Priors can be viewed as weights on the likelihood

[7] See Lubik and Schorfheide (2006) and An and Schorfheide (2007) for more details.

function used to give more prominence on the desired parts of the parameter subspace. Well-known Bayes' theorem links the prior with the likelihood function, establishing the posterior density.

In our case, we have used Bayesian estimation merely to fine-tune our calibration. After thorough initial calibration of the model based on analysis of the various model properties (in-sample simulations, shock response functions, and model's interpretation of history) we run Bayesian Estimator with relatively narrow priors centered on the calibrated values. The purpose is to find a point in the close neighborhood of the calibration which explains the data better, but does not deviate from the calibrated values too much. A subset of key parameters selected from Appendix A: Table 4 are estimated for which the prior distributions and estimated values are given in Table 2.

Table 3. RMSE Comparison of the Main Model Variables

Variable	1Q	2Q	3Q	4Q	5Q	6Q
Core Inflation, % YoY						
original	0.8	1.3	1.7	2.1	2.3	2.3
estimated	0.7	1.1	1.4	1.8	1.9	1.9
Real GDP, % YoY						
original	1.2	1.7	2.0	2.2	1.8	1.7
estimated	1.0	1.3	1.4	1.5	1.6	1.7
Nominal Interest Rate, %						
original	1.3	1.2	1.3	1.4	1.5	1.5
estimated	1.2	1.2	1.3	1.4	1.6	1.6
Nominal Exchange Rate Depreciation, % YoY						
original	2.1	3.2	3.8	4.1	4.6	4.8
estimated	2.1	3.3	4.0	4.3	4.7	4.9

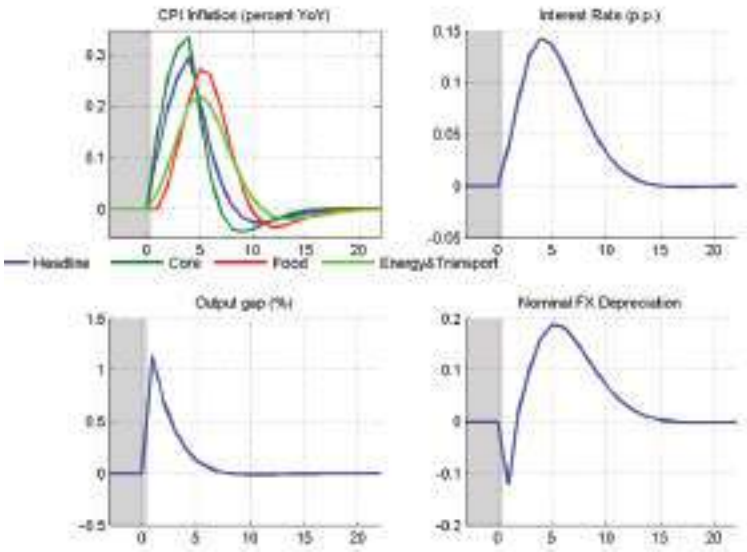
The estimation improved in-sample forecasting performance of the model. Properties of the estimated model were analyzed by checking its in-sample fit and comparing it to the fit of the original version of the model. RMSE of the estimated model shows better results for inflation and GDP growth, and almost the same results for the interest and exchange rates (Table 3).

5 Economic Implications and Model Properties

5.1 Dynamic Properties

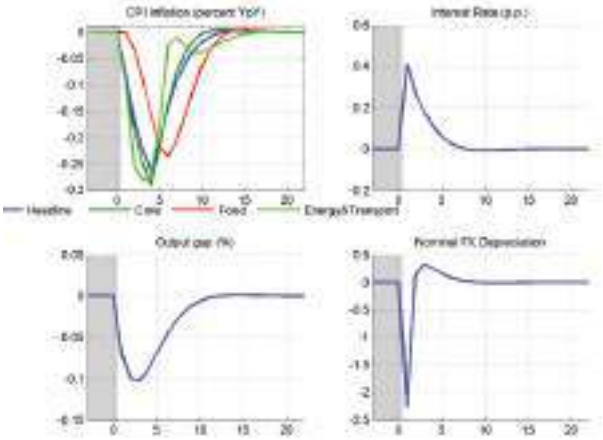
In this section we demonstrate the dynamic properties of the model by analyzing impulse responses to main structural shocks. Impulse response function is an important tool for understanding the dynamic properties, and the monetary transmission channels of the model, thus helping in the calibration of the model. An impulse-response function (IRF) refers to the reaction of the modelled variables in response to an (one percent) unexpected shock in the first period of simulation. The figures are presented relative to the variables' steady state.

Figure 4. Demand Shock



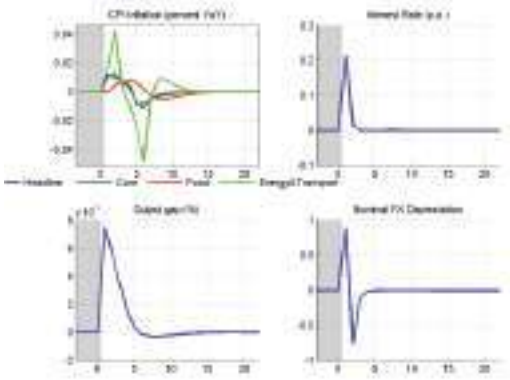
The aggregate domestic demand temporary increases when a positive output shock hits the economy. Since core price dynamics in Sri Lanka are mainly driven by excess demand pressures, we are expecting an immediate increase in the price of core items. This inflation should pass through within the supply chain to other sectors resulting in higher headline inflation. As one of the main objectives of CBSL is to maintain price stability, the authorities need to react by tightening the policy rate to mitigate the demand side inflationary pressure. The uncovered interest rate parity principle implies that the higher interest rate, which makes Sri Lanka more attractive for foreign investors results a temporary appreciation of the nominal exchange rate. The stronger currency coupled with tight policy stance can reduce domestic economic activity, and the vanishing excess demand and lower import prices can bring inflation back to its target.

Figure 5. Monetary Policy Tightening



An unexpected increase in the Sri Lankan policy rate makes the country more attractive to invest thus the UIP condition implies an immediate exchange rate appreciation. As the change of policy rate passes through to commercial loan and deposit rates, the increased returns encourage domestic agents to postpone their spending and save more. On the other hand, the overvalued domestic currency makes Sri Lankan export (import) more expensive (cheaper) indicating a temporary contraction of the real activity. The lower imported production costs caused by the strong domestic currency together with economic slowdown (negative output and real exchange rate gap) can reduce demand (core) and exchange rate (Energy &Transportation) sensitive inflations temporarily.

Figure 6. Temporary Exchange Rate Shock

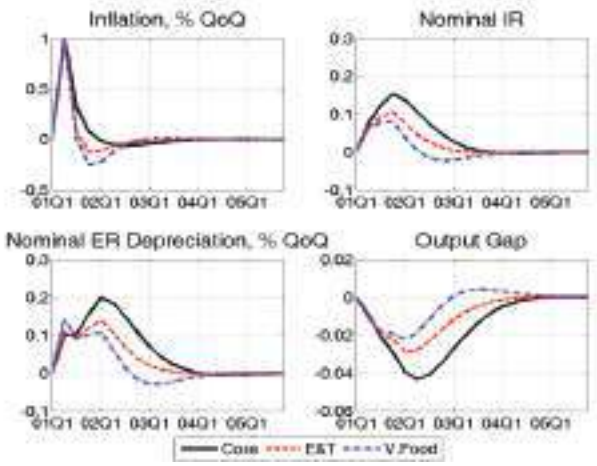


The rupee temporarily depreciates in a response to an unexpected foreign exchange (UIP) shock representing a temporary worsening of foreign investors' appetite for Sri Lankan assets. The weak currency increases the import prices which raise domestic commodity prices (Energy

& Transport and non-volatile food) directly, and also results in a supply side inflationary pressure in the other sectors through the higher production costs. Since Sri Lanka is highly globally integrated the growing competitiveness of traded goods - due to the depreciation of rupee - heats economic activity. This excess demand results in an inflationary pressure. To reach price stability and to bring exchange rate closer to its desired level, the CBSL needs to cool down economic activity and to appreciate domestic currency by setting more restrictive monetary conditions.

Difference in dynamic properties of the inflation components is consistently reflected in the structure of the model. The transmission of the inflationary shocks into economy depends on its nature and therefore requires different magnitude and duration of the monetary policy reaction. Volatile food price shocks are usually caused by the temporary factors and fade out relatively fast, while the prices included into core index have more persistent factors behind them and require more attention of the monetary policy. Impulse responses in Figure 7 show reactions of the monetary policy to the 1 percentage point increase in the headline inflation caused by the different inflationary shocks. Current model structure implies the strongest policy reaction in case of the core inflation shock as the impact of this shock on the economy is the highest and most persistent if compared to the other inflationary shocks. In line with its temporary nature, the effect of the volatile food price shock is the smallest and requires relatively modest policy reaction.

Figure 7. Policy Response to the Different Supply Shocks



5.2 Historical Shock Decomposition

Another important tool used in calibration process is analyzing the past shocks identified by the model during the filtration stage to check whether the interpretation of past events is in line with expert's views and stylized facts. Figure 8 shows the historical shock decomposition

of annual inflation. The graph implies that the model identifies the source of past inflationary pressures properly.

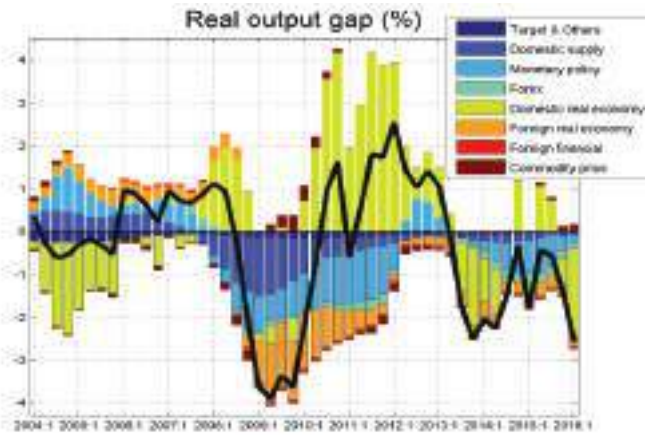
The foreign real economy and the weak exchange rate (captured by positive effect of monetary and exchange rate shocks) contributed to the Sri Lankan inflation positively until the beginning of financial crises, but the main contributors of the high inflation period between 2007 and 2009 were the growing domestic non-core prices. One factor behind these dynamics was the high imported inflation caused by increasing international commodity prices but since domestic administered energy inflation was higher than what underlying factors explained, the model identifies large domestic supply shocks for this period. The imported disinflation due to the big drop in international commodity prices during the years of financial crises resulted in a large domestic disinflation in 2009 which effect was amplified by the negative real effect of the crises, captured by the negative foreign economy shocks. Although increasing commodity prices forced domestic prices to go up from 2010 the stable exchange rate (negative contribution of exchange rate and monetary policy shocks) and the permanently weak foreign demand kept Sri Lankan inflation stable until 2012. As the commodity prices fell again in late 2011 the domestic prices started to decline but the looser monetary stance, and the depreciation of rupee led to a higher inflation. After the stabilization of exchange rate prices started to fall from 2013. Disinflation was amplified by the reduction in domestic and foreign economic activity from 2014 and the low commodity prices from 2015.

Figure 8. Shock Decomposition of Annual Inflation

Despite the weak domestic demand, weak currency (captured by the positive effect of monetary policy and foreign exchange shocks) and strong foreign demand kept output gap close to zero in the early 2000's. As domestic demand increased from the mid 2000's and as the exchange rate started to depreciate significantly, Sri Lankan economy became slightly

overheated from 2006 until being hit by the global financial crises. The negative effect of declining foreign demand caused by the crisis was amplified by a tight monetary stance resulting in overvaluation of the rupee until its devaluation in 2012. These impacts were muted and offset by an improvement in domestic demand from 2009 when the civil war ended. The tight monetary policy, decreasing domestic and foreign demand have resulted in a permanently opened output gap since 2013.

Figure 9. Shock Decomposition of Real Output Gap



5.3 Historical Forecast Performance

The third important tool used in empirical validation process is checking the model's historical in sample forecast performance. In this exercise, we examine whether the model would have given reasonable projections and policy advices in the past. These in-sample simulations for each quarter in range from 2004Q1 to 2015Q4 are conducted as follows:

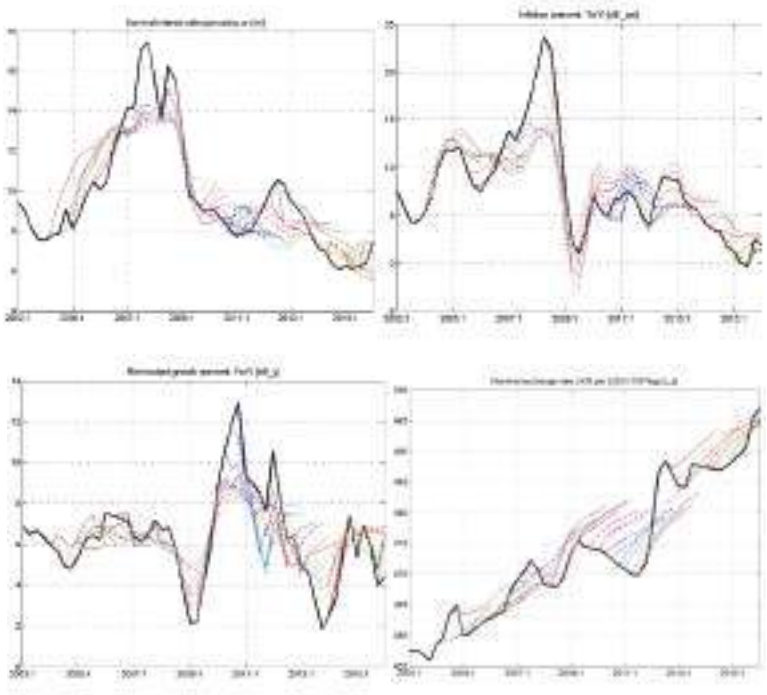
- all the observed variables are treated as known until the starting date of each simulation;
- external variables which are exogenous to the model[8] are treated as known over the forecast horizon (8 quarters ahead), because the QPM is not supposed to produce forecast for those variables.

Figure 10 shows the in-sample forecast of the main macro variables (colored dashed lines) compared with the actual data (solid black line). The figures suggest that the forecasting ability

[8] These are: US output gap; Fed funds rate; US CPI; international oil and food prices gap;

of model is satisfactory: the model forecasts inflation and real growth quite precisely, however there are periods when the model failed to predict the actual outcome.

Figure 10. In-sample Forecast of the Main Macro Variables



The in-sample simulations for inflation and interest rates deviated substantially from the actual outcome in the high inflationary period from 2007 to the middle of 2008, when domestic commodity prices increased much more than what international price dynamics would have explained. However, the forecast performance of the model improved after the domestic supply shocks died out and foreign shocks (financial crises, low commodity prices in 2009) started to drive the dynamics of Sri Lankan prices. The forecast was a slightly biased for the period 2010 – 2011 when the model was unable to predict the significant appreciation of the rupee.

Similarly, the model performs well in the case of real growth: the forecast errors are small before and during the financial crises but failed to project the large growth rates that were observed after the end of the civil war and the small growth rates when floods afflicted the Sri Lankan economy.

We can conclude that the forecast performance of the model performs is very good in periods when only small shocks or only foreign shocks hit the Sri Lankan economy but underperforming for periods with large, well identifiable and unpredictable domestic shocks. This finding implies that the current calibration of this simple model captures the fundamental relationship of economic variables and the underlying dynamics of the Sri Lankan economy well.

The historical performance is also evaluated by examining the forecast errors. Table 4 reports the ratio of the root mean square errors (RMSE) of the model forecast to that from the random walk (RW) for one to eight quarters ahead. A value smaller than one indicates that our model outperforms the random walk. The smaller the ratio is the better the model predicts the variable than the random walk. The QPM outperforms the random walk model as the computed ratios are less than unity for all variables over the forecast horizon, with an exception of interest rate forecast in one quarter ahead.

Table 4. Ratio of RMSE of the Model Forecast to that from the Random Walk

Quarters ahead	1Q	2Q	3Q	4Q	5Q	6Q	7Q	8Q
Real GDP growth (percent, YoY)	0.69	0.60	0.52	0.47	0.46	0.48	0.50	0.54
CCPI Inflation (percent, YoY)	0.52	0.50	0.49	0.49	0.46	0.47	0.49	0.51
*LKR per USD FX rate (100*log)*	0.88	0.80	0.77	0.74	0.72	0.71	0.70	0.69
Nominal Interest Rate (percent p.a.)	1.09	0.71	0.61	0.59	0.53	0.48	0.45	0.43

6 Directions for Future Analysis

The current model needs to be extended further in few other directions to provide a comprehensive policy analysis on Sri Lankan economy. First, it is important to extend the model to capture the effects of fiscal policy that are essential in monetary policy implementation. Large and persistent fiscal deficit in Sri Lanka is an important factor to be considered. Adding a fiscal block to the model will capture the effect of government spending, including countercyclical fiscal policy, as well as changes made to the tax structure on output and inflation. In addition, as well as the effect of government borrowings on equilibrium interest rates and the external balance will also be taken into consideration.

Secondly, the model can also be extended to capture the financial sector in order to incorporate the effect of financial distortions on interest rates and investments, highlighting the importance of macro-financial linkages. Since the onset of the financial crisis, the link between

financial markets and real economic activity has become increasingly important. In the Sri Lankan context, the CBSL focuses on both price stability and financial system stability as its key objectives under the current Monetary Law Act. At present, financial stability assessment and its macroeconomic implications are monitored and assessed outside of the core model. However, going forward the financial sector assessment is expected to be incorporated within the FPAS, in order to produce projections that are conditional on the status of financial sector stability. Therefore, adding financial frictions would be essential in order to incorporate the effect of financial distortions on interest rates and investments. Literature offers different micro-foundations of financial frictions. This includes the influential work of Bernanke et al. (1999) on credit market imperfections under the financial accelerator model. In addition, Gertler and Kiyotaki (2010) and Gertler and Karadi (2011) extend the standard DSGE model considering the banking sector as a source of financial frictions due to the moral hazard problem. As a first step towards incorporating financial sector linkages, a monetary block is proposed to be added to the core QPM. This extension will capture the implications of growing money to GDP and credit to GDP ratios and frequent occurrence of credit cycles in the recent years. Also, this will suit the current enhanced monetary policy framework in Sri Lanka that still incorporates the features of both monetary targeting and inflation targeting.

Due to the limited information and data available on Sri Lankan economy, values of the model parameters in this study are mostly based on judgment. In future, once necessary data are available, model parameters could be estimated using Sri Lankan data to incorporate micro foundations and to improve the model performance.

7 Conclusion

This paper outlines a model based systematic approach developed under FPAS for conducting monetary policy analysis at the CBSL. QPM, which is the key element of this system, is a semi-structural open economy macroeconomic model based on the principles of DSGE modelling. QPM allows forecasting of key macroeconomic variables with the facility to conduct simulation of alternative policy options. While QPM will be the main macroeconomic model of CBSL, various nowcasting and near-term forecasting tools that CBSL has been using for some time would continue with a number of new models for near-term projections to provide useful insights to the QPM projections.

The paper presents the economic rationale and theoretical and practical aspects underpinning the development of the QPM together with the means of calibration and fine-tuning the model. Further, model simulations are presented to illustrate how policy making institutions might respond to various types of shocks with a view to achieving macroeconomic stability, in particular, to bring inflation back to the announced target over the medium term. The paper

also provides information on the historical decomposition of the causal factors to the evolution of some of the key macroeconomic variables.

As the Sri Lankan economy has undergone a significant economic transformation, a coherent macroeconomic model like QPM coupled with the systematic decision-making process introduced through FPAS would facilitate proactive monetary policy making in a more forward-looking manner. Particularly, with the transition of the conduct of monetary policy from a monetary targeting framework to a flexible inflation targeting framework, FPAS is expected to serve as an indispensable tool in the overall monetary policy decision making process of CBSL.

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Box 1. Handling Noisy GDP Data

GDP estimation is a strenuous process that faces a tradeoff between estimates accuracy and its timeliness. GDP estimates, therefore, are released on scheduled timelines and are subjected to revision later. At present, real GDP compilation in Sri Lanka is carried out by the Department of Census and Statistics in compliance with the guidelines of the Systems of National Income Accounting (SNA) 2008. The first set of real GDP estimate for a particular quarter is released by the DCS approximately ten weeks after that quarter has ended. As the revision policy is in place, these estimates are subjected to revise not more than six times during three years from the first release of particular estimates. Table B.1 shows available quarterly GDP revisions in Sri Lanka.

Table B.1. Quarterly Gross Domestic Product at Constant (2010) Prices: 2015

	$Q_1$2015	Q_2 2015	Q_3 2015	$Q_4$2015
First release	6.0	6.7	4.8	2.5
1st Revision	4.4	6.0	5.6	
2nd Revision	4.9	7.0		
3rd Revision	4.4			

As has been illustrated in Table B.1., initial GDP estimates, which are mainly based on incomplete and preliminary information, can be substantially different from its revisions due to the noise and the news associated with the GDP compilation process. However, as this data inconsistency could affect policy making process, it is necessary to handle noise in GDP data in macroeconomic modeling and forecasting exercises.

Variety of methods has been applied to address the noise macroeconomic data. Filter based methods, state space and factor models are among commonly used methods. In early period, Kalman filter which allows the estimation process to adjust as and when revised data are available, has been used to address noisy economic data (Howrey, 1978). Another possible ways of handling noisy GDP data in macroeconomic modelling is to use a state space model where the measurement equation becomes an integral part of the estimation. However, success of the forecasts based on state space models heavily depends on the structure of the measurement equations imposed. Weakly-structured measurement equations will result in less accurate forecasts than if noise in the data were ignored (Ghosh and Lien, 2001; Fukuda, 2007).

