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Characterising Alternative Fiscal Policy Rules for Sri Lanka

E.W. Kithsiri J. B. Ehelepola[1]

Abstract

This paper characterises fiscal policy rules for Sri Lanka using alternative policy reaction functions for the sample period 2003:Q1 to 2014:Q2. It estimates fiscal policy rules widely used in literature including simple tax difference rules, primary balance rules and Taylor-type fiscal rules.

The findings suggest that, first, the fiscal authority responds to changes in output gap and government expenditure moderately. Second, tax smoothing is moderately high and statistically significant. Third, contemporaneous fiscal rules are better than backward-looking rules in characterising the fiscal reaction behaviour in Sri Lanka. Fourth, deficit rules are marginally better than debt rules in matching with Sri Lankan data. Fifth, the fiscal policy in the country is procyclical rather than countercyclical, similar to many other countries. Finally, the contemporaneous Taylor-type fiscal rule that responds to output, government expenditure and deficit while smoothing out tax rate describes the fiscal policy behaviour of Sri Lanka more appropriately than other alternative fiscal rules estimated.

***Key Words**: Fiscal Policy, Fiscal Rule, Policy Instrument, Debt, Deficit, Tax, Expenditure, Sri Lanka*

***JEL Classification:** C5; C6; E6; H3; H6*

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1. Introduction

Empirical evidence suggests that there are several advantages of implementing formal fiscal rules with sufficient commitment. Garcia et al. (2011) argue that adopting a fiscal rule results in fiscal discipline as opportunistic political views together with a fragile institutional framework exert bias towards increasing deficits, otherwise. A proper fiscal rule defends taxpayers against excessive future taxes aimed at financing budget deficits (Kopits, 2001; Brender and Drazen, 2007). Following a fiscal rule delivers favourable results. It increases credibility of the fiscal authority since a fiscal rule with a genuine commitment to implement will raise the confidence of the market participants. This avoids the time inconsistency problem and keeps market expectations stable. Further, it induces stability due to lowered volatility. It is, however, observed that in many countries fiscal policy is procyclical and this leads to amplify macroeconomic volatility. Therefore, countercyclical fiscal rules can be designed to attenuate such volatility and stabilise the economy (Kopits and Symansky, 1998; Garcia et al., 2011)

According to the International Monetary Fund (IMF), a fiscal rule imposes a long-lasting constraint on fiscal policy through numerical limits on budgetary aggregates.[2] These fiscal rules are typically aimed at correcting distorted incentives and containing pressures to overspend, particularly in good times, so as to ensure fiscal responsibility and debt sustainability. The IMF identifies four types of fiscal rules: budget balance rules (BBR), debt rules (DR), expenditure rules (ER) and revenue rules (RR).[3] According to the IMF's Fiscal Rules Dataset (2014),[4] there are 89 countries which have already implemented at least one type of fiscal rules.

Most of the policy-rule related macroeconomic studies focus on monetary policy. The conventional view of the role of fiscal policy has, however, started to change with some influential papers, including Leeper (1991), Sims (1994), Woodford (1996) and Woodford (2001b), which incorporate monetary-fiscal interaction and its importance in policy design.[5] In light of the monetary policy reaction functions introduced by McCallum (1988) and

[2] Kopits and Symansky (1998) define fiscal rules as a permanent constraint on fiscal policy, expressed in terms of a summary indicator of fiscal performance.

[3] Braun and Tommasi (2002) argue that imposing simplistic numerical limits on fiscal variables as a solution to fundamental fiscal problems is inappropriate. Instead they suggest that governments and international organisations should use more comprehensive tailor-made solutions, particularly in developing countries which may require some explicit political analysis as well.

[4] Additional resources can be found at: http://www.imf.org/external/datamapper/fiscalrules/map/map.htm.

[5] The Fiscal Theory of the Price Level (FTPL), pioneered by Leeper (1991), Sims (1994), Woodford (1996) and Woodford (2001b), essentially says that the fiscal policy influences the price level and this explains another important dimension of the fiscal policy.

Taylor (1993a), interest on policy rule based studies started to grow sharply.[6] Alesina and Bayoumi (1996) show that tighter fiscal rules are associated with larger average surplus and lower cyclical variability of the budget balance, while Bohn and Inman (1996) using budget data from a panel of 47 states of the US for the period 1970-1991, find that the state's end-of-the-year balance requirements do have significant positive effects on a state's general fund surplus. Fatas and Mihov (2006) investigate how budget rules affect fiscal policy outcomes, using data from 48 US states and find that (1) strict budgetary restrictions lead to lower policy volatility and (2) fiscal restrictions reduce the responsiveness of fiscal policy to output shocks.

Recent events such as the global financial crisis (GFC) of 2008 and the current European sovereign debt crisis triggered serious concerns about the sustainability of public finances, forcing fiscal authorities to review their existing control mechanisms and take necessary measures to ensure sustainable paths for public finances. This further strengthens the process of adopting rule-based fiscal policies, which has started to happen over the last three decades, slowly moving away from the long-used discretionary policy instruments. One of the first examples of legislation on fiscal discipline is the Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA) in the US. TEFRA was created in order to reduce the budget gap by generating revenue through the closure of tax loopholes and the introduction of tougher enforcement of tax rules, as opposed to changing marginal income tax rates. The Fiscal Responsibility Act of New Zealand, enforced in 1994, that legislates reporting requirements by the Minister of Finance to Parliament in respect of fiscal management, is another example.[7] Other important initiatives include the Maastricht Treaty of the European Union (EU) (1991) and fiscal responsibility laws enacted in Peru and Brazil in the late 1990s, aiming mainly at lowering the total public debt to prudent levels and maintaining the fiscal deficits at sensible levels. Australia, the United Kingdom (UK) and the EU also implemented similar legislative measures to improve fiscal discipline in the same period. A considerable number of emerging markets, including the Latin American region and the South Asian region have introduced similar acts in the beginning of the new millennium. Tapsoba (2014), Dabla-Norris et al. (2010) and Cabezon and Prakash (2008) find that the introduction of fiscal rules proved to be useful in stabilising the economy while improving fiscal discipline in developing countries.

This paper aims to examine the fiscal performance of and to characterise fiscal policy rules for Sri Lanka, since 2003, subsequent to the implementation of numerical fiscal targets. The rest of the paper is structured as follows. Section 1 outlines the relationship between fiscal

[6] Taylor advocates a fiscal policy rule analogous to the well-known Taylor's monetary rule, where a measure of the fiscal stance reacts to the output gap. Taylor (2000) shows countercyclical evidence of fiscal policy in the United States (US) economy.

[7] Details of this is available at http://www.treasury.govt.nz/publications/guidance/publicfinance/pfaguide/12.htm

rules and the government budget constraint and briefly reviews the Fiscal Management (Responsibility) Act (FMRA) of Sri Lanka, Section 2 discusses the methodology, Section 3 describes data and provides empirical results and Section 4 concludes the paper.

1.1 Fiscal rules and the government budget constraint

Fiscal rules typically characterise different ways of satisfying inter-temporal government budget constraint.[8] Depending on the type of the budgetary aggregate on which some form of restriction is imposed, Schaechter et al. (2012) categorise fiscal rules into five groups: debt rule, budget balance rule, structural budget balance rule, expenditure rule and revenue rule. These rules have different characteristics in terms of their objectives, operational guidance and transparency. Mitchell et al. (2000), for instance, present a systematic study of the characteristics of different fiscal policy rules, considering both their theoretical properties and comparative behaviour in model simulations.[9] The fiscal policy reaction function has a strong relationship with the government intertemporal budget constraint since the sustainability of fiscal policy depends greatly on the fiscal authority's ability to honour the budget constraint in the long run.

The budget constraint alone is, however, not sufficient in conducting fiscal policy. It is silent on the role of revenue and expenditure adjustments when there is a disequilibrium. It does not explicitly indicate the timing of a particular adjustment; instead, it says an adjustment is needed at some time. In practice, the adjustment occurs continuously through a fiscal rule, minimising the deviations of the policy instrument variables from their expected targets. This necessitates an appropriately tailored fiscal policy rule with proper targets and policy instruments,[10] that complement the budget constraint in conducting fiscal policy effectively.[11]

[8] For more details, see the IMF's Fiscal Rules Dataset at http://www.imf.org/external/datamapper/FiscalRules/map/map.htm.

[9] The three models they utilised in developing these rules are: (1) McKibbin-Sachs Global model (MSG2), of which revised versions are maintained by Warwick McKibbin at the Australian National University and the Brookings Institution; (2) MULTIMOD Mark II model, developed by the IMF; and (3) NIGEM model, developed at the National Institute of Economic and Social Research and jointly maintained with the London Business School.

[10] Although either tax revenue or government expenditure can be used as the policy instrument in the fiscal rule, the latter is less preferred for the fact that it produces less acceptable dynamic outcomes in full model simulations as per Mitchell et al. (2000).

[11] Fiscal rules further assures instrument stability; that is, a smooth change in the policy instrument without abrupt fluctuations (for example, tax smoothing).

1.2 The Fiscal Management (Responsibility) Act (FMRA) of Sri Lanka

The FMRA (2003) specifies seven objectives, out of which two are predominant and relevant for the current study:

(1) The deduction of government debt to prudent levels by ensuring that the budget deficit at the end of the year 2006 does not exceed five percent of the estimated gross domestic product and to ensure that such levels are maintained thereafter.

(2) Ensuring that at the end of the financial year commencing on 1 January, 2006, the total liabilities of the Government (including external debt at the current exchange rates) do not exceed 85 percent of the estimated gross domestic product for that financial year; and that at the end of the financial year commencing on January 1, 2013, the total liabilities of the Government (including external debt at the current exchange rates) do not exceed 60 percent of the estimated gross domestic products for that financial year.

Though there was some progress in fiscal performance, the targets were not achieved in 2006. This was mainly attributable to the Tsunami disaster in December 2004, which adversely impacted the Sri Lankan economy. Consequently, the reconstruction and rehabilitation expenditure of the government increased in the following few years. Further, the direct and spillover effects of the world commodity price hike together with the global financial crisis (GFC) hit the Sri Lankan economy in 2007-2008, making it difficult to achieve the FMRA targets. In addition, the final phase of the internal conflict of the country escalated the government's expenditure on intensified military activities, meeting the urgent needs of internally displaced persons (IDPs) in the Northern Province, continuing the resettlement, reconstruction and rehabilitation activities in the Eastern Province, in 2008-2009 period. With these unanticipated events, the government enacted an amendment to FMRA resetting the debt target in 2013.[12] Accordingly, the debt target was lifted up to 80 percent in 2013 (instead of the original target of 60 percent) and rescheduled to achieve 60 percent in 2020 instead.

[12] Fiscal Management (Responsibility) (Amendment) Act, No. 15 of 2013 came into operation from 1 January 2013.

2. Methodology (Different types of fiscal rules)

This section briefly discusses the frequently used fiscal rules.

2.1 Tax difference rule reacting to debt

In light of the publicly available versions of the IMF's MULTIMOD model, Mitchell et al. (2000) and Perez and Hiebert (2004) specify a general form of tax difference rule that targets debt as a percent of GDP, as follows:

$$\Delta\tau_t = \alpha\left(b_{t-1} - \tilde{b}_{t-1}\right) + \beta\Delta\left(b_{t-1} - \tilde{b}_{t-1}\right) \quad (1)$$

where Δ is the first difference operator, τ_t is the average tax rate calculated as the ratio of total tax revenue to output and $\tilde{b}_t$ is the exogenous debt target[13] of the actual debt level expressed as a percentage of GDP, b_t. Equation (1) above says that the fiscal authority changes the tax rate in response to any deviation of the debt level from its desired target. Accordingly, the coefficients α and β establish the speed of adjustment. The coefficient α in particular, advocates an adjustment to the tax rate when the debt level deviates from its target in the previous period. In comparison, β responds to the rate of change of the debt gap. If the gap is accelerating, it recommends an increase in the tax rate and vice versa. If the gap remains constant, on the other hand, β proposes zero adjustment. Being the coefficient of the second-order term, β thus contributes to smoothing out the fluctuations effectively.

2.2 Tax difference rule reacting to deficit

Another simple variant of the tax difference rule which takes the following functional form is discussed in Mitchell et al. (2000)[14]:

$$\Delta\tau_t = \gamma\left(d_{t-1} - \tilde{d}_{t-1}\right) \quad (2)$$

where $\tilde{d}_{t-1}$ is an exogenous target value for the deficit/GDP ratio which is generally of time-varying nature. The National Institute Global Economic Model[15] (NIGEM), which is a quarterly model based on real economic data, uses $\gamma = 0.2$ with typical values for the

[13] In practice, the target value could either be time varying or time-invariant.

[14] This is similar to the one used in NIGEM.

[15] NIGEM contains over 60 countries and regions, modelled using over 5,000 variables. NIGEM is used by over 40 organisations including the IMF, OECD and ECB and is open and transparent to both academic and peer review. For more details, see http://nimodel.niesr.ac.uk/.

nominal interest rate and for the nominal growth rate that ensure convergence of debt gap to zero monotonically.[16]

2.2 A rule with primary balance reacting both to debt and deficit

In a recent paper, Collignon (2012) discusses a fiscal policy rule where the primary balance (i.e. primary deficit, pd_t), as the policy instrument, responds to changes in both debt and deficit, as follows:

$$\Delta pd_t = \psi_1\left(d_{t-1} - \tilde{d}_{t-1}\right) + \psi_2\left(b_{t-1} - \tilde{b}_{t-1}\right) \quad (3)$$

where $\tilde{d}_{t-1}$ and $\tilde{b}_{t-1}$ are the exogenous target values for the deficit/GDP and debt/GDP ratios respectively, as in the above rules. The coefficients ψ_1 and ψ_2 indicate the adjustment speed at which the government responds to the two policy objectives. Larger values of the coefficients ψ_1 and ψ_2 signify that the government takes quicker corrective measures when deficit/GDP ratio and debt/GDP ratio deviate from their desired targets and vice versa. In the extreme case of $\psi_1 = \psi_2 = 0$, the government does not respond to changes in b_t and d_t at all. ψ_1 and ψ_2 describes two distinct parts of the fiscal consolidation process and even if $\psi_2=0$, debt levels can still drop given that $\psi_1 > 0$. The difference in deficit is fully corrected in the following period when $\psi_1=1$. The fiscal authority will increase the primary balance sufficiently to ensure that the deficit will stay below the target in the following period, when $\psi_1 > 1$ and the fiscal adjustment smoothes out over several years for $1 > \psi_1 > 0$. Collignon (2012) argues that ψ_1 is more important than ψ_2 theoretically as well as empirically, at least in the European context.[17]

2.4 A Taylor fiscal rule reacting to real output and structural deficit

Taylor (2000) proposes a simple fiscal rule analogous to that of the well-known Taylor rule for monetary policy, as follows:

$$d_t = f(outputgap) + dst_t \quad (4)$$

which can be represented as,

$$d_t = \alpha(y_t - \tilde{y}_t) + dst_t \quad (5)$$

[16] For details of the stability conditions for the fiscal rules, see Mitchell et al. (2000) and Collignon (2012).

[17] Bohn and Inman (1996) study a similar policy rule for the US economy, however, excluding ψ_1.

where α is the output response parameter and dst_t is the structural budget surplus[18] and d_t is the actual budget surplus. Both dst_t and d_t are seasonally adjusted and measured as a percentage of GDP.[19] Taylor argues that the relationship can also be viewed as a way to differentiate between automatic stabilisers and discretionary policy.[20]

2.4 A Taylor fiscal rule reacting to debt, government expenditure and output

It is a common practice to include some type of fiscal closure rule in the large scale macroeconomic models. In these models, the fiscal closure rule, or the fiscal reaction function, is supposed to serve twin objectives: firstly, it ensures that the intertemporal government budget constraint is satisfied; and secondly, it explains the expected behaviour of the government and how the adjustment process takes place in response to various shocks and policy innovations.

Bhattarai et al. (2012) use a Taylor fiscal policy reaction function where tax-to-output ratio (τ_t) acts as the policy instrument. This rule characterises tax smoothing and systematic responses to the deviation of lagged debt-to-output ratio from a time-varying target, the deviation of output from its natural level and the deviation of government spending-to-output ratio from its steady state level as follows[21]:

$$\frac{\tau_t}{\tilde{\tau}} = \left(\frac{\tau_{t-1}}{\tilde{\tau}}\right)^{\rho_\tau} \left[\left(\frac{b_{t-1}}{b^*_{t-1}}\right)^{\psi_b} \left(\frac{y_t}{\tilde{y}_t}\right)^{\psi_y} \left(\frac{g_t}{\tilde{g}}\right)^{\psi_g}\right]^{(1-\rho_\tau)} exp\left(\tilde{\varepsilon}_{\tau,t}\right) \quad (6)$$

where $\tilde{\tau}$ is the steady state value of tax-to-output ratio, b^*_t is the time varying debt target, $\tilde{y}_t$ is the natural level of output and $\tilde{g}$ is the steady state level of spending-to-output ratio. The parameters ψ_b, ψ_y and ψ_g characterise the responsiveness of the corresponding variables while ρ_t measures tax persistence. The non-systematic fiscal policy shock $\tilde{\varepsilon}_{\tau,t}$ is assumed to follow i.i.d. N $(0,\tilde{\sigma}^2_\tau)$. By taking natural logarithms, the above fiscal rule can equivalently be denoted in the additive form which resembles the conventional Taylor rule.

[18] The structural budget surplus is the budget surplus excluding cyclical fluctuations. It reveals what government revenues and expenditures would be if output was at its potential level and hence does not show cyclical variations in economic activity.

[19] The equation can also be denoted as, $d_t - dst_t = \alpha(y_t - \tilde{y}_t)$ which essentially says that the difference between the actual budget surplus and the structural budget surplus is proportional to the output gap.

[20] Taylor (2000) shows that if the changes in the structural surplus are dominated by discretionary actions (countercyclical and otherwise), then the term α (the output gap) would represent the full effect of the automatic stabilisers on the surplus.

[21] The functional form of the rule Bhattarai et al. (2012) used is similar to that in Davig and Leeper (2007) and Davig and Leeper (2011).

$$(\tau_t - \tilde{\tau}_t) = \rho_\tau(\tau_{t-1} - \tilde{\tau}_{t-1}) + (1-\rho_\tau)\begin{bmatrix}\psi_b(b_{t-1} - b^*_{t-1}) + \psi_y(y_{t-1} - \tilde{y}_{t-1}) + \\ \psi_g(g_{t-1} - \tilde{g}_{t-1})\end{bmatrix} \quad (7)$$

This paper uses both the backward looking rule given in the equation (7) and an analogous contemporaneous variant of it. Since the steady state is unobservable, Corresponding long term trend values,[22] denoted by $\tilde{\tau}_t$ and $\tilde{g}_{t-1}$, are used to replace $\tilde{\tau}$ and $\tilde{g}$. The output gap $(y_{t-1} - \tilde{y}_{t-1})$ is calculated as the percentage deviation of output from its Hodrick-Prescott (HP) trend value. An alternative form of the above fiscal rule can be obtained by replacing debt with overall deficit, which yields

$$(\tau_t - \tilde{\tau}_t) = \rho_\tau(\tau_{t-1} - \tilde{\tau}_{t-1}) + (1-\rho_\tau)\begin{bmatrix}\psi_d(d_{t-1} - d^*_{t-1}) + \psi_y(y_{t-1} - \tilde{y}_{t-1}) + \\ \psi_g(g_{t-1} - \tilde{g}_{t-1})\end{bmatrix} \quad (8)$$

where d_t and d^*_t denote the overall budget deficit of the government as a percent of output and its target value, respectively. I estimate both the backward-looking and contemporaneous specifications of this rule as well.[23]

3. Empirical analysis

3.1 Data description

Quarterly data for the period 2003:Q4 to 2014:Q2 are used for this study. The starting point of this particular period is motivated by the fact that Sri Lanka introduced numerical fiscal targets in 2003. As per the different rules discussed in the methodology above, the following data series are considered in estimating the rules. Growth rates are calculated on quarter-to-quarter basis to mitigate seasonal fluctuations. A description and data source of each of the variables used in the study are in the Table 1 given below.