Use of factor models in macroeconomic modelling and forecasting also minimizes the impact of noise in the data generating process. These models are based on the view that a common factor can generate idiosyncratic movements in many different variables. Therefore, when

noise in one data series is not correlated across variables in the model, factor models reduce the effect of noisy data on macroeconomic modelling and forecasting (Bernanke and Bovin, 2003). However, it is also argued that, in factor models the noise added from using several variables may cost more than benefits in macroeconomic modelling (Faust and Wright, 2009). The presence of noisy data, in general, makes modelling and forecasting complicated. This issue becomes crucial when dealing with a critical macroeconomic variable such as real GDP, where the effect of 'noise' on modeling and forecasting is substantial.

In order to address this issue of noisy GDP data, the QPM introduces an additional variable for GDP named 'Adjusted GDP' which is considered as the actual level of GDP free of any noise. The GDP figures published by DCS are considered as observed GDP in the model and observed GDP adjusted for noise is given as an input to the transition equations in the model. The GDP measurement error is computed within the model during the filtration stage.

Appendix B. Complete Model

Model Equations

$$\hat{\hat{y}}_t = a_1 \cdot \hat{\hat{y}}_{t-1} + a_2 \cdot \hat{\hat{y}}_{t+1} - a_3 \cdot \hat{\hat{r}}_t + a_4 \cdot \hat{\hat{y}}_t^{foreign} - a_5 \cdot \hat{\hat{z}}_t + \varepsilon_t^{\hat{y}} \quad (1)$$

$$i_t^{pol} = a_7 \cdot i_{t-1} + (1 - a_7) \cdot (i_t^{neu} + a_8 \cdot \hat{\hat{\pi}}_t + a_9 \cdot \hat{\hat{y}}_t) + \varepsilon_t^i \quad (2)$$

$$i_t^{pol} = i_t^{foreign} + 4 \cdot (\quad {}^{e}s_t - s_t^{uip}) + \rho_t + \varepsilon_t^{\Delta s} \quad (3)$$

$$\Delta s_t^{pol} = a_{10} \cdot \Delta s_{t-1}^{pol} + (1 - a_{10}) \cdot (-\Delta \overline{z}_t + \overline{\pi}_t - \pi_{ss}^{foreign} + a_{11} \cdot \hat{\hat{z}}_{t-1}) + \varepsilon_t^{\Delta s^{pol}} \quad (4)$$

$$\Delta s_t^{pol} = 4 \cdot (s_t^{pol} - s_{t-1}) \quad (5)$$

$$\Delta s_t^{uip} = 4 \cdot (s_t^{uip} - s_{t-1}) \quad (6)$$

$$i_t^{uip} = i_t^{foreign} + 4 \cdot (\quad {}^{e}s_t - s_t^{pol}) + \rho_t + \varepsilon_t^{\Delta s} \quad (7)$$

$$i_t = a_{12} \cdot i_t^{pol} + (1 - a_{12}) \cdot i_t^{uip} \quad (8)$$

$$s_t = a_{12} \cdot s_t^{uip} + (1 - a_{12}) \cdot s_t^{pol} \quad (9)$$

$$\hat{\hat{\pi}}_t = \pi_{t+4} - \overline{\pi}_t \quad (10)$$

$$i_t^{neu} = \overline{r}_t + \pi_{t+1}^4 \quad (11)$$

$$r_t = i_t - \pi_{t+1}^4 \quad (12)$$

$$r_t = \hat{\hat{r}}_t + \overline{r}_t \quad (13)$$

$$\pi_t = a_{14} \cdot \pi_t^c + a_{13} \cdot \pi_t^{vf} + (1 - a_{14} - a_{13}) \cdot \pi_t^{et} + \pi_t^{disc} \quad (14)$$

$$\pi_t^{disc} = a_{26} \cdot \pi_{t-1}^{disc} + \varepsilon_t^{\pi^{disc}} \quad (15)$$

$$\pi_t^c = a_{15} \cdot \hat{\hat{y}}_t + a_{16} \cdot \pi_{t-1}^c + (1 - a_{16} - a_{19}) \cdot \pi_{t+1}^c - a_{17} \cdot (\hat{\hat{z}}_t - a_{13} \cdot \hat{\hat{rp}}_t^{vf/c} - (1 - a_{13} - a_{14}) \cdot \hat{\hat{rp}}_t^{et/c}) + a_{18} \cdot \hat{\hat{rp}}_t^{et/c} + a_{19} \cdot \Delta p_t^{food,imp,c} + \varepsilon_t^{\pi^c} \quad (16)$$

$$\pi_t^{vf} = a_{20} \cdot \pi_{t-1}^{vf} + (1 - a_{20}) \cdot \overline{\pi}_t^{vf} - a_{21} \cdot \hat{\hat{rp}}_{t-1}^{vf/c} + \varepsilon_t^{\pi^{vf}} \quad (17)$$

$$\pi_t^{et} = a_{22} \cdot \pi_{t-1}^{et} + (1 - a_{22} - a_{23}) \cdot \pi_{t+1}^{et} + a_{23} \cdot \Delta p_{t-1}^{oil,imp,et} + a_{24} \cdot \hat{\hat{q}}_{t-1}^{oil,et} - a_{25} \cdot \hat{\hat{rp}}_{t-1}^{et/c} + \varepsilon_t^{\pi^{et}} \quad (18)$$

$$rp_t^{vf/c} = p_t^{vf} - p_t^c \quad (19)$$

$$rp_t^{vf/c} = \overline{rp}_t^{vf/c} + \hat{\hat{rp}}_t^{vf/c} \quad (20)$$

$$\Delta \overline{rp}_t^{vf/c} = 4 \cdot (\overline{rp}_t^{vf/c} - \overline{rp}_{t-1}^{vf/c}) \quad (21)$$

$$\Delta^4 \overline{rp}_t^{vf/c} = \overline{rp}_t^{vf/c} - \overline{rp}_{t-4}^{vf/c} \quad (22)$$

$$\Delta\overline{rp}_t^{vf/c} = a_{27} \cdot \Delta\overline{rp}_{t-1}^{vf/c} + (1 - a_{27}) \cdot \Delta\overline{rp}_{ss}^{vf} + \varepsilon_t^{\Delta\overline{rp}^{vf/c}} \quad (23)$$

$$rp_t^{et/c} = p_t^{et} - p_t^c \quad (24)$$

$$rp_t^{et/c} = \overline{rp}_t^{et/c} + \hat{rp}_t^{et/c} \quad (25)$$

$$\Delta\overline{rp}_t^{et/c} = 4 \cdot (\overline{rp}_t^{et/c} - \overline{rp}_{t-1}^{et/c}) \quad (26)$$

$$\Delta^4\overline{rp}_t^{et/c} = \overline{rp}_t^{et/c} - \overline{rp}_{t-4}^{et/c} \quad (27)$$

$$\Delta\overline{rp}_t^{et/c} = a_{28} \cdot \Delta\overline{rp}_{t-1}^{et/c} + (1 - a_{28}) \cdot \Delta\overline{rp}_{ss}^{et} + \varepsilon_t^{\Delta\overline{rp}^{et/c}} \quad (28)$$

$$\overline{r}_t = \overline{r}_t^{foreign} - \Delta\overline{z}_{t+1} + \rho_t \quad (29)$$

$$\Delta\overline{y}_t = a_6 \cdot \Delta\overline{y}_{t-1} + (1 - a_6) \cdot \Delta\overline{y}_{ss} + \varepsilon_t^{\Delta\overline{y}} \quad (30)$$

$$\Delta\overline{z}_t = a_{30} \cdot \Delta\overline{z}_{t-1} + (1 - a_{30}) \cdot \Delta\overline{z}_{ss} + \varepsilon_t^{\Delta\overline{z}} \quad (31)$$

$$\rho_t = a_{32} \cdot \rho_{t-1} + (1 - a_{32}) \cdot \rho_{ss} + \varepsilon_t^{\rho} \quad (32)$$

$$\overline{\pi}_t = a_{29} \cdot \overline{\pi}_{t-1} + (1 - a_{29}) \cdot \overline{\pi}_{ss} + \varepsilon_t^{\overline{\pi}} \quad (33)$$

$$y_t = \hat{y}_t + \overline{y}_t \quad (34)$$

$$\Delta\overline{y}_t = 4 \cdot (\overline{y}_t - \overline{y}_{t-1}) \quad (35)$$

$$\Delta^4\overline{y}_t = \overline{y}_t - \overline{y}_{t-4} \quad (36)$$

$$\Delta y_t = 4 \cdot (y_t - y_{t-1}) \quad (37)$$

$$\Delta^4 y_t = y_t - y_{t-4} \quad (38)$$

$${}^e\hat{y}_t = \hat{y}_{t+1} \quad (39)$$

$$\pi_t = 4 \cdot (p_t - p_{t-1}) \quad (40)$$

$$\pi_t^4 = p_t - p_{t-4} \quad (41)$$

$$\pi_t^c = 4 \cdot (p_t^c - p_{t-1}^c) \quad (42)$$

$$\pi_t^{c,4} = p_t^c - p_{t-4}^c \quad (43)$$

$$\pi_t^{vf} = 4 \cdot (p_t^{vf} - p_{t-1}^{vf}) \quad (44)$$

$$\pi_t^{vf,4} = p_t^{vf} - p_{t-4}^{vf} \quad (45)$$

$$\pi_t^{et} = 4 \cdot (p_t^{et} - p_{t-1}^{et}) \quad (46)$$

$$\pi_t^{et,4} = p_t^{et} - p_{t-4}^{et} \quad (47)$$

$${}^e\pi_t = \pi_{t+1} \quad (48)$$

$${}^e\pi_t^c = \pi_{t+1}^c \quad (49)$$

$$ {}^{e}\pi_t^{vf} = \pi_{t+1}^{vf} \tag{50} $$

$$ {}^{e}\pi_t^{et} = \pi_{t+1}^{et} \tag{51} $$

$$ \overline{\pi}_t^{vf} = \overline{\pi}_t + (1 - a_{13}) \cdot \Delta\overline{rp}_t^{vf/c} - (1 - a_{14} - a_{13}) \cdot \Delta\overline{rp}_t^{et/c} \tag{52} $$

$$ \overline{\pi}_t^{et} = \overline{\pi}_t + (a_{14} + a_{13}) \cdot \Delta\overline{rp}_t^{et/c} - a_{13} \cdot \Delta\overline{rp}_t^{vf/c} \tag{53} $$

$$ z_t = p_t - s_t - p_t^{foreign} \tag{54} $$

$$ z_t = \hat{\hat{z}}_t + \overline{z}_t \tag{55} $$

$$ \Delta s_t = 4 \cdot (s_t - s_{t-1}) \tag{56} $$

$$ \Delta^4 s_t = s_t - s_{t-4} \tag{57} $$

$$ \Delta z_t = 4 \cdot (z_t - z_{t-1}) \tag{58} $$

$$ \Delta\overline{z}_t = 4 \cdot (\overline{z}_t - \overline{z}_{t-1}) \tag{59} $$

$$ {}^{e}s_t = a_{31} \cdot s_{t+1} + (1 - a_{31}) \cdot (s_{t-1} + 2 \cdot (-\Delta\overline{z}_t + \overline{\pi}_t - \pi_{ss}^{foreign})/4) \tag{60} $$

$$ \hat{y}_t^{foreign} = a_{33} \cdot \hat{y}_{t-1}^{foreign} + \varepsilon_t^{\hat{y}^{foreign}} \tag{61} $$

$$ r_t^{foreign} = i_t^{foreign} - \pi_{t+1}^{foreign} \tag{62} $$

$$ i_t^{foreign} = a_{34} \cdot i_{t-1}^{foreign} + (1 - a_{34}) \cdot (\overline{r}_t^{foreign} + \pi_{ss}^{foreign}) + \varepsilon_t^{i^{foreign}} \tag{63} $$

$$ \overline{r}_t^{foreign} = a_{35} \cdot \overline{r}_{t-1}^{foreign} + (1 - a_{35}) \cdot \overline{r}_{ss}^{foreign} + \varepsilon_t^{\overline{r}^{foreign}} \tag{64} $$

$$ \pi_t^{foreign} = a_{36} \cdot \pi_{t-1}^{foreign} + (1 - a_{36}) \cdot \pi_{ss}^{foreign} + \varepsilon_t^{\pi^{foreign}} \tag{65} $$

$$ \pi_t^{foreign} = 4 \cdot (p_t^{foreign} - p_{t-1}^{foreign}) \tag{66} $$

$$ q_t^{oil} = p_t^{oil} - p_t^{foreign} \tag{67} $$

$$ q_t^{oil} = \overline{q}_t^{oil} + \hat{q}_t^{oil} \tag{68} $$

$$ \hat{q}_t^{oil} = a_{38} \cdot \hat{q}_{t-1}^{oil} + \varepsilon_t^{\hat{q}^{oil}} \tag{69} $$

$$ \Delta\overline{q}_t^{oil} = a_{39} \cdot \Delta\overline{q}_{t-1}^{oil} + (1 - a_{39}) \cdot a_{37} + \varepsilon_t^{\Delta\overline{q}^{oil}} \tag{70} $$

$$ \Delta\overline{q}_t^{oil} = 4 \cdot (\overline{q}_t^{oil} - \overline{q}_{t-1}^{oil}) \tag{71} $$

$$ \Delta p_t^{oil} = 4 \cdot (p_t^{oil} - p_{t-1}^{oil}) \tag{72} $$

$$ \Delta p_t^{oil,imp,et} = \Delta p_t^{oil} + \Delta s_t - \Delta\overline{q}_t^{oil} + \Delta\overline{z}_t - \overline{\pi}_t + \overline{\pi}_t^{et} \tag{73} $$

$$ \hat{\hat{q}}_t^{oil,et} = \hat{\hat{q}}_t^{oil} - \hat{\hat{z}}_t + a_{13} \cdot \hat{rp}_t^{vf/c} - (a_{13} + a_{14}) \cdot \hat{rp}_t^{et/c} \tag{74} $$

$$ q_t^{food} = p_t^{food} - p_t^{foreign} \tag{75} $$

$$q_t^{food} = \overline{q}_t^{food} + \hat{q}_t^{food} \tag{76}$$

$$\hat{q}_t^{food} = a_{41} \cdot \hat{q}_{t-1}^{food} + \varepsilon_t^{\hat{q}^{food}} \tag{77}$$

$$\Delta\overline{q}_t^{food} = a_{42} \cdot \Delta\overline{q}_{t-1}^{food} + (1 - a_{42}) \cdot a_{40} + \varepsilon_t^{\Delta\overline{q}^{food}} \tag{78}$$

$$\Delta\overline{q}_t^{food} = 4 \cdot (\overline{q}_t^{food} - \overline{q}_{t-1}^{food}) \tag{79}$$

$$\Delta p_t^{food} = 4 \cdot (p_t^{food} - p_{t-1}^{food}) \tag{80}$$

$$\Delta p_t^{food,imp,c} = \Delta p_t^{food} + \Delta s_t - \Delta\overline{q}_t^{food} + \Delta\overline{z}_t - a_{13} \cdot \Delta\overline{rp}_t^{vf/c} - (1 - a_{13} - a_{14}) \cdot \Delta\overline{rp}_t^{et/c} \tag{81}$$

Table 1. Model Variables

Variable	Model name	Description
y	l_y	Real output (100*log)
Δy	dl_y	Real output growth (percent, QoQ annualized)
$\Delta^4 y$	d4l_y	Real output growth (percent, YoY)
$\hat{y}$	l_y_gap	Real output gap (%)
$\overline{y}$	l_y_tnd	Real potential output (100*log)
$\Delta\overline{y}$	dl_y_tnd	Real potential growth (percent, QoQ annualized)
$\Delta^4\overline{y}$	d4l_y_tnd	Real potential growth (percent, YoY)
${}^{e}\hat{y}$	e_l_y_gap	Expected output gap (percent)
i	rn	Nominal interest rate (percent p.a.)
i^{neu}	rn_neutral	Policy neutral rate (percent p.a.)
$\overline{r}$	rr_tnd	Eq. real interest rate (percent p.a.)
$\hat{r}$	rr_gap	Real interest rate gap (p.p.)
r	rr	Real interest rate (percent p.a.)
i^{pol}	rn_pol	Inflation targeting nominal interest rate (percent p.a.)
i^{uip}	rn_uip	Exchange rate smoothing nominal interest rate (percent p.a.)
π	dl_cpi	Inflation (percent, QoQ annualized)
π^4	d4l_cpi	Inflation (percent, YoY)
p	l_cpi	CPI (100*log)
π^c	dl_cpi_core	Core Inflation (percent, QoQ annualized)
$\pi^{c,4}$	d4l_cpi_core	Core Inflation (percent, YoY)
p^c	l_cpi_core	Core CPI (100*log)
π^{vf}	dl_cpi_vfood	Volatile Food Inflation (percent, QoQ annualized)
$\pi^{vf,4}$	d4l_cpi_vfood	Volatile Food Inflation (percent, YoY)
p^{vf}	l_cpi_vfood	Volatile Food CPI (100*log)
π^{et}	dl_cpi_et	Energy & Transport Inflation (percent, QoQ annualized)
$\pi^{et,4}$	d4l_cpi_et	Energy & Transport Inflation (percent, YoY)
p^{et}	l_cpi_et	Energy & Transport CPI (100*log)
${}^{e}\pi$	e_dl_cpi	Expected inflation (percent, QoQ annualized)
${}^{e}\pi^c$	e_dl_cpi_core	Expected core inflation (percent, QoQ annualized)
${}^{e}\pi^{vf}$	e_dl_cpi_vfood	Expected volatile food inflation (percent, QoQ annualized)

Variable	Model name	Description
${}^{e}\pi^{et}$	e_dl_cpi_et	Expected energy & transport inflation (percent, QoQ annualized)
$\hat{\pi}$	infl_dev	Inflation deviation from the target (p.p.)
$\overline{\pi}$	pie_tar	Inflation target (percent)
$\overline{\pi}^{vf}$	pie_tar_vfood	Volatile food inflation target (percent)
$\overline{\pi}^{et}$	pie_tar_et	Energy & Transport inflation target (percent)
π^{disc}	dl_cpi_disc	Headline CPI Discrepancy
$rp^{vf/c}$	l_rp_vfood	V.Food/Core relative price (100*log)
$\overline{rp}^{vf/c}$	l_rp_vfood_tnd	V.Food/Core relative price trend (100*log)
$\hat{rp}^{vf/c}$	l_rp_vfood_gap	V.Food/Core relative price gap (percent)
$\Delta\overline{rp}^{vf/c}$	dl_rp_vfood_tnd	V.Food/Core relative price trend growth (percent, QoQ annualized)
$\Delta^4\overline{rp}^{vf/c}$	d4l_rp_vfood_tnd	V.Food/Core relative price trend growth (percent, YoY)
$rp^{et/c}$	l_rp_et	Energy&Transport/Core relative price (100*log)
$\overline{rp}^{et/c}$	l_rp_et_tnd	Energy&Transport/Core relative price trend (100*log)
$\hat{rp}^{et/c}$	l_rp_et_gap	Energy&Transport/Core relative price gap (percent)
$\Delta\overline{rp}^{et/c}$	dl_rp_et_tnd	Energy&Transport/Core relative price trend growth (percent, QoQ annualized)
$\Delta^4\overline{rp}^{et/c}$	d4l_rp_et_tnd	Energy&Transport/Core relative price trend growth (percent, YoY)
Δs	dl_s	Nominal depreciation of LKR per USD (percent, QoQ annualized)
$\Delta^4 s$	d4l_s	Nominal depreciation of LKR per USD (percent, YoY)
s	l_s	Nominal exchange rate LKR per USD (100*log)
${}^{e}s$	e_l_s	Expected nominal exchange rate (100*log)
s^{pol}	l_s_pol	FX smoothing policy exchange rate (100*log)
s^{uip}	l_s_uip	Exchange rate consistent with IT interest rates (100*log)
Δs^{pol}	dl_s_pol	Targeted exchange depreciation (percent, QoQ annualized)
Δs^{uip}	dl_s_uip	Exchange rate depreciation consistent with IT interest rates (100*log)
Δz	dl_z	RER depreciation (percent, QoQ annualized)
z	l_z	Real exchange rate (100*log)

Variable	Model name	Description
$\hat{z}$	l_z_gap	Real exchange rate gap (percent)
$\overline{z}$	l_z_tnd	Eq. real exchange rate (100*log)
$\Delta\overline{z}$	dl_z_tnd	Eq. real depreciation (percent, QoQ annualized)
ρ	prem	Risk premium (percent p.a.)
$\hat{y}^{foreign}$	l_y_gap_f	Foreign output gap (%)
$r^{foreign}$	rr_f	Foreign real interest rate (percent p.a.)
$i^{foreign}$	rn_f	Fed Funds rate (percent p.a.)
$\overline{r}^{foreign}$	rr_tnd_f	Foreign equilibrium real interest rate (percent p.a.)
$\pi^{foreign}$	dl_cpi_f	Foreign CPI inflation (percent, QoQ annualized)
$p^{foreign}$	l_cpi_f	Foreign CPI (100*log)
p^{oil}	l_oil	Brent oil price (100*log)
q^{oil}	l_roil	Real oil price (100*log)
$\overline{q}^{oil}$	l_roil_tnd	Real oil price trend (100*log)
$\hat{q}^{oil}$	l_roil_gap	World real oil price gap (percent)
$\hat{q}^{oil,et}$	l_roil_et_gap	Domestic real oil price gap (percent)
$\Delta\overline{q}^{oil}$	dl_roil_tnd	Eq. real oil price growth (percent, QoQ annualized)
Δp^{oil}	dl_oil	Growth of Brent oil price (percent, QoQ annualized)
$\Delta p^{oil,imp,et}$	dl_oilimp_et	Imported oil price inflation, energy&transport (percent, QoQ annualized)
p^{food}	l_food	FAO food price (100*log)
q^{food}	l_rfood	Real food price (100*log)
$\overline{q}^{food}$	l_rfood_tnd	Real food price trend (100*log)
$\hat{q}^{food}$	l_rfood_gap	Real food price gap (percent)
$\Delta\overline{q}^{food}$	dl_rfood_tnd	Eq. real food price growth (percent, QoQ annualized)
Δp^{food}	dl_food	Growth of FAO food price (percent, QoQ annualized)
$\Delta p^{food,imp,c}$	dl_foodimp_core	Imported food price inflation, core (percent, QoQ annualized)