[22] These are approximated by the corresponding data series treated with the Hodrick-Prescott (HP) filter.

[23] The literature such as Mitchell et al. (2000), Perez and Hiebert (2004), Brzozowski and Siwinska Gorzelak (2010) and Wyplosz (2012) discuss backward-looking and contemporaneous fiscal policy rules, avoiding forward-looking specifications. Country studies for instance Kopits (2001), De Mello (2008) and Burger et al. (2011) also use backward-looking and contemporaneous rules. Following these, I estimate backward-looking and contemporaneous fiscal policy rules only.

Table 1: Data series and derived variables used in estimating rules

Variable[a]	Description[b]	Source[c]
TAX(τ_t)	Total tax revenue	CBSL
TAXHP($\tilde{\tau}_t$)	Total tax revenue, HP filtered to remove cyclical variations	CBSL, AE
EXPD(g_t)	Government expenditure	CBSL
EXPDHP($\tilde{g}_t$)	Government expenditure, HP filtered to remove cyclical variations	CBSL, AE
DET(b_t)	Government debt stock	CBSL
DETT($\tilde{b}_t$)	Government debt target (according to FMRA, MoFP estimates)	CBSL, MoFP, AE
DETHP($\tilde{b}_t$)	Government debt, HP filtered to remove cyclical variations	CBSL, MoFP, AE
PD(pd_t)	Primary deficit (primary balance)	CBSL
DEF(d_t)	Overall deficit (overall balance)	CBSL
DEFT($\tilde{d}_t$)	Overall deficit target (according to FMRA, MoFP estimates)	CBSL, MoFP, AE
DEFHP($\tilde{d}_t$)	Overall deficit, HP filtered to remove cyclical variations	CBSL, MoFP, AE
Y(y_t)	Nominal GDP	CBSL, DCS
YGAP($y_t - \tilde{y}_t$)	Output gap; deviation of output from the its longterm trend	CBSL, DCS, AE

[a] In the models, either the target or the HP trend is used (not both simultaneously).

[b] All these quantities are expressed as a percentage of GDP.

[c] Abbreviations used are as follows: CBSL: Central Bank of Sri Lanka; MoFP: Ministry of Finance and Planning; AE: Author's Estimates; DCS: Department of Census and Statistics of Sri Lanka.

It is evident that the tax revenue (as a percentage of GDP) in Sri Lanka has been gradually declining over the last two decades. It has gone down to a low 11.4 percent in 2013 from 17.8 percent recorded in 1995[24] and the sharp drop of tax revenue after 2007 is displayed in the first panel of Figure 1.

Figure 1: Tax revenue and expenditure of the government

[24] The ratio remained around 17 percent from the 1950s to the early 1990s. However, it has followed a declining path over the last two decades.

This decline has occurred in spite of the evident steady increase in real per-capita income in the country. It suggests that the tax base has not been sufficiently broadened, in line with increases in income or economic activities. Moreover, a range of tax exemptions and tax holidays, tax evasions, poor tax administration and discretionary and ad hoc tax policy changes also contribute to this decline.

The government of Sri Lanka appointed a ten-member Commission on Taxation in 2009 to study the country's tax system,[25] with the goal of assessing why the revenue has declined and to devolve recommendations to remedy the situation. Covering a wide scope of the taxation system of the country, the commission made several key recommendations, including (1) avoiding frequent changes to taxation; (2) nationalising various taxes operational at different levels of government at the national, provincial, and local authority level with the view to maximise revenue objectives at each level; and (3) various amendments to customs duty in line with the international trade agreements, such as replacing complex tax system prevailed for motor vehicle importation with a simple transparent system. The International Monetary Fund (IMF) also insisted the government take necessary action to expand the tax base, simplify the tax and tariff systems, and improve tax administration. In spite of remedial measures taken, government revenue has not yet improved to the level expected.

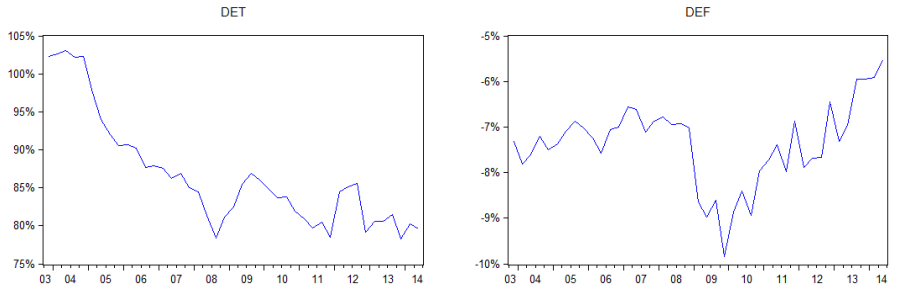
The fiscal consolidation efforts of the government, in line with the FMRA, made government expenditure (as a percentage of GDP) decline at a faster trend than the revenue drop, placing both the primary balance and the overall balance in a favourable trend after 2009. The Tsunami disaster[26] adversely affected government finances as it triggered additional expenditure due to the rehabilitation, reconstruction and resettlement activities necessary in the following years. This expenditure hike is depicted in the second panel of Figure 1.

The total debt level, which was over 100 percent as a percent of GDP in 2003, has significantly reduced over time, although the target is yet to be achieved (see the first panel of Figure 2). The overall budget deficit has sharply gone up in the 2008-2009 period due to the internal conflict-related government expenditure but returned back to a declining path afterwards.

[25] This is in pursuance of section 2 of the Commission of Inquiry Act (Chapter 393) of Sri Lanka.

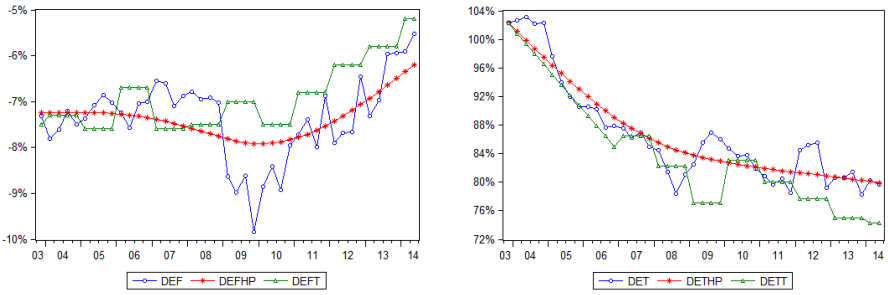
[26] The Tsunami disaster of December 2004 caused 35,000 deaths in Sri Lanka, destroying thousands of homes, public facilities and infrastructure facilities.

Figure 2: Government debt stock and budget deficit



Neither debt nor deficit targets are given explicitly for each year in the FMRA. It instead gives the medium to long-term targets to be achieved over a period of several years. For instance, in 2003, FMRA set a deficit target of not exceeding 6 percent, to be achieved by the end of 2006, without specifying any intermediate goals. Thus, I assume a linearly interpolated targets for such periods, as shown in the second panel of Figure 3 below.

Figure 3: Actuals, Targets and HP trend values for debt and deficit



Both the debt and deficit targets have been revised several times, for various reasons, including unforeseen events such as the Tsunami disaster and repeatedly postponed thereafter (Kinda et al., 2015). Thus, for the debt and deficit targets, I use the annual projections of deficit and debt in the Medium Term macroeconomic Framework, prepared by the CBSL together with the Ministry of Finance and Planning (MoFP), incorporating the medium-term targets specified under the FMRA. As an alternative measure of the respective targets, the HP trend of debt and deficit data series are also used.

Data plots in the three figures above suggest the non-stationarity of several data series, as they seem to grow (decline) over the given time span. If some variables are stationary while others are not, taking the first difference of such variables is useful to prevent possible spurious correlation problems. When the data series is not sufficiently long enough,

however, the unit roots tests such as the Augmented Dickey-Fuller (ADF) or Phillips Perron (PP) tests are not strong enough to distinguish between a series having unit roots issue and a series with slow mean-reverting[27] property. Accordingly, these tests could be biased towards non-rejecting the null hypothesis of unit root for data series with short sample periods (De Jong et al., 1992).

For some of the model functional forms I consider in the above section, it needs to have the first difference of the corresponding variables. Table 2 shows that all of them satisfy the stationarity condition. It is also noticed that many variables which are not stationary at their levels are stationary when expressed as deviations from their respective target values (i.e. as gaps, for instance, the output gap). Although differencing is a way to make a series stationary, it sometimes comes at a cost, which is the risk of loosing vital information embedded in the original data.[28] Keeping these limitations in mind, the first difference needs to be used with caution.

Table 2: Stationarity of variables (unit root test)

Variable	ADF test (Reported values)			
	Level		First difference	
	t-Statistic	Probability*	t-Statistic	Probability*
TAX (τ_t)	-0.520563	0.8769	-5.936910	0.0000
TAXHP ($\tilde{\tau}_t$)	-2.050642	0.2650	-3.214133	0.0266
EXPD (g_t)	0.246488	0.9724	-5.440788	0.0000
DET (b_t)	-2.025025	0.2754	-6.242427	0.0000
DETT ($\tilde{b}_t$)	-2.288529	0.1802	-6.109278	0.0000
PD (pd_t)	-2.234566	0.1977	-6.950113	0.0000
DEF (d_t)	-1.769045	0.3903	-8.688059	0.0000
DEFT ($\tilde{d}_t$)	-0.316073	0.9138	-6.475981	0.0000
YGAP ($y_t - \tilde{y}_t$)	-2.645532	0.0917	-6.867883	0.0000
DETGAP ($b_t - \tilde{b}_t$)	-3.091957	0.0348	-6.634410	0.0000
DEFGAP ($d_t - \tilde{d}_t$)	-3.181559	0.0282	-9.224631	0.0000
TAXGAP ($\tau_t - \tilde{\tau}_t$))	-2.627143	0.0957	-6.424812	0.0000
EXPDGAP ($g_t - \tilde{g}_t$)	-2.572786	0.1066	-5.927565	0.0000
DETGAPa ($b_t - \tilde{b}_t$)	-3.091957	0.0348	-6.634410	0.0000
DEFGAPa ($d_t - \tilde{d}_t$)	-3.181559	0.0282	-9.224631	0.0000

Notes: DETGAPa and DEFGAPa are computed by using their respective targets implied by FMRA while all other GAP variables are computed as the difference between the corresponding variable and its own HP trend.

*MacKinnon (1996) one-sided p-values.

[27] A mean-reverting time series is normally stationary since the finite variance assures that a drift in data will revert back before long without moving far away from its mean.

[28] In a related study, Christiano and Ljungqvist (1988) warn that using data with first difference could lead to possible model misspecifications. Further, Perron (1989) stresses that omitting structural breaks in actual data due to differencing could lead to wrong conclusions for a unit root process for a series.

The unit root test for individual variables reveals that most of them are non-stationary at level.[29] The first differences, however, are clearly stationary. The study uses most of the variables in their gap form and, interestingly, all the variables which are to be used in estimation are now stationary.[30] Further, these variables do not suffer from any data issues such as outliers, breakages or increasing/decreasing volatility.

3.2 Results and discussion

Tax difference rule reacting to debt

By using the ordinary least squares (OLS) method, I estimate equation (1), $\Delta\tau_t = \alpha\left(b_{t-1} - \tilde{b}_{t-1}\right) + \beta\Delta\left(b_{t-1} - \tilde{b}_{t-1}\right)$, for two cases, one with the debt target and the other with the alternative debt target, which is the HP trend of the debt data series. The two coefficients α and β are estimated to be less than 0.03 in both cases and are associated with very small t-statistics, suggesting no statistical significance of the parameters, even at 10 percent level of significance (see Appendix A1 for details). The contemporaneous version of the model is also estimated and the results found to be not very different to that of the backward-looking case.

Tax difference rule reacting to deficit

Estimates of equation (2), $\Delta\tau_t = \gamma\left(d_{t-1} - \tilde{d}_{t-1}\right)$, reveals a slightly larger value for the coefficient γ. It reports 0.064 and 0.063 for the deficit target and the alternative deficit target (which is the HP trend), respectively. The figures are, however, statistically insignificant and neither of the reported t-statistics support rejecting the null-hypothesis that the coefficients are not different from zero. Further, the extremely low R^2 value of less than 1 percent implies a very weak association between the fitted model and data. Thus, this rule does not seems to be suitable for explaining deficit dynamics in Sri Lanka. For summary of the numerical results, see Appendix A2.

[29] It is widely known that many macroeconomic time series data are non-stationary by nature. Engle and Yoo (1987), however, demonstrate that a linear combination of two or more non-stationary time series could be stationary without being subject to unit root problem. Such a linear combination of data series are referred to as cointegrating equations and interpreted as long-run relationship among the variables. In the present study, however, I find no evidence in support of cointegration among the variables.

[30] EXPDGAP marginally shows non-stationary properties since the test probability is 0.066 above the level that corresponds to 10 percent level of significance. This could be due to the too-short data span. When EXPDGAP is tested from 1996, for instance, it shows stationarity. Further, when EXPDGAP is checked with the Phillips-Perron test, it gives t-statistics of -2.817076 with probability 0.0644 and this suggests clear stationarity. Thus, I safely disregard this marginal effect.

Primary balance reacting both to debt and deficit

Next, I estimate equation (3), $\Delta pd_t = \psi_1(d_{t-1} - \tilde{d}_{t-1}) + \psi_2(b_{t-1} - \tilde{b}_{t-1})$, as suggested by Collignon (2012). The deficit-parameter ψ_1 is estimated to be moderately large with a value of 0.33, while the debt-parameter is 0.02 only. When the alternative targets of HP trends are used, the two parameters are found to be 0.56 and 0.03 respectively. In both cases, the deficit parameter ψ_1 is statistically significant even though the debt-parameter ψ_2 is insignificant. Motivated from this result, a variant of the above rule excluding debt is also estimated: $\Delta pd_t = \psi_1(d_{t-1} - \tilde{d}_{t-1})$. Excluding the debt gap from the reaction function produces slightly weak results as the estimated value of the coefficient ψ_1 is now 0.26 and 0.49 respectively for the two cases which were previously 0.33 and 0.56 respectively. The results are still statistically significant.

The primary balance (pd_t) and overall budget deficit (d_t) are closely related to each other by definition,[31] and accordingly it is intuitive to expect a fairly strong value for coefficient ψ_1. This is further evident from the high correlation of 0.72 between the two series. Results therefore suggest that a rule where a change in primary balance reacts to a deviation in the budget deficit from its target in the previous period could be a potential candidate in characterising the fiscal policy rule in Sri Lanka.[32] More details of this analysis are given in Appendices A3 and A4.

A Taylor fiscal rule reacting to both real output and structural deficit

Following Taylor (2000), I estimate the simple Taylor-type fiscal rule given in equation (4): $d_t = \alpha(y_t - \tilde{y}_t) + dst_t$. The HP trend of deficit data series $\tilde{d}_t$ can be used as a proxy for the structural deficit (dst_t).[33] The results suggest that the rule works fairly well with the Sri Lankan data. The coefficient α is estimated to be 0.43 with an associated t-statistic of 6.76, suggesting strong statistical significance of the coefficient. The regression model possesses a high explanatory power since it is associated with a R^2 value of 0.76. Therefore, this fairly simple Taylor-type fiscal rule seems to characterise the fiscal reaction in Sri Lanka reasonably well.

The rule can equivalently be viewed as $d_t - \tilde{d}_t = \alpha(y_t - \tilde{y}_t)$. This is a relationship between the cyclical component of the overall budget deficit and the output gap, since ($d_t - dst_t$) denotes the cyclical component of deficit. The correlation coefficient between the output

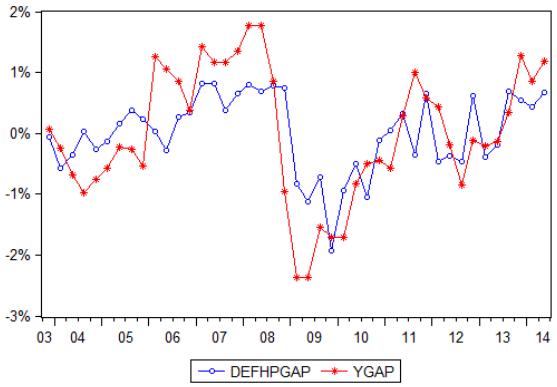
[31] The overall balance is defined as the difference between revenue and grants, and expenditure and net lending. The primary balance is computed in the same way except that it excludes interest payments from expenditure.

[32] It should still be noted, however, that the associated R^2 value is not more than 25 percent, implying the regression model's comparably low explanatory power.

[33] Note that structural and cyclical deficits add up to the total government deficit (i.e. $d_t = ds_t + (d_t - dst_t)$).

gap and the cyclical component of deficit is 0.722. Figure 4 depicts the close relationship between the two series.[34]

Figure 4: Cyclical components of the overall budget deficit (DEFHPGAP) and the output gap (YGAP)



The estimated value for the coefficient $\alpha = 0.43$, which essentially says that a 1 percent drop in output gap would cause the cyclical component of the budget surplus to decline (or to increase the budget deficit) by 0.43 percent. The close association of the two series in Figure 4 implies procyclical behaviour in the evolution of budget surplus (or deficit) and the output gap over time. It suggests that the Sri Lankan government increases expenditure, widening the deficit, when the economy performs well and vice versa. Similar studies in developing/ emerging economies reveal that fiscal policy is procyclical, rather than countercyclical (Gavin and Perotti, 1997; Talvi and Vegh, 2005; Ilzetzki and Vegh, 2008 and Garcia et al. (2011) for instance[35]). This behaviour is commonly observed in countries whose revenues depend greatly on commodity exports such as oil or minerals.

Two possible reasons for this procyclical behaviour in Sri Lanka could be: (1) delays in implementing policies so that by the time the desired countercyclical policy action is

[34] Detailed results are given in Appendix 5

[35] Talvi and Vegh (2005) argue that the fiscal authority is forced to increase expenditure as soon as it receives revenue. Gavin and Perotti (1997), on the other hand, suggest that the government reduces expenditure when the economy is under recessionary pressure during which they are subject to limited access to global credit markets. Garcia et al. (2011) show that countries such as Chile have enacted fiscal rules which relate government expenditure to the long-run (instead of short-run) price of the main commodity in the economy (Copper in Chile). Based on a quarterly dataset for 49 countries covering the period 1960-2006, Ilzetzki and Vegh (2008) find overwhelming evidence to support the idea that procyclical fiscal policy in developing countries occurs.

implemented following long bureaucratic procedures, the economy may have shifted to a newer phase of the business cycle; and (2) influence from the political economy factors, so that when the economy is performing well, various pressure groups and government spending agents want to raise expenditure and when the economy is under contractionary pressure, expenditure cuts are required to curtail too large budget deficits.