Table 2. Model Structural Shocks

Shock	Model name	Description	StDev
$\varepsilon^{\hat{y}}$	shock_l_y_gap	Demand shock	1.00
ε^{i}	shock_rn	MP shock	1.00
ε^{π^c}	shock_dl_cpi_core	Core inflation shock	1.50
$\varepsilon^{\pi^{vf}}$	shock_dl_cpi_vfood	Volatile food inflation shock	13.00
$\varepsilon^{\pi^{et}}$	shock_dl_cpi_et	Energy & transport inflation shock	15.00
$\varepsilon^{\pi^{disc}}$	shock_dl_cpi_disc	CPI discrepancy shock	0.70
$\varepsilon^{\Delta s}$	shock_dl_s	UIP shock	3.00
$\varepsilon^{\Delta\overline{y}}$	shock_dl_y_tnd	Potential growth shock	0.30
$\varepsilon^{\Delta\overline{z}}$	shock_dl_z_tnd	Eq. RER shock	0.30
ε^{ρ}	shock_prem	Risk premium shock	0.20
$\varepsilon^{\overline{\pi}}$	shock_pie_tar	Inflation target shocks	0.20
$\varepsilon^{\Delta s^{pol}}$	shock_dl_s_pol	Exchange rate policy shock	3.00
$\varepsilon^{\Delta\overline{rp}^{vf/c}}$	shock_dl_rp_vfood_tnd	Volatile food VS core relative price trend shock	0.30
$\varepsilon^{\Delta\overline{rp}^{et/c}}$	shock_dl_rp_et_tnd	Energy & transport VS core relative price trend shock	0.50
$\varepsilon^{\hat{y}^{foreign}}$	shock_l_y_gap_f	Foreign demand shock	0.51
$\varepsilon^{i^{foreign}}$	shock_rn_f	Foreign MP shock	0.37
$\varepsilon^{\overline{r}^{foreign}}$	shock_rr_tnd_f	Foreign eq. real interest rate shock	0.07
$\varepsilon^{\pi^{foreign}}$	shock_dl_cpi_f	Foreign inflation shock	2.27
$\varepsilon^{\hat{q}^{oil}}$	shock_l_roil_gap	Real oil price gap shock	18.00
$\varepsilon^{\Delta\overline{q}^{oil}}$	shock_dl_roil_tnd	Eq. real oil price growth shock	1.00
$\varepsilon^{\hat{q}^{food}}$	shock_l_rfood_gap	Real food price gap shock	5.00
$\varepsilon^{\Delta\overline{q}^{food}}$	shock_dl_rfood_tnd	Eq. real food price growth shock	0.50

Table 3. Model Parameters

Parameter	Model name	Description	Value
$\Delta\overline{z}_{ss}$	ss_dl_z_tnd	Steady-state of RER depreciation	2.000
$\overline{\pi}_{ss}$	ss_pie_tar	Steady-state of headline inflation target	4.879
ρ_{ss}	ss_prem	Steady-state of the country risk premium	5.000
$\Delta\overline{y}_{ss}$	ss_dl_y_tnd	Steady-state of the potential output growth	6.500
$\overline{r}_{ss}^{foreign}$	ss_rr_tnd_f	Steady-state of the foreign real interest rate	1.000
$\pi_{ss}^{foreign}$	ss_dl_cpi_f	Steady-state of the foreign inflation	2.000
$\Delta\overline{rp}_{ss}^{vf}$	ss_dl_rp_vfood_tnd	Steady-state of the change in volatile food relative price	0.000
$\Delta\overline{rp}_{ss}^{et}$	ss_dl_rp_et_tnd	Steady-state of the change in energy and transport relative price	0.000
a_1	c1_l_y_gap	Backward-lookingness in demand	0.548
a_2	c2_l_y_gap	Forward-lookingness in demand	0.200
a_3	c3_l_y_gap	Elasticity of demand on real interest rate	0.035
a_4	c4_l_y_gap	Elasticity of demand on foreign demand	0.094
a_5	c5_l_y_gap	Elasticity of demand on real exchange rate	0.064
a_6	c1_dl_y_tnd	Persistence of potential real GDP growth	0.900
a_7	c1_rn	Interest rate smoothing in IT consistent monetary policy rule	0.813
a_8	c2_rn	Weight on inflation objective in in IT consistent monetary policy rule	0.774
a_9	c3_rn	Weight on output objective in in IT consistent monetary policy rule	0.099
a_{10}	c1_dl_s_pol	Weight on exchange rate smoothing in FX policy rule	0.500
a_{11}	c2_dl_s_pol	Weight on real exchange rate misalignment in FX policy rule	0.822
a_{12}	w_rn_rule	Relative importance of IT in decision maker preferences	0.807
a_{13}	w_vfood	Weight of volatile food in CPI	0.185
a_{14}	w_core	Weight of energy and transport in CPI	0.689
a_{15}	c1_dl_cpi_core	Elasticity of core inflation on excess demand	0.251
a_{16}	c2_dl_cpi_core	Backward-lookingness in core inflation	0.274
a_{17}	c3_dl_cpi_core	Elasticity of core inflation on imports as a part of real marginal costs	0.137
a_{18}	c4_dl_cpi_core	Elasticity of core prices on energy and transport prices	0.043

Parameter	Model name	Description	Value
a_{19}	c5_dl_cpi_core	Elasticity of core inflation on imported food inflation	0.029
a_{20}	c1_dl_cpi_vfood	Persistence of volatile food inflation	0.268
a_{21}	c2_dl_cpi_vfood	Elasticity of volatile food inflation of relative price gap	1.290
a_{22}	c1_dl_cpi_et	Persistence of energy and transport inflation	0.209
a_{23}	c2_dl_cpi_et	Elasticity of energy and transport inflation on imported oil inflation	0.181
a_{24}	c3_dl_cpi_et	Elasticity of energy and transport inflation on oil price gap	0.166
a_{25}	c4_dl_cpi_et	Elasticity of volatile food inflation of relative price gap	0.449
a_{26}	c1_dl_cpi_disc	Persistence of discrepancy in headline inflation identity	0.079
a_{27}	c1_dl_rp_vfood_tnd	Persistence of volatile food relative price trend	0.900
a_{28}	c1_dl_rp_et_tnd	Persistence of energy and transport relative price trend	0.900
a_{29}	c1_pie_tar	Persistence of inflation target	1.000
a_{30}	c1_dl_z_tnd	Persistence of equilibrium real exchange rate appreciation	0.900
a_{31}	c1_e_l_s	Forward-lookingness in exchange rate	0.872
a_{32}	c1_prem	Persistence of country risk premium	0.950
a_{33}	c1_l_y_gap_f	Persistence of foreign output gap	0.910
a_{34}	c1_rn_f	Persistence of foreign nominal interest rate	0.500
a_{35}	c1_rr_tnd_f	Persistence of foreign equilibrium real interest rate	0.500
a_{36}	c1_dl_cpi_f	Persistence of foreign inflation	0.285
a_{37}	ss_dl_roil_tnd	Long-run inflation of (real) oil prices	7.500
a_{38}	c1_l_roil_gap	Persistence of gap in world oil prices	0.750
a_{39}	c1_dl_roil_tnd	Persistence of equilibrium world oil price inflation	0.950
a_{40}	ss_dl_rfood_tnd	Long-run inflation of (real) food prices	7.000
a_{41}	c1_l_rfood_gap	Persistence of gap in world food prices	0.900
a_{42}	c1_dl_rfood_tnd	Persistence of equilibrium world food price inflation	0.950

Responsibility, Immunity and Liability: Are Financial Supervisors Liable for Depositors' Losses?

A Sri Lankan Case Study

L M Pavithri Vithanage [1]

Abstract

A stable financial system is a fundamental need for economic growth and prosperity. Hence, an efficient and continuous financial supervisory function is underscored by legal, economic and political rationale where prevention of bank runs reigns as the prime motive. The liquidity crisis faced by some financial institutions in Sri Lanka in 2008 resulted in the Central Bank of Sri Lanka being sued by depositors/investors of such institutions for alleged negligence. This situation is not alien in financial markets world over, as in times of crisis supervisory actions and responses are often criticised and questioned. Hence, supervisors, who are expected to work without fear or favour, perform their balancing act under a cloud of legal risk. In this background, the responsibilities and powers of the Central Bank of Sri Lanka is analysed to verify whether the supervisory role of the Central Bank conforms to the Basel Core principles. Immunity and accountability of the Central Bank of Sri Lanka is discussed in general as a preface to discussing the recent legal action faced by the financial sector supervisor of Sri Lanka, their implications and lessons to be learnt. With a plethora of new laws and regulations being borne out of crisis, the supervisors may be exposing themselves to a higher degree of legal risk apart from creating new liabilities. This paper recommends new provisions to be considered to be adopted into the financial sector laws in Sri Lanka.

Keywords: *Regulator, Supervision, Lender of Last Resort*

JEL Classification: *E58; G28; K23*

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1. Introduction

At times of crisis, financial supervision is under spotlight. Goodhart states that 'a supervisor is only noticed when either he/she angers the regulated by some restrictive or intrusive action, or when supervision "fails" in the sense that a financial institution collapses or a customer gets ripped-off'.(Goodhart 21)

Supervision is broadly defined as monitoring and enforcement of rules laid down by the regulators.(Lastra 84) Lastra defines supervision as a seamless process that flows through the life cycle of a financial entity, from the entry of an institution into the market to crisis management (Lastra 85).

The primary role of the financial sector supervisor is to preserve financial stability. Unlike price stability which could be measured by facts or figures,(Gadanecz et al. 365) financial system stability cannot be easily measured and has no single definition.(Schinasi 3) Schinasi defines financial stability as 'a condition in which an economy's mechanisms for pricing, allocating, and managing financial risks … are functioning well enough to contribute to the performance of the economy' (10). Allen and Wood define financial stability as 'a state of affairs in which an episode of financial instability is unlikely to occur, so that fear of financial instability is not a material factor in economic decisions taken by households or businesses' (Allen and Wood).

The financial crisis that crippled the world in 2007-09 had the legislators, the policy makers, the supervisors, the market analysts and such other stakeholders of the financial sector including the depositors and the general public questioning the effectiveness of supervision in the background of its expected functions, roles, goals and responsibilities.(The Group of Thirty 18) While there is no one perfect method of financial supervision that can cure any instability and prevent all crises, the crisis saw more than one finger being pointed at the financial supervisors for failures and lapses on their part, which have allegedly fanned and fuelled the crisis to reach beyond territorial limits and cause wide havoc around the world (Bernanke).

The Sri Lankan financial markets were not directly affected by the events of the global financial turmoil. However, the crash of an unregulated financial institution, which was a member of a large financial conglomerate resulted in panic among depositors, causing a liquidity crisis in several non-bank financial institutions. The crisis that ensued required an executive response. A 'Stimulus Package' was endorsed by the Cabinet of Ministers to stabilise the crisis hit finance companies in the short run.[2] The legislative responses have

[2] Central Bank of Sri Lanka, '*Press Release: Central Bank Begins Implementation of Stimulus Package*

been equally spontaneous. The liquidity crisis laid bare the weaknesses of the regulatory and supervisory system, and the enforceability of the law to effectively curb financial instability. Hence, the Finance Companies Act, No. 78 of 1988 was overhauled and the Finance Business Act, No. 42 of 2011 was enacted with 'more teeth' to the supervisor.

The most dramatic development consequent to the liquidity crisis came from the corner of depositors. Some depositors of some financial institutions, both regulated and unregulated, took the Central Bank of Sri Lanka (CBSL) to courts over alleged negligence, mala fide actions and derogation of duties and responsibilities.[3] Even though the CBSL enjoys immunity under the Monetary Law Act, No 49 of 1950,[4] courts in Sri Lanka have not interpreted the provisions of the law as granting iron-clad immunity to the supervisor. In some cases, the Supreme Court of Sri Lanka, which is the apex court in the country, has required the CBSL to be involved in repayment processes of unregulated shadow banking institutions all the while broadly and generally interpreting the provisions of the Finance Companies Act.[5] The judicial responses to depositor action has raised questions about financial supervisor's independence, accountability, immunity and the ability to carry out its functions without fear or favour. It has also given rise to a public discussion about the legal liability of the financial supervisor to third party losses.[6]

This paper aims to analyse whether the prudential supervisor could be held liable for depositors' losses, with emphasis on Sri Lanka.

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and Intervenes to Stabilise Registered Finance Companies of the Ceylinco Group' (CBSL, 6 March 2009 <www.cbsl.gov.lk/pics_n_docs/latest_news/press_20090306e.doc>

[3] SC/FR/449/08 Buddhika Lakmal Wijesekara vs The Monetary Board et al; SC/FR/262/2009 Susil Gunadasa Illangasinghe et al vs The Monetary Board et al; SC/FR/317/2009 E M De Soysa et al vs The Monetary Board et al

[4] s 47

[5] Central Bank of Sri Lanka, 'Current Status of The Finance & Guarantee Company Ltd., Finance & Guarantee Property Developers (Pvt) Ltd. and F&G Real Estate Co. Ltd'(Central Bank of Sri Lanka, 7 December 2009 <http://www.cbsl.gov.lk/pics_n_docs/latest_news/press_20091207ea.pdf>; Central Bank 'Ceylinco Shriram Capital Management Services Company (Pvt) Limited, Ceylinco Capital Investment Company (Pvt) Limited, Ceylinco Consolidated (Pvt) Limited and CLC Asset Management (Pvt) Limited'(Central Bank of Sri Lanka, 9 July 2009) <http://www.cbsl.gov.lk/pics_n_docs/02_prs/_docs/notices/publicnotice_20090710e.pdf>; Central Bank 'The Golden Key Credit Card Company Limited'(Central Bank of Sri Lanka, 28 April 2009) < http://www.cbsl.gov.lk/pics_n_docs/02_prs/_docs/notices/notice_02052009e.pdf>

[6] Ajith Cabraal, 'Failure of deposit taking institutions: Causes, Legal remedies and Solutions' (Bar Association of Sri Lanka, Colombo, 30 June 2009) <http://www.cbsl.gov.lk/pics_n_docs/02_prs/_docs/speeches/g_speech_20090630e.pdf>

The paper is divided into three parts. Firstly, the rationale for financial supervision would be discussed. Secondly, the powers conferred on the CBSL as the financial supervisor would be analysed against the Basel Core Principles.(Supervision) The balance between immunity and accountability would be discussed in general and several cases instituted by depositors against the CBSL would be analysed to ascertain the judicial thoughts on the role and the function of the CBSL.

The outcome of the study is to be able to make recommendations that would be useful for future amendments to laws of Sri Lanka in order to address legal risks.

2. The Role of Supervision

The peculiar features of banks and other deposit taking institutions, in particular asset-liability mismatch, risky asset portfolio, low capitalization and access to tax-payer funded safety nets at times of crisis, make the industry more susceptible to risks and hazards. Unlike an institution that carries on its activities funded by its shareholders, the banks and other deposit taking institutions are funded primarily by public deposits. This peculiar feature of banking paves the way for public scrutiny of its business, regulations and strict supervision due to the inordinate effects of its failure on many stakeholders including the general public. The multiplicity of markets, instruments, infrastructure, regulators, supervisors and institutions makes the financial sector multidimensional and complex. Multiple stakeholders bring in multiple expectations, which when coupled with numerous goals make financial supervision an extremely tricky task. Each stakeholder expects a different outcome from supervision, hence supervisors are called upon to perform a balancing act.

Regulation could be defined as rule setting where supervision is the monitoring process. Regulation and supervision are complementary in its functions and in many jurisdictions, including Sri Lanka, both tasks are performed by a single entity.

2.1 Legal rationale for financial supervision

The failure of a deposit taking institution is expected to result in greater hardships for the public than that of a comparable non-deposit taking institution (Great Britain. Treasury 6). Hence, one of the main arguments for regulation and supervision of deposit taking institutions is depositor protection, which is inherently linked to prevention of bank runs. Not all depositors are sophisticated and possess financial literacy, hence the supervisor is called upon to monitor the health of deposit taking institutions according to the prudential rules and thereby ensure safety of funds of the depositor. Whilst there can be no guarantee of a zero per cent failure and institutions may fail and be allowed to fail as a disciplinary

measure, due to its inordinate impact on the everyday lives of ordinary citizens, supervisory authorities are expected to minimise the probability of failure of financial institutions. Prevention of runs can be identified as a fundamental factor common to legal, economic and political rationale for financial supervision, which would be discussed at a later stage.

Banking assets are mostly illiquid in nature, comprising loans and long term investments, securities, reserves and physical assets. The liabilities are liquid and comprise mainly of deposits that are payable on demand. Managing the maturities of assets and liabilities is one of the primary tasks of a bank and any wide mismatch therein would result in illiquidity of the bank and may even lead to insolvency within a short period of time. Cabral argues that large banks seek to enhance their profits by widening the gap between their assets and liabilities (Cabral). Even though this practice may yield profits in the short run, the bank may face a liquidity shock at any given stressful situation. This practice also leads to adverse selection and moral hazard due to availability of publicly funded safety nets to too big to fail banks whereby the management is not afraid of taking risks in the expectation of bailout funds from the Government.

Financial institutions are subject to systemic risk. Systemic risk is defined by Lastra as the 'risk that financial difficulties at one or more bank spill over to a large number of other banks or the financial system as a whole' (138-139). The shock of failure that cripples the financial system temporarily may within a very short time frame result in a wide-scale bank run and ultimately, if not contained swiftly and appropriately by the supervisor, cause the failure of the entire financial system. Systemic risk is expected to be identified, gauged and mitigated by the financial supervisor. The failure of the Financial Supervisory Authority (FSA) to identify the build-up of systemic risk within the UK financial sector was categorised by HM Treasury as a key failure that led to the crisis in 2007 whereby 'the regulators and supervisors failed to provide the robust scrutiny and challenge that banks and other financial institutions needed to ensure that risks building up on their balance sheets were manageable – not only at the level of individual firms, but across the system as a whole' (Great Britain. Treasury., A New Approach to Financial Regulation : The Blueprint for Reform 5).

While stringent financial regulation and supervision are called for due to the prevalence of the systemic risk, some scholars resist regulation and supervision on the basis of free market policies. Alan Greenspan, five times the Chairman of the Federal Reserve, who has remained vociferous about anti-regulation, has reportedly admitted that prior to the crisis he had relied on the premise that regulation is no better than market forces (Andrews). However, without regulation and supervision, the externalities caused by systemic risk may not be mitigated or internalized, which therefore could result in economic inefficiencies as seen in the crisis. Schwarcz argues that systemic risk should be regulated to maximize economic efficiency to prevent a tragedy of the commons, 'an event in which the benefits of exploiting finite capital resources accrue to individual market participants, each of which is motivated to maximize

use of the resource, whereas the costs of the exploitation are distributed among an even wider class of persons, in this case ordinary people who are harmed by unemployment and poverty'(Schwarcz 205-206).

The legal rationale for regulation and supervision rests on the premise that sound regulation coupled with strong enforcement powers would minimise bank failures, mitigate systemic risks and promote financial system stability.

2.2 Economic rationale for financial supervision

The economic role of a bank is to convert illiquid assets into liquid liabilities (Diamond and Dybvig 401-402). Banks promote capital formation, access to finance and liquidity for individuals and enterprises hence contributing towards the economic performance of a country.

The main economic rationale for supervision stems from the peculiarity of banks at their failure. Unlike other businesses, the prices of banking products do not encapsulate the losses that are borne by society at their failure. Hence bank failures result in negative externalities and social costs (Atsem). The failure of several banks at the same time causing systemic collapse results in widely felt externalities that impose massive costs on society (Wagner). Bank failures result in job losses for employees and denial of access to bank accounts for daily transactions to the depositors, causing great distress. Further, the 2007-09 crisis resulted in systemically important banks and some non-banks in several countries being bailed out with public funds, burdening the public with the cost of bank rescues. Hence, sound financial supervision is needed in order to minimise negative externalities in the form of social costs at a bank failure, which are hitherto not borne by any party to banking transactions (Llewellyn).

The nature of banking itself gives rise to failure. Bank balance sheets are saddled with risky assets that are not easily tradable or convertible into liquid assets at times of crises. By amassing risky assets of similar nature and driven by similar opportunities and profit margins that result in poor diversification of both asset and liability portfolios, bank balance sheets appear to be more and more similar each day. Goodhart quoting Wagner states that poor diversification of assets and liabilities by financial institutions makes them more vulnerable to failure under the same shock (C. Goodhart). Due to the similarity of institutions, the failure could become contagious and develop into a systemic crisis. Therefore, one of the requirements of regulation and supervision is to arrest concentration of risk by avoiding poor diversification of assets and liabilities of financial institutions.