A Taylor fiscal rule reacting to debt (or deficit), expenditure and output

With the promising results of the above simple Taylor-type fiscal rule, I consider other variants of the Taylor-fiscal rule, given in equations (7) and (8). The debt rule in equation (7) is estimated for the contemporaneous and backward-looking specifications, as given below:

$$(\tau_t - \tilde{\tau}_t) = \rho_t(\tau_{t-1} - \tilde{\tau}_{t-1}) + (1-\rho_t)\begin{bmatrix}\psi_b(b_{t-1} - \tilde{b}_{t-1}) + \psi_y(y_{t-1} - \tilde{y}_{t-1}) \\ +\psi_g(g_{t-1} - \tilde{g}_{t-1})\end{bmatrix} \quad \text{(A)}$$

$$(\tau_t - \tilde{\tau}_t) = \rho_t(\tau_{t-1} - \tilde{\tau}_{t-1}) + (1-\rho_t)\left[\psi_b(b_t - \tilde{b}_t) + \psi_y(y_t - \tilde{y}_t) + \psi_g(g_t - \tilde{g}_t)\right] \text{(B)}$$

Both rules (A) and (B) are estimated with the regular debt target and the alternative HP-trend target and the results are summarised in Appendix A6. These results have interesting implications. First, the debt response coefficient (ψ_b) is statistically insignificant in all cases. Second, interest rate smoothing is moderate and statistically significant at even 1 percent level of significance in all rules. Third, the output response coefficient (ψ_y) and government expenditure response coefficient (ψ_g) are both significant in all except the first one. Fourth, the contemporaneous specification seems to be preferred over its backward-looking counterpart. Similarly, equation (8) is estimated with the two alternative deficit targets, each with contemporaneous and backward-looking specifications as given below. The results are summarised in the Appendix A7.

$$(\tau_t - \tilde{\tau}_t) = \rho_t(\tau_{t-1} - \tilde{\tau}_{t-1}) + (1-\rho_t)\begin{bmatrix}\psi_d(d_{t-1} - \tilde{d}_{t-1}) + \psi_y(y_{t-1} - \tilde{y}_{t-1}) \\ +\psi_g(g_{t-1} - \tilde{g}_{t-1})\end{bmatrix} \quad \text{(C)}$$

$$(\tau_t - \tilde{\tau}_t) = \rho_t(\tau_{t-1} - \tilde{\tau}_{t-1}) + (1-\rho_t)\left[\psi_d(d_t - \tilde{d}_t) + \psi_y(y_t - \tilde{y}_t) + \psi_g(g_t - \tilde{g}_t)\right] \quad \text{(D)}$$

The results suggest somewhat analogous conclusions as above.[36] First, the deficit response coefficient (ψ_d) is statistically insignificant when deficit is backward looking, but it is significant when the rule is contemporaneous. Second, interest rate smoothing is moderately small but statistically significant at even 1 percent level of significance in all cases. Third, the output response coefficient (ψ_y) is significant in all cases except the last one where the output gap is contemporaneous and HP trend is used as the target. Fourth, the government

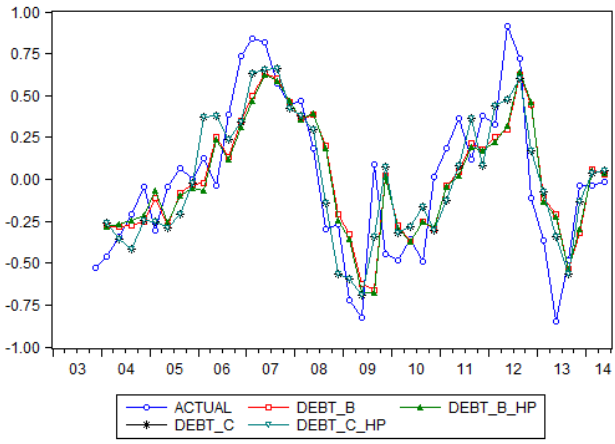
[36] Although some comparisons of debt and deficit targeting rules treat them as qualitatively different, Mitchell et al. (2000) argue that the difference between these two targeting rules (debt and deficit) is only a difference of degree, not a different of kind.

expenditure response coefficient (ψ_g) is insignificant in backward-looking specifications. The test results also suggest the possible existence of autocorrelation issues in the contemporaneous rule with the HP trend as the target (i.e. the rule D_{hp}), as reflected by very low Durbin-Watson statistics[37] of 0.907. This suggests omission of D_{hp} from the selection process.

Actual and fitted policy response

Following McCallum (2000), I plot the actual tax rate gap $(\tau_t - \tilde{\tau}_t)$ and the fitted values derived from the Taylor-type debt rules and deficit rules[38] and they are given in Figure 5 and Figure 6 respectively.

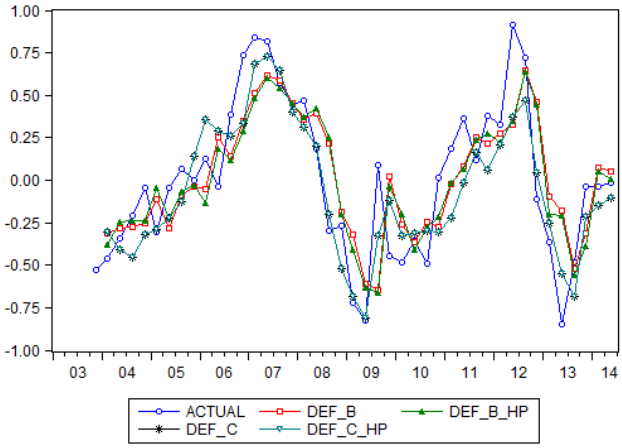
Figure 5: Time plot of the actual tax rate gap $(\tau_t - \tilde{\tau}_t)$ and the fitted values, derived from debt rules.



[37] The Durbin-Watson statistic tests for autocorrelation in the residuals from a statistical regression analysis. It takes values from 0 to 4 and a value of 2 denotes that the sample is free from autocorrelation.

[38] The results do not support the simple tax difference rules in explaining the fiscal reaction behavior in Sri Lanka since the coefficients of the model are very small in magnitude and not different from zero, statistically. Some versions of the primary balance rules and the simple Taylor rules seems to be fine. They are, however, not very informative. Thus, the Taylor-type rules where the government adjusts the tax rate in response to any deviation in debt (or deficit), output or government expenditure from their corresponding targets, are only considered here.

Figure 6: Time plot of the actual tax rate gap $(\tau_t - \tilde{\tau}_t)$ and the fitted values, derived from deficit rules.



The two figures are not very different to each other and the fitted values follow the dynamics of the actual tax gap $(\tau_t - \tilde{\tau}_t)$ reasonably well. These fitted graphs seem to be less volatile as reflected by the maxima and minima with lesser intensity, compared to the actual plot. This is partly explained by the strong policy smoothing advocated by the fitted rules.

Selecting the best model among the alternatives is an important part of statistical analysis. This is relevant here since I am interested in identifying the rule which explains the fiscal policy behaviour in Sri Lanka most reasonably. The use of information criteria has became a useful tool in model selection as it measures the relative quality of statistical models for a given set of data.[39] Accordingly, reported values for the Akaike information criterion (AIC), Schwarz criterion (SC) and Hannan Quinn criterion (HQC) are also considered,[40] in addition to residual sum of squares (RSS), standard error of regression (SE) statistics and intuition in deciding on the most suitable rule, in making the decision. Appendix A6 reveals that the contemporaneous debt rule with the alternative debt target of the HP trend (rule B_{hp}) is the best among the alternative debt rules, due to the lowest statistics of SE, AIC, SC and HQC. Similarly Appendix A7 gives the results for deficit rules. Contemporaneous rules have significant coefficients with the correct signs. It is, however, noted that the contemporaneous deficit rule with the alternative deficit target of HP trend

[39] It also used to determine the appropriate length of the distributed lag. See for example, Lutkepohl (2005).

[40] Broadly, these tests provide a relative estimate of the information foregone when a given model is used to represent the data-generating process and accordingly, the model with the smallest information criterion is preferred over the others.

(rule D_{hp}) has a serious autocorrelation problem, as reflected by the very low Durbin-Watson statistics together with abnormally high R-squared statistics. Among the other rules, the contemporaneous (rule D) seems to be the most suitable as per the above criteria.

Figure 7: Actual tax rate gap $(\tau_t - \tilde{\tau}_t)$ and the fitted values of the best debt and deficit rules

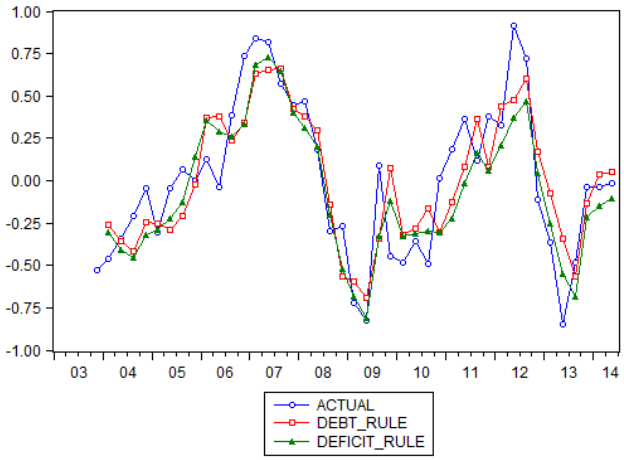


Figure 7 given above shows the time plot of the actual tax rate gap $(\tau_t - \tilde{\tau}_t)$ and the fitted value of the same obtained by the best debt rule (rule B_{hp}) and the deficit rule (rule D). It shows that the alternative rules match with the actual tax rate gap dynamics fairly well. The discrepancy between the debt rule and deficit rule is very small as they move very closer to each other. Test statistics in Appendices A6 and A7 suggest that the deficit rule performs marginally better than the debt rule. The fitted values slightly lag behind the actuals in the beginning of the period, however, the magnitude is small. During the two peak periods that occurred in 2007 and 2012, actual figures are slightly sharper than the fitted values. In light of the argument made in McCallum (2000), this could imply that the fiscal authority of Sri Lanka responds more aggressively than suggested by the rule. During 2009 and 2013, however, the fiscal authority does not seem to raise tax sufficiently as advocated by the rules.

4. Conclusion

Fiscal policy rules have became increasingly popular among fiscal authorities, attracting wide attention all over the world. Many countries have adopted some form of such rules to enhance fiscal discipline, transparency and good governance. This study discusses several alternative fiscal policy rules and empirically estimates them to characterise the fiscal policy reaction behaviour in Sri Lanka.

It is found that Sri Lankan data does not support the simple tax difference rules proposed by Mitchell et al. (2000) and Perez and Hiebert (2004). This implies that in Sri Lanka the tax rate does not respond significantly to either debt or deficit alone. Further, the rule where the primary balance reacts to debt and deficit proposed by Collignon (2012) does not seem to be suitable for Sri Lanka, as reflected by the statistically insignificant debt coefficients. The simple rule where the primary balance responds only to the overall deficit works fairly well except that it is not a widely used rule and, more importantly, it is not very informative. The simple Taylor-type fiscal rule proposed by Taylor (2000) provides promising results. Motivated by this, several versions of a more comprehensive Taylor fiscal rules, where the government adjusts the tax rate in response to any deviation in debt, output or government expenditure from their corresponding target or long-run trend paths, are estimated.

The results have interesting implications. First, the fiscal authority weakly responds to debt. Second, policy smoothing is moderate but strongly significant. Third, the output response coefficient (ψ_y) and government expenditure response coefficient (ψ_g) are both moderately high and strongly significant in contemporaneous rules. A similar set of rules with deficit are also estimated and interestingly, contemporaneous deficit rules suggest that the fiscal authority does respond to deficit. Based on various model selection criteria, it is also found that the contemporaneous deficit rule, where the government adjusts the tax rate in response to any deviation in deficit, output or government expenditure from their corresponding targets or long-run trend paths, characterises the fiscal policy reaction in Sri Lanka more closely than the others. It is further found that a similar contemporaneous debt rule can be used as an alternative fiscal policy rule in Sri Lanka. Moreover, the analysis discloses the procyclical behaviour of fiscal policy in Sri Lanka.

In many countries, it is observed that the influence of politically motivated interest groups creates externalities that cause deficit bias in government budget, superimposing the set rules. Further, rules can be neglected easily when they advocate policies which strongly conflict with the political objectives. This is very common in developing countries including Sri Lanka, but is not limited to developing countries. Formulating proper rules is therefore not sufficient. Establishing and empowering institutions that support the implementation of fiscal rules without being subject to such adverse influences is also very important.

References

Alesina, A. and Bayoumi, T. (1996). The costs and benefits of fiscal rules: evidence from US states. *Technical report, National Bureau of Economic Research*.

Bhattarai, S., Lee, J. W., and Park, W. Y. (2012). Policy regimes, policy shifts, and US business cycles, *working paper series – 109, Federal Reserve Bank of Dallas*.

Bohn, H. and Inman, R. P. (1996). Balanced-budget rules and public deficits: evidence from the US states. *Carnegie-Rochester conference series on public policy*, volume 45, pp 13–76. Elsevier.

Braun, M. and Tommasi, M. (2002). Fiscal rules for sub-national governments: Some organizing principles and Latin American experiences. *Citeseer*

Brender, A. and Drazen, A. (2007). Electoral fiscal policy in new, old, and fragile democracies. *Comparative Economic Studies*, 49(3): pp 446–466.

Brzozowski, M. and Siwinska-Gorzelak, J. (2010). The impact of fiscal rules on fiscal policy volatility. *Journal of Applied Economics*, 13(2): pp205–231.

Burger, P., Stuart, I., Jooste, C., and Cuevas, A. (2011). Fiscal sustainability and the fiscal reaction function for South Africa. *IMF Working Papers*, pp 1–27.

Cabezon, E. and Prakash, T. (2008). Public financial management and fiscal outcomes in sub-Saharan African heavily-indebted poor countries. *Staff studies - International Monetary Fund*, 8-217.

Christiano, L. J. and Ljungqvist, L. (1988). Money does Granger-cause output in the bivariate money-output relation. *Journal of Monetary Economics*, 22(2): pp217–235.

Collignon, S. (2012). Fiscal policy rules and the sustainability of public debt in Europe. *International Economic Review*, 53(2): pp539–567.

Dabla-Norris, E., Allen, R., Zanna, L.-F., Prakash, T., Kvintradze, E., Lledo, V., Yackovlev, I., and Gollwitzer, S. (2010). Budget institutions and fiscal performance in low-income countries. *IMF working papers*, pp 1–56.

Davig, T. and Leeper, E. M. (2007). Fluctuating macro policies and the fiscal theory. NBER *Macroeconomics Annual 2006*, Volume 21, pp 247–316. MIT Press.

Davig, T. and Leeper, E. M. (2011). Monetary–fiscal policy interactions and fiscal stimulus. *European Economic Review*, 55(2): pp 211–227.

De Mello, L. (2008). Estimating a fiscal reaction function: the case of debt sustainability in Brazil. *Applied Economics*, 40(3):271–284. 19

De Jong, D. N., Nankervis, J. C., Savin, N. E., and Whiteman, C. H. (1992). Integration versus trend stationary in time series. Econometrica: *Journal of the Econometric Society*, pp 423–433.

Engle, R. F. and Yoo, B. S. (1987). Forecasting and testing in co-integrated systems. *Journal of Econometrics*, 35(1): pp143–159.

Fatas, A. and Mihov, I. (2006). The macroeconomic effects of fiscal rules in the US states. *Journal of Public Economics*, 90(1): pp 101–117.

Garcia, C. J., Restrepo, J. E., and Tanner, E. (2011). Fiscal rules in a volatile world: A welfare-based approach. *Journal of Policy Modeling*, 33(4): pp 649–676.

Gavin, M. and Perotti, R. (1997). Fiscal policy in Latin America. In NBER *Macroeconomics Annual 1997*, Volume 12, pp 11–72. MIT Press.

Ilzetzki, E. and Vegh, C. A. (2008). Procyclical fiscal policy in developing countries: Truth or fiction? *Technical report, National Bureau of Economic Research*.

Kinda, T., Kolerus, C., Muthoora, P., and Weber, A. (2015). Fiscal rules at a glance. IMF background document.

Kopits, G. (2001a). Fiscal policy rules for India? Economic and Political Weekly, pp 749–756. Kopits, M. G. (2001b). Fiscal rules: useful policy framework or unnecessary ornament? *Staff studies - International Monetary Fund,* 1-145.

Kopits, M. G. and Symansky, M. S. A. (1998). Fiscal policy rules. Number 162. International Monetary Fund.

Leeper, E. M. (1991). Equilibria under active and passive monetary and fiscal policies. *Journal of Monetary Economics*, 27(1):129–147.

Lutkepohl, H. (2005). *New introduction to multiple time series analysis. Springer Science & Business Media.*

McCallum, B. T. (1988). Robustness properties of a rule for monetary policy. *Carnegie-Rochester conference series on public policy*, volume 29, pp 173–203.

McCallum, B. T. (2000). Alternative monetary policy rules: a comparison with historical settings for the United States, the United Kingdom, and Japan. *Technical report, National Bureau of Economic Research*.

Mitchell, P. R., Sault, J. E., and Wallis, K. F. (2000). Fiscal policy rules in macroeconomic models: principles and practice. *Economic Modeling*, 17(2):171–193.

Perez, J. J. and Hiebert, P. (2004). Identifying endogenous fiscal policy rules for macroeconomic models. *Journal of Policy Modeling*, 26(8):1073–1089.

Perron, P. (1989). The great crash, the oil price shock, and the unit root hypothesis. Econometrica: *Journal of the Econometric Society*, pp 1361–1401.

Schaechter, A., Kinda, T., Budina, N. T., and Weber, A. (2012). Fiscal rules in response to the crisis-toward the next-generation rules: A new dataset. - *International Monetary Fund - Working paper*.

Sims, C. A. (1994). A simple model for study of the determination of the price level and the interaction of monetary and fiscal policy. *Economic theory*, 4(3):381–399.

Talvi, E. and Vegh, C. A. (2005). Tax base variability and procyclical fiscal policy in developing countries. *Journal of Development Economics*, 78(1):156–190.

Tapsoba, S. J.A. (2014). Options and strategies for fiscal consolidation in India. Economic Modelling, 43:225–237.

Taylor, J. B. (1993). Discretion versus policy rules in practice. *Carnegie Rochester conference series on public policy*, volume 39, pp 195–214. Elsevier.

Taylor, J. B. (2000). Reassessing discretionary fiscal policy. *The Journal of Economic Perspectives*, pp 21–36.

Woodford, M. (1996). Control of the public debt: a requirement for price stability? *Technical Report, National Bureau of Economic Research*.