Goodhart argues that ordinary individuals have no time or expertise to continuously calculate riskiness and assess reputation of financial institutions (Lastra 74). One can also add

financial products to the said statement as the subprime crisis in the US in 2007 was primarily blamed on the widely conceived misjudgement of escalating housing values where persons who were unable to take a mortgage under market rates bought houses under subprime rates in the hope of selling such properties in a few years' time for a higher price and settling the debts – an expectation that proved to be fatally wrong. An ordinary depositor or a creditor of a financial institution does not have the financial literacy or the foresight to a level where risks and rewards of complex financial instruments could be identified and losses could be mitigated. While credit rating agencies and external audit reports published by auditors are available to consumers to make informed decisions, such agencies are recruited and paid by the financial institutions themselves, which gives rise to agency issues and biased opinions that does not support depositors' interests. Therefore, one of the main expectations of a financial supervisor would be to monitor the health of the institutions on established standards, take steps in the event of an institution failing to meet the required standards and preserve depositors' interests. The economic rationale for supervision and regulation of financial markets does not require replacement of competition with regulation and supervision. Llewelllyn argues that regulation and competition are not in conflict. Supervision, which is the monitoring of enforcement of regulation can also be said to not be in conflict with market competition.

2.3 Political or public policy rationale for financial supervision

One of the key motives for banking supervision is to prevent bank runs, i.e. panic withdrawal by depositors fearing an imminent failure of a bank, which has the potential to develop into a self-fulfilling prophecy. Hence, deposit taking institutions have access to several safety nets. The most fundamental safety nets are deposit insurance schemes and lender of last resort facilities from the Central Bank, both involving significant costs to the state. Even when there is no explicit deposit insurance scheme in place, the implicit guarantee of deposits by the government works as a safety net for the banks (MacDonald 11). Therefore, depositor protection has become a political fact of life. This causes moral hazard issues as the availability of safety nets promotes excessive risk taking by banks, whereby firstly, they become too big to fail, secondly, having the insurance of a government rescue they continue to seek higher profits in the short term taking excessive risks (Atsem). However, a detailed discussion of this vicious cycle of moral hazards falls outside the scope of this paper.

The role of effective financial supervision and the importance of preserving the financial system stability have been underscored during the time of the crisis. Many financial institutions failed and had to be bailed out with tax payer money, hurting the government coffers of many countries and ailing the economy of the world. In the United Kingdom, the banking bailout bill peaked at £ 955Bn (National Audit Office 6). In the United States, the Troubled Asset Relief Programme was funded up to USD 700Bn (Ericson M, He E). In

Europe, the bailing out process is on-going and appears to be far from over. The fiscal costs at crisis include not only bailout funding but also the costs of recapitalisation of banks and the reimbursement of insured depositors. Arguing that major financial instability or crisis can also bring about significant fiscal instability, Eschenbach and Schuknecht state that fiscal costs measured by fiscal debt could be as high as 50% of GDP of a country (Felix Eschenbach and Schuknecht 6). Basing their research on 124 systemic banking crises over the period of 1970 to 2007, Laeven and Valencia argue that fiscal costs, net of recoveries, associated with banking crises could range from 13.3% to a shocking 55.1% of the GDP (Laeven and Valencia 24). During the 2007-09 crises, the amount of financial support given to banks on a global basis has been approximately $7 trillion or 12% of global GDP (Huertas). Generally associated with too big to fail or too interconnected to fail concepts, large banks and banking conglomerates have been the primary recipients of rescue packages by governments, giving rise to unrest and social discontent worldwide.

The market confidence and financial inclusiveness are also strong political tools. Access to finance empowers society by including individuals, small and medium enterprises and an 'un-bankable' strata of the society in the web of financial intermediation. Widely practiced through microfinance, it is one of the key social and development goals of developing economies (World Bank ix). With no continuous and reliable funding sources at hand, many industries and entrepreneurs rely on their own savings, loans from informal credit sources such as money lenders and ad hoc grants which prevent them from achieving optimal levels of production. Most developing countries thus encourage credit to rural and SME sectors with a view to achieving provincial and sectorial growth. Access to finance paves the way for new entrants to the market, expansion of businesses that would create more job opportunities and improve production, therefore profits, which would all contribute towards the economic growth of the country. Governments that practice 'pro poor growth' policies need to improve access to finance as a prerequisite alongside with prevention of market failure (OECD 11). However, one of the key issues with regard to priority sector lending is credit/counterparty risk. Often associated with sectors with high non-performing assets or low profitability, the fundamental task for the financial supervisor would be to balance the risks of lending with policy goals of the government. Hence, independence of the financial supervisor is an essential component to strike a balance between public policy goals and the financial system stability.

The Basel Core Principles for effective bank supervision lists financial supervisors' independence and accountability as key principles for effective supervision. Lastra (49) includes functional and operational guarantees as a composite element of independence of a central bank which may well be applied in the case of a financial supervisory agency. This requires to be guaranteed by way of a law that safeguards independence. The decisional independence of the supervisory agency would depend on its decision making power

guaranteed by law as well as on the people who are appointed to carry out the duties and functions of the agency. The ability to take independent decisions without seeking pre or post assent of the political order would afford room for the supervisor to issue directions, rules and regulations to the financial industry, taking a balanced approach to mitigate exposure to risks and accumulation of low yielding assets.

Lastra (47), in her discussions on central banking independence, stresses the need to have appointment and dismissal procedures for board members, term of office of Governor and relationship between the Central Bank and the Treasury or the Minister of Finance as some of the key provisions to be included in a law to guarantee the independent function of the central bank. These provisions could be generally applicable to guarantee independence of any other agency such as the financial supervisory agency.

It is therefore evident that for reasons that are diverse and perhaps self-serving, supervision of the financial system is called for by legal, economic and political quarters woven together by the pressing need to avoid failures and prevent bank runs. It recognises the important role played by financial supervisors in the market and also rests heavy responsibilities on the supervisors that need effective execution. While the market players may urge for less regulation and supervision and more self-regulation and discipline, subject to general standards set by regulators and supervisors, the expectations of the public are levelled at a higher interventionist hard-knuckled control oriented supervision. This is especially true for deposit taking institutions that rely heavily on retail funding where individual depositors expect a greater deal of trust and confidence to part with their hard earned money.

3. Supervision of deposit taking institutions in Sri Lanka

The Central Bank of Sri Lanka (CBSL) is the apex financial institution in Sri Lanka. It has been established in 1950 under the Monetary Law Act, No 58 of 1950 (MLA)[7] as 'the authority responsible for the administration and regulation of the monetary and banking system of Ceylon' entrusted with the objectives of monetary policy, exchange rate policy, promoting and maintaining a high level of production, employment and real income in Sri Lanka and encouraging and promoting the full development of the productive resources of Sri Lanka.[8] Mr John Exter, the Founder Governor of the CBSL who also drafted the MLA, in his recommendations to establish a central bank had stated that the 'establishment of the Central Bank should greatly strengthen the banking system. Through its power to examine

[7] It was established as the Central Bank of Ceylon and was renamed as the 'Central Bank of Sri Lanka' in 1985.

[8] Monetary Law Act No 58 of 1949, s 5

and supervise the operations of the commercial banks, it can prevent them from engaging in unsound banking practices and thus protect Ceylon depositors against bank failures' (Exter 8). In 2002, the MLA was revised and the objective of preserving the stability of the financial system was added.[9]

The main deposit taking institutions that are authorised by the CBSL are the licensed commercial banks, the licensed specialised banks (hereinafter collectively referred to as 'banks') and the licensed finance companies (finance companies). The banks and finance companies are the predominant holders of the deposit liabilities in the financial system (Central Bank of Sri Lanka 178). The co-operative societies established under the Co-operative Societies Law No. 5 of 1972 and other micro finance institutions too accept deposits. The supervision of banks is entrusted to the Bank Supervision Department of the CBSL. The Department of Supervision of Non-Bank Financial Institutions supervises licensed finance companies and registered finance leasing establishments (Central Bank of Sri Lanka, Objectives, Functions & Organization).

The laws applicable to banks in Sri Lanka are mainly the Banking Act No 30 of 1988, the Foreign Exchange Act No. 12 of 2017, the Companies Act No. 7 of 2007, the Finance Leasing Act No. 56 of 2000 and the Financial Transactions Reporting Act No. 6 of 2006.[10] For finance companies all the laws mentioned above apply except the Banking Act which is replaced by the Finance Business Act No. 42 of 2011.

The statutory duties, responsibilities and powers entrusted to the CBSL to carry out its functions would be critically examined hereunder. Subject to criticism (Delis and Staikouras 511-512) of being vague, the Core Principles for Effective Bank Supervision -(BCPs) issued by the Basel Committee on Banking Supervision act as a benchmark for establishing key components of financial supervisory systems (IMF 25).

3.1 Licensing

Banking is founded on trust and confidence, hence preserving the integrity of the system by making it impenetrable by fraudulent, incompetent and financially unsound persons is a key requirement of supervision. According to Lastra, licensing is the screening stage that prevents unsuitable persons from entering the financial sector (R. Lastra 110). While licensing is an integral part of financial supervision, some scholars argue that licensing coupled with supervision *stricto sensu* would create a bubble of complacency for depositors where a false sense of security would exist (Cartwright 298, 301).

[9] Monetary Law (Amendment) Act No. 32 of 2002, s 2

[10] All laws are available in the electronic form at http://www.lawnet.lk/list_page.php?id=3.

The Monetary Board, with the approval of the Minister of Finance, is empowered to license commercial banks (LCBs) and specialised banks (LSBs) in terms of Sections 2 and 76A of the Banking Act. The finance companies are licensed under Section 5 of the Finance Business Act.[11] For both banks and finance companies provisional approval may be granted prior to issuing a license.[12]

The main exemption to licensing is contained in Section 31 of the Banking (Amendment) Act No. 33 of 1995 whereby, inter alia, a building society incorporated under the National Housing Act (Chapter 401) or a non-profit organisation that accepts deposits only from its registered members under the prior written approval of the Monetary Board are exempt from the requirement to obtain a license to accept deposits.

According to the BCPs, a financial supervisory agency should clearly define the permissible activities of licensed banks. Barth et al argue that due to conflicts of interest, increased risk taking due to availability of safety nets and the formation of large financial conglomerates that are too big to supervise, restrictions should be placed on permissible activities of banks (Barth et al. 3-4). Schedules 2 and 4 of the Banking Act set out the permissible activities for banks in Sri Lanka that include accepting deposits and granting loans and advances; dealing with securities; and engaging in hire-purchase services, factoring and leasing. The banks in Sri Lanka are not permitted to engage in insurance activities and real estate investment, development, and management. The Sri Lankan practice in this regard is in line with most low or middle income economies in the world.

As per the BCPs, the supervisor must restrict the use of the word 'bank' in the name of institutions.[13] The restriction is expected to prevent the general public from being 'misled by unlicensed, unsupervised institutions implying otherwise by the use of "bank" in their titles'. Section 16 of the Banking Act of Sri Lanka mandates the use of, as part of the name of a licensed bank, any of the words "bank", "banker" or "banking", or any of its derivatives, transliterations, or their equivalent in any other language and prohibits the use of such words in the name or the description of any other institution except with the prior written approval of the Monetary Board. However, the effectiveness of this prohibition is undermined by the exceptions in subsection (3) of section 16 of the Banking Act which extends to, *inter alia*, subsidiaries of banks that could use the word 'bank' in their names even though they are not licensed banks. Even when the equity investment in the subsidiary is sold by the bank, there are no provisions in the Banking Act to remove the word 'Bank' from its name. Therefore, in order to mitigate the confusions that may arise, the CBSL has been conducting extensive public awareness programmes to educate the public of the licensed deposit taking

[11] Finance Business Act, No 42 of 2011

[12] Banking Act, s 3(4); Finance Business Act, s 5 (3) (b)

[13] Principle 2

institutions. In Sri Lanka, finance companies are licensed by the Monetary Board under Section 2 of the Finance Business Act and the usage of the word 'finance' in the name of companies has been restricted to licensed finance companies.[14]

As per the BCPs, clear and objective criteria promote transparency of the licensing process and also make it resistant to political influence and interference (See Principles 15 and 16). In Sri Lanka, the Monetary Board is required to satisfy itself as to the suitability of the applicant having regard to the interests of the national economy, including the banking needs. According to the evaluation criteria published by the Monetary Board, an applicant should satisfy the Board in particular on the history of the company; the financial status, experience and suitability of the directors and key officers; the adequacy of the capital and the ability to comply with the provisions of the law.

In summary, licensing procedure in Sri Lanka appears to be sound and comprehensive, and also, conform to the requirements of the BCPs.

3.2 Supervision *Stricto Sensu*

Lastra refers to supervision *stricto sensu* (prudential supervision) as the 'monitoring of the safety and soundness of a financial institution during its healthy life' (R. Lastra 110). Prudential supervision includes onsite and offsite supervision, spot examinations and continuous supervision by way of reporting requirements (Basel Committee 2). The CBSL has adopted the risk based supervision (RBS) approach, which focuses on identification and management of risks and the assessment of adequacy of resources to mitigate risks as opposed to relying on historical data to carry out point-in-time assessments. Minimum capital, liquidity, classification of loans and advances and provisioning, fit and propriety of directors and key management officers, deposit insurance and single borrower limits are some of the areas on which directions have been issued by the Monetary Board. Compliance with directions is mandatory.

Supervisors conduct on-site examinations by visiting the premises of financial institutions to gather information and peruse records. The conduct of on-site examinations and spot examinations of banks is sanctioned under sections 41 and 76L of the Banking Act and Sections 29, 29A and 29B of the Monetary Law Act. The purpose of the on-site examination is to ascertain whether a bank is in sound financial conditions and whether its business has been carried on in accordance with the provisions of the law. In the process, all books and records including minutes of meetings of the board of directors, accounts, vouchers, title deeds and other documents and records relating to the business of the bank would be

[14] Finance Business Act, s 10 (2)

perused on sample basis according to the internationally accepted CAMEL model (Capital Adequacy, Asset Quality, Management, Earnings and Liquidity).

The licensed finance companies are examined in terms of Section 24 of the Finance Business Act. The on-site examination of the finance companies has been strengthened by extending the powers of the supervisors to obtain search warrants in instances where resistance is anticipated. To address any shortcomings or noncompliance revealed at an on-site examination, corrective action is recommended by the CBSL. The on-site examination reports are submitted to the Monetary Board. On-site supervision enables the supervisor to independently verify the veracity of the information provided by the financial institution and also the quality and reliability of the internal control mechanism as at a particular time.[15] The effectiveness of an on-site examination lies also in its frequency. A study (Plank et al. 26) suggests that there is a positive correlation between the frequency of on-site audits and banking discipline. Delis and Staikouras (513) argue that intensifying the frequency of examinations beyond a certain threshold may constrain bank risk. The Banks and finance companies in Sri Lanka are subject to on-site supervision at least once in every two years.[16] The Standard & Poor's Ratings Services (Standard and Poors') has expressed its concerns over the low frequency of on-site examinations as 'not being sufficient' to assist the supervisors in an early detection of accumulating risks. The CBSL, however, has refuted the claim on the basis that where risks have been flagged at regular onsite examinations, such banks have been supervised more closely with follow up/spot examinations on a regular basis.

Off-site or continuous supervision is an important monitoring mechanism. The CBSL, as a part of continuous supervision requires the financial institutions to provide a continuous flow of information at given intervals to identify risks, stresses, non-compliances and the corporate affairs of such entities. The data returns from banks and finance companies are fed into the two electronic surveillance systems maintained at the Bank Supervision and Non-Bank Supervision Departments of the CBSL. Each system flags potential threats and weaknesses across the industry, which facilitates the identification, management and mitigation of systemic risk. Spot examinations are carried out to further investigate the issues flagged by the surveillance system.

The CBSL has published a list of qualified auditors to carry out external audits of banks in terms of the Banking Act. The banks and finance companies are required to submit audited financial statements to the CBSL and also publish the same in newspapers in Sinhala, Tamil and English languages.

[15] Delis and Staikouras (n 81) 513
[16] Ibid

The supervisory role of the CBSL has been under intense public pressure since the collapse of an unregulated deposit taking institution in 2008. One of the sovereign rating agencies, Standards and Poor's, in its 2012 Country Assessment has commented that finance companies have been 'weakly' supervised and that the banking regulations in Sri Lanka are 'somewhat weaker than international standards'. However, Delis and Staikouras (511, 519) argue that "letter-of-law evaluations supplemented by the opinions of experts" on the basis of "vague" BCPs is a flawed methodology. Hence, the true assessment of the fragility of the Sri Lankan financial system is debatable.

3.3 Sanctioning

The enforceability of regulations is the true test of effective supervision (Bhattacharya and Daouk 75, 79). The CBSL is empowered to take a wide array of actions to enforce the provisions of the Banking Act and the Finance Business Act, which includes the powers to issue orders, initiate action in a court of law and also, to suspend or cancel a license.

In terms of the Banking Act, where the Director of Bank Supervision (DBS) is satisfied that a licensed commercial bank (LCB) has carried on its affairs in a manner that causes loss to depositors or other creditors or has failed to comply with the provisions of the Banking Act, the DBS may issue cease and desist orders or direct the bank to take steps to comply with the Act or correct the conditions resulting from failure. Similar provisions are also applicable for licensed specialised banks (LSBs).

The Finance Business Act which was enacted in 2011, carries extensive sanctions. In the case of finance companies, on a report submitted by the Director of the Department of Supervision of Non-Bank Financial Institutions (D/SNBFI) that a licensed finance company has carried on its affairs in a manner that causes loss to depositors or has failed to comply with the provisions of the Finance Business Act, the Monetary Board may impose a penalty; issue a cease and desist order, publish the name of the finance company as a finance company regarding which the Board has serious supervisory concerns; appoint a manager; appoint a Central Bank officer as a representative; remove any director, manager or employee of the finance company; and also reorganise the share capital of the finance company. Violation of the provisions of the Finance Business Act constitutes an offence, which, on conviction after a trial before a Magistrate, is given a penalty not exceeding three year imprisonment, a fine not exceeding three million rupees or both can be imposed as specified in the Act.

The exercise of sanctioning powers of the CBSL is subject to secrecy and not disclosed to the public. However, in 2007, the Monetary Board issued corporate governance directions to banks that contained a direction as follows:

'A statement of the regulatory and supervisory concerns on lapses in the bank's risk management, or non-compliance with these Directions that have been pointed out by the Director of Bank Supervision, if so directed by the Monetary Board to be disclosed to the public, together with the measures taken by the bank to address such concerns'[17] (Emphasis added).

A similar direction has been issued to finance companies in 2008[18].

However, no directions have been issued so far by the Monetary Board directing banks or finance companies to disclose lapses/noncompliance with the law. Hence, it appears that the possibility of being 'directed to disclose' is expected to act as a deterrent more than being a sanction.

The CBSL has been alleged to be inefficient in some areas in carrying out its regulatory and supervisory duties including administrating sanctions to licensed institutions, which in turn has exposed it to public, legislative and judicial scrutiny. During the period 2000-2011, No director or key management official of a bank or finance company has been prosecuted under the Banking Act, the Finance Companies Act (now repealed) or the Finance Business Act by the CBSL. Even though legislative changes have given more powers to the supervisor to initiate action against noncompliance or unlawful conduct, no action has been filed by the CBSL against any director or officer of a regulated institution. Further, consequent to the collapse of 13 finance companies in the early 1990s, the Finance Companies Act has been amended in 1991 introducing provisions for recovery of assets that are misappropriated or improperly utilised by any director or officer of a finance company.[19] The timing and the contents of the amendment indicate that the new provisions have been introduced swiftly to be made use of under the crisis situation that prevailed at the time. However, no action has been taken by the CBSL under the said amendment. The failure of 13 finance companies and the actions taken by the CBSL to prevent the failures have been criticised by the Parliamentary Committee on Public Enterprises and subsequently, a Presidential Commission of Inquiry had been appointed to examine, inter-alia, the findings of the report of the Public Enterprises of the Parliament of Sri Lanka and the individual conduct by the relevant officials of the CBSL, who were in charge of the regulation and supervision of banking and non-banking financial sectors during the period 1991 to 2005. The findings have been reported on 15 December 2008 to H.E. the President("The Report of the

[17] Corporate Governance for Licensed Commercial Banks in Sri Lanka, No. 11of 2007, Direction 3(8)(ii)(i); Corporate Governance for Licensed Specialised Banks in Sri Lanka, No. 12 of 2007, Direction 3(8)(ii)(i)

[18] The Finance Companies (Corporate Governance) Direction, No. 3 of 2008 direction 10(2)(i)

[19] The Finance Companies (Amendment) Act No 23 of 1991, s 5

Presidential Commission of Inquiry into Matters Relating to Failed Finance Companies") however, the report has not been published.

On a positive note, during the liquidity crisis in 2008-9, the Monetary Board has broadly interpreted the powers contained in the Finance Companies Act and has taken measures outside the scope of the Finance Companies Act in order to preserve the system stability. The measures taken include the removal of the board of directors, issue of new shares and appointment of managing agents to the finance companies in liquidity stress without following the statutory procedure of suspension of license, which in any event would only exacerbate the crisis.[20] The public had been made aware of the measures adopted by the CBSL through regular press notices.[21]

The CBSL was under heavy public criticism for failing to administer sanctions against illegal deposit taking institutions. Under the Finance Companies Act No. 78 of 1988 (now repealed) which was the fundamental statute to supervise non-bank deposit taking institutions from 1988 to 2011, adequate provisions were not available to restrain illegal deposit taking institutions and no definition for the term 'deposit' existed. The conduct of finance business without authority was an offence that required proof of accepting money as deposits and lending and investments of the same. The lacuna had resulted in several unscrupulous companies being set up as 'finance companies' accepting deposits from the public and solely using the said funds for consumption purposes without making any investments or granting loans (Fuard). In 2008, the Monetary Board has determined that 6 persons/companies have carried on unauthorised finance business. However, the CBSL did not institute legal action against all of the said persons, which seriously undermines the enforceability of sanctions in the law and the effectiveness of supervision of the CBSL. The law has since been strengthened by granting more power and more flexibility to the supervisor.