Woodford, M. (2001). The Taylor rule and optimal monetary policy. *American Economic Review*, pp 232–237.

Wyplosz, C. (2012). Fiscal rules: theoretical issues and historical experiences. *Technical report, National Bureau of Economic Research*

Appendices

A.1 Tax difference rule reacting to debt

Backward looking rule: $\Delta\tau_t = \alpha\left(b_{t-1} - \tilde{b}_{t-1}\right) + \beta\Delta\left(b_{t-1} - \tilde{b}_{t-1}\right)$

Contemporaneous rule: $\Delta\tau_t = \alpha\left(b_t - \tilde{b}_t\right) + \beta\Delta\left(b_t - \tilde{b}_t\right)$

Table A1: Parameter estimation of tax difference rule reacting to debt

Description	Backward looking		Contemporaneous	
	Regular debt target	Alternative debt target	Regular debt target	Alternative debt target
Parameters estimates (α)	-0.010	-0.003	-0.004	0.022
	(-0.744)	(-0.104)	(-0.322)	(0.907)
(β)	0.017	0.027	0.012	0.016
	(0.823)	(0.961)	(0.584)	(0.566)
Estimation method	OLS	OLS	OLS	OLS
Observations	42	42	42	42
R-squared	0.012	0.016	0.000	0.038
Adjusted R-squared	-0.013	-0.010	-0.025	0.014
RSS	4.828	4.810	4.914	4.726
S.E. of regression	0.352	0.351	0.351	0.344
Durbin-Watson statistics	1.956	1.942	1.904	1.952

Notes: t-statistics are in the parenthesis, ***p < 0.01, **p < 0.05, *p < 0.1.

A.2 Tax difference rule reacting to deficit

Backward looking rule: $\Delta\tau_t = \gamma\left(d_{t-1} - \tilde{d}_{t-1}\right)$

Contemporaneous rule: $\Delta\tau_t = \gamma\left(d_t - \tilde{d}_t\right)$

Table A2: Parameter estimation of tax difference rule reacting to deficit

Description	Backward looking		Contemporaneous	
	Regular debt target	Alternative debt target	Regular debt target	Alternative debt target
Parameters estimates (γ)	-0.008	-0.113	0.064	0.063
	(-0.151)	(-1.352)	(1.231)	(0.747)
Estimation method	OLS	OLS	OLS	OLS
Observations	42	42	42	42
R-squared	-0.008	0.034	0.027	0.005
Adjusted R-squared	-0.008	0.034	0.027	0.005
RSS	4.955	4.746	4.781	4.891
S.E. of regression	0.348	0.340	0.341	0.345
Durbin-Watson statistics	1.862	1.843	1.807	1.771

Notes: t-statistics are in the parenthesis, ***p < 0.01, **p < 0.05, *p < 0.1.

A.3 Primary balance reacting both to debt and deficit

Backward looking rule: $\Delta pd_t = \psi_1(d_{t-1} - \tilde{d}_{t-1}) + \psi_2(b_{t-1} - \tilde{b}_{t-1})$

Contemporaneous rule: $\Delta pd_t = \psi_1(d_t - \tilde{d}_t) + \psi_2(b_t - \tilde{b}_t)$

Table A3: Parameter estimation of tax difference rule reacting to debt

Description	Backward looking		Contemporaneous	
	Regular debt target	Alternative debt target	Regular debt target	Alternative debt target
Parameters estimates				
(ψ_1)	-0.328	-0.558	0.196	0.520
	(-2.411)**	(-3.054)***	(1.348)	(2.756)***
(ψ_2)	-0.022	-0.026	0.021	0.071
	(-0.658)	(-0.540)	(0.594)	(1.415)
Estimation method	OLS	OLS	OLS	OLS
Observations	42	42	42	42
R-squared	0.185	0.245	0.053	0.164
Adjusted R-squared	0.164	0.226	0.029	0.143
RSS	13.633	12.620	15.841	13.987
S.E. of regression	0.584	0.562	0.629	0.591
Durbin-Watson statistics	2.713	2.454	2.626	2.396

Notes: t-statistics are in the parenthesis, ***p < 0.01, **p < 0.05, *p < 0.1.

A.4 Primary balance reacting to deficit

Backward looking rule: $\Delta pd_t = \psi_1(d_{t-1} - \tilde{d}_{t-1})$

Contemporaneous rule: $\Delta pd_t = \psi_1(d_t - \tilde{d}_t)$

Table A4: Parameter estimation of primary balance rule reacting to debt

Description	Backward looking		Contemporaneous	
	Regular debt target	Alternative debt target	Regular debt target	Alternative debt target
Parameters estimates (ψ_1)	-0.260	-0.494	0.131	0.347
	(-2.959)***	(-3.597)***	(1.381)	(2.385)**
Estimation method	OLS	OLS	OLS	OLS
Observations	42	42	42	42
R-squared	0.176	0.240	0.044	0.122
Adjusted R-squared	0.176	0.240	0.044	0.122
RSS	13.781	12.712	15.980	14.687
S.E. of regression	0.580	0.557	0.624	0.598
Durbin-Watson statistics	2.737	2.478	2.649	2.463

Notes: t-statistics are in the parenthesis, ***p < 0.01, **p < 0.05, *p < 0.1.

A.5 A simple Taylor fiscal rule

Backward looking rule: $d_t = \alpha(y_{t-1} - \tilde{y}_{t-1}) + dst_{t-1}$

Contemporaneous rule: $d_t = \alpha(y_t - \tilde{y}_t) + dst_t$

Table A5: Parameter estimation of primary-balance difference rule reacting to debt and deficit

Description	Backward looking		Contemporaneous	
	Regular debt target	Alternative debt target	Regular debt target	Alternative debt target
Parameters estimates (α)	0.500 (4.227)***	0.420 (6.117)***	0.482 (3.799)***	0.428 (6.764)***
Estimation method	OLS	OLS	OLS	OLS
Observations	42	42	42	42
R-squared	0.193	0.728	0.023	0.757
Adjusted R-squared	0.193	0.728	0.023	0.757
RSS	26.810	9.018	32.457	8.086
S.E. of regression	0.809	0.469	0.879	0.439
Durbin-Watson statistics	0.803	1.872	0.722	1.732

Notes: t-statistics are in the parenthesis, ***p < 0.01, **p < 0.05, *p < 0.1.

A.6 A Taylor fiscal rule, reacting to debt, government expenditure and output

The backward looking specification (A) and the contemporaneous specification (B) of the debt rule are as follows,

$$(\tau_t - \tilde{\tau}_t) = \rho_\tau(\tau_{t-1} - \tilde{\tau}_{t-1}) + (1-\rho_\tau)\begin{bmatrix}\psi_b(b_{t-1} - \tilde{b}_{t-1}) + \psi_y(y_{t-1} - \tilde{y}_{t-1}) \\ +\psi_g(g_{t-1} - \tilde{g}_{t-1})\end{bmatrix} \quad \text{(A)}$$

$$(\tau_t - \tilde{\tau}_t) = \rho_\tau(\tau_{t-1} - \tilde{\tau}_{t-1}) + (1-\rho_\tau)\begin{bmatrix}\psi_b(b_t - \tilde{b}_t) + \psi_y(y_t - \tilde{y}_t) \\ +\psi_g(g_t - \tilde{g}_t)\end{bmatrix} \quad \text{(B)}$$

Table A.6: Taylor fiscal rule, reacting to debt, government expenditure and output

Description	Backward looking		Contemporaneous	
	Regular target (A)	HP trend as the target (A_{hp})	Regular target (B)	HP trend as the target (B_{hp})
ρ_τ	0.559	0.557	0.425	0.439
	(3.543)***	(3.551)***	(3.627)***	(3.745)***
ψ_b	0.004	0.029	-0.002	0.023
	(0.146)	(0.498)	(-0.124)	(0.568)
ψ_y	0.212	0.236	0.296	0.321
	(1.870)*	(1.973)*	(4.145)***	(4.004)***
ψ_g	0.176	0.143	0.398	0.369
	(1.028)	(0.775)	(3.659)***	(3.149)***
Estimation method	OLS	OLS	OLS	OLS
Observations	42	42	42	42
R-squared	0.565	0.567	0.687	0.689
Adjusted R-squared	0.531	0.533	0.661	0.664
S.E. of regression	0.310	0.309	0.263	0.262
RSS	3.647	3.624	2.631	2.608
Durbin-Watson statistics	1.832	1.825	1.831	1.880
AIC	0.584	0.578	0.258	0.249
SC	0.750	0.744	0.423	0.415
HQC	0.645	0.639	0.319	0.310

Notes: (1) t-statistics are in parenthesis. (2) levels of significance: ***p < 0.01, **p < 0.05, *p < 0.1. and (3) A_{hp} and B_{hp} refers to the models where hp trend of the debt series is used as the target.

A.7 A Taylor fiscal rule, reacting to deficit, government expenditure and output

The backward looking specification (C) and the contemporaneous specification (D) of the debt rule are as follows,

$$(\tau_t - \tilde{\tau}_t) = \rho_\tau(\tau_{t-1} - \tilde{\tau}_{t-1}) + (1-\rho_\tau)\begin{bmatrix}\psi_d(d_{t-1} - \tilde{d}_{t-1}) + \psi_y(y_{t-1} - \tilde{y}_{t-1}) \\ +\psi_g(g_{t-1} - \tilde{g}_{t-1})\end{bmatrix} \quad \text{(C)}$$

$$(\tau_t - \tilde{\tau}_t) = \rho_\tau(\tau_{t-1} - \tilde{\tau}_{t-1}) + (1-\rho_\tau)\begin{bmatrix}\psi_b(d_t - \tilde{d}_t) + \psi_y(y_t - \tilde{y}_t) \\ +\psi_g(g_t - \tilde{g}_t)\end{bmatrix} \quad \text{(D)}$$

Table A.7: Taylor fiscal rule, reacting to deficit, government expenditure and output

Description	Backward looking		Contemporaneous	
	Regular target (C)	HP trend as the target (C_{hp})	Regular target (D)	HP trend as the target (D_{hp})
ρ_τ	0.590	0.742	0.356	0.234
	(3.404)***	(3.172)***	(3.256)***	(2.824)***
ψ_d	-0.076	-0.843	0.208	0.745
	(-0.414)	(-0.577)	(2.753)***	(6.677)***
ψ_y	0.234	0.467	0.211	0.010
	(1.791)*	(0.991)*	(3.381)***	(0.199)
ψ_g	0.126	-0.239	0.496	0.641
	(0.554)	(-0.296)	(5.006)***	(8.973)***
Estimation method	OLS	OLS	OLS	OLS
Observations	42	42	42	42
R-squared	0.567	0.577	0.738	0.858
Adjusted R-squared	0.532	0.544	0.717	0.847
S.E. of regression	0.309	0.305	0.240	0.177
RSS	3.629	3.544	2.196	1.186
Durbin-Watson statistics	1.831	1.848	1.441	0.907
AIC	0.579	0.556	0.077	-0.538
SC	0.745	0.721	0.243	-0.373
HQC	0.640	0.617	0.138	-0.477

Notes: (1) t-statistics are in parenthesis. (2) levels of significance: ***p < 0.01, **p < 0.05, *p < 0.1. and (3) C_{hp} and D_{hp} refers to the models where hp trend of the debt series is used as the target.

Inflation Dynamics in Sri Lanka: An Empirical Analysis

Sanduni Kulatunge[1]

Abstract

This paper examines the dynamics of inflation in Sri Lanka using the cointegration approach on quarterly time series data. Considering recent empirical studies in the context of inflation in emerging countries including Sri Lanka, an empirical model has been constructed with seven variables; namely inflation, economic growth, government expenditure, exchange rate, money supply, oil prices and interest rates.

The main determinants of inflation in Sri Lanka are the economic growth, exchange rate, government expenditure, money supply, oil prices and interest rates in the long run. According to the estimated impulse response functions, both domestic shocks (money supply, interest rate and economic growth) and external shocks (exchange rate and oil prices) have an effect on inflation in the short run. These findings would be useful for policy makers in their effort in maintaining price stability in Sri Lanka on a sustainable basis.

Key Words: *Inflation, Money Supply, Co-integration, Error Correction Model*

JEL Classification: *E31, E51, E52*

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1. Introduction

Inflation is an important macroeconomic variable. It can be defined as a sustained rise in the general level of prices i.e. a persistent rise in the price levels of commodities and services, leading to a fall in the currency's purchasing power. Low inflation environment provides a better environment for economic growth, encourages investors, employment opportunities and higher living standards. It is widely accepted that the pursuit of price stability is primary to long-run growth and development and should be the concern of every economy (Mallik, 2001; Kihangire, 2005; Odusunya and AbdulMalic, 2010; Bashir et al., 2011; Bhattacharya, 2013). Higher inflation causes adverse impacts on the economic performance of countries in many aspects and hence, the identification of determinants of inflation is very important.

Inflation reduces real value of money and tends to deteriorate the purchasing power parity of money in the country. In particular, higher inflation weakens export competitiveness and discourages exporters. According to Sahaduhhen (2012), unpredicted running and galloping inflation are regarded as unprecedented effects on an economy because they distort and disrupt the price mechanism, discourage investment and saving, adversely affect fixed income groups and creditors and ultimately leads to the breakdown of morals.

The stabilisation of the general price level has become a major macroeconomic objective of the monetary authorities in many other countries including Sri Lanka (Colombage, 2005). An analysis of the economic history reveals that inflation has been a major issue for policy makers in Sri Lanka. Table 1 provides a comparison of inflation rates in Sri Lanka with other economies and illustrates that except for Sri Lanka and emerging market and developing economies, all other regions maintain their inflation at low levels.

Table 1: Sri Lanka and World Inflation (Annual Average % Change)

Country	1980	1990	2000	2010	2013
Sri Lanka	26.1	21.5	6.2	6.2	6.9
World	17.9	27.7	4.6	3.6	3.8
Advanced economies	13.7	5.1	2.3	1.5	1.4
Euro area	n/a	n/a	2.2	1.6	1.5
Major advanced economies (G7)	12.4	4.7	2.2	1.4	1.3
European Union	12.6	27.5	3.1	2.0	1.7
Emerging market and developing economies	n/a	98.7	8.6	5.9	6.2
Developing Asia	n/a	7.7	1.9	5.3	5.0
ASEAN-5	17.4	9.2	2.8	4.4	4.9

Source: Database of World Economic Outlook (2013)

Maintaining economic and price stability are core objectives of modern central bank practices. Similarly, maintaining low inflation has become a major objective of the government and the Central Bank of Sri Lanka (CBSL). Therefore, investigating the effect of key macroeconomic variables on inflation is vital for policy makers in the pursuit of their efforts to maintain macroeconomic stability.

Sri Lanka suffered from approximately 30 years of internal conflict only ended in 2009, which arguably is a major obstacle for the country's economic growth. Currently, Sri Lanka's economy is facing two challenges in terms of the high economic growth which commenced since the end of the internal conflict and the need to maintain macroeconomic stability to create the conditions for economic growth. Hence, maintaining a low inflation level has become important for Sri Lanka especially after the ending of the internal conflict. In particular, as Ratnasiri (2009) aptly claims, the identification of determinants of inflation and forecasting remain vital for economic agents. Therefore, it is essential to identify the main causes of inflation in Sri Lanka in order to adopt more viable economic policies. This study therefore is timely, as identifying the dynamics of inflation in Sri Lanka is essential especially for policy making purposes.

Similar to other developing countries, Sri Lanka has experienced a high inflation level during the last few decades. Considering the importance, several attempts have been made to explore determinants of inflation in Sri Lanka. For example, Weerasekara (1992) using causality tests, variance decompositions and impulse response functions identifies that the main source of inflation is the money supply in Sri Lanka. Meanwhile, Ratnasiri (2009) examines determinants of inflation in Sri Lanka by concentrating on economic factors and proves that both the demand side and supply side factors affected inflation in Sri Lanka. According to the findings of Cooray (2008), there is a long run relationship between price level, real GNP, exchange rate and import prices, exemplifying that supply side factors are the most important determinants of inflation in Sri Lanka. Bandara (2011) also investigates the determinants of inflation in Sri Lanka from 1993–2008, a period which was characterised by upward and downward trends in the economy. This study reveals that money supply, exchange rate and GDP contain information which helps in exploring the behaviour of inflation in Sri Lanka. Thus it is evident that these attempts are important in understanding the behaviour of inflation in Sri Lanka.

The present study, however, differs from the existing literature in the following ways. First, probing into determinants of inflation requires an explicit examination of the most relevant set of variables. Considering this, the study attempts to examine main determinants of inflation in Sri Lanka using a set of variables such as the government expenditure, money supply, GDP, interest rates, oil prices and exchange rate.[2] To that end, this study would

[2] Ratnasiri (2009) investigates determinants of inflation using variables of output gap, money supply, rice price, interest rate and exchange rate depreciation. However, the study does not consider dynamic interaction between inflation and fiscal variables.

contribute to the available literature on inflation by focusing on the relationship of inflation with real, external, monetary and fiscal sectors of the economy, since a limited numbers of studies investigate the overall impact of macroeconomic aggregates on inflation, which is helpful for better economic policies. Second, with the consideration of the government expenditure, this study investigates the fiscal impact on expenditure, which plays a vital role in an economy. In particular, existing studies on inflation in Sri Lanka do not consider the effects of government expenditure on inflation, a gap that will be filled through this study. Third, this study identifies how oil price changes impact inflation, since most of the previous researchers in this area have not considered the effect of oil price changes on inflation in Sri Lanka. As Sri Lanka is a net importer of oil, Sri Lanka is vulnerable to spikes in international oil prices.[3] Temporary shocks such as a raise in international oil prices and other commodity shocks have been dominant inflationary triggers (Goyal, 2011). Finally, the existing literature has identified there are several types of relationships (such as positive, negative, no correlation and threshold value) between inflation and other variables. Therefore identifying such kind of relationships would be important for economic policies. Hence, the findings of this study would have several important implications for policy makers such as monetary and fiscal authorities not only for Sri Lanka, but also for respective authorities in other emerging/developing economies.

Although there are several studies on inflation dynamics in Sri Lanka, there is scope for a fresh look at the determinants of inflation. Ratnasiri (2009) carried a VAR base analysis to identify the determinants of inflation in Sri Lanka, covering the period of 1980-2005 only. Thus this paper attempts to investigate the dynamics of inflation in Sri Lanka for the period of 2000Q1 to 2013Q4. Moreover, Sri Lanka could maintain inflation at a single digit level during last six years since 2009 especially after the ending of the internal conflict. Hence, identifying the determinants of inflation during a low inflation period would be useful for policy makers in their effort in maintaining price stability in Sri Lanka. Thus, it is evident that Sri Lanka's economy has undergone a significant structural change after 2009. After the ending of the internal conflict, the economy of Sri Lanka has displayed its true potential. While appropriate demand management policies are required to maintain low and stable inflation, effective addressing of supply-side impediments is also needed (CBSL, 2010). Hence, policy makers should continue to adopt appropriate policy measures to maintain inflation at low single digit level. Accordingly, identifying methods for the investigation of the overall impact of macroeconomic aggregates on inflation would be needed in order to sustain domestic price stability in a dynamic economic environment.

The remainder of the paper is structured as follows; Section 2 provides detailed background information, while Section 3 presents the theoretical background and literature review of the

[3] Relevance of external factors on inflation can be gauged most notably by prices of energy, as Sri Lanka is a net importer of oil. External effects are thought to play an important role in small open economies (Kusper, 2012). Ratnasiri (2009) uses only exchange rate to capture the external impact on inflation.

study explaining the different findings of previous research related to the determinants of inflation. In addition, this section highlights determinants of inflation with special reference to Sri Lanka. Section 4 explains the methodology, while Section 5 consists of empirical analysis and Section 6 presents the concluding remarks of the study, which summarise the empirical findings of the study and the policy implications.

2. Inflation in Sri Lanka

2.1 Overview of Inflation in Sri Lanka

Around 1950, Sri Lanka's inflation rate was relatively low and was lower than industrial and developing countries (Rupananda, 1994). Inflation, which is measured by the Colombo Consumers' Price Index (CCPI, 1952=100), was 0.07 per cent during the period of 1948-1956. Increase in the general price level remained low during this period mainly due to the maintenance of a fixed exchange rate regime since 1948, maintenance of price controls and slower rate of monetary expansion (CBSL, 1998). Table 2 and Figure 1 show annual percentage changes in inflation in Sri Lanka during the period of 1948-2014.

Table 2: Annual Average Inflation (1948-2014)

Period	Inflation (%)
1948-1956 **Post independence open economy**	0.07
1956-1965 **Closed economy**	1.2
1965-1970 **Semi open economy**	4.0
1970-1977 **Closed socialist economy**	5.7
Since 1977-2014 **Open economy**	10.9

Source: Central Bank of Sri Lanka

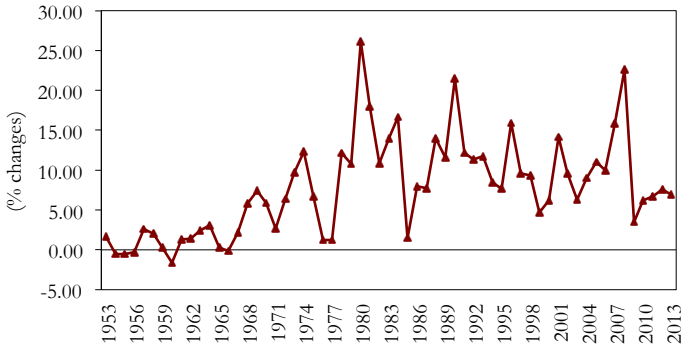
CCPI inflation was relatively low during the period of 1956-1965 as well, averaging 1.2 per cent due to economic controls such as direct control on international trade and foreign exchange outflows (CBSL, 1998). On the other hand, the period of 1965-1970, inflation was moderately high (4.0 per cent) due to the increase in import prices and the devaluation of the rupee. However, the devaluation of the rupee resulted in increased exports during this period.

The period of 1970-1977 was characterised by import substitution restrictions under a protectionist framework, the highest trade restriction ever adopted in Sri Lanka. Inflation increased to the double digit level of 12.3 per cent for the first time in history in 1974 due to an oil price hike. Average inflation was around 5.7 per cent during this period.

Consequently, after introducing open economy policies in 1977, the Sri Lankan economy was opened to the rest of the world by removing trade barriers and exchange controls. With the removal of import and exchange controls, imports began to gain greater significance in affecting prices (Cooray, 2008). Further, after liberalisation, there was a rapid increase in public investment. This resulted in a rapid growth in the money supply. According to Weerasekara (1992), there has been a rapid growth in the nominal money supply and continuous depreciation of the exchange rate after introducing trade liberalisation policies in 1977. All these reforms resulted in accelerating inflation. The depreciation of the rupee and abolishment of the dual exchange rate in 1977 caused an increase in import price. Essential food items such as wheat flour and bread prices were revised upward in 1980, 1981 and 1984. Public transport fares and kerosene prices also increased in 1980 and 1983. In addition, the government public investment programme, high government capital expenditure and high budget deficit fuelled higher inflation. As a result, between 1978 and 1984, year on year inflation was 15.9 per cent, recording the highest ever inflation rate of 26.1 per cent in 1980, since independence. However, inflation reduced significantly to 1.5 per cent in 1985. This was the first instance that a single digit rate was achieved since 1977. Enhanced production of most agricultural crops as a consequence of favourable weather conditions, continued restrictive credit policies, lagged effect of non-expansionary fiscal policies as well as lower import prices were contributory factors towards the lower inflation (CBSL, 1985). However adverse weather conditions and the internal conflict of the country caused an acceleration in inflation to double digit level again in 1988 and 1989.

In 1990, inflation rose significantly up to 21.5 per cent due to the increase in fertiliser prices, exchange rate depreciation of the previous year, increase in fuel prices and the upward revision of paddy prices (CBSL, 1990). During the period of 1991-1993 inflation remained low compared with 1990, due to favourable weather condition and contactionary monetary policies, but stood at a double digit level. The reduction of domestic food production due to drought conditions, cutting back of the subsidy on wheat and higher energy prices caused increased inflation up to a double digit level in 1996 (CBSL, 1996). Annual average inflation increased up to 15.9 per cent in 1997 and reduced to 4.2 per cent in 1999 mainly due to fiscal discipline, prudent monetary management, low import prices and tariff structure. Again, higher international commodity prices, currency depreciation and supply shortages in the country caused increase in inflation up to 14 per cent in 2001.

Figure 1: Annual Inflation in Sri Lanka



Sri Lanka experienced relatively low inflation in 2003 due to favourable domestic production and continued focus of monetary management on price stability. During this period, interest rates were reduced in order to stimulate the economy. However, international oil prices started to increase sharply from the end of 2004 and reached historically high levels in 2005, affecting oil importing countries like Sri Lanka adversely. In 2007 inflation increased by 17.5 per cent on year-on-year basis owing to continued escalation of global oil and gas prices, adverse developments of international commodity prices, reduction of domestic food production due to disturbance in major paddy production in the North and East due to terrorist activities and adverse weather conditions (CBSL, 2007).

By 2009 inflation reduced to single digit levels of 3.4 per cent, which was the lowest inflation recording in more than two decades. Both demand and supply side factors such as stringent monetary policy measures adopted by the CBSL, improved domestic supply conditions, decline in international commodity prices and stable exchange rate resulted in lower inflation during the year (CBSL, 2009). Inflation has continued to remain at a single digit level since then, recording 6.2 per cent, 6.7 per cent, 7.6 per cent, 6.9 per cent in 2010, 2011, 2012 and 2013, respectively. Increase in domestic food supply, monetary policy measures adopted by the CBSL and downward tariff revisions to some consumer items caused low inflation in 2011, whereas improved supply conditions of agricultural production, downward revisions of some administered prices and duties on imported items and demand management strategies, together with managed inflation expectations, were the main drivers for low inflation in 2012 (CBSL, 2012). According to the CBSL (2013), prudent monetary management and improved domestic food supply led to a gradual decline in headline inflation, while core inflation was moderated to its lowest level by 2013, reflecting effective demand management policies and the lagged effect of the tight monetary policy stance in 2012. Due to the combined impact of prudent monetary management, relatively stable exchange rate, moderation in international commodity prices, fiscal policy measures taken

towards addressing supply side disturbances and well managed inflation expectations by end 2014, year-on-year and annual average inflation were recorded at 2.1 per cent and 3.3 per cent, respectively (CBSL, 2014). Inflation on a year-on-year basis remained in the negative territory at -0.3 per cent for the third consecutive month in September 2015, supported by improved domestic supply conditions and subdued global commodity prices such as crude oil, dairy products, and wheat and maize.

It is observed that inflation has been significantly volatile in Sri Lanka and it was mainly determined by both demand side and supply side factors during the period of 1948-2013. It is essential to quantify the main sources of inflation in Sri Lanka, which may have caused such volatility in inflation in order to adopt better economic policies.

2.2 Measures of Inflation in Sri Lanka

Three major indicators such as CCPI, Wholesale Price Index (WPI) and Gross Domestic Product Deflator (GDPD) are used to measure changes in the general price level. The CCPI is the official cost of living index in Sri Lanka and currently 2006/2007 is taken as the base year. The CCPI is widely used by firms and individuals in planning current and future consumption and investment. It is compiled by the Department of Census and Statistics and is available on a monthly basis.

The CCPI covers a large number of commodities and is heavily weighted towards food items which comprise 41 per cent of the index. Housing, water, electricity, gas, and other fuels and transport items weighted 24 per cent and 12 per cent, respectively, in the commodity basket. The main categories of the commodity basket and their respective weights are shown in Table 3.[4]

The other available price indices are the WPI and the GDPD. These indices differ in terms of the goods and services included in the consumer basket, weights assigned to each item, geographic area of price collection, population coverage and the base year.

[4] Department of Census and Statistics is in the process of introducing a National Consumer Price Index (NCPI).

Table 3: Colombo Consumers' Price Index: Weights by Main Categories

Category	CCPI Base 2002=100 (%)	CCPI Base 2006/07=100 (%)
1. Food and Non-alcoholic Beverages	46.7	41.0
2. Clothing and Footwear	3.1	3.1
3. Housing, Water, Electricity, Gas and Other fuels	18.3	23.7
4. Furnishing, Household Equipment and Routine Household Maintenance	3.2	3.6
5. Health	4.2	3.2
6. Transport	9.5	12.3
8. Communication	4.4	4.8
9. Recreation and Culture	2.2	1.5
10. Education	5.8	3.9
11. Miscellaneous Goods and Services	2.7	2.9
Total	100.0	100.0

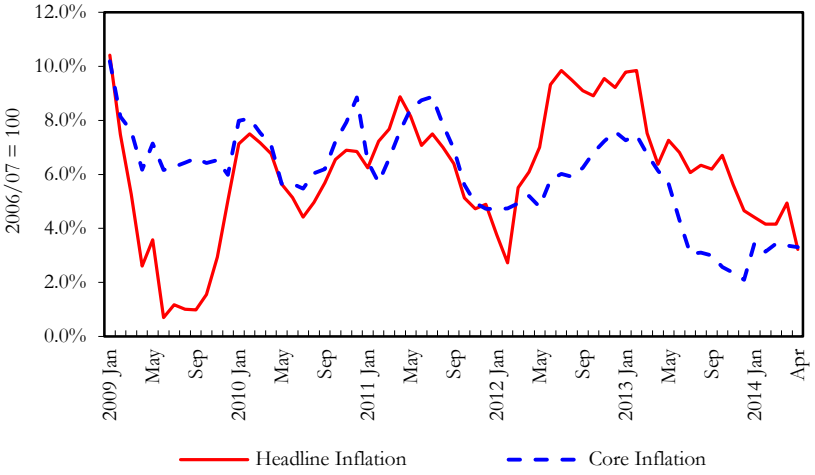
Source: Department of Census and Statistics

Broadly, there are two measures of measuring inflation, namely headline inflation and core inflation. Headline inflation refers to the rate of change in the overall price index. Factors like administrative price changes (electricity and transport), increase in imported prices (crude oil and sugar), adverse weather conditions (landslides, floods and drought), and seasonal demand due to New Year and Christmas influence headline inflation to exhibit some volatility. Core inflation reflects demand-pull inflation that responds to demand management policies. This captures the impact of underlying demand pressures. Inflation arising due to changes in food and energy prices is volatile and is often subject to temporary fluctuations caused by supply shocks, driven by weather disturbances or external shocks, and changes in administered prices or tax policies, which are beyond the control of the monetary authority. Core inflation excludes such volatile prices. In Sri Lanka core inflation is measured by excluding certain items such as fresh food, coconut nuts, rice, transport and fuel and energy, which are either highly volatile or administered prices.

Movements in Headline inflation and core inflation in Sri Lanka are presented below in Figure 2. In 2009, low levels of headline inflation were recorded compared to high core inflation. This low inflation was mainly attributed to favourable developments of the supply side factors such as decline in international commodity prices and revision of domestic administrative prices. Headline inflation was higher than the core inflation in 2012 due to the price increases of the non-food category, mainly on account of the upward price adjustment

for fuel and bus fares. Low volatility in core inflation reflects that the demand driven inflationary pressure was well contained from mid 2013 till 2014.

Figure 2: Headline Inflation and Core Inflation



Source: Department of Census and Statistics

3. Theoretical Background and Literature Review

3.1 Theoretical Background

There are various theories of inflation in economic thought and numerous empirical studies have been conducted on the determinants of inflation. The relationship between inflation and its key determinants is an important building block in macroeconomic theory (Sahadudheen, 2012).

Most of the theories of inflation are formulated on the basis of demand pull and cost push theories. There are a number of causes of inflation which are related to expansion monetary or fiscal policy and this type of inflation can be referred as demand pull inflation (Mosayeb and Rahimi, 2009). Inflation may be caused by an increase in the quantity of money in circulation relative to the ability of the economy to supply. When there is an excess demand in the economy, producers raise their prices and gain higher profit margins. Possible causes of demand pull inflation are higher demand from government stimulus, monetary stimulus to the economy, faster economic growth in other countries and improved business confidence in the country.

The main sources of cost push inflation may be due to the cost of production, increasing wages, higher imports, raising taxes, budget deficit and fiscal deficit (Bashir, 2011). If there is

an increase in the costs of firms, then firms will pass the cost to consumers. According to Sach and Larrain (1993) weather related factors (drought/flood) and failure in harvests would lead to price increase. Werasekara (1992), Rupananda (1994), Laryea (2001) and Rathnasiri (2009) find that inflation determinants belong to main demand pull and cost push inflation theories.

Phillip's curve suggested by A.W. Phillips in 1958, shows that wage inflation and unemployment are negatively related. This referred to as the trade-off between inflation and unemployment. Criticising Phillip's curve, Friedman (1968) and Phelps (1967) argued that this trade-off is not stable in the real world. According to them, the long-run Expectation Augmented Phillips Curve (EAP) was perfectly vertical at the natural rate of unemployment. Especially during the period of oil crisis, Phillip's curve seemed to breakdown all together. When oil price increases, inflation and unemployment increase accordingly. This is called as stagflation. The breakdown of the original Phillips curve can be explained in the EAP curve shown below in Eq. 1.

$$\pi = \pi^{e} - \beta 1(u - u^{*}) + E \quad (1)$$

Inflation = Expected Inflation – (*B* *Cyclical Unemployment) + Supply Shock

When expected inflation increases, actual inflation also increases in any given unemployment level. Thus the modern Phillip's curve depends on expected inflation, the deviation of unemployment from the natural rate (cyclical unemployment) and supply shocks.

While the traditional Phillips curve is subject to considerable theoretical criticism, the New Keynesian Phillip's Curve (NKPC) relates inflation to the output gap and the cost-push effect influenced by expected inflation. At the cost of a lower output gap, policymakers could reduce inflation under the concept of the NKPC. Thus, the NKPC is used widely by academies to explain the effects of past and future inflation on current inflation. The standard model of the NKPC is in the following form;

$$\pi_t = \beta E_t \pi_{t+1} + \alpha x_t + v_t \quad (2)$$

Where π_t denotes inflation rate, β is the discount factor, E_t is expectations operator, x_t is output gap and v_t is exogenous shock to inflation process.

According to Gali and Gertler (1999), it is often difficult to detect a statistically significant effect of real activity on inflation using the structural formulation implied by the theory, when the measure of real activity is an output gap and failure to find a significant short-run link between real activity and inflation is unsettling for the story. There are some doubts on using NKPC to model inflation among researchers. Later, researchers have introduced a hybrid form of the backward-looking and the forward-looking Phillips curve (Mankiw, 2001). Hence, there are several theories explaining the causes of inflation; however, most of them are formulated on the basis of the aggregate demand (demand pull) and cost-push theories of inflation.

3.2 Empirical Evidence

In addition to the theoretical literature reviewed previously, a number of empirical studies on inflation will be summarised in this section in order to examine the past experiences on inflation studies. Inflation could be the result of different sources simultaneously, hence, a single theory may not be sufficient and a combination of theories may be a good solution instead (Mosayeb and Rahimi, 2009).

The NKPC has frequently been used in the recent past in order to describe inflation dynamics. Gali and Gertler (1999) estimate the NKPC equation using the generalized method of moments (GMM) method. According to their findings, forward-looking behaviour is more important than backward-looking behaviour. Also, they suggest there is a robust and significant impact of marginal costs on inflation. Conversely backward looking price setting is not quantitatively important. Later, some researchers used proxies for marginal cost such as average unit labour cost. According to Woodford (2001), labour share is a much better measure of the true output gap for the purpose of explaining inflation variation. Nason and Smith (2008) who have estimated the NKPC for UK and Canada find that inflation tracks real unit labour costs rather than output gap measures. But some have argued that the output gap is the most appropriate variable in explaining inflation. However, the NKPC is a better method to estimate macroeconomic models and the monetary transmission mechanism.

Determinants of inflation have been examined by both developed and developing countries. It has been identified that there is a large number of factors in determining inflation. Cougani and Swagel (2001) investigate sources of inflation in 53 developing countries grouped by region (Africa, Asia, the Mediterranean and South America) and exchange rate regime (fixed or floating) for the period of 1964 to 1998. According to them, both demand pull and cost push factors affect inflation in developing countries. Their study shows that for African countries past realisations of inflation play a main role and accounted for two thirds of the variance of inflation. In contrast, South America's main determinant of inflation is fiscal variables. Their conclusion is faster money growth and exchange rate depreciation lead to higher inflation, while oil price hikes partly impact inflation.

In a similar vein, Osario and Unsal (2011) engaged in an empirical study to investigate inflation dynamics in Asia by presenting a two-step quantitative analysis of inflation dynamics. Those are Global VAR (GVAR) framework which is proposed by Pesaran, Schuermann and Weiner (2004) in order to estimate inflationary dynamics in the Asia and Pacific region and structural VAR for each country. Results show that inflation in China and India are mainly driven by domestic supply shocks. In Asia, commodity prices are especially a major source of inflation in demand side. Likewise, Moccero et al (2011) investigate the determinants of inflation in major OECD countries. They have divided OECD countries into four categories namely, USA, UK, Europe and Japan. They identify that output gap and unemployment related measures of the intensity of resource use are important factors of inflation determination in four economies during the recent past.

Some of the studies find determinants of inflation from monetarist and structuralist perspectives. Callen and Chang (1999) examined the modelling and forecasting inflation in India. According to them, India followed monetarist and structuralist approaches for recent studies on inflation. Their models are based on the monetary approach and output gap and assessed the ability to forecast inflation development in India. They have used bivariate VAR estimation, series of granger causality and variance decompositions for their models. Results show that, money supply is the main determinant of inflation in India and foreign inflation has some effect on inflation in the short term. Thus, the output gap has some impact on inflation after one-quarter.

A VAR model is estimated for the period of 2004-2012 by Bhattacharya (2013), in order to examine major reasons for inflation in Vietnam, which experienced a high inflation level during the last several decades. Accordingly, nominal effective exchange rate, credit growth and real GDP are key drivers of inflation in the long run. Especially, there is a strong and significant relationship between credit growth and inflation in Vietnam. Interest rates of Vietnam do not have an impact on headline inflation in the short term or medium term which may reflect the weakness of the monetary policy in Vietnam. On the other hand, Laryea and Sumalia (2001) reveal that in the short run, output and monetary factors are the main sources of inflation in Tanzania and the exchange rate plays a main role in the long run. Proving the monetary theory on inflation, they find that monetary factors are more important in inflation determinants than real factors in Tanzania and conclude that the government should adopt a contractionary monetary and fiscal policy to control inflation.