3.4 Crisis Management

In the crisis management stage, damage mitigating mechanisms are set in motion. While some crisis management mechanisms induce moral hazard, a discussion of same is outside the scope of this Paper.

[20] Central Bank of Sri Lanka, 'Press Release: Central Bank Begins Implementation of Stimulus Package and Intervenes to Stabilise Registered Finance Companies of the Ceylinco Group' (CBSL, 6 March 2009) <www.cbsl.gov.lk/pics_n_docs/latest_news/press_20090306e.doc>

[21] N 16

3.4.1 The Lender of Last Resort (LOLR) function of the Central Bank

Deposit taking institutions are exposed to and inalienable from liquidity risk owing to their function of transforming liquid liabilities to illiquid assets (Davis) whereby solvent institutions could be illiquid and insolvent within a short period of time. The notion that it is 'generally possible to distinguish illiquidity from insolvency' has been discarded by Goodhart as a myth (C. A. E. Goodhart 339, 343). Therefore, one of the crucial functions of a central bank would be to provide lender of last resort facilities in the wake of illiquidity.

In Sri Lanka, the CBSL performs dual functions of conducting the monetary policy and supervising the financial system. Basing their findings on 104 bank failures in 24 countries, Goodhart and Schoenmaker assert that there is no requirement to separate the functions of monetary policy and financial stability (Goodhart and Schoenmaker 539, 556). Therefore, it can be stated that the dual role played by the CBSL does not hinder its ability to exercise the LOLR function.

The CBSL is empowered under Section 86 of the Monetary Law Act to grant lender of last resort assistance to banks. Further, under the Finance Companies Act, No 78 of 1988, it was empowered to grant direct loans or refinance loans to finance companies in distress. The CBSL has not exercised the LOLR function for the last 10 years, which may be attributable to bad experience of non-recovery in full of the loans granted during the financial crisis in early 1990s, where the CBSL had granted a sum of Rs. 2.7Bn to 13 failed finance companies as refinance and direct loans (Gnanadass). Consequently, being embroiled in long winding up processes, the recoverability of the said loans has been minimal. The Committee on Public Enterprises (COPE) has in its Second Report found that "the CBSL has failed, neglected and acted in a lethargic manner in relation to the recovery of a sum of Rs. 7000 million which had been granted to bankrupt financial companies". The criticism levelled against the CBSL for failure to recover the loans granted in 1990s may have made it once bitten twice shy to grant loans to finance companies during the liquidity crisis during 2007-8.

3.4.2 Availability of a Deposit Insurance Scheme

The CBSL has implemented the Sri Lanka Deposit Insurance Scheme (SLDIS) in terms of the Monetary Law Act with effect from October 1, 2010. All banks and finance companies have been required to obtain its membership. In an event of cancellation or suspension of a license of a bank or a finance company, each depositor would be entitled to a payment of not exceeding Rs. 600,000. The deposits of member banks and finance companies, Government of Sri Lanka, shareholders, directors, key management personnel, other related parties, abandoned property and dormant accounts have been excluded from the scheme. The SLDIS is a pre-contributed DIS where the initial capital has been borne by the CBSL and a premium is required to be paid by members on a monthly or quarterly basis.

Consequent to suspension and/or cancellation of license of a few finance companies, the effectiveness of SLDIS is currently being tested.

3.4.3 Resolution mechanism

The Monetary Law Act, the Banking Act and the Finance Business Act provide for the winding up of banks and finance companies. However, the winding up of deposit institutions have proved to be lengthy and caused inordinate hardships to depositors. For example the winding up order for Mercantile Credit Limited had been issued in 2005 by the District Court of Colombo whereas the company was bankrupt in 1990.

The CBSL has thus, in the absence of similar provisions in the law, prepared a resolution plan for banks and finance companies which allow the CBSL to intervene and stabilise an institution prior to its failure (Ratnasiri 185), which includes deposit insurance, purchase and assumption, bridge banking, open-bank assistance. The traditional resolution methods of restructuring, mergers and acquisition and finally, liquidation have also been included in the resolution plan of the CBSL. To set the resolution plan in motion, several quantitative and qualitative trigger points have been identified including continuous decline in deposits, capital adequacy, cash balances or the liquid assets ratio or increase in the non-performing loans ratio.

In 2008, the Monetary Board invoked the provisions of Section 30 of the Monetary Law Act to contain the issues at a Systemically Important Bank in Sri Lanka, the Seylan Bank PLC. Being a member of a financial conglomerate with (as in 2008) 6 finance companies, 2 leasing companies and 2 banks, a run on Seylan Bank instigated by the failure of an unregulated deposit taking institution within the group was threatening the stability of the wider financial system. The CBSL having prepared for a crisis, had set in motion the resolution plan and replaced the board of directors, appointed a managing agent and called for liquidity injections from a state bank without disrupting the banking services of the bank. The Bank was open for business on the following day. The swift action of the CBSL had been commended by the Standard and Poor's Rating (Standard and Poor's).

While resolution of licensed deposit taking institutions have been addressed by law and through policy measures by the CBSL, resolution of unregulated deposit taking institutions have only led to long drawn court cases with no result either for the depositors or for the regulators. In terms of the Finance Companies Act (repealed in 2011), the options available to the CBSL were to require the institution to obtain registration, repay the depositors or wind up the institution, From 1988 to 2011, the CBSL has not commenced winding up proceedings of any unauthorised deposit taking institution. The Finance Business Act has given the CBSL more flexibility in this regard.

4. Legal liability for depositor losses – a myth or a reality?

4.1 Immunity from suit vs Accountability?

Immunity has roots in independence. Dempegiotis quoting Friedman states that an independent central bank is generally regarded as the 'most efficient' institutional framework to attain monetary as well as financial system stability (Dempegiotis 131). Hence immunity may promote efficiency of central banks. The first principle of the Basel Core Principles (BCPs) states that the financial supervisors should be operationally independent but remain accountable for the discharge of its duties. It further states that the supervisors should have legal protection when exercising their duties under the statutes.

Dempegiotis (131) defines accountability as 'an obligation' of which, execution would be measured on 'specific criteria' and which ex-post requires 'justification' of actions and assumption of responsibility for failure. Lastra and Shams categorises accountability of central banks under 'Public accountability' (Lastra and Heba Abstract). Immunity accorded to public officials when executing public duties have been frowned upon on the basis of want of democracy and rule of law in the process. The financial supervisors have not been 'elected' by the people to govern the financial sector. They are viewed as a group of 'white-collared gentlemen' who form a bureaucratic government that enjoys legal, operational and decisional freedom (Dempegiotis). The financial supervisors world over are hence subject to accountability to the three organs of the Government, the Executive, the Legislature and the Judiciary to curb exercising unfettered discretion in matters that concern the public at large.

The CBSL enjoys operational independence from the Government. However, the inclusion of the Secretary to the Ministry of Finance as a member of the Monetary Board had been critiqued by the IMF on the basis that it undermines the operational independence of the CBSL (Caruana and Burton).

The legal protection accorded to financial supervisors is largely to avoid the psychological factors of fear or favour being interferential in the execution of its duties. In a study undertaken by the World Bank Group on 20 jurisdictions, it has been observed that the fear psychosis enlarges with the amount of stress in the system (Washington et al.). Further, it has been observed that most jurisdictions accord statutory protection for supervisors in the circumstances where the supervisor (employee) has carried out the function in good faith within the scope of his employment.

The financial supervisors in many jurisdictions have been subject to legal action by depositors but none so famously as in the series of cases instituted by the Three Rivers District Council against the Bank of England (BOE), involving the collapse of the Bank of Credit and Commerce International (BCCI), claiming that the BOE had breached its

obligations under the First Banking Co-ordination Directive and that it had been guilty of misfeasance in public office. The case, of which the details are now well known (Arora 487), was the first case of its kind faced by the BOE in its three-centuries-long existence. While the case was adjourned by the liquidators of the BCCI in 2005, the academic interests have been reignited by the collapse of the Northern Rock Bank (NR) in September 2007 (Gray 37). However, due to the nationalisation of the NR ("TIMELINE-Northern Rock Nationalised"), depositors' interests have been safeguarded hence there appears to be no likelihood of a case being instituted against the FSA on the same grounds.

With great power comes great responsibility, and also accountability. The nexus between the financial power concentrated in regulators (and also in some financial institutions as seen during the LIBOR scandal in the UK (Peston) and public accountability should be strengthened. However, this Dissertation would be limited to a discussion on the accountability of the financial sector supervisor and its legal liability, as a detailed dissection of immunity, responsibility and accountability would fall outside the ambit of this essay.

Proctor argues on the basis of the judgments in Davis v Radcliffe (WLR) and Yuen Kun-Yeu v Attorney General of Hong Kong (AC) that depositors cannot sue the regulator for the tort of breach of statutory care, neither for losses from negligent supervision (Proctor 23). He points out that the Common Law courts have held continuously that the financial regulatory function is for the protection of markets and depositors as a whole and falls short of private duty of care (71).

The officers of CBSL are accorded legal protection under Section 47 of the Monetary Law Act whereby except on grounds of misconduct or wilful default, no member of the Monetary Board or officer or servant of the CBSL shall be liable for any damage or loss suffered by the bank. In terms of the Finance Business Act prior sanction of the Attorney-General is mandatory to institute prosecution. However, the law has not excluded legal scrutiny of any act done, order made or decision given by the CBSL as no immunity from suit has been accorded.

4.2 Case Studies

In the wake of the liquidity crisis in 2007, the depositors of several unregulated entities and one licensed finance company instituted action against the CBSL alleging, inter-alia, negligence and bad faith in carrying on its duties as the financial supervisor. The following is an analysis of the final/interim orders given by the courts and the implications of same on the CBSL.

4.2.1 Failure of the Sakwithi House Construction (Pvt) Limited

A company named 'Sakwithi House Constructions (Private) Limited' owned and managed by a person named Sakvithi Ranasinghe a.k.a. Chandana Weerakumara Ranasinghe had been investigated by the CBSL under section 11 of the Finance Companies Act to ascertain whether such person is carrying on finance business illegally. Ranasinghe had placed advertisements in print and electronic media over several years soliciting funds from the public which had prompted the CBSL to commence its investigation. Ranasinghe, in an apparent attempt to distance himself from the application of the Finance Companies Act had issued documents titled 'letter of employment in Sakwithi House Construction Limited (Sakwithi House)' in lieu of certificates of deposit (Faurd). During the investigations by the CBSL, Ranasinghe had allegedly fled the country in September 2008 defaulting approximately Rs. 900 million of 5000 depositors (Fuard).

Consequently, on 25 September 2008, the CBSL published notices informing the public that 'Sakwithi House Constructions (Private) Limited' is not a registered finance company and is not authorized to carry on finance business by accepting money from the public as deposits or in any other form.[22]

A Fundamental Rights Application was filed in the Supreme Court of Sri Lanka by one of the depositors seeking compensation from the CBSL alleging negligence on the part of the CBSL for failing to protect the public from the illegal scheme operated by Ranasinghe by acting in a timely manner (Ramanayake). The case was in limine dismissed by the Supreme Court on the basis that there are no grounds on which Petitioner's fundamental rights have been violated by the CBSL.

It therefore appears that the court had been reluctant to interpret as certificates of deposits any document which does not carry the word 'deposit' and to adduce liability to the CBSL in an event when a person has made deposits with a company that by the plain reading of its name does not denote in any way to be a bank.

4.2.2 Failure of the Golden Key Credit Card Company Private Limited

The Golden Key Credit Card Co. Limited (GKCL), a member of the Ceylinco Group a diverse conglomerate in Sri Lanka, had been issuing credit cards to the public on accepting 'security deposits' in cash. The company had been offering rates of return in the range of 24% to 30% p.a. on the said 'security deposits' and had held about Rs. 26 Bn on behalf of about 10,000 depositors.

[22] CBSL, 'Conduct of Finance Business by Unauthorised Persons' (CBSL, 25 September 2008) <http://www.cbsl.gov.lk/pics_n_docs/02_prs/_docs/notices/notices%20_to_public_20080925e.pdf>

The business of the company had been investigated by the CBSL in 2006 and due to the nature of the company being similar to issuing payment cards, a decision had been taken to regularise the company in terms of a regulation to be issued with regard to payment cards.[23]

Consequent to the failure of the Sakwithi House in September 2008, the depositors of the GKCL have been demanding the return of the funds on an immediate basis. On 27 December 2008, the CBSL had issued a press release assuring the depositors of regulated institutions of the safety of their investments.[24] GKCL failed in December 2008.

A Fundamental Rights Application was filed in the Supreme Court of Sri Lanka by a group of depositors seeking compensation from the CBSL alleging negligence on the part of the CBSL for failing to protect the public from the illegal scheme operated by the GKCL (Selvanayagam, S).

The Supreme Court, for the first time in the history of the CBSL, directed the CBSL on 23.03.2009 and 30.03.2009 to determine that the GKCL had been carrying on finance business without authority and to take action under section 11 of the Finance Companies Act. The court further directed the CBSL, inter- alia, to obtain a Declaration of Assets and Liabilities from directors and key officers of the GKCL and suspend such person's bank accounts and obtain details of the balances.

The Court appointed a Committee of Chartered Accountants (CCA) on 18 May 2009 to prepare a list of the depositors and formulate a scheme of payment (Selvanayagam, S). The Secretariat of the CCA was established in the CBSL (Weerarathne). The CCA had taken steps to repay the depositors by disposing the assets of the company on a staggered basis.[25] Thereafter, a Task Force was approved of by the Supreme Court to identify assets of the company, sell the same and make payments to the depositors, whereas at April 2014, Rs. 2.036 Bn has been repaid to the depositors.[26] As a final settlement of the said case, on 04.08.2015, a methodology has been filed of record in the Supreme Court, whereby the Treasury would advance funds upto Rs 8.5Bn to repay the security deposit holders of the GKCCCL. Accordingly, security deposit holders with deposits worth Rs. 2 million or less will be compensated in less than a month while depositors with upto Rs. 10 million rupees

[23] Gerald Ranasinghe vs The Monetary Board and 16 others (2009) SCFR 192/2009

[24] Bank Supervision Department, 'CBSL on Golden Key Issue' (CBSL, 27 December 2008) <http://www.cbsl.gov.lk/htm/english/02_prs/p_1.asp?yr=2008>

[25] Similar measures have been adopted by the Supreme Court in Susil Gunadasa Illangasinghe et al vs The Monetary Board and 21 others which relates to the failure of Ceylinco Shriram Capital Management Services Limited, and E DE Soyza vs The Monetary Board and 34 others which relates to the failure of F&G Real Estate Company (Private) Limited. Both institutions have engaged in unauthorised solicitation of deposits.

[26] http://www.ft.lk/2014/07/26/golden-key-announces-completion-of-phase-3/

will be compensated within two months and depositors who have deposits greater than Rs. 10 Million, within a year.

In another development, due to the delay in settling the said liabilities within the time periods set out in the modalities, a Contempt of Court action has been filed by the security deposit holders of GKCCCL against the Monetary Board of the Central Bank and the Minister of Finance ("Golden Key Depositors' Complaint – Contempt Case against CB: SC Re-Fixes for 17 January | FT Online"). The said case is ongoing as at the date of this paper.

4.2.3 Liquidity crisis at Industrial Finance Limited (IFL)

IFL, a licensed finance company had been severely affected by the liquidity crisis in 2007 where it was unable to repay the deposits on demand. It is alleged that the liquidity crisis had been the result of a transfer of deposits to IFL from an unauthorised deposit taking institution, without transferring assets to the equivalent value.[27] In order to contain the crisis, the CBSL appointed the People's Leasing Company Limited as the Managing Agent of IFL with effect from 16 December 2009 (Wijedasa) and consequently removed the board of directors of the company. The CBSL by directions issued on 12 July 2010 has required IFL to, *inter alia*, convert the deposit liabilities transferred from the unauthorised entity into preference shares. A Writ Application was filed by a Depositors Association in 2010 praying for a writ of certiorari, quashing the direction of the CBSL to convert deposits into shares.

This was the first case filed by depositors of a licensed finance company against the CBSL. In an unprecedented move, the Court of Appeal granted leave to proceed. On 19.07.2012, the Petitioner moved the court to withdraw the application and it has been pro forma dismissed by the Court without costs.[28]

4.2.4 General analysis

It appears that the Supreme Court of Sri Lanka has taken an active role in granting relief to depositors and has obtained the assistance of the CBSL to establish a repayment mechanism for the depositors of failed financial institutions irrespective of the illegal nature of the business carried on by such institutions. The unusual and unprecedented measures adopted by the Supreme Court reveals a lacuna in the Sri Lankan financial systems where there is no asset management mechanism in place to restructure or dispose of assets of distressed

[27] *Industrial Finance Depositors Society Limited vs The Monetary Board and 3 others* (2010) CA Writ Application No 865/2010, paragraph 11

[28] Similarly, a case instituted by the depositors of Central Investment and Finance Ltd has been dismissed by the Court of Appeal. http://www.sundaytimes.lk/140622/business-times/appeal-court-dismisses-case-by-cifl-depositors-opposing-central-bank-recovery-plan-104036.html

companies. In the circumstances, the Court has relied upon the supervisor of the financial system to provide assistance to formulate a repayment mechanism.

The Supreme Court has issued orders on the CBSL to make determinations under Section 11 of the Finance Companies Act with regard to companies carrying on unauthorised finance business. These orders appear to negate the decisional independence of the Monetary Board, where it is the sole authority in Sri Lanka to determine whether a person is carrying on finance business. The Court, however, being consistent with judgments of foreign courts, had not determined that the CBSL should compensate the depositors.

The effectiveness of the supervisory powers of the CBSL has been challenged before the Court of Appeal in the Industrial Finance Company Case where the Court has granted leave to proceed. The granting of leave to proceed itself is indicative of the fact that the Court is willing to make judgment on the capabilities and bona fides of the CBSL in executing its functions. This case however was dismissed by the Courts after 2 years of hearing on the application of the Petitioner.

In conclusion, the case studies indicate that the Courts in Sri Lanka have not determined that the financial supervisor is liable for depositors' losses. However, it appears that the Sri Lankan financial sector lacks an agency to revive or restructure failed financial institutions and such lacuna has been de facto filled by the Supreme Court of Sri Lanka through the CBSL and a Committee of Chartered Accountants, which comprises civilians with no statutory powers.

5. Conclusions and Recommendations

A stable and a well-developed financial system is key to economic development. In order to preserve financial stability, to safeguard the reputation of the financial markets and to protect the interests of the depositors, an effective financial supervisor is a vital need, promoted by legal, political and economic quarters.

In Sri Lanka, the Monetary Law Act has conferred on the Central Bank of Sri Lanka (CBSL), the responsibility of maintaining the financial system stability. Analysing the Sri Lankan laws pertaining to banks and finance companies, it is clear that the statutes have provided for a supervisory structure in line with the Basel Core Principles (BCPs). Its licensing procedure and supervision *stricto sensu* is in compliance with the standard expected from the BCPs and follows the rationale of supervision.

However, it is observed that in the areas of exercising sanctions the CBSL has shown weaknesses which may expose the CBSL to supervisory failures. Cartwright quoting

Galbraith states that 'Regulatory bodies, like the people who comprise them, have a marked life-cycle. In youth they are vigorous, aggressive, evangelistic, and even intolerant. Later, they mellow, and in old age — after a matter of ten or fifteen years, they become, with some exceptions, either an arm of the industry they are regulating or senile' (Cartwright 298, 301). It is up to the CBSL to assume its powers and execute all aspects of supervision with equal efficiency and vigour. In the case of licensed finance companies the new law has conferred more power and flexibility to the CBSL, which if not exercised, the CBSL would run the risk of being subject to Writs of Mandamus compelling it to perform its duties. The crisis management measures adopted by the CBSL have proven to be practical and successful in the instance of the rescue of the Seylan Bank, a systemically important bank in Sri Lanka that was rescued amidst a liquidity crisis that affected the entire financial sector. Hence, the powers granted by laws to the CBSL can be stated as being adequate to execute its supervisory functions.

It was observed that the CBSL enjoys operational independence but also is accountable to the executive, legislature and the judiciary. However, in terms of the Monetary Law Act, the supervisors do not have immunity from suit hence the decisions and actions taken by the officers of the CBSL can be subjected to judicial review. The recent cases instituted against the CBSL by some depositors of both licensed and non-licensed deposit taking institutions were studied in the backdrop of the adequacy of supervision. The Supreme Court has not decided, quite rightly so, that the CBSL should repay the depositors of failed deposit taking institutions. However, the Court has involved the CBSL in the mechanism established by the Court to repay the depositors. The involvement of the CBSL in the repayment process falls outside the scope of its objectives and gives arise to conflict of interests where it is required to be a member of a team to resolve a failed financial institution at the same time being the financial sector supervisor for licensed banks and finance companies.

The analysis of the determinations of the Supreme Court and actions taken by the CBSL reveals several lacunas in the Sri Lankan financial sector, namely the lack of an institution to restructure failed financial institutions, non-availability of a statutory special resolution regime and an exclusive fast tracked liquidation process for financial institutions. The case study revealed that the financial supervisor is involved in the court processes not as a punishment for lax supervision or as an indication of the liability of the CBSL to repay the depositors but to fill the lacuna in the financial system.

In the circumstances, it is recommended that an orderly liquidation mechanism be established in Sri Lanka by a statute that is empowered to liquidate a failed financial institution more effectively than the civil courts. It would be both time and cost efficient and the depositors and other creditors would receive a higher repayment in terms of time value of money. The entity should be independent from the CBSL and should not involve itself in any supervisory activities.