A number of empirical studies have been conducted on the impact of government expenditure on inflation and theoretical and empirical evidence proves that prolonged fiscal expansions contribute to inflation and hence, there exists a positive long run relationship between government expenditure and inflation. Han and Mulligan (2008) carried out the study on three dimensions of data; cross country data was analysed for the relationship between inflation and size of government in long run for 80 countries, while time series data were used to identify the changes in total expenditure in disaggregate levels of defence and non-defence spending. In order to rectify the possible endogeneity problems in size of the government and non-defence expenditure, the government spending on social security to output ratio was used. Accordingly, they found a positive strong relationship between inflation and government's size during wartime. Furthermore, non-defence expenditure is negatively related with inflation and it is insignificant.

Conversely, Magazzino (2011) assessed the empirical evidence of the nexus between public expenditure and inflation for the Mediterranean countries and no clear evidence unveiled that the government spending caused price dynamics. Based on that study, he proved a long-run relationship between the growth of public expenditure and inflation, albeit only for Portugal. Furthermore, Magazzino found a short-run evidence of a unidirectional flow from expenditure to inflation for Cyprus, Malta and Spain, a unidirectional flow from inflation to public expenditure in France and a bidirectional flow for Italy.

3.3 Sri Lankan Context

Several attempts can be observed in relation to the identification of determinants of inflation in Sri Lanka. These studies include Weerasekara (1992), Rupananda (1994), Bandara (1996), Colombage (2005), Gunasinghe (2007), Cooray (2008), Ratnasiri (2009) and Bandara (2011) among others. Most of these studies reveal the importance of both supply side and demand side factors in the determination of inflation in Sri Lanka.

Weerasekara (1992) reveals that the main source of inflation in Sri Lanka is money supply, using broad money supply and nominal exchange rate (rupee/US dollar) for the period of 1978 to 1992. Causality tests, variance decompositions and impulse response functions were performed on the VAR and the result of the model shows that an increase in money supply causes inflation. Exchange rate changes also caused inflation. According to the findings, there is bilateral causality between money supply and exchange rate changes.

Cooray (2008) finds a long run relationship between price level, real GNP, exchange rate and import prices. Two models, which are the known closed economy model based on the monetarist explanation modified to incorporate the time lags in the adjustment of prices in the money supply, and the open economy model that incorporates variables of import price index and foreign exchange rate were used. After the liberalisation of the economy, exchange rates and import prices became important factors on the general level of prices. According to findings, supply side factors are most important in the determination of inflation in Sri Lanka.

Ratnasiri (2009) examines the determinants of inflation in Sri Lanka for the period of 1980-2005 using a VAR based co-integration approach. This study finds that money supply growth and the increases in rice price are the most influencing factors for inflation in Sri Lanka in the short run as well as in the long run, while GDP growth and exchange rate depreciation is not important. Ratnasiri's study proves that both demand side and supply side factors affect inflation in Sri Lanka.

Rupananda (1994) highlights that after 1977, import prices and structural factors are more responsible for increasing inflation in Sri Lanka than monetary factors and indirect taxes marginally affected changes in price levels. Similarly; Bandara (1996) reveals that exchange rate and money supply have a large impact on inflation in the long run, while exchange rate depreciation significantly affects inflation in the short run. However, Colombage (2005) applies different econometric methods to ascertain the main determinants of inflation in Sri Lanka. It is shown that money supply plays a significant role in inflation in the short run as well as in the long run. Meanwhile, Gunasinghe (2007) examines the relationship between inflation and economic growth by using a co-integration analysis, generalised impulse response analysis and granger causality test. Results show that there is a negative relationship between inflation and economic growth. Further, Bandara (2011) investigates the determinants of inflation in Sri Lanka during the period of 1993-2008. Results of the model

of inflation show that money supply, exchange rate and GDP helps in the determination of inflation in Sri Lanka.

In a similar vein, several empirical studies on inflation have emphasised on factors like political stability, credibility and reputation of government on inflation determinants. These kinds of factors vary from traditional inflation theories. Mozayed and Mohhamad (2009) find that the Iran-Iraq war had a positive significant effect on inflation during the investigated period. According to Rathnasiri (2009) and Swagel (2001), structural factors such as industrial and trading policies of government and weather conditions also influence inflation in developing countries.

Therefore, both demand side and supply side factors have been considered as influencing factors for inflation in theoretical and empirical literature. This review shows that most of the causes of inflation identified through empirical evidence are common for developing countries including Sri Lanka. In fact, the majority of the empirical studies in this area define inflation by using one of the following measures: the cost of living of the country, exchange rate, GDP, interest rates, out-put gap, money supply, budget deficit, climate changes, credit growth, political stability and import price etc.

Hence, this study would contribute to the available literature of inflation by focusing on the relationship between real, external, monetary and fiscal sectors on the economy and inflation.

4. Methodology

4.1 The Model

In order to determine the effect of variables on inflation, the following model, which was developed by Obstfeld and Rogoff (1996) and later modified by Ubide (1997) and Larea and Sumalia (2001), is applied. The model draws upon several theories relating to the inflation process and is set in a developing country. Ubide (1997) and Larea and Sumalia (2001) used this model for identifying inflation dynamics in two developing countries (Mozambique and Tanzania). Hence, the model is appropriate for analysing inflation dynamics in a developing country like Sri Lanka.

$$\log P_t = \alpha(\log P_t^T) + (1-\alpha)(\log P_t^{NT}) \quad (3)$$

Where, overall price level is P which is the weighted average of the price of tradable goods (P^T) and non-tradable goods (P^{NT}).

$$0 < \alpha < 1$$

The prices of tradable good are assumed to be determined in the world market. Prices of tradable goods depend on exchange rate (e) and foreign prices ($P^{\acute{}}$).

$$\log P^T = \log e_t + \log P_t^f \tag{4}$$

Therefore, the depreciation (appreciation) of the exchange rate or increase (decrease) in foreign prices will cause an increase (decrease) in the domestic price level in a small open economy like Sri Lanka. Thus, it is assumed that the price of non-tradable goods are mainly determined by money demand and money supply. So, real money supply (M^s/P) equals real money demand (m^d) that can be represented by the money market equilibrium condition.

$$\log P_t^{NT} = \beta\ (\log M_t^s - \log m_t^d) \tag{5}$$

Demand for real money balances can be depicted as follows.

$$\log m_t^d = \gamma_o(\log y_t - \gamma_t i_t) \tag{6}$$

So demand for real money balances depend on real money income (y) and interest rates (i). Interest rate denotes opportunity cost of holding money.

We can obtain the equation of non-tradable goods by substituting Eq. 5 and 6.

$$\log P_t^{NT} = \beta\ (\log M_t^s - \gamma_o \log y_t + \gamma_t i_t) \tag{7}$$

However the main model of this study slightly deviated from the model of Obstfeld and Rogoff (1996) which has been explained above. Crude oil prices have been considered as foreign prices in the model. In addition, to capture the government expenditure on inflation, recurrent expenditure has been included in the model. Long run equation of inflation is shown in Eq. 8.

$$P_t = f\ (NEER_t, EX_t, GDP_t, MS_t, OILP_t, INT_t) \tag{8}$$

Where; the dependent variable is the inflation level (CCPI Index) and the independent variables are exchange rate (NEER), government expenditure (EX), gross domestic product (Real GDP), money supply (MS), crude oil price (OILP) and interest rate proxies by 91 – Treasury bill rate (INT). Hence, several shocks such as real, external, monetary and fiscal are captured in this study.

4.2 Data and Estimation Method

The CCPI is the official index of inflation in Sri Lanka. As there are several base years, both CCPI and GDP were converted into base years of 2006/2007 and 2002, respectively. NEER[5] represents the effective exchange rate in the country. Broad money supply (M_2) is

[5] NEER is an index consisting volume quotation *i.e.,* US$/RS (price of home currency in terms of foreign currency). The NEER of a given country *i* is an index number expressed with a base of 100 (or 1) corresponding to its value at a given point in time *t* (León-Ledesma, Miguel and Mihailov, 2014).

used as the measure of money supply. Interest rate is the 91-days Treasury bill rate. Recurrent expenditure represents government expenditure of the country. All variables are expressed in logarithmic form, except interest rate. GDP and money supply are seasonally adjusted. To conduct this study, we have used data from the Central Bank of Sri Lanka (CBSL). On the basis of data availability, the model was estimated with data of a quarterly frequency for the period of 2000Q1 to 2013Q4. Broad money supply, GDP, government expenditure and oil price were in US dollar millions.

Variables used in the empirical analysis are defined in the following manner.

- CCPI = Inflation (Base year - 2006/2007)
- NEER = Nominal Effective Exchange Rate
- EX = Government Recurrent Expenditure
- GDP = Real Gross Domestic Product (Base year -2002)
- OILP = Crude Oil (Brent)Price
- MS = Broad Money Supply
- INT = Interest Rate Represented by 91-days Treasury Bill Rate

Descriptive statistics of data are given in Table 4.

Table 4: Descriptive Statistics

	CCPI	NEER	EX	GDP	MS	OILP	INT
Mean	106.99	114.09	1,472.49	5,229.38	10,837.46	65.50	11.30
Median	98.38	104.87	1,342.59	5,119.58	9,381.78	63.75	10.10
Maximum	176.26	168.31	2,969.79	6,818.39	23,348.66	139.30	21.30
Minimun	49.45	88.29	701.01	4,103.44	4,518.17	19.30	6.98
Std. Dev.	40.65	21.90	611.02	717.25	5,741.73	33.96	3.95
Skewness	0.2070	1.0060	0.5943	0.0911	0.7003	0.2643	0.8757
Kurtosis	1.5747	2.9707	2.3444	1.5720	2.2111	1.7912	2.6388
Jarque-Bera	5.1397	9.4448	4.2565	4.8358	6.0295	4.0617	7.4622
Observations	56	56	56	56	56	56	56

Source: Author's Calculation

Table 4 shows that, on average CCPI and NEER were around 106.99 index points and 114.09 index points, respectively, and interest rates have increased by around 11.30 per cent per quarter. Money supply amounted to US dollars 10,837.46 million per quarter, while government expenditure amounted to US dollars 1,472.49 million. GDP was around US dollars 5,229.38 million in constant terms, while oil prices was US dollars 65.50 per barrel.

By following the previous empirical literature (for example: Greenidge and DaCota, 2002; Odusunya and Atlanda, 2010; Bhashir, 2011 and Sahadudhhen, 2012), we mainly employ the co-integration method to examine the long run relationship between inflation and other variables namely money supply, GDP, government expenditure, exchange rate, oil prices and interest rates. Cointegration means that although many developments can cause permanent changes in the individual series, there is some long run equilibrium relation trying to keep the individual components together, representing a linear combination of the set of variables (Marmol and Velasco, 2004). When non-stationary variables move together over time it is described as a long run relationship between the variables. Short run disturbances will be adjusted towards the long run equilibrium. If two or more non-stationary series are having a long run relationship, they are said to be cointegrated.

The adjustment process in the short run towards the long run equilibrium is captured using the Vector Error Correction Mechanism (VECM). It permits consistent estimation of the cointegration space, providing short-run dynamics: movements in the short run which guides the economy towards the long-run equilibrium. The VECM specification restricts the long run behaviour of the endogenous variables to converge to their cointegrating relationships, while allowing a wide range of short run dynamics. The impulse response function will be used to examine the speed of recovery and adjustment path of inflation to an exogenous shock. The Granger causality test has been conducted in order to examine the causal relationship among variables. Variance decomposition tests are also employed in order to explain how much of a change in a variable is due to its own shock and how much is due to shocks from other variables.

5. Empirical Analysis

5.1 Unit Root Tests

In the first stage, this study performs the unit root test on each variable in order to examine the stationary or non-stationary level in a time series data set. If both stationary and non-stationary variables were included in an equation and estimated by Ordinary Least Squares (OLS), this will lead to a spurious regression. Therefore, it is important to differentiate between stationary and non-stationary variables. There are various alternative tests for testing whether a series is stationary. Commonly used tests are Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests.

This section conducts the unit root test using Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) test. A summary of the unit root test results are presented in Table 5 below.

Table 5: Results of Unit Root Tests

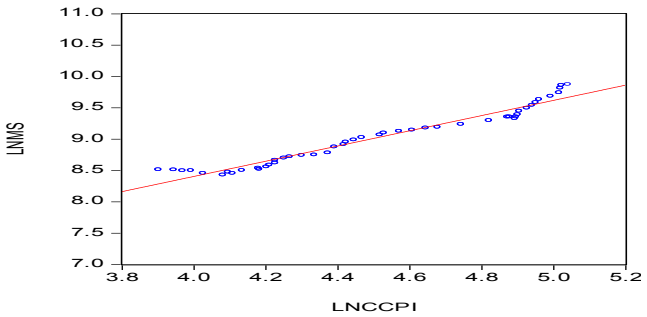
Variable	Indicator	ADF		PP	
		Level	1st Difference	Level	1st Difference
LNCCPI	Statistic	-1.0486	-5.1530	-1.4288	-5.0689
	P-Value	0.7294	0.0000	0.5617	0.0001
LNEX	Statistic	-0.6637	-10.1036	-1.6875	-34.4973
	P-Value	0.8464	0.0000	0.4319	0.0001
LNGDP	Statistic	-0.2059	-4.3492	-1.4583	-12.7548
	P-Value	0.9307	0.0000	0.5471	0.0000
INT	Statistic	-2.2083	-4.7236	-1.8663	-7.5198
	P-Value	0.2058	0.0000	0.3445	0.0000
LNOILP	Statistic	-1.3743	-7.0355	-1.1267	-8.3809
	P-Value	0.5883	0.0000	0.6991	0.0000
	Statistic	-2.3088	-6.4217	-2.3131	-6.4254
	P-Value	0.1729	0.0000	0.1716	0.0000

At levels, the null hypothesis of unit root cannot be rejected for all the variables. Therefore the ADF and PP were conducted again for the first difference of each variable. The results show that the non-stationary hypothesis is rejected for the first difference of all the above variables. This indicates that each variable is integrated in order 1. This concludes that each variable in the study can be made stationary by taking the first difference. In summary, since CCPI, MS, NEER, EX, GDP, OILP and INT are integrated in the same order ($I(1)$), these variables are suitable for the long run cointegration test.

5.2 Preliminary Observations on the Relationships

Several factors behind the volatility of inflation in Sri Lanka are discussed below. According to the classical theory, increases in money supply have positive effects on the inflation rate in a country. Without increasing production of goods and services in an economy, the increase in money supply leads demand pull inflation. Figure 3 below shows a positive relationship between inflation and money supply. When money supply increased, inflation also accelerated. The correlation between the two variables is 0.9653.

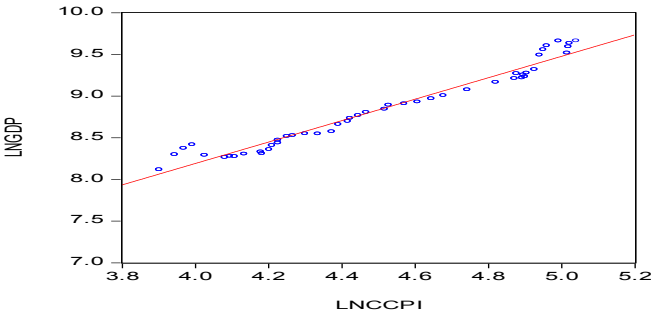
Figure 3: CCPI Index and Money Supply



Source: Author's Calculation

If a developing country like Sri Lanka grows fast, productivity will increase in the tradable sector. It will result in increased wages and an increase in the prices of goods. Figure 4 below helps to get an idea of the time path of inflation and economic growth. It is clear that higher inflation is associated with higher growth in GDP. The correlation between inflation and GDP is 0.5787. Mallik and Chowdhury (2001) find evidence of a long-run positive relationship between GDP growth rate and inflation for four South Asian countries (Bangladesh, India, Pakistan and Sri Lanka).

Figure 4: CCPI Index and GDP

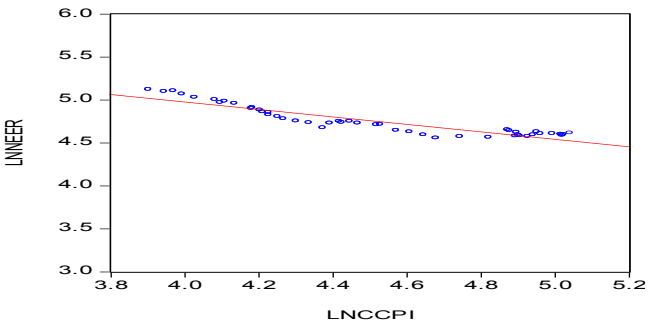


Source: Author's Calculation

The depreciation of the exchange rate also affects the prices (domestic currency units) of tradable goods and indirectly affects the general price level. Exchange rate depreciation raises the domestic price of imported goods, thereby fuelling domestic inflation (Almounsor, 2010). Figure 5 below illustrates the relationship between inflation and the exchange rate

(NEER) and the correlation coefficient between the two variables are -0.8654. Bhattacharya (2013) supports this view in his study where he states that the key driver of inflation in the short-run is the movement in the nominal effective exchange rate in Vietnam.

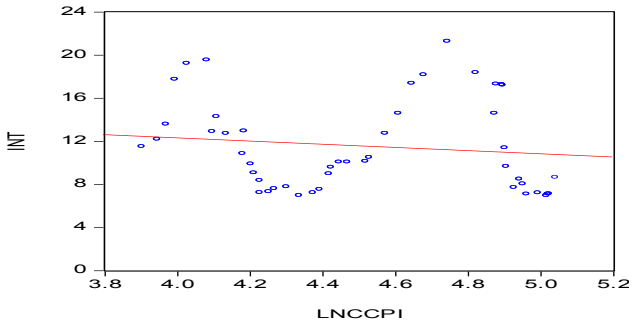
Figure 5: CCPI Index and Exchange Rate



Source: Author's Calculation

Interest rate is another variable which is highly correlated with inflation. If domestic interest rates are kept low, then it would increase inflation. Studies of Kihangire and Mugyenyi (2005) and Greenidge and DaCosta (2002) find that a decreased interest rate influence increases inflation. Figure 6 below represents the fluctuations of inflation and Treasury bill rates (91 days). There is a negative relationship (-0.3049) between interest rates and inflation.

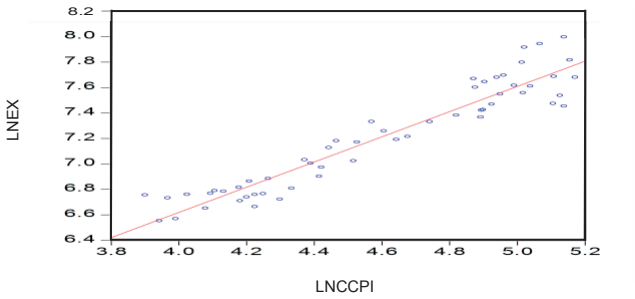
Figure 6: CCPI Index and Interest Rates



Source: Author's Calculation

Ezrim *et al* (2008) and Bashir *et al* (2011) find that government expenditure and inflation are positively related with each other. Government expenditure may result in increasing the price level, reflecting its fiscal dominance, which could be usually seen in the developing countries. When government spends more, it would result in pressures on prices through the expansion of aggregate demand. Figure 7 below illustrates a positive relationship between inflation and government expenditure and the correlation coefficient between the two variables are 0.9215.

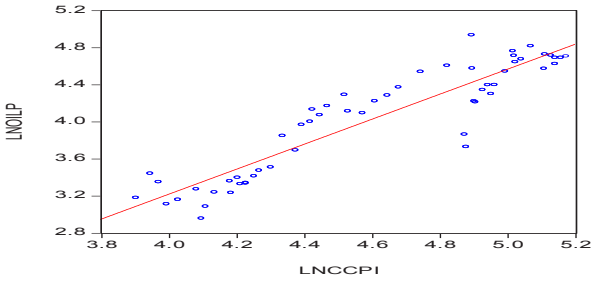
Figure 7: CCPI Index and Government Expenditure



Source: Author's Calculation

A developing country like Sri Lanka mainly depends on imported goods such as crude oil, wheat, milk etc. Thus, the volatility of international oil prices especially the increasing domestic price level in the country. Therefore, changes in oil prices are closely related with inflation. According to Goyal (2011), South Asian countries oil prices and other external shocks gives a useful opportunity to better understand the structure of inflation of these economies. Figure 8 below shows a positive relationship between inflation and oil prices. The correlation between the two variables is 0.9326.

Figure 8: CCPI Index and Oil Price



Source: Author's Calculation

Accordingly, money supply, GDP, oil prices and government expenditure positively correlated with inflation, while increasing inflation has shown a sharp depreciation in the exchange rate (NEER). The interest rate has fluctuated considerably along with inflation.

5.3 Co-integration Analysis (Long Run Analysis)

This study uses the cointegration analysis developed by Johansen and Juselius (1990) to estimate the long run relationship among variables. The results of the Johansen co-integration are reported in Appendix 1. To test the null hypothesis $r = 0$ against the general alternative $r = 1,2,3,4,5 \text{ or } 6$, λ_{trace} statistics should be used. Since λ_{trace} statistics of $r = 0$ is 143.4142, and it is larger than the critical value of 125.6154, the null hypothesis is rejected at the 5 per cent significance level, so that the variables are cointegrated using this test. Similar to the λ_{trace} statistic, the $\lambda_{\max}$ statistic of $r = 0$ is 51.2222, and it is larger than the critical value of 46.2314, the null hypothesis is rejected at the 5 per cent significance level. So the λ_{trace} and $\lambda_{\max}$ statistics confirm that there is one co-integration vector.

Several significant findings have been discovered from this analysis. The result of the normalised cointegration coefficients are presented in table 6 below.

Table 6: Normalised Cointegration Coefficients

	LNCCPI	LNNEER	LNEX	LNGDP	LNMS	LNOILP	INT
β **Coefficient**	1.0000	0.6423	-0.5498	-0.6800	-0.2365	-0.1183	0.0437
Std. Error		0.1192	0.0527	3.0011	0.0712	0.0362	0.0202
t-Statistic		5.3881*	-10.4406*	-0.2266	-3.3222*	-3.2649*	2.1697*

**Significant at 5% level*

Source: Author's Calculation

It is expected that money supply, government expenditure, oil price and GDP exert a positive influence on inflation rates in Sri Lanka and that interest rates and exchange rates negatively relate to the inflationary process. According to the normalised co-integration equation of long run regression; all variables carry the expected signs during the review period. Therefore, the resultant long run model for inflation determinants for Sri Lanka can be specified as follows.

$$\text{LNCCPI}(-1) = 1.56311 - 0.642\text{LNNEER}(-1) + 0.549\text{LNEX}(-1) + 0.680\text{LNGDP}(-1) + 0.236\text{LNMS}(-1) + 0.118\text{LNOILP}(-1) - 0.043\text{INT}(-1) \quad (9)$$

Eq. 9 above shows the long term dependence of inflation on the variables included in the model. It has been found that, the appreciation of the exchange rate has a significant negative impact on inflation in the long run. The appreciation of exchange rate by 1 per cent is associated with the decrease in inflation by 0.64 per cent. Wimalasuriya (2008) found that during the period 2000-2005, a 1 per cent depreciation of the exchange rate induced a 0.3 per cent increase in retail consumer prices in the long run in Sri Lanka. The same relationship has been observed by Greenide and DaCosta (2002) and Almounsor (2010). According to Cooray (2008) and Bandara (1996) the exchange rate is a central factor in influencing Sri Lankan inflation. The depreciation in the exchange rate can cause a rise in import prices and it might cause cost push inflation. In addition, the exchange rate affects inflation through supply side. Hence the exchange rate is one of the main macroeconomic fundamentals that affect inflation in a small open economy like Sri Lanka. Exchange rate policies have a role to play in stabilising inflation (Kihangire and Mugyenyi, 2005).

The long run inflation function indicated that government expenditure has a positive impact on inflation. When government expenditure is increased by 1 per cent, the inflation rate also increases by 0.55 per cent in the long run. When government spending is increased, it would result in pressures on prices through the expansion in aggregate demand. Also, the internal conflict that prevailed in Sri Lanka for around three decades made a significant volatility in inflation and further, the high defence expenditure was a major burden on government spending. The positive impact of government expenditure on inflation may have been strengthened by defence expenditure among other components of government expenditure. For example, Magazzino (2011) reveals that there is a long-run relationship between public expenditure/GDP growth and inflation for Portugal.

In the same manner, economic growth caused by increased aggregate demand leads to an acceleration in inflation in the economy. When the GDP increases by 1 per cent, the inflation rate will increase by 0.68 per cent. Bandara (2011), Callen and Chang (1999), Bhattacharya (2013) and Greenide and DaCosta (2002) have found that GDP is a key driver of inflation in the long run through the demand side of the economy.

This shows that 1 per cent increase in money supply will increase inflation by 0.24 per cent. Since all the variables are expressed in logarithm, the estimated coefficients are interpreted as elasticities. Price elasticity with respect to money supply is 0.24. Devapriya and Ichihashi (2012) found that during the period 1950-2010, a 1 per cent change in growth rate of money supply will induce 0.18 positive change in the inflation rate in Sri Lanka. Due to high money supply, investments will increase and more employment opportunities will generate. As a result aggregate demand will increase and ultimately there will be an increase in domestic price levels due to higher demand. Accordingly, money supply affects inflation through the demand side. Weerasekara (1992), Laryea and Sumaila (2001) Ratnasiri (2009), Odusunya and Atanda (2010), Bandara (2011), Bashir (2011), Sahdudhhen (2012) and Arif and Ali (2012) also found that money supply has a long run significant impact on inflation.

However, results of long run analysis found that the exchange rate has a higher impact on inflation than money supply. These improvements have included greater clarity and transparency with respect to monetary objectives and instruments as well as greater exchange rate flexibility (Osorio and Unsal, 2011). And the contribution of monetary shocks to inflation may diminish over time, perhaps reflecting the improvements in monetary frameworks in the country.

In the same manner, oil prices indicate a positive impact on inflation. When oil prices increase by 1 per cent, the inflation rate increases by 0.12 per cent in the country. Due to higher oil prices, expenditure on imports will increase and investments will decline accordingly. As a result, the production of goods and services will reduce and it will impact the acceleration of inflation. According to Kihangire and Mugyenyi (2005), higher oil prices affect oil importing economies in two ways and could lead to an increase in firms' production costs and reduce profits.

Moreover, inflation and interest rates are correlated with each other. Studies by Greenidge and Da Costa (2002) and Kihangire and Mugyenyi (2005) find that the decrease in interest rates influence increased inflation. The empirical results show that the interest rate has a marginal impact on inflation. Accordingly, the increase of 1 per cent in interest rates leads to around 0.04 per cent decrease in inflation. When the interest rate increases more than the inflation rate, it leads to increase or constant savings and decreased expenditure on goods and services. As a result of decrease in money demand, the money supply also decreases. Thus, there will be a downward trend in domestic prices.

5.4 Vector Error Correction Estimates (Short Run Analysis)

Given that the above mentioned variables are cointegrated, the next step is to estimate the Vector Error Correction Estimates (VECM). A summary of the VECM results are presented in Table 7 below.

Each error correction equation includes the error correction coefficient (α), error correction term lagged once (u_{t-1}), current and first lag values of variables of the first difference of each variable. All regressors in the ECM models are predetermined and are one quarter ahead predicted values and they are true ex-ante forecasts. First row includes error correction coefficients.

Table 7: Summary Results of VECM

	D (LNCCPI)	D (LNNEER)	D (LNEX)	D (LNGDP)	D (LNMS)	D (LNOILP)	D (INT)
α Coefficient	-0.0640	0.3434	0.8635	0.0098	0.0839	-0.1303	-0.0868
Std. Error	0.0843	0.1449	0.4973	0.0112	0.1469	0.8774	0.8912
t-Statistic	-0.7594	2.3696*	1.7365	0.8777	0.5712	-0.1485	-0.9742

**Significant at 5% level*

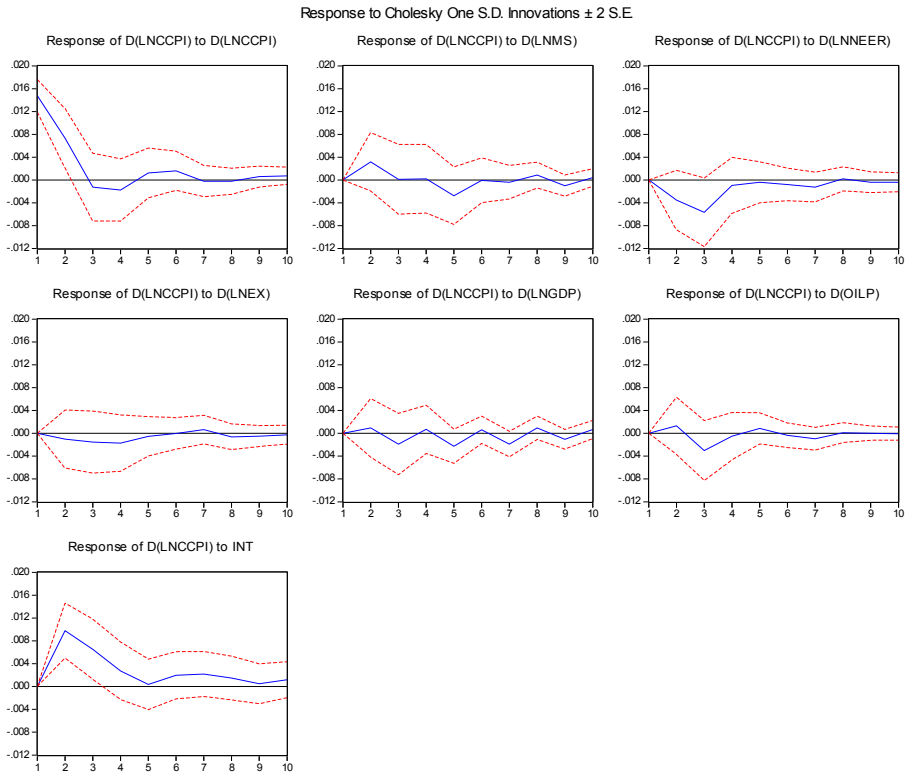
Source: Author's Calculation

The magnitude of each error correction term shows how quickly the deviation of each variable from the long run equilibrium is corrected gradually towards the equilibrium level through a series of partial short run adjustments. Short run dynamics show in lag 1 (-1). T statistics of (-1) coefficients of these variables explain that these variables are weakly exogenous. However, the error correction term has a negative sign as expected. The error correction model of the inflation rate is -0.0640. The interpretation of this error correction term is that once the inflation rate deviates from the equilibrium value determined by the fundamentals, the adjustment rate of the inflation rate is 6.40 per cent on quarterly basis. This can be considered as quite a slow rate of adjustment.

5.5 Impulse Response Analysis

Impulse response functions trace the impact of a shock emanating from endogenous variables to other variables (Almousor, 2010). In this section the study investigates how an exogenous shock to a variable affects other variables in the model through an analysis of their impulse response functions. The results of impulse response function analysis are given in Figure 9 below.

Figure 9: Results of Impulse Response Analysis



Source: Author's Calculation

In impulse response results, we find that a positive shock of CCPI to the inflation has a positive effect on inflation until 3 periods and then stabilize gradually. It proved that domestic price shocks lead to more inflation. The response of inflation to money supply shows that money supply will have an expansionary effect until 2 quarters and stabilizes thereafter. The appreciation of exchange rate has a significant negative impact on inflation over the medium term horizon of 8 quarters. Accordingly, the inflation response to appreciation on the exchange rate is immediate. Almounsor (2010) also found that the nominal appreciation on the exchange rate reduces inflation. Government expenditure has a small negative impact on inflation until 6 quarters and gradually stabilises. However, it is not in line with what is expected and observed. A positive shock to the GDP will have an expansionary effect on inflation in 2 periods and a contractionary effect over the medium term. Shock to oil prices has positive impact on inflation until 2 periods. On the other hand,

the decrease in interest rates has a positive impact on inflation until 5 quarters and gradually stabilises thereafter. The result of interest rates on the Granger causality test is consistent with results of Ratnasiri (2009) who has done a VAR based analysis. The impulse responses suggest that external shocks (i. e., exchange rate and oil prices) have an increasing impact on inflation. Also, domestic shocks associated with money supply, interest rates and GDP have an increasing impact on inflation over short term.

5.6 Variance Decomposition

The results of the variance decomposition of the CCPI are given in Appendix 2. The variance decomposition of the CCPI gives the changes in the growth in CCPI attributable to each of the other variables included in the model as well as itself. After 5 periods, the CCPI is explained more than 65 per cent by itself and interest rates and oil prices contribute around 19 per cent and 7 per cent respectively. Hence, the variance decomposition of inflation indicates that short run dynamics in inflation are explained mostly by its own fluctuations, followed by interest rates and oil prices. After 10 periods, about 50 per cent of the variance in the inflation is explained by inflation itself. About 20 per cent variance in inflation is from interest rates; about 15 per cent and 7 per cent variances are from government expenditure and oil prices. Other variables contribute very little to explaining inflation after 10 periods. This result shows that inflation itself, government expenditure and interest rates accounted for over 85 per cent variability in the inflation after 10 periods.

5.7 Diagnostic Tests

Several diagnostic test namely serial correlation test, heteroskedasticity test and normality tests were performed. A detailed description of diagnostic tests is shown in Appendix 3. First, serial correlation tests were conducted. Serial correlation determines how well the past values of a variable predict the future value of the same variable. At 5 per cent significance level, it fails to reject the hypothesis that there is no serial correlation issue in variables. Secondly, heteroskedasticity tests were performed. Since the p value of Chi-Square (0.1455) is not less than 0.05, it does not reject H0, which means that there is no heteroaskedasticity. The final diagnostic test was done by conducting the normality test. According to the normality test, since p-value is 0.0700 which is greater than 0.05, we do not reject H0 at 5 per cent level of significance and it can be concluded that residual are normally distributed.

6. Conclusions and Policy Implications

This paper reviews the impact on key macroeconomic determinants of the inflation in Sri Lanka covering the period of 2000–2013 for quarterly data. As such, this study would contribute to the available literature of inflation by focusing on the relationship of inflation with real, external, monetary and fiscal sectors of the economy. In particular, existing studies on inflation in Sri Lanka do not consider the fiscal effect on inflation in detail. Thus, most of the research in this area have not considered oil price changes on inflation in Sri Lanka. Moreover, under significant structural changes of the economy after the end of the internal conflict and the persistence of current low inflation situation in Sri Lanka, identifying the determinants of inflation is vital for policy makers in their effort in maintaining price stability.

Depending on the necessity, tests and models such as unit roots, cointegration analyses, VECM, impulse response and variance decomposition tests were employed. According to the results of the research, several determinants of Sri Lanka's inflation have been identified.

The study revealed that both long run and short run factors influence inflation in Sri Lanka. Based on the results of the model, exchange rate, money supply, GDP, government expenditure, oil prices and interest rate explain inflation in Sri Lanka. This study found that increase in the money supply will increase domestic price level in the country. Due to higher money supply, investments will increase and more employment opportunities will be generated. As a result, the aggregate demand will increase and ultimately there will be an increase in domestic price level due to higher demand. Accordingly, money supply affects inflation through demand side. Further, there is a strong positive link between inflation and the exchange rate. The exchange rate is one of the main macroeconomic fundamentals that affect inflation in a small open economy like Sri Lanka.

Government expenditure also affects inflation through demand side. Higher expenditure increases the aggregate demand of goods and services. This would result in higher domestic price levels. In the same manner, GDP has a positive impact on inflation. Consequently, it has shown that there is a positive relationship between international oil prices and inflation. Thus empirical findings indicate that the decreasing interest rates have a positive effect on inflation in Sri Lanka. Therefore, it has proved that in the long run, both supply side and demand side factors namely, money supply, exchange rate, government expenditure, oil price GDP and interest rates play important roles in the inflation process in Sri Lanka during the investigated period.

In the short run, the error correction term has negative sign as expected and there is quite a low rate of adjustment. Impulse responses suggest that key drivers of inflation in the short term are exchange rate, money supply, interest rates, oil prices and GDP. Results of Variance decomposition results revealed that inflation itself, government expenditure and interest rates accounted for over 85 per cent variability in the inflation after 10 periods. Therefore, it has been proved that both demand pull and cost push factors affect inflation in Sri Lanka as shown by Ratnasiri (2009).

According to the above results, a number of policy implications can be derived. First small open economies like Sri Lanka experience demand pull inflation due to the impact of expansionary monetary and fiscal policies. As highlighted by Almousor (2010), over the medium term, close coordination between monetary policy and fiscal policy is important to alleviate inflationary pressures. Policies include wage control, monetary policy (reduction in money supply) and fiscal policy (increase in personal income tax and reduction in government expenditure) and increase in output of goods and services will help in controlling inflation in Sri Lanka.

As GDP is a main factor affecting inflation in Sri Lanka, the results of this study emphasise the need to create a stable macroeconomic policy environment to promote growth in an effort to maintain price stability. Also, policy makers need to give their attention to inflation-growth relationship which is a relatively under-explored area. Attempts to reduce inflation to a very low level (or zero) are likely to adversely affect economic growth (Mallik and Chowdhrury, 2001). Hence, the challenge for policymakers is to find a growth rate which is consistent with a stable inflation rate in Sri Lanka. Although a country needs inflation for growth, significantly high growth rates may accelerate the inflation rate as found by Bruno and Easterly (1998).