Further, in respect of licensed banks and finance companies which are systemically important, an effective resolution regime is recommended to be established with statutory powers in order to avoid systemic disruptions and losses at instances of instability or failure. The Financial Stability Board has published a report (Key Attributes of Effective Resolution Regimes for Financial Institutions) which can be mutatis mutandis adopted to suit the financial system of Sri Lanka.

In conclusion, it can be stated that the judicial review of the functions of the CBSL and involvement of the CBSL in the repayment of deposits indicate the lacunas in the financial landscape of Sri Lanka, which is the absence of a statutory special resolution regime, an orderly liquidation mechanism and an institution to restructure assets of failed financial institutions. Therefore, in order to preserve the independence of the CBSL and to allow its effective execution of statutory duties, the Legislature and policy makers should consider the establishment of a statutory special resolution regime, an orderly liquidation mechanism and an asset restructuring mechanism in Sri Lanka.

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Testing the Validity of Conditional Four Moment Capital Asset Pricing Model: Empirical Evidence from the Colombo Stock Exchange

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Abstract

The Capital Asset Pricing Model (CAPM) is one of the most used model in finance during the last five decades. This is despite heavy criticism against it along with an ongoing debate among academia about the empirical validity of the model. Three major extensions to the conventional model have been suggested; higher-moment CAPM, multi-factor model and conditional CAPM. All these models have shown mixed results in empirical studies. In the recent past, these extensions are integrated and tested for empirical validity and show some positive results (Vendrame, Tucker & Guermat, 2016). In this study, the empirical validity of conditional four-moment CAPM is tested on the Colombo Stock Exchange (CSE) of Sri Lanka. Individual stock returns on 74 listed companies covering a 17-year period from 2000 to 2016 are used. A two step procedure is followed with the estimation of the short window time series regressions in the first step, while cross-sectional regressions are estimated in the second step. Test results show inconclusive evidence about the conditional four-moment CAPM. Risk of co-skewness is significant though risk of covariance and co-kurtosis are not significant explaining the average return on individual stocks on the CSE during the period under study.

***Key Words**: CAPM, co-skewness, co-kurtosis, Four-moment, individual stocks*

***JEL Classification:** C1; G12*

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1. Introduction

The Capital Asset Pricing Model (CAPM) plays a major role in the current finance industry and in making investment decisions. The CAPM is introduced by Sharpe (1964), Lintner (1975) and Mossin (1966) following the mean-variance portfolio theory introduced by Henry Markowitz (1952). The model primarily describes the linear relationship between expected return on an asset and expected market return in excess of risk free return. Black (1972) has suggested a two-factor model to be used in the absence of the risk-free asset. Though early studies by Black, Jensen and Scholes (1972) and Fama and MacBeth (1973) support the CAPM with evidence of a linear relationship between average asset returns and market risk, Black, Jensen and Scholes (1972) fail to find empirical evidence to support the other implications of the CAPM, such as that the intercept equals the risk-free rate. Many later studies also find evidence against the CAPM. Basu (1977), Banz (1981) and Fama and French (1992) find evidence that not only beta but other factors such as earnings to price (E/P) ratio, size and book value to market value (B/M) ratio also have the explanatory power of average returns.

Despite the vast amount of empirical evidence against the CAPM, it has been widely used in finance to estimate the cost of capital for firms, to assess investment opportunities and to evaluate performance of portfolio management. Jagannathan and Wang (1996) provide three reasons for the extensive use of CAPM over the years. First, alternative asset pricing models also have failed to be proven empirically. The second is the lack of the intuitive appeal of the theories behind other models. For an example, Arbitrage Pricing Theory can only be applied to well diversified portfolios and it does not say anything about how expected returns are determined. Thirdly the uncertainty about the empirical evidence against the CAPM and their economic importance have helped the wide use of the CAPM.

However, efforts of researchers to find better models to explain the average asset returns led to some extensions to the CAPM. The first extension was introduced by Kraus and Litzenberger (1976) by introducing skewness of excess market return to the CAPM. The kurtosis was introduced to the model by Fang and Lai (1997) and empirical evidence is found in consistence with the proposed model. The studies show that investors are willing to pay a premium for assets with positive co-skewness and expect a risk premium on assets with positive kurtosis.

The evidence that the P/E ratio, B/M, size of the firm and leverage have the power to explain the average asset returns (Basu, 1977; Banz, 1981; Fama & French, 1992) directed towards the introduction of the second form of extension by Fama and French (1993). They introduce a three-Factor model by introducing size effect and book-to-market ratio effect in addition to the market portfolio in to the model. The third extension to the model is the conditional CAPM. Pettengil, Sundharam, and Mathur (1995) and Jagannathan and Wang (1996) suggested that CAPM is held conditionally though it is not held unconditionally.

Empirical tests of CAPM have been subject to criticisms in various frontiers. One of the early criticism is Roll's (1977) critique on the market portfolio. He argues that the CAPM is never tested without knowing the exact definition of the market portfolio. Another criticism is on the use of ex-post returns to test the CAPM (Elton, 1999) whereas the CAPM model describes the ex-ante returns. Econometrics approaches and methodologies used to test the CAPM empirically have also been criticised and several alternatives have been proposed (Shanken, 1992; Kim, 1995). In a recent study, Ray, Savin, and Tiwari (2009) find evidence that conventional tests over-reject the CAPM and use of the new HAR based tests provide much supportive evidence for the CAPM. Vendrame, Tucker and Guermat (2016) test whether the use of individual stocks, conditional model, higher moment and other risk factors such as size effect can perform better than the traditional, static and portfolio based CAPM model and find that the use of individual stocks with higher moment, in combination with size factor and conditional model explain the cross-sectional variation in asset returns.

As in the international case, even in Sri Lanka, empirical evidence shows mixed results on the CAPM. Samarakoon (1997) concludes that there is negative relationship between beta and average return, while Thilakarathne and Jayasinghe (2014) conclude that the beta plays a significant role in explaining average returns of stocks in the CSE. Riyath and Nimal (2016) find evidence that the Fama and French (1993) three factor model performs better than the CAPM.

Many empirical studies on the CAPM assume that the asset returns are normally distributed and distributions are static. But in real world, asset returns are not normally distributed and returns vary with time (Aggarwal & Rao, 1990; Shahi & Shaffer, 2017). Therefore, it would be more appropriate to use a higher-moment dynamic model to explain the average return of assets.

The objective of this study is to empirically test the conditional four-moment CAPM on individual assets on the Colombo Stock Exchange (CSE), the only stock exchange in Sri Lanka. It is tested whether the co-skewness, co-kurtosis of asset returns with the market return are helpful to explain the stock returns on the CSE in addition to the market return in the conventional CAPM. The estimation of risk parameters beta, gamma and delta using one year short- windows make sure that the models are conditional. Further, instead of estimating risk parameters on portfolios, in this study parameters are estimated on individual stocks. Overall, the model integrates two extensions of the CAPM, namely the conditional CAPM and four-moment CAPM. The analysis process closely follows Vendrame, Tucker and Guermat (2016) and Kraus and Litzenberger (1976) processes. The two steps procedure is followed; In the first stage, time series regressions are used to estimate conditional beta, gamma and delta on each stock for each year. Then these estimates are used to perform cross-sectional regressions in each year to estimate risk premiums in the second stage.

As far as the author is aware, there is no study that has been conducted on either conditional CAPM or on the higher moment CAPM on CSE. Therefore, this would add to the literature on the Sri Lankan stock market as the first study on conditional higher-moment CAPM on the CSE, filling the existing gap. Further, this would be one of the first studies even in the international context that integrates two extensions of the CAPM, apart from the study by Vendrame, Tucker and Guermat (2016).

The study is carried out using weekly stock prices of 74 firms listed in the CSE, for the period January 2000 to December 2016. All Share Price Index (ASPI), the main index of the CSE, is used as the proxy to the market portfolio, while the three-month Treasury bill rate is used as the risk-free rate. In summary, the results provide inconclusive evidence on the conditional four-moment CAPM. Test results indicate that co-skewness can explain the average return of stocks on the CSE during the period 2000 to 2016, while the conditional covariance and co-kurtosis has no explanatory power of asset returns. Moreover, the results support the evidence that the return distributions and risk parameters vary over time. Further, it shows evidence of skewness and kurtosis in return distributions.

The rest of the paper is structured as follows, in Section 2, literature on the CAPM and its extensions are discussed. The model of four-moment CAPM is outlined in Section 3. Section 4 describes data and methodology. Empirical analysis and interpretations of the test results are presented in Section 5, while Section 6 summarizes and concludes.

2. Literature review

Since its introduction, validity of the CAPM has been empirically tested by many researchers. While some studies (Fama & MacBeth, 1973; Limmack & Ward, 1990; Sauer & Murphy, 1992) provide supportive evidence for CAPM, many studies (Black, Jensen & Scholes, 1972; Blume & Friend, 1973; Basu, 1977; Banz, 1981; Fama & French; 1992) have shown evidence against the CAPM. At present, the general concession on CAPM is that the market risk is not the only factor in deciding return on an asset. However, there are ongoing debates on the validity of the CAPM, with criticism on procedures, econometrics methods and tests used to test the empirical validity of the CAPM. As a result, different methodologies, various versions and extensions to the CAPM have been introduced.

In this chapter, the next section begins with a brief discussion on the CAPM model and its assumptions. Then some of the important empirical evidence available in favour and against the CAPM is presented. There are criticisms against the CAPM and empirical tests conducted on the CAPM. Those criticisms are discussed before discussing the literature on the extensions to the CAPM. The CAPM is tested using empirical data from the Colombo Stock Exchange (CSE). Therefore, finally a brief introduction to the CSE and some studies carried out in relation to the CAPM model in the CSE are discussed.

2.1 Introduction to the Capital Asset Pricing Model (CAPM)

Following the mean-variance portfolio theory of Markowitz (1952), Sharpe (1964) and Lintner (1975) proposed a model to explain the average return on individual assets. As in many economics and financial models, the CAPM is derived under certain assumptions. Since the CAPM is derived based on the Markowitz mean-variance portfolio theory, the CAPM requires the same assumptions to be held and two more assumptions about investors ability to lend and borrow money and their homogenies expectations. The key assumptions of the CAPM are as follows:

i) Investors view the outcome of any investment as being represented by a probability distribution of returns.
ii) Investors maximize one period expected utility. This requires either the returns to be normally distributed or investors have quadratic utility functions.
iii) Investors make their investment decisions based on expected returns and standard deviations of returns.
iv) Investors are risk averse. They prefer higher expected return to lower expected return for a given level of risk as measured by standard deviation or lower risk to a higher risk for a given level of expected return.
v) There are no transaction costs or taxes involved in investing in assets.
vi) Investors can borrow and/or lend any amount of money at the risk-free rate of interest.
vii) All investors have the same view on the return distributions on all the investments, i.e., have homogeneous views about investments.

(Sharpe, 1964; Lintner, 1975; Mossin,1966)

Based on the above assumptions, the model relates the expected return on an asset to the risk-free rate, market return in excess of the risk-free rate and the assets' responsiveness to the market excess return in a linear fashion.

Mathematically the CAPM model can be represented by equation (1).

$$E(R_i) = r_f + \beta_i\left[E(R_m) - R_f\right] \tag{1}$$

Where E(.) is the expected operator, R_i- return on the ith stock, R_m – return on the market, R_f – risk free rate, and $\beta_i = \frac{Cov(R_i,R_m)}{\sigma^2(R_m)}$ - measure of the systematic risk of stock i.

$$\sigma^2(R_i) = E[R_i - E(R_i)]^2 \tag{2}$$

$$Cov(R_i, R_m) = E\{[R_i - E(R_i)][R_m - E(R_m)]\} \tag{3}$$

Here the market portfolio is a value weighted portfolio of all risky assets available to an investor. There are three main implication of the model (Fama & MacBeth, 1973).

a) The model implies that there exists a linear relationship between expected excess return on any asset and its beta.
b) The covariance between the asset return and the market return is the only variable that explains the variation in returns between assets. Accordingly, investors are awarded for holding the systematic risk and not rewarded for bearing the idiosyncratic risk.
c) The expected excess return of an asset is proportional to its beta. That is, higher the risk (beta) of an asset higher the expected return on that asset and the market risk premium is positive.

However, it is worth to note that the model is a single period static model. Further, it does not clarify about what the single period is, whether it is a month, quarter, year or several years. In reality, the economies are dynamic and therefore the (expected) return on assets also changes with time. The model expects beta to be static, at least during the single period. Moreover, the market portfolio plays a key role in the model, but there is no proper definition to the market portfolio. Asset returns are expected to be normally distributed, but observed otherwise. All these pitfalls have created enough ambiguities on the empirical evidence about the CAPM as discussed in the following subsections.

2.2 Evidence in favour of the CAPM

As one of the major breakthroughs in Asset Pricing Theory, the CAPM attracted the attention of many academia and finance managers. Sharpe (1964) and Lintner (1975) developed the CAPM model theoretically without any empirical evidence to support the model. In a different approach, Mossin (1966) also developed the same model and introduced the concept of market risk premium. Following those developments, many studies have been carried out to assess the empirical validity of the CAPM.

In one of the early studies using monthly returns of common stocks traded on the NYSE for the period January 1926 to June 1968, Fama and MacBeth (1973) found supportive evidence for the CAPM. In their study, they used a three-step approach and this method was widely used in subsequent studies. They conclude that, on average, there is a positive linear relationship between beta and return, despite the fact that they observe nonlinearity in sub periods. Therefore, this has been interpreted as a weak support for the CAPM by Schwert (1983). Further Fama and MacBeth (1973) conclude that no other measure of risk systematically affects the average return. In Fama and MacBeth (1973) study, as in many other studies, the average realised return is used as a proxy for expected return and realised returns of an equity index is used as a proxy for market return. Apart from this affirmative evidence

from the US, Sauer and Murphy (1992), and Limmack and Ward (1990) found positive evidence from Germany and the UK, respectively.

2.3 Evidence against the CAPM

As discussed in Section 2.1 (Introduction to the CAPM), there are three main implications of the model. The model can be empirically validated only if empirical evidence supports these three implications. Almost every test of CAPM is based on either a time series regression or a cross sectional regression. In the cross-sectional regression approach, average asset returns are regressed on estimated betas while in the time series regression approach, excess return on an asset is regressed on market excess return. In the cross-sectional regression approach, it is expected that the intercept term to be equal to the risk-free rate and coefficient on beta to be equal to the average market excess return over the risk-free rate. In the time series approach, the intercept, which is called Jensen alpha, is expected to be zero. Most of the studies based on cross-sectional regressions find a linear relationship between beta and returns but their slopes are too small. Further, the estimated intercept significantly different from the risk-free rate. The same is evident in the time series regressions, as assets with high beta recorded negative intercepts and assets with low beta recorded positive intercepts (Black, Jensen & Scholes, 1972; Blume & Friend, 1973; Fama & French; 1992, 2004).

The CAPM also implies the completeness of beta, i.e., the market risk is the only factor that explains the differences in excess returns across assets. Many studies have challenged the role of beta as a complete and efficient measure of systematic risk of an individual asset as they find other factors, such as earnings-price ratio (Basu, 1977), size of the firm in terms of market capitalization (Banz, 1981), leverage (Bhandari, 1988), and book to market value (Rosenberg, Reid and Lan 1985) affect the asset returns. The most significant evidence against the CAPM is provided by Fama and French (1992) following the same methodology by Fama and MacBeth (1973) but for data of non-financial firms on the NYSE, AMEX and NASDAQ from 1963 to 1990. Fama and French claimed that the relationship between beta and asset returns disappears in that period. Moreover, they show that size effect and book to market value is able to explain the average stock return. Consequently, they introduced a three-factor model for asset pricing.

2.4 Criticisms on CAPM and empirical tests

However, none of these studies are exempt from criticism. These criticisms can be broadly categorised into two frontiers; criticisms based on the validity of the assumptions of the CAPM and criticisms based on the shortfalls in the econometrics approaches. Roll's (1977) critique on the market portfolio is one of the famous critiques on the assumptions of the CAPM. In the CAPM the market portfolio plays a major role. However, it is not clear what assets are included in the market portfolio. Therefore, Roll (1977) argue that the CAPM can never be tested without knowing the exact composition of the true market portfolio.

Almost all the studies discussed so far use the ex-post observed returns, but the CAPM model specifies the relationship between expected return and risk. The problem of ex-ante returns being proxied by ex-post returns is criticised by Elton (1999) providing evidence of realized negative excess returns in the stock market for the 11-year period from 1973 to 1984. This problem has been addressed in several studies, which have been concluded in favour of the CAPM. Claus and Thomas (2001) use equity analysts forecast and current market price to find that the equity premium is approximately three percent. Fama and French (2002) estimate the equity premium using fundamental based returns and conclude that the average realised equity premium is much higher than the expected equity premium during the period 1951 to 2000.

Another important assumption in Markowitz portfolio theory, on which the CAPM has been developed, is that the asset returns are normally distributed. But there is empirical evidence that returns are not normal (Aggarwal & Rao, 1990; Barnea & Downes, 1973; Fama, 1965; Officer, 1972). This observation has led to the introduction of higher moment CAPM. Further, Shahi and Shaffer (2017) conclude that the distribution of asset returns changes with time, therefore challenging the validity of the CAPM. Some recurrent changes to the return distribution has been observed by Ariel (1987) and Penman (1987).

Errors in variables (EIV) is one of the criticisms associated with the econometrics approaches used in the empirical test of the CAPM. EIV occurs due to the two pass procedure followed in estimation. The result is the underestimation of the market risk premium and overestimation of the other risk premiums (Shanken, 1992; Kim, 1995). Alternative methods of estimations to overcome the EIV problem have been proposed by Gibbons (1982), Shanken (1992), Kim (1995) and Malloch, Philip and Satchell (2016).

Appropriateness of different estimation procedures such as OLS, WLS, GLS, and GMM to empirically test the CAPM is also discussed in the literature. In each method, there are merits and demerits and there is no consensus about the best procedure to follow. Shanken and Zhou (2007) provide a good comparison between different estimation methods based on a simulation analysis.

In addition to the empirical challenges to the validity of the CAPM there are some theoretical challenges to the CAPM. The first challenge is imminent from the behavioural economists who challenge the expected utility theory (EUT) on which mean-variance portfolio theory is derived. Behavioural economists based on Prospect Theory by Kahneman and Tversky (1979) argue that the investors are not rational and efficient all the time as assumed in the EUT. In a very recent paper using an algebraic analysis Lai and Stohs (2015) show that the CAPM is having an endogeneity problem or circularity. They show that the beta of an asset depends on its excess return and therefore proportional to the same. As a result, contrary to the CAPM, the excess return of the asset determines beta, instead beta determines the excess return. Thus, it is incorrect to interpret as beta represents the systematic risk.

In the attempts to address the above criticisms several extensions and different forms of CAPM models haves been suggested. These extensions are briefly discussed in the following sub section.

2.5 Extensions to the CAPM

The vast amount of empirical evidence against the CAPM directed to extensions of the CAPM. The first extension of the CAPM is introduced by Kraus and Litzenberger (1976) by incorporating the effect of skewness. Derivation of three moment CAPM model assumes that the investors' expected utility can be represented by the first three moments; the mean, variance and skewness, of the end of period wealth and investors maximize the expected utility. Further it assumes that investors are averse to variance as in the CAPM but prefer to positive skewness. Investors are willing to pay a premium for assets with positive skewness as they receive the premium for the risk. Authors also derive a quadratic market model that corresponds to the three moment CAPM. They went on to test their model empirically using the stock data on the NYSE from 1926 to 1970. The portfolio formation method similar to Black, Jensen and Scholes' method (1972). Fama and MacBeth's (1973) procedure is used to address the problem of estimation errors. But they use realised deflated excess rate of return. Finally, Kraus and Litzenberger (1976) conclude that there is a significant price for systematic skewness and a zero intercept as predicted by the model. Friend and Westerfield (1980) conducted a similar study that incorporates both stocks and bonds in to the analysis and found contradicting results to Kraus and Litzenberger (1976).

The model further extended to incorporate the fourth moment of asset returns by kurtosis by Fang and Lai (1997). In this model, it is assumed that investors are averse to kurtosis. Thus, the expected return for kurtosis is positive. The model was tested empirically following the grouping method suggested by Kraus and Litzenberger (1976) and using stock data on NYSE stock for the period 1969 to 1988. Empirical evidence supports the model. Further, Hung (2008) shows that the higher moment CAPM model is unable to produce superior results than the traditional CAPM model in one period ahead forecasting.

The inclusion of skewness and kurtosis can be justified by the Prospect Theory (Kahneman & Tversky, 1979). In Prospect Theory, it is assumed that the investors assigned higher weights to losses than to gains. On the other hand, since late 1980s the global financial markets have experienced major crises. Therefore, most likely higher moment models will be able to capture the systematic risk in the current asset markets (Vendrame, Tucker & Guermat, 2016).

While the higher moment CAPM model tries to fill the gap of the inability of single factor beta to explain the asset returns by adding higher moments of the return distribution, Fama and French (1993) introduce a three-factor model by adding the size of the firm (SMB) and leverage (HML) factors into the model and conclude that the market factor together with SMB and HML explain the average stock returns. Series of latter studies confirm the three-factor model (Fama & French, 1996a, 1996b, 1998, 2002).

The other major branch of extension to the traditional CAPM is the conditional CAPM. Pettengil, Sundharam and Mathur (1995) suggest the use of a conditional beta approach when realized market returns are used to test the CAPM. Pettengil, Sundharam and Mathur (1995) argue that when the market excess return is positive the relationship between beta and realized return is also positive. But when the market excess return is negative then the relationship between beta and realized return is negative. They carry out an empirical test using stocks that are included in the CRSP equally-weighted index for the period 1926 to 1990. Their evidence supports the existence of a systematic relationship between beta and returns for the whole sample periods as well as for subsample periods and positive trade-off between market risk and return. Similar results were found in the Swiss stock market by Isovak (1999) for the period 1983-1991 and by Tang and Shum (2003) in 13 international stock markets.

In line with the argument that the market risk premium varies with time and therefore the beta, Jaganthan and Wang (1996) suggest a different form of the conditional CAPM. Jaganathan and Wang (1996) contend that the CAPM is derived based on the assumptions that the investors live only one period, which is far away from reality. During a business cycle, the relative risk of firms varies, therefore the expected returns and beta vary with time and depend on the status of the economy. Therefore, they suggest a conditional version of the CAPM and interpret it as "the expected return on an asset based on the information available at any given point of time is linear in its conditional beta" (Jaganathan & Wang, 1996). They test the model empirically using the CRSP value weighted index as the proxy for the market portfolio and observed that the 30 percent of the return variation is explained by the conditional CAPM. Further, once they include a measure of return on human capital to the market portfolio the model can explain 50 percent of the variation.

However, Freeman and Guermat (2006) criticise the econometric tests used in existing empirical studies on conditional CAPM and proposed an adjusted test. Lewellen and Nagel (2006), also argue that the conditional CAPM has failed to explain the pricing anomalies such as size effect and loser-winner effect. Meantime they have suggested a direct method of estimating the conditional CAPM model using short window regression and therefore avoiding the use of conditioning information.

Vendrame, Tucker and Guermat (2016) carried out a study to investigate the drawbacks that may have contributed to the weak and conflicting outcomes of the empirical studies. Their study tests whether the use of individual stocks, conditional model, higher moment and other risk factors such as size effect can perform better than the traditional, static and portfolio based CAPM model. In summary, the results indicate that the use of individual stocks with higher moment in combination with size factor and conditional model explain the cross-sectional variation in asset returns.

2.6 Colombo Stock Exchange

The Colombo Stock Exchange (CSE) is the only stock exchange in Sri Lanka and was established in 1985. Market capitalization as at 14th June, 2017 is Rs 3,068.3 bn (USD 20 bn) with the 295 listed companies representing 20 business sectors. There are two market indices; All Share Price Index (ASPI) and S&P 20 SL index. In the recent past, attention of foreign investors on the CSE has increased as an emerging market in the South Asian Region.

Only a limited number of studies have been carried out on the CSE. Among them early studies done by Samarakoon (1997) contributed significantly. Samarakoon (1997) documented that the relationship between average return and beta is negative while there is a strong positive relationship between earning-price ratio and average return. In an attempt to identify a better model to explain cross sectional variation in stock returns in the CSE, Riyath and Nimal (2016) find evidence that Fama and French (1993) three factor model perform better than the CAPM. Both these studies closely follow the Fama and MacBeth (1973) procedure.

In contrast to the above observations, Thilakarathne and Jayasinghe (2014) conclude that the beta plays a significant role in explaining average returns of stocks in the CSE and size of the company has a weak positive relationship. Further, they find that earning-to-price ratio has a weak negative relationship with average return. As in the international case, mixed results for the validity of CAPM is observed in the CSE.

However, all these studies on the CSE test the validity of the original form of the CAPM or multifactor models. According to the best of my knowledge, there is no study that has tested the validity of higher order moment CAPM on the CSE. Further, many studies on higher moment CAPM have been carried out on well-developed markets such as US and there is not that much studies carried on emerging markets such as Sri Lanka. In this study, it is attempted to fill that gap by testing the four-moment CAPM on CSE in Sri Lanka.

3. The model: four-moment CAPM

The original form of the CAPM as specified by equation (1) states that the expected return of an asset is determined by the beta factor of the particular asset and the relationship between beta, and expected return is linear. However, as many later time relevant studies found empirical evidence against this form of CAPM (Black, Jensen & Scholes, 1972; Fama & French, 1992) some extensions to the CAPM are introduced, as discussed in Section 2.5. In this study, the validity of the four-moment CAPM is tested in the CSE. Therefore, a brief introduction to the four-moment CAPM model and related concepts such as co-skewness and co-kurtosis are provided in this section.

In addition to the expected return and variance of return in the traditional CAPM, the third and fourth moment of the return distribution are considered in the four-moment CAPM.

Skewness (S3) and kurtosis (K4) are defined as follows.

$$\text{Skewness} = S^3(R_i) = E[R_i - E(R_i)]^3 \quad (4)$$

$$\text{Kurtosis} = k^4(R_i) = E[R_i - E(R_i)]^4 \quad (5)$$

And co-skewness and co-kurtosis between asset i and market portfolio are defined as:

$$\text{Co-skewness} = Cos(R_i, R_m) = E\{[R_i - E(R_i)][R_m - E(R_m)]^2\} \quad (6)$$

$$\text{Co-kurtosis} = Cok(R_i, R_m) = E\{[R_i - E(R_i)][R_m - E(R_m)]^3\} \quad (7)$$

Following Fang and Lai (1997) and under the mean-variance-skewness-kurtosis optimization the four moment CAPM model can be written as

$$E(R_i) - R_f = \lambda_\beta \frac{E[(R_i-\bar{R}_i)(R_m-\bar{R}_m)]}{[E(R_m-\bar{R}_m)]^2} + \lambda_s \frac{E[(R_i-\bar{R}_i)(R_m-\bar{R}_m)^2]}{[E(R_m-\bar{R}_m)]^3} + \lambda_k \frac{E[(R_i-\bar{R}_i)(R_m-\bar{R}_m)^3]}{[E(R_m-\bar{R}_m)]^4} \quad (8)$$

$$E(R_i) - R_f = \lambda_\beta \beta_i + \lambda_s \gamma_i + \lambda_k \delta_i \quad (9)$$

$$\beta_i = \frac{E[(R_i-\bar{R}_i)(R_m-\bar{R}_m)]}{[E(R_m-\bar{R}_m)]^2}, \quad \gamma_i = \frac{E[(R_i-\bar{R}_i)(R_m-\bar{R}_m)^2]}{[E(R_m-\bar{R}_m)]^3} \text{ and } \delta_i = \frac{E[(R_i-\bar{R}_i)(R_m-\bar{R}_m)^3]}{[E(R_m-\bar{R}_m)]^4}$$

Equation (8) and (9) state that the expected excess return of any individual stock is a linear function of three co-moments of the stock return with the market portfolio.

λ_β –risk premium for the market risk (ie: market risk premium)

λ_γ – risk premium for risk of standardized co-skewness

λ_δ – risk premium for risk of standardized co-kurtosis

It is assumed that the asset with positive co-skewness ($[R_i - E(R_i)] > 0$) tends to deliver higher return than the expected return and therefore is considered as a less risky asset. As a consequence, investors are willing to pay a premium for holding an asset with positive co-skewness (Kraus & Litzenberger, 1976; Friend & Westerfiels, 1980; Vendrame, Tucker & Guermat, 2016). Meanwhile, the asset with positive co-kurtosis tends to deliver large losses and therefore is considered as a risky asset. Like in the case of co-variance in the presence of positive co-kurtosis investors need to compensate for holding the risk and expect higher expected return (Fang & Lai, 1997; Vendrame, Tucker & Guermat, 2016). Therefore, in the four-moment CAPM a negative value for λ_γ and positive values for λ_β and λ_δ are expected.

4. Data and methodology

4.1 Data

Weekly data of stock prices of 74 firms out of 295 firms listed in the CSE is obtained from the data library of the CSE for the period of January 2000 to December 2016. Most of the stocks do not trade frequently in the CSE and therefore the mostly traded 74 firms during the sample period are selected for the study. As the market portfolio is proxied by the ASPI, weekly data for the same is obtained from the data library of the CSE for the same period. The three-month Treasury bill rate is used as the risk-free asset and weekly data on a 3-month Treasury bill rate are obtained through Bloomberg.

As the market price of stocks are available, return on individual stock and market are calculated as $R_{it} = ln\left(\frac{P_t}{P_{t-1}}\right)$ where P_t represents the price of the stock/ASPI at time t. As the interest rate of the 3-month Treasury bill rate is expressed in annualised terms it is adjusted to a weekly rate of return by dividing 52. Then weekly excess return is calculated for each and every stock in the sample and for the market portfolio proxied by the ASPI.

Preliminary analysis of excess returns show that there is positive correlation between stock excess returns and market excess return (Table 1, Appendix A). The correlation coefficients are calculated for the whole sample period and all 74 coefficients are significant. Table 2 (Appendix A) shows the summary statistics for excess stock returns and market excess return for the whole sample period. Test for normality is performed using the Jarque-Bera test and the resulting test statistics are also reported in Table 2. Distributions of returns for all stocks and market significantly deviate from normal distribution as all test statistics are significant. This observation justifies the use of four-moment CAPM to explain the average stock returns.

4.2 Methodology

The aim of the study is to test the validity of the four-moment CAPM represented by equation (9) in Section 3. In the absence of skewness and kurtosis, this model is equivalent to the traditional CAPM model. As explained in Section 3, investors expect high return for the assets with high co-variance and co-kurtosis with the market and are willing to pay a premium for assets with positive co-skewness with the market. Accordingly, testing the validity of four-moment CAPM is equivalent to testing the following hypothesis:

$H_{01}: \lambda_\beta > 0$

$H_{02}: \lambda_s < 0$

$H_{03}: \lambda_k > 0$

in the equation (9).

In many empirical studies following Fama and MacBeth (1973) and Black, Jensen and Scholes, (1972) the CAPM is tested on portfolios instead of individual assets. There are criticisms on use of portfolios to test the CAPM. It is argued that grouping reduces the variation in betas and lowers the power of statistical tests (Kim,1995). Further, Kim (1995) argues that important information on risk premium is lost when grouping is used. Therefore, in this study individual stocks are used as in Vendrame, Tucker and Guermat's (2016) study.

Further, many empirical studies have been criticised for the use of the static model that assumes that the return distribution does not change over time (Ariel, 1987; Penman,1987; Shahi & Shaffer, 2017). The solution for that problem is to use the conditional CAPM. Again, following Vendrame, Tucker and Guermat (2016) the direct estimation method proposed by Lewellen and Nagel (2006) is used to overcome the limitation of the static model. Therefore, the following two steps estimation procedure is followed.

In step one β, γ and δ for each and every stock for each one year period are estimated as in Kraus, and Litzenberger's, (1976) and Vendrame, Tucker and Guermat's (2016) studies by estimating the following three regressions.

$$r_{it} = \alpha_1 + \beta_i r_{mt} + \mu_t \tag{10}$$

$$r_{it} = \alpha_2 + \gamma_i r_{mt}^2 + \nu_t \tag{11}$$

$$r_{it} = \alpha_3 + \delta_i r_{mt}^3 + \varepsilon_t \tag{12}$$

where, $r_i = \frac{R_i - R_f}{R_f}$ and $\bar{r}_i = \frac{\overline{R_i - R_f}}{\bar{R}_f}$ are the deflate excess returns introduced by Kraus, and Litzenberger (1976). The regression models (10) – (12) are estimated using the OLS method for each year and for each security, and thus obtaining 1,258 estimates for each of the three conditional co-moments beta, gamma and delta.

The cross-sectional regression of average excess returns, i.e., $\bar{r}_{it}$, on one period lagged conditional co-moments (beta, gamma and delta) is performed in the second step to estimate the risk premia for each year.

$$\bar{r}_{it} = \alpha_t + \lambda_{\beta t}\beta_{i(t-1)} + \lambda_{\gamma t}\gamma_{i(t-1)} + \lambda_{\delta t}\delta_{i(t-1)} + u_i \tag{13}$$

Then following Fama and MacBeth's (1973) method, as Vendrame, Tucker and Guermat (2016) did, annual risk premiums are averaged and tested for significance using the t-test. Total market risk premium is estimated as the sum of individual risk premiums.ie:

$total\ market\ risk\ premium = \lambda_{\beta t} + \lambda_{\gamma t} + \lambda_{\delta t}$ and the significance is tested using the t-test. The use of one year rolling window to obtained estimates of β, γ and δ ensures that we estimate the conditional models.

The econometrics software "E-views" is used to carry out the required data manipulations and estimations. Weekly stock prices, index value of ASPI and three-month Treasury bill rates are uploaded to E-views. Then two E-views programs are used in the process of estimation and hypothesis testing where each corresponds to the two stages of the methodology. Adjustment of T-bill rates, calculation of weekly deflated excess returns for each firm and for the market, generation of data series for square and cube of excess market return and finally estimation of time series regressions for each firm in each year are performed in the first program. All together 3,774 estimates of beta, gamma and delta are obtained in the first stage. The second program performs 16 cross-sectional regressions of mean excess return on one year lagged estimated betas, gammas and deltas for each year to estimate the risk premiums that correspond to each of the three risk factors for each year. In total 48 risk premiums are estimated in the second stage. Then total market risk premium is calculated as the sum of risk premium for beta, gamma and delta. Finally, to test the significance of average risk premiums conventional one sample t-test is used in each of the four series separately. The outcomes of these analyses are discussed in the next section.

5. Empirical Analysis

The aim of this study is to test the validity of the four-moment CAPM in the Sri Lankan stock market using data on the CSE. As explained in the previous section, the two-step procedure is carried out to empirically test the hypotheses mentioned in previous section. Weekly stock prices of 74 firms traded in the CSE during year 2000 to 2016 are used in the analysis. Table 2 (Appendix A) shows the skewness and kurtosis of excess return for the whole sample period for each and every firm. These results provide some evidence of non-normality of return distributions in line with Aggarwal and Rao (1990), Barnea and Downes (1973), Officer (1972), and Shahi and Shaffer (2017).

At the first stage of the analysis, time series regressions given by equations (10) to (12) are estimated for each firm and for each year to estimate beta, gamma and delta. The results of these estimates are summarised in Table 3 to 6 (Appendix A). Maximum and minimum values of the estimates of beta, gamma and delta for each year are provided in Table 3 (Appendix A), while Table 4 (Appendix A) summarises the beta estimates for individual firms. Table 5 and 6 (Appendix A) summarise the gamma and delta estimates for individual firms respectively. These results provide evidence that the risk measures beta, gamma and delta are time varying. For an example, maximum beta for firm 1 is 2.2597 and the minimum is 0.5009 during this 17

years' period. The estimates for gamma for the same firm shows much more variation recording a high of 25.75 and a minimum of -30.84. Same kind of variation in other risk parameters can be observed in the results. This observation of time varying risk measures is consistent with Ang and Chen (2007) and justifies the use of conditional CAPM rather than conventional static CAPM in testing the validity of CAPM, as proposed by Jaganthan and Wang (1996).

Having estimated beta, gamma and delta for each firm for each year in the first stage, cross-sectional regressions of deflated mean excess returns of firms on one year period lagged beta, gamma and delta are performed in the second stage (Equation 13). Risk premiums for beta, gamma and delta are estimated for each year through the estimation of these cross-sectional regressions and results are provided in Table 7 (Appendix A). None of the coefficients are significant at 10 per cent significant level for years 2001, 2003, 2011, 2013 2015, and 2016. Although insignificant intercept supports the CAPM, insignificant risk premiums do not support the four-moment CAPM. In year 2002 the intercept is not significant while all other three risk premiums are significant at a 10 per cent level. However, in that year sign of the market risk premium (ie beta premium) is negative and is against expectation. Last two columns of Table 7 (Appendix A) shows adjusted R2 value of the regression and the probability of F-statistics as measures of goodness of fit. Maximum R2 value of 0.0835 is recorded in year 2011. All regressions have very low R2 values, indicating that low explanatory power of risk factors studied. Further, only the models for years 2002, 2007 and 2012 are significant at 5 per cent significant level. Overall, these individual regressions provide less supportive evidence for CAPM.

The test of the conditional four-moment CAPM is carried out on average premiums and results are shown in Table 8 (Appendix A). As expected by theory, intercept term is insignificant. Further sign of risk premium for skewness and kurtosis are negative and positive, respectively. These observations are consistent with the theoretical expectation of the model. However, all these are insignificant at 5 per cent level, yet the risk premium for skewness is significantly different from zero at 10 per cent significant level. Therefore, it can be concluded that co-skewness is significant at the 10 per cent significant level in explaining average stock returns on the CSE during 2000 and 2016.

The sign of market risk premium is negative and insignificant at 10 per cent level. More interestingly total market risk premium is also negative and insignificant even at the 10 per cent significant level. Overall, test results provide inconclusive evidence on the conditional four moment CAPM.

These findings agree up to some extent with the results of Kraus and Litzenberger (1976) and Vendrame, Tucker and Guermat (2016) where they conclude that there is a price for positive co-skewness. Moreover, the insignificant risk premium on co-kurtosis is also consistent with

the observations of Vendrame, Tucker and Guermat (2016). The result of negative beta is consistent with Samarakoon (1997) as he finds average return has a negative relationship with beta on the CSE.

However, findings of this study contradict with the results of Vendrame, Tucker and Guermat (2016) in many ways. First, using conventional t-statistics Vendrame, Tucker and Guermat (2016) find that the intercept term is different from zero, where as in my study intercept is insignificant. Further their results show that the market risk premium, and the total market premium are significant. Fang and Lai (1997) also find that empirical evidence supports the four-moment CAPM and contradicts with the results of this study.

Finally, it must be noted that there are limitations to this study. The most influential one would be the nonsynchronous trading problem due to the low trading frequency of many stocks in the CSE market, though some measures have been taken to minimize this problem. Secondly, the use of OLS and conventional t-statistics with non-normal returns may not be appropriate. In order to overcome this problem, and possible autocorrelation and heteroscedasticity problem method of GMM could be used in the estimation process and Newey-West HAC standard errors could be used (Newey & West, 1987; 1994) in hypothesis testing. Future studies use the GMM method to overcome this problem. Further, data of a longer time period with different frequency of return calculation (daily, weekly and monthly) may be used in future studies. In this study the model integrates only two extensions of the CAPM model. Thus, the scope of a future study can be extended to integrate all three extension of the CAPM and test the four-moment CAPM with augmented Fama-French factors.

6. Summary and Conclusions

Introduction of the CAPM is considered as one of the major breakthroughs in finance. Since its introduction by Sharpe (1964), Lintner (1975) and Mossin (1966), the model is heavily used by finance managers of firms as well as in the academic world. The simplicity of the model and intuitive appeal of the model attracted the practitioners in the finance industry. The absence of any other alternative model with good empirical support also helps the model to be popular among practitioners (Fama & French, 2004). Moreover, it attracted the attention of academics not only for that reason but also the criticisms levelled against it. Initially, researchers tried to empirically validate the model (Black, Jensen & Scholes, 1972; Fama & MacBeth, 1973, Blume & Friend, 1973). With more evidence against the CAPM, researchers sought for variations of the CAPM and as a consequence three extensions are introduced. Introduction of skewness by Kraus and Litzenberger (1976) and latter higher order moments (Fang & Lai, 1997) is the first extension to the CAPM. Then the three-factor model is suggested by Fama and French (1993) and conditional CAPM (Pettengil, Sundharam, &

Mathur, 1995; Jaganthan & Wang, 1996). In a very recent study, Vendrame, Tucker and Guermat (2016) integrates these three extensions and test on the NYSE.

In this study, the validity of conditional four-moment CAPM is empirically tested on individual stocks listed on the CSE. The study closely follows Vendrame, Tucker and Guermat's (2016) study. Weekly data of 74 firms on the CSE for the period of 2000 to 2016 were used. The analysis was carried out in two steps; in the first step, short-window time series regressions were performed to estimate beta, gamma and delta and these estimates are used in the second step cross-sectional regressions to estimate the risk premiums. Conventional t-test was carried out to test the significance of average risk premium.

The preliminary analysis of return data shows evidence of skewness and kurtosis of return distribution. Further, average beta, gamma and delta estimate for each 17 year indicates the time varying nature of risk parameters.

The overall results of the test provide inconclusive evidence on the conditional four-moment CAPM. Risk premium for co-skewness is significant at a 10 per cent significant level, while covariance and co-kurtosis risks are not significant in explaining individual stock returns in the CSE during 2000 to 2016. Moreover, the average intercept term over the full sample period and in 8 of the cross-sectional regressions are not significantly different from zero. This observation supports the conditional four-moment CAPM. The positive and negative signs of risk premiums for gamma and delta, respectively, are observed as expected by the underlying assumption of the model.

Nevertheless, total market risk premium calculated as the sum of individual risk premium is also not significantly different from zero, and caries a negative sign. More interestingly, the sign of the market risk premium is negative, indicating the possibility of a negative relationship between beta and average returns, though it is not significant. Overall, this study provides inconclusive evidence on the four-moment CAPM on the CSE.

The low frequency of trading in many stocks on the CSE may have led to this result. According the Econometric view, there is a possibility of improvement of this study by using the GMM in the estimation process and HAC standard deviations in hypothesis testing. As there is some empirical evidence that the three-factor model can explain the stock returns on CSE one can extend the study by including those factors to this model and testing the four-moment CAPM with Fama-French factors.

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Appendices

A.1 Tables

Table A1: Correlation of excess stock returns with the market excess return

Firm	Correlation	t stat	Firm	Correlation	t stat	Firm	Correlation	t stat
1	0.7407	32.7822	26	0.4318	14.2342	51	0.4075	13.2665
2	0.6987	29.0373	27	0.4675	15.7243	52	0.5098	17.6192
3	0.6608	26.1742	28	0.4233	13.8932	53	0.5469	19.4224
4	0.5594	20.0677	29	0.3504	11.1222	54	0.3983	12.9111
5	0.4662	15.6698	30	0.4553	15.2062	55	0.3727	11.9434
6	0.4799	16.2652	31	0.4331	14.2850	56	0.4901	16.7192
7	0.3481	11.0409	32	0.4458	14.8090	57	0.2722	8.4090
8	0.3978	12.8900	33	0.4095	13.3449	58	0.5579	19.9872
9	0.5086	17.5627	34	0.2575	7.9217	59	0.4866	16.5583
10	0.4543	15.1626	35	0.5005	17.1867	60	0.6322	24.2574
11	0.3922	12.6760	36	0.3778	12.1303	61	0.6718	26.9658
12	0.4952	16.9485	37	0.5746	20.8731	62	0.3680	11.7667
13	0.3508	11.1376	38	0.3234	10.1601	63	0.4752	16.0566
14	0.5579	19.9872	39	0.4635	15.5524	64	0.4988	17.1099
15	0.5368	18.9173	40	0.4625	15.5102	65	0.4752	16.0566
16	0.6738	27.1151	41	0.4335	14.3044	66	0.5036	17.3307
17	0.5091	17.5866	42	0.5055	17.4189	67	0.2618	8.0655
18	0.2181	6.6429	43	0.2438	7.4747	68	0.5574	19.9620
19	0.4556	15.2169	44	0.4185	13.6985	69	0.6068	22.6986
20	0.5330	18.7310	45	0.4132	13.4916	70	0.4314	14.2157
21	0.4937	16.8779	46	0.5436	19.2549	71	0.3630	11.5845
22	0.5543	19.7998	47	0.5440	19.2772	72	0.3065	9.5724
23	0.3891	12.5578	48	0.3639	11.6174	73	0.3465	10.9824
24	0.7071	29.7330	49	0.4124	13.4611	74	0.4157	13.5897
25	0.2896	8.9964	50	0.4343	14.3346			

Table A2: Summary statistics for the stock returns

Firm	Mean	Std. Dev.	Skewness	Kurtosis	JB stat
1	0.08%	0.0469	1.4812	14.2945	5033.26
2	0.01%	0.0461	1.6507	11.9689	3372.02
3	0.01%	0.0460	2.1228	20.6875	12214.65
4	0.09%	0.0706	1.2880	9.7339	1918.99
5	-0.12%	0.0866	1.5377	11.4564	2989.08
6	-0.34%	0.0594	0.0567	4.5398	88.00
7	-0.22%	0.0889	0.6223	9.1069	1433.98
8	-0.04%	0.0683	0.7149	6.5479	540.17
9	-0.23%	0.0707	0.5522	6.9433	619.06
10	-0.12%	0.0702	0.7656	6.9107	651.13
11	-0.30%	0.0775	2.3065	26.9530	21966.41
12	-0.28%	0.0645	0.8180	7.6140	884.72
13	-0.13%	0.1121	1.8891	24.2669	17223.76
14	0.03%	0.0395	1.6012	17.9650	8646.08
15	0.03%	0.0500	0.4744	6.3552	448.81
16	0.04%	0.0410	0.4586	11.2417	2538.64
17	0.30%	0.0609	2.0344	15.1371	6049.27
18	0.15%	0.1281	-0.2194	309.7410	3473497.00
19	0.21%	0.0858	1.8245	12.4436	3783.78
20	0.13%	0.0378	-0.3728	16.9751	7230.50
21	0.17%	0.0544	1.4110	11.0581	2691.12
22	0.01%	0.0578	1.0311	7.9348	1056.01
23	0.18%	0.0367	0.9088	9.1260	1507.37
24	0.12%	0.0401	0.9579	10.6690	2306.72

Table A2: Cont…

Firm	Mean	Std. Dev.	Skewness	Kurtosis	JB stat
25	0.20%	0.0431	0.6560	17.6411	7977.07
26	0.12%	0.0756	1.1854	9.8465	1937.98
27	-0.08%	0.0658	0.0723	11.5388	2692.40
28	-0.23%	0.0806	1.7278	18.1874	8955.85
29	-0.19%	0.0735	0.6411	7.3967	774.33
30	-0.13%	0.0675	0.4138	6.7785	552.35
31	-0.06%	0.0944	1.4835	9.6770	1970.83
32	0.08%	0.0748	1.0756	8.2797	1199.89
33	-0.03%	0.0721	1.4941	11.3344	2893.94
34	-0.13%	0.1009	1.3189	130.3279	598764.30
35	-0.16%	0.0685	1.6692	10.8430	2682.29
36	0.24%	0.0524	0.4379	9.0848	1395.16
37	0.12%	0.0412	1.5586	11.6154	3098.84
38	0.08%	0.0520	-1.0500	37.8133	44904.47
39	0.11%	0.0471	0.4519	7.4061	746.86
40	0.04%	0.0585	2.8307	29.3348	26785.65
41	-0.03%	0.0466	0.7350	10.5418	2179.55
42	0.10%	0.0514	0.7022	8.3491	1129.12
43	0.14%	0.0921	-0.1767	212.0683	1613616.00
44	0.06%	0.0580	1.0825	9.8010	1880.56
45	0.00%	0.0443	0.5354	7.2774	717.77
46	-0.04%	0.0681	1.3483	8.9758	1586.73
47	-0.07%	0.0698	1.4442	9.7743	2002.13
48	0.04%	0.0689	0.2867	13.0263	3723.21
49	0.15%	0.0923	2.0832	16.4829	7351.80
50	0.26%	0.0938	2.3918	19.2098	10544.96
51	-0.01%	0.0702	1.0162	8.1816	1143.69
52	0.14%	0.0674	1.2237	8.6454	1397.68
53	-0.03%	0.0801	2.7023	21.7169	14011.00
54	0.02%	0.0574	2.9705	45.6163	68349.18
55	-0.05%	0.0683	0.4613	13.1711	3850.50

Table A2: Cont…

Firm	Mean	Std. Dev.	Skewness	Kurtosis	JB stat
56	-0.01%	0.0741	1.2715	10.0255	2060.83
57	0.27%	0.0747	1.1681	65.8614	146079.50
58	0.03%	0.0395	1.6012	17.9650	8646.08
59	0.07%	0.0522	1.4439	10.5553	2415.18
60	-0.03%	0.0400	1.7479	16.5002	7179.37
61	0.00%	0.0443	1.1789	11.3284	2765.87
62	0.09%	0.0519	0.7064	8.1754	1062.47
63	0.09%	0.0579	0.3352	11.4973	2682.14
64	0.09%	0.0519	0.7063	8.1754	1062.49
65	0.09%	0.0579	0.3352	11.4973	2682.14
66	0.11%	0.0570	0.4098	20.5040	11335.70
67	0.07%	0.1222	1.2389	257.7111	2395296.00
68	-0.01%	0.0445	1.2800	9.5278	1815.04
69	-0.10%	0.0628	0.1448	9.9226	1772.20
70	-0.02%	0.0703	0.3482	6.8698	570.74
71	0.02%	0.0813	-0.1134	12.6505	3440.02
72	-0.09%	0.1070	-8.5350	187.3852	1265846.00
73	-0.19%	0.0699	0.7029	10.0639	1915.07
74	-0.14%	0.0745	0.7094	7.3496	772.74
Mkt	0.07%	0.0263	0.6953	8.5969	1227.81

Note: This table shows summary of excess returns. JB stat column shows the test statistics for the Jarque-Bera normality test. All these test statistics are significant indicating that returns are not normally distributed.

Table A3: Summary of estimates for the 17-year period

Year	Beta		Gamma		Delta	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
2000	2.4521	-1.2443	24.0421	-58.1385	1308.4120	-825.3348
2001	2.7765	0.2939	17.7623	1.1601	99.1653	5.5966
2002	2.3165	-0.1035	37.7754	-17.0842	664.0376	-104.4101
2003	1.8186	0.1464	0.6835	-16.0654	235.8253	27.3067
2004	2.0879	-0.3430	14.5244	-7.5655	324.0003	-72.2851
2005	1.8226	0.0898	3.7516	-37.0456	649.3086	24.3296
2006	2.3474	0.1265	40.8820	-11.1436	455.2237	-18.6599
2007	3.2842	-0.1006	22.4285	-50.2987	2077.7940	-29.2873
2008	2.5034	-0.0290	1.9825	-26.4593	230.8908	-5.3654
2009	1.7221	0.0449	25.7511	-2.8122	255.6264	-22.5095
2010	3.0705	-0.3232	85.9203	-10.9722	1263.8500	-87.3830
2011	3.2848	-0.1671	40.5012	-29.2050	1733.9670	14.3916
2012	3.8500	0.0163	32.9060	-13.0442	1107.0010	-25.9923
2013	2.6751	-0.0622	57.0589	-57.6054	1854.3860	-143.3809
2014	3.5060	-0.6249	32.0654	-87.0365	4346.9000	-624.2718
2015	3.2368	-0.2998	45.2601	-49.5508	3580.6420	-1303.3500
2016	3.4759	0.0796	28.4544	-84.6127	2522.8610	-209.0743

Table A4: Summary of Beta estimates for each firm

Firm	Mean	Maximum	Minimum	Firm	Mean	Maximum	Minimum
1	1.2532	2.2597	0.5009	38	0.7505	1.6791	0.0449
2	1.1605	1.8709	0.6419	39	1.0249	2.6776	0.0642
3	1.0888	2.1749	0.2533	40	0.9639	1.5755	-1.2443
4	1.5169	2.4102	0.7716	41	0.8337	2.1711	0.3329
5	1.5150	2.3671	0.4705	42	1.0591	1.4401	0.2050
6	1.3204	2.2542	0.4988	43	0.9238	1.7148	-0.0290
7	1.1176	2.9631	-0.3430	44	0.9035	1.6397	0.2712
8	1.2490	2.8005	0.4268	45	0.6468	1.2972	0.2776
9	1.4086	2.4769	0.5893	46	1.3925	2.0811	0.8304
10	1.1729	2.1819	0.1923	47	1.5008	3.2848	0.6248
11	1.5282	3.5060	0.1761	48	1.0395	2.2425	0.2058
12	1.2076	2.5034	0.4308	49	1.4960	3.2368	-0.3232
13	1.6381	2.8447	0.3850	50	1.6576	3.2842	0.0666
14	0.8512	1.7156	0.3232	51	1.0695	1.9772	0.1271
15	1.0550	1.7579	0.4578	52	1.2596	2.2255	0.1634
16	1.0116	1.8044	0.4527	53	1.6130	2.7766	0.8262
17	1.2320	2.4083	0.5998	54	1.0095	1.6240	0.4983
18	0.9781	1.5686	0.5729	55	1.1633	2.4918	0.2939
19	1.5576	2.9289	0.1130	56	1.4205	2.1401	0.9084
20	0.8271	1.2936	0.3052	57	0.6896	2.3474	-0.6249
21	1.1151	1.8142	0.3514	58	0.8512	1.7156	0.3232
22	1.1819	1.8187	0.3687	59	1.0078	1.4609	0.1464
23	0.6251	2.4005	-0.1006	60	0.8896	1.7950	0.2709
24	1.0858	1.7938	0.4717	61	1.1685	1.7114	0.8731
25	0.5335	1.3911	-0.0993	62	0.8118	1.4593	-0.1036
26	1.0755	1.7655	0.1900	63	1.0382	2.2232	0.3912
27	1.1567	2.1768	0.3850	64	0.9893	1.4593	0.5016
28	1.4761	3.8501	0.3073	65	1.0382	2.2232	0.3912
29	0.8588	1.9000	-0.0622	66	1.1546	1.7157	0.5296
30	1.1521	2.6538	-0.1978	67	1.2321	3.0705	0.4007
31	1.4957	2.5883	0.8456	68	0.8975	1.5049	0.4789
32	1.2750	2.2902	0.1440	69	1.3265	2.0879	0.3082
33	1.1658	2.6521	0.4054	70	1.1073	2.4178	0.2629
34	1.1562	2.5511	-0.1671	71	1.1228	2.1826	0.0521
35	1.1813	2.0444	0.4405	72	1.4611	2.5823	0.2375
36	0.8225	1.4890	0.0913	73	0.9818	2.0727	-0.1067
37	0.8538	1.2949	0.3466	74	1.2022	2.2786	0.4415

Table A5: Summary of Gamma estimates for each firm

Firm	Mean	Maximum	Minimum	Firm	Mean	Maximum	Minimum
1	-5.8748	25.7511	-30.8359	38	-4.1497	8.1200	-30.2391
2	2.1951	21.3027	-21.1274	39	-5.8437	22.7637	-60.7236
3	0.0158	24.8879	-25.6171	40	-2.3889	24.0421	-22.8136
4	-3.1097	25.3790	-45.0726	41	-4.5838	12.4555	-34.1050
5	-7.6441	31.7995	-63.1894	42	-3.5915	14.4406	-18.4933
6	-5.0808	28.4544	-63.4273	43	-1.7007	26.5332	-50.2987
7	-8.1487	18.0102	-48.3791	44	-0.4181	43.1615	-57.0288
8	1.0116	29.4899	-22.2140	45	-2.0417	12.8844	-28.1457
9	-3.4456	45.2602	-36.3391	46	-4.0955	18.4038	-50.3931
10	-11.7633	13.8430	-84.6127	47	-1.9806	40.5012	-47.6704
11	-9.0215	25.5480	-62.3217	48	3.3475	57.0589	-11.0710
12	-0.6856	30.3074	-40.8469	49	-5.0454	24.6729	-48.3919
13	-11.4327	40.8820	-75.3869	50	-1.3744	45.0715	-66.1713
14	1.7719	35.0372	-13.6398	51	-5.0101	17.0335	-32.0175
15	-0.0437	20.8599	-18.7076	52	-2.9075	32.0654	-39.2869
16	-1.9187	23.0281	-22.1740	53	0.9931	28.5149	-38.6423
17	-4.1358	46.5286	-33.9183	54	-5.1976	12.9091	-52.6719
18	-0.6061	14.5149	-14.6838	55	-6.9938	18.1645	-58.1385
19	-1.7753	25.1605	-28.6478	56	-1.5801	21.1223	-26.5592
20	-7.0214	7.7567	-46.6623	57	-4.9178	21.3295	-35.8904
21	-3.6287	23.5455	-59.0704	58	1.7719	35.0372	-13.6398
22	-1.8914	20.1071	-20.0761	59	-0.6435	33.8233	-32.4478
23	-4.6796	9.3414	-57.6054	60	0.1286	14.8066	-11.7219
24	-4.3353	17.8759	-39.2207	61	-0.6119	23.7798	-19.4277
25	-4.3225	13.8269	-36.3547	62	-5.2840	12.4470	-27.9753
26	-2.8601	25.6664	-47.7266	63	-2.8237	14.7211	-35.2567
27	-5.2712	37.1824	-37.0456	64	-5.0442	12.4470	-27.9753
28	-0.4980	33.2142	-47.8053	65	-2.8237	14.7211	-35.2567
29	-10.9971	13.1516	-72.5252	66	-3.8441	20.7761	-51.8976
30	-4.9023	22.4107	-41.8273	67	-0.6517	85.9203	-51.2243
31	-3.1821	24.0930	-49.5508	68	-3.1712	9.1170	-16.7966
32	2.7988	31.8615	-27.3127	69	-3.2016	17.6167	-38.6185
33	0.8171	17.4333	-30.1225	70	-5.7028	24.8050	-41.0369
34	0.0998	25.6465	-29.2050	71	4.7338	37.7754	-22.4955
35	1.3761	40.9568	-17.9644	72	-1.6052	32.4369	-20.6863
36	-5.7717	16.8618	-35.9374	73	-5.9070	19.6068	-87.0365
37	-0.8740	13.8262	-27.6667	74	-4.3322	19.9256	-46.1193

Table A6: Summary of Delta estimates for each firm

Firm	Mean	Maximum	Minimum	Firm	Mean	Maximum	Minimum
1	493.89	2107.59	66.12	38	391.18	1722.30	-15.24
2	449.65	2104.98	61.86	39	624.76	3538.03	20.58
3	462.80	1590.66	58.60	40	376.61	1750.20	-825.33
4	559.26	1577.50	56.93	41	388.80	1936.67	23.42
5	586.11	2416.25	8.90	42	461.85	1654.33	27.57
6	624.68	2812.58	32.15	43	473.13	1470.89	20.79
7	514.10	2061.23	-42.43	44	419.85	2061.10	46.36
8	518.68	2484.17	26.22	45	290.07	1170.52	30.49
9	558.12	1738.66	36.21	46	556.88	2418.56	41.39
10	390.52	1262.55	5.14	47	548.38	1733.97	-87.38
11	846.41	4346.90	17.25	48	413.88	2638.40	-58.47
12	383.97	1727.00	-140.17	49	717.14	3580.64	-80.14
13	576.98	1543.19	-22.51	50	780.74	3007.45	0.11
14	393.95	2018.43	21.53	51	376.14	1749.72	-135.48
15	469.53	2050.73	26.57	52	406.55	1552.31	-111.79
16	445.87	1836.83	52.72	53	686.58	2523.71	97.78
17	548.33	2019.78	28.55	54	461.42	2525.04	15.88
18	433.44	1842.06	58.38	55	555.25	1376.53	5.60
19	576.54	1865.13	-45.61	56	581.78	1958.17	63.93
20	413.16	1744.43	-7.43	57	132.65	1235.00	-1303.35
21	499.96	2234.16	21.56	58	393.95	2018.43	21.53
22	448.63	1449.66	24.94	59	463.60	2064.84	38.35
23	268.89	1854.39	-29.29	60	317.09	1349.05	68.31
24	537.23	2436.01	44.97	61	539.91	2655.91	41.31
25	287.33	1102.25	13.32	62	374.97	1294.63	-104.41
26	205.68	767.57	-598.15	63	449.72	2610.42	50.83
27	541.59	2728.21	-18.66	64	411.01	1294.63	25.45
28	627.05	2429.32	22.56	65	449.72	2610.42	50.83
29	436.60	3447.15	-347.78	66	504.05	1906.53	24.50
30	431.53	1218.91	43.44	67	528.66	1703.02	27.31
31	568.00	2273.36	98.98	68	346.91	1107.59	55.08
32	444.87	1283.71	-209.07	69	557.64	2607.85	58.10
33	440.09	1570.74	63.84	70	331.12	1297.49	-231.25
34	516.11	2250.32	-15.01	71	419.94	2025.96	-143.38
35	358.79	1051.19	63.37	72	540.00	1646.48	24.38
36	380.54	976.89	-5.37	73	490.08	2541.82	-72.29
37	355.46	1308.37	22.10	74	495.64	1689.89	33.37

Table A7: Estimates of risk premium in each year

Year	α	λ_β	λ_γ	λ_δ	Adj R^2	F- Stat
2001	0.002196	0.004959	-0.000003	-0.000012	0.0258	0.1870
2002	0.002225	-0.014097	-0.003685	0.000986	0.0689	0.0462**
2003	0.000376	-0.001852	0.000101	0.000007	-0.0108	0.5318
2004	0.005041	0.001736	-0.000178	-0.000031	-0.0340	0.1990
2005	0.002518	-0.004243	0.000128	0.000004	0.0283	0.1733
2006	0.003528	0.010349	-0.000289	-0.000038	0.0417	0.1135
2007	-0.001654	-0.000164	-0.000871	0.000065	0.1134	0.0095**
2008	-0.007615	-0.001520	0.000157	-0.000002	0.0536	0.0771*
2009	0.013237	-0.006731	-0.001439	-0.000093	0.0018	0.3784
2010	0.010399	0.007171	-0.002081	0.000199	0.0385	0.1259
2011	-0.000403	-0.003067	-0.000042	-0.000001	0.0835	0.0280
2012	-0.000387	-0.008870	0.000039	0.000010	0.1550	0.002**
2013	-0.000577	0.001337	-0.000002	-0.000010	0.0552	0.073*
2014	0.003949	-0.004902	0.000038	0.000008	0.064	0.0546*
2015	-0.001445	0.001278	0.000024	-0.000002	0.0540	0.0761*
2016	-0.004156	0.001387	-0.000032	-0.000001	0.0021	0.3751

Note: This table shows the results of cross-sectional regressions of average stock returns over 52 weeks on beta, gamma and delta of the four-moment CAPM. Corresponding p-values are given in parenthesis. Adj R2 column shows adjusted R2 value and the last column shows the F-statistics value for the overall significance of the model. Significant coefficients at the 10% and 5% levels are indicated with * and ** respectively.

Table A8: Results of the test of the conditional four-moment CAPM

Coefficient	Estimate	t stat	P value
α	0.001702	1.339675	0.2003
λ_β	-0.001077	-0.709569	0.4889
λ_γ	-0.000508	-1.923353	0.0736**
λ_δ	0.0000681	1.079821	0.2973
Market risk premium $(\lambda_\beta + \lambda_\gamma + \lambda_\delta)$	-0.001517	-0.953428	0.3555

Note: This table shows the results of test of four-moment CAPM. Significant coefficients at 5% level are indicated with **.

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Staff Studies is the bi-annual (March and September) peer-reviewed Journal of the Central Bank of Sri Lanka. The Journal aims at stimulating innovative research for the analysis of current macroeconomic issues and policy challenges faced by central banks while providing a forum to present recent theoretical and empirical research.

Paper submissions could be on (but not limited to) the following areas:

- Monetary theory and policy
- Exchange rate dynamics
- Macroeconomic modelling
- Fiscal policy and public debt dynamics
- International trade and international finance
- Financial sector issues
- Macro-prudential policies and regulation
- Commodity market dynamics
- Sustainable development
- Poverty, inequality and labour market issues

In line with its aims, the Journal welcomes papers from officers of the Central Bank either as single authored contributions or as collaborative research conducted with external academics/ researchers.

Submission of well edited manuscripts should be made electronically to the editors of Staff Studies at directorerd@cbsl.lk. The Modern Language Association (MLA) style is recommended for formatting and examples of this style guide can be found at https://owl.english.purdue.edu/owl/resource/747/01/.

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