Keynesian style demand side policies alone would not be enough to reduce inflation. Supply side factors like exchange rate and oil prices are important determinants in inflation. Greater volatility of exchange rate will result in higher volatility in inflation. This study has found that the exchange rate has a significant impact on inflation in Sri Lanka. Hence, exchange rate is one of the main macroeconomic fundamentals that affect inflation in a small open economy like Sri Lanka. As Sri Lanka is a net importer of crude oil, volatility on international oil prices has a positive impact on inflation. Nguyen et al (2012) explain that external shocks such as oil prices are difficult to avoid in a small open economy. Accordingly exchange rate movements and international oil prices have both short-run and long-run effects on the inflation. The impact of increased foreign prices such as crude oil could be off-set to some extent by managing the exchange rate at an appropriate level. Finally, higher government expenditure would lead to higher inflation in a country. Government expenditure affects through demand side, as with high expenditure, aggregate demand of goods and services will increase and it would lead to higher overall prices in the economy (Bashir, 2011). Hence targeting a low inflation level together with tight fiscal policy would help to reduce inflation level in the country.

There are a few limitations in this study. Temporary shocks that raise domestic prices such as weather related factors or other commodity shocks have not been addressed in this paper. These factors may be dominant inflation triggers. Hence, expanding the analysis by including more variables such as weather related factors, credit growth, political stability etc. may lead to more robust results. Moreover, the use of alternative methods such as SVAR and FAVAR (for example: Osairo and Unsal, 2011) would help to deepen understanding of dynamics of inflation in Sri Lanka. Future research can consider the above directions in order to derive firm policy conclusions.

References

Arif, K. M. and Ali, M. M, 'Determinants of inflation in Bangladesh, an empirical investigation', *Journal of Economics and Sustainable Development*, Vol 3, No, 12, (2012).

Almousor, A. 'Inflation dynamics in Yemen: An empirical analysis', *IMF Working paper*, WP/10/144, (2010).

Bhattacharya, R, 'Inflation dynamics and monetary policy transmission in Vietnam and Emerging Asia', *IMF Working Paper*, WP/13/155, (2013).

Bandara, A. 'Short–run dynamics of Inflation: Do monetary and exchange rate policies matter?-An empirical investigation for Sri Lanka', *Staff Studies, Central Bank of Sri Lanka*, (1996).

Bandara, R. 'The determinants of inflation in Sri Lanka: An application of the vector auto regression model', *South Asia Economic Journal*, 12 (2), (2011), 271-286.

Bashir, F. 'Determinants of inflation in Pakistan: An Econometric analysis using Johansen co-integration approach', *Australian Journal of Business and Management Research*, Vol. 1 No 5, (2011), 71-82.

Bruno, M, 'Does high inflation really lower growth', *Finance and Development,* Vol. 32, 35-38, (1995).

Bruno, M. and Easterly, W, Inflation crisis and long-run growth', *Journal of Monetary Economics,* Vol. 41, 3-26, (1998).

Callen, T. and Chang, D, 'Modelling and forecasting inflation in India ', *IMF Working paper*, WP/99/119, (1996).

Caraballo, A, 'Inflation and supply shocks in Spain: A regional approach ', *46th ERSA Congress, University of Seville,* (2006).

Cooray, A. V, 'A model of Inflation for Sri Lanka', *Review of Applied Economics*, 4 (1), (2008), 35-44.

Colombage, S. S, 'Determinants of inflation in Sri Lanka: An econometric analysis', *Journal of Humanities, Social Sciences and Education*, (2005).

Cougani, P. and Swagel, P, 'Sources of inflation in developing countries ', *IMF Working papers*, WP/01/198, (2001).

Central Bank of Sri Lanka, 'Annual Reports (Various Issues)'.

Central Bank of Sri Lanka, 'Economic progress of independent Sri Lanka ' (1998).

De. Grauwe, P. and Polan, M, 'Is Inflation Always and Everywhere a Monetary Phenomenon? ', *International Macroeconomics*, No. 2841, (2001).

Devapriya, K. P. N. T. N. and Ichihashi, M, 'How does budget deficit affect inflation in Sri Lanka?' *IDEC Discussion Paper,* (2012).

DaCosta, D. and Greenidge, K, 'Determinants of inflation in selected Caribbean countries', *29th Annual Review Seminar*, (2002).

Ezirim, C. Muoghalu, M. I. and Elike, U , 'Inflation versus public expenditure growth in the US: An empirical investigation', *North American Journal of Finance and Banking Research*, Vol. 2, (2008).

Friedman, M, 'The Role of Monetary Policy', *American Economic Review,* Vol. 58, 1-17, (1968).

Frisch, H, 'Inflation theory 1963-1975: A second g generation survey', *Journal of Economic Literature*, Vol. 15, (1977), 1289-1317.

Gali, J. and Gertler, M, 'Inflation Dynamics: A structural econometric analysis', *Journal of Monetary Economics*, Vol. 44(2), (1999).

Greenidge, K. and DaCosta, D, 'Determinants of inflation in selected Caribbean countries', *Business, Finance & Economics in Emerging Economies*, Vol 4 No. 2, (2006).

Gunasinghe, C, 'Inflation and economic growth: A case study of Sri Lanka', *Proceeding of the fourth academic sessions 2007, University of Ruhuna*, (2007).

Goyal, A , 'Inflationary pressures in South Asia', *MPDD working papers*, WP/11/14, (2011).

Han, H and Mulligan, C. B. , 'Inflation and the size of government', *Federal Reserve Bank of St. Louis Review*, May/June 2008, 90(3, Part 2), (2008), 245-267.

Hossain, T, 'An economic analysis of the determinants of inflation in Bangladesh', *International journal of social sciences*, Vol.11, No 1, (2012).

Juselius, K, *The cointegrated VAR model- methodology and applications,* Oxford university press, (2005).

Kihangire, D. and Mugyenyi, A, 'Is inflation always and everywhere a non-monetary phenomenon? Evidence from Uganda', *Bank of Uganda, Working paper*, WP/05/05, (2005).

Kusper, H, 'The role of external and country specific factors in Hungarian inflation developments', *Maayar Nemzeti Bank*, WP 2012/05, (2012).

León-Ledesma, Miguel and Mihailov A., 'Advanced International Macroeconomics and Finance', *Oxford University Press*, (2014).

Lim, C. H. and Papi, L, 'An econometric analysis of the determinants of the inflation in Turkey', *IMF Working Paper*, WP/97/170, (1997).

Laryea, S .A. and Sumaila, U. R, 'Determinants of inflation Tanzania', *Institute of Development Studies and Human Rights*, WP 2001: 12, (2001).

Mallik, G. and Chowdhury, A, 'Inflation and economic growth-evidence from four South Asian Countries', *Asia-Pacific Development Journal*, Vol 8, No 1, (2001), 123-135.

Mankiw, N. G, 'The inexorable and mysterious trade-off between inflation and unemployment', *The Economic Journal*, III (May), (2001), C45-C61.

Mankiw, N. G, *Macroeconomics*, Fifth Edition edn (New York: Worth Publisher, 2003).

Magazzino, C, 'The nexus between public expenditure and inflation in the Mediterranean countries', *MPRA paper*, No. 28493, (2011).

Moccero, D. Watanabe, S. and Cournes, B, 'What drives inflation in the major OECD economies?' *Economic Department, Working papers*, 854, (2011).

Mosayeb, P. and Rahimi, M, 'Sources of inflation in Iran: An application of the ADRL approach', *International Journal of Applied econometrics and Quantitative Studies*, Vol. 6-1, (2009).

Nason, M. and Smith, W, 'The new Keynesian Philips curve: Lessons from single equation econometric estimation', *Federal Reserve Bank of Richmond Economic Quarterly*, Vol. 94. 361-395, (2008).

Nguyen, H. Covoli, T. and Wilson, J. K, 'The determinants of inflation in Vietnam', *Asian Economic Bulletin*, Vol. 29, No 1, (2012), 1-14.

Obstfeld, M. and Rogoff, K, 'Foundations of open economy macroeconomics', *MIT Press*, (1996).

Odusanya, I. A. and Atanda, A. A. , 'Analysis of inflation and its determinants in Nigeria', *Pakistan Journal of Social Sciences*, Vol. 7, No. 2.97-100, (2010).

Osario, C and Unsal, D. F, 'Inflation dynamics in Asia: Causes, changes and spill overs from China', *IMF Working paper*, WP/11/257, (2011).

Phelps, E.S, 'Phillips curves, expectations of inflation and optimal unemployment over time', *Economica,* Vol. 34, 283-299, (1958).

Ratnasiri, H. P. G. S. , 'The main determinants of inflation in Sri Lanka, A VAR based analysis', *Staff Studies of CBSL* , Vol. 39 , (2009).

Rupananda, W, 'Econometric model for inflation in Sri Lanka', *Economic Review, People's Bank*, Vol. 20, (1994).

Sachs, J. D. and Larraín B. F, 'Macroeconomics in the global economy', *Englewood Cliffs, New Jersey: Prentice Hall*, (1993).

Sahadudhhen, I, 'A co-integration and error correction approach to the determinants of inflation in India', *International journal of Economics and Research*, Vol. 3, No. 1 (2012), (2012), 105-112.

Loungani, P, and Swagel, Phillips, 'Sources of inflation in developing Countries', *IMF working paper*, WP/01/198, (2001).

Tayeh, S. N. A. and Mustafa, M. H, 'The determinants of public expenditures in Jordan', *International Journal of Business and Social Science*, 2(8), (2011), 45–49.

Ubide, A, 'Determinants of inflation in Mozambique', *IMF Working Paper*, WP/97/145, (1997).

Weerasekara, Y. M. W. B, 'Inflation in Sri Lanka. A causality analysis', *The South East Asian Central Banks, Staff Papers* , No 46, (1992).

Wimalasuriya, S. M, 'Exchange rate pass-through: To what extent do prices changes in Sri Lanka', *Staff Studies of CBSL*, Vol. 37 Number 1 & 2, (1998).

Woodford, M, 'Inflation stabilization and welfare', *NBER Working Paper*, No. 8071, (2001).

Zang, X, 'China's inflation: Demand –pull or cost –push?' *Asian Economic Papers*, Vol 11.3, (2012).

Appendix 1

Johansen Test for Cointegration

Hypothesized No. of CE(s)	Test Statistics		0.05 Critical Values	
	Trace Statistic	Max-Eigen Statistic	Trace	Max-Eigen
None *	143.4142	51.22223	125.6154	46.23142
At most 1	92.19198	34.12467	95.75366	40.07757
At most 2	58.06732	24.38630	69.81889	33.87687
At most 3	33.68102	20.69609	47.85613	27.58434
At most 4	12.98493	7.823024	29.79707	21.13162
At most 5	5.161909	5.151201	15.49471	14.26460
At most 6	0.010708	0.010708	3.841466	3.841466

Appendix 2

Results of Variance Decomposition

Period	S.E.	LNCCPI	LNNEER	LNEX	LNGDP	LNMS	LNOILP	INT
1	0.015526	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.028879	92.34880	0.010468	1.110741	1.663374	0.027925	0.181348	4.657339
3	0.039214	79.89355	0.664895	2.710622	1.388850	0.015391	3.878408	11.44829
4	0.047689	69.78947	0.863180	4.285550	1.863999	0.126407	6.021076	17.05032
5	0.054317	64.69302	1.259049	5.950861	2.021374	0.136882	6.593631	19.34519
6	0.060325	59.84908	1.647806	8.419882	2.956293	0.153606	7.009425	19.96391
7	0.065099	55.67246	2.162705	11.01335	3.417938	0.139577	7.268367	20.32560
8	0.068693	52.68285	2.481547	12.85160	4.046059	0.180549	7.195480	20.56191
9	0.071345	50.92168	2.935552	14.04401	4.232004	0.207482	7.124490	20.53478
10	0.073769	49.53084	3.251606	15.12357	4.484202	0.240756	7.066291	20.30274

Source: Author's Calculation

Appendix 3

Results of Diagnostics Tests

(1) Serial Correlation LM Test

Lags	LM-Stat	Probability
1	57.02089	0.2015
2	75.66529	0.1086
3	43.04227	0.7123
4	61.75365	0.1044
5	55.08815	0.2553
6	59.18262	0.1512
7	56.75604	0.2084
8	53.06927	0.3202
9	53.20709	0.3155
10	38.18978	0.8677

(2) Heteroskedasticity Test

Chi-Sq	DF	Probability
883.3377	840	0.1455

(3) Normality Test

Component	Jarque-Bera	df	Prob.
1	2.939448	2	0.2300
2	2.008116	2	0.3664
3	4.062167	2	0.1312
4	6.205006	2	0.0449
5	3.273492	2	0.1946
6	1.361198	2	0.5063
Joint	19.84943	12	0.0700

Transmission of Monetary Policy Impulses on Bank Retail Interest Rates: An Empirical Study of Sri Lanka

Theja Dedu Samarasinghe Pathberiya

Abstract

The study examines the transmission of monetary policy impulses to bank retail interest rates in Sri Lanka. Understanding the interest rate pass-through process, from policy rates to bank retail rates are imperative to conduct monetary policy operations successfully. The variables used in this study are central bank policy interest rates that are repo and reverse repo rates, overnight interbank call money market rates, and various types of commercial bank lending and deposit rates. Among other econometric techniques, the Error Correction Mechanism is used in the present study as a main technique to analyse the interest rate pass through mechanism empirically. The data is for the 10-year period from 2003 to 2013. The key conclusion is, in general, that there is no one for one interest rate pass-through to the long-run commercial bank rates from money market rate. Nevertheless, there is a sizable and satisfactory pass-through in the long-run in fixed deposit rates. In contrast, the long-run pass-through is not satisfactory with regard to retail loan interest rates. In the short-run, bank retail rates deviated from the equilibrium due to monetary policy shocks, but were adjusted to their equilibrium levels in the long-run. Also it was found that, on average, short-run adjustment speed of deposit rates is less compared with the lending rates. Further, the short-run adjustment speed is higher for shorter maturities. In general, there is no asymmetry in interest rate pass-through in Sri Lanka.

Key Words: *Monetary Policy, Interest Rate Pass-through, Central Bank of Sri Lanka, Asymmetry*

JEL Classification*: E52, E43, E58, D82*

1. Introduction

1.1 Background

Monetary policy Transmission Mechanism (MTM) can be broadly defined as the process through which central bank monetary policy actions are transmitted into changes in the real GDP and inflation [Taylor (1995)]. The MTM commences with monetary policy actions of central banks. Central banks have multiple tools at their disposal to initiate the transmission process with the objective of achieving policy targets. They range from occasionally used changes in interest on reserves to highly used open market operations (OMO) [Mishkin (2013)]. Modern central banks mostly choose between two policy operational targets to transfer their stance into the real economy: the policy interest rates and the monetary base.

The transmission of interest rate channel is broadly divided into two stages. The first stage is the interest rate pass-through from central bank tools to retail interest rates. The retail interest rates are the lending and deposit rates of commercial banks and other non-bank deposit taking institutions. The second stage is the transmission of the changes in retail interest rates to the aggregate demand and thereby the whole economy. The focus of this study is to understand the second part of stage one, i.e. the interest rate transmission from money market rates to various bank retail rates, in the case of Sri Lanka. The first part of stage one is the interest rate transmission from central bank policy rates to money market rates. Normally, it is accepted that there are lesser asymmetries in this stage. The analysis in this study focuses on the effect of monetary policy stances on the lending and deposit rates of commercial banks in Sri Lanka.

Sri Lanka is an emerging open market economy with an independent monetary authority, the Central Bank of Sri Lanka (CBSL). The CBSL monetary policy follows two key monetary policy objectives. The first objective is to achieve price and economic stability within the Sri Lankan economy. The second is to achieve financial system stability. Until recently, the CBSL dealt with the objective of price stability with a monetary targeting framework. The purpose of the monetary targeting framework was to influence the broad money supply in order to achieve the final target of price stability.

1.2 Importance of Understanding Transmission of Monetary Impulses on Bank Retail Interest Rates

Understanding the interest rate pass-through process, from policy rates to bank retail rates is imperative to conduct monetary policy operations. Having a better understanding of monetary policy impulses on retail bank interest rates is important in two aspects. First, it is an important part in the whole transmission mechanism of monetary policy. Correct assessment of the impact of monetary policy changes on retail market rates is an essential step to understand and foresee the effects of monetary conditions on the real economy. Second, it is an important aspect of the soundness of the banking sector of a country. Aziakpono and Wilson (2010) demonstrate that the completeness in the long or short-run and to the asymmetry of the pass-through are ways of gauging the degree of competitiveness and the soundness of the financial system, especially the banking sector. Accordingly, it is clear that an effective transmission of monetary policy impulses to bank retail rates is important to have a smooth process of monetary policy and thereby to achieve both the price stability and financial stability. A complete or nearly complete pass-through of interest rate is essential to achieve the ultimate goals of monetary policy. If policy makers have a better understanding of the degree and the speed of the pass-through, they can make better statements to the market regarding the expected effects of a particular change of monetary policy.

1.3 Measuring Interest Rate Pass-through

When analysing the interest rates pass-through process there are some important questions that should be raised, such as; What is the extent to which monetary policy impacts/influences retail bank rates? What is the time lag before retail bank rates are affected? Is there any asymmetric effect involved in the process of interest rate pass-through? Based on the literature on this topic, many scholars have attempted to answer these questions using many different approaches, both statistical and econometric tools. However, it is possible to categorize all of these tools under three main categories of *simple regression* analysis, *vector auto regression* analysis and the *error correction* analysis. There are many

advantages as well as loopholes in each of these methods. Among these methods the error correction mechanism (ECM) is very popular in the study of interest rate pass-through. The ECM has the ability and the capacity to observe both the short-term adjustment of the bank retail interest rates to policy rates changes and the long-run pass-through of the policy rates to bank retail rates. The ECM also has the ability to explain how the variables adjust to deviations from long-run equilibrium. Additionally, ECM accounts for the integration of variables that are used in the analysis.

1.4 Research Motivation

Sri Lanka has implemented a monetary targeting framework since 1980s. Further, Sri Lanka is expected to move toward an inflation targeting framework in the coming years [CBSL Annual Report (2011)]. An important element of both these policy frameworks is to understand the whole monetary transmission mechanism. The first step of such transmission is the interest rate pass-through to various types of retail market interest rates. According to the literature reviewed, there is only a handful of studies conducted on interest rate pass-through in Sri Lanka. However, those few studies conducted on interest rate pass-through have not considered the bank retail rates comprehensively. It is essential to understand how monetary policy impulses affect across different maturities of deposit rates and various types of lending rates such as rates on secured and unsecured loan rates. The most recent study done in this regard is Amarasekara (2005).

Furthermore, the studies conducted on interest rate pass-through are out-dated as they used data prior to 2003, before competitive OMO were adopted. The CBSL moved into a system of active OMO in 2003 from a passive OMO approach so as to conduct its monetary policy operations more effectively and in a market based manner. This was against the former conduct of monetary policy of non market oriented monetary policy measures such as credit ceilings, quantitative controls and statutory reserve requirements, which operate through regulations.

Additionally, the existing studies conducted do not have a comprehensive study of asymmetry of the interest rate pass-through due to monetary policy impulses. It would be beneficial to the CBSL to have knowledge of such impact through a comprehensive study.

1.5 Objectives of the Study

The broad objective of the present study is to contribute to the understanding of the interest rate pass-through process in Sri Lanka. More precisely, the analysis focuses on the pass-through between money market interest rates on overnight maturities and various kinds of deposit and lending rates of commercial banks. The deposit rates include savings rates and various other maturities spanning from 3 months to 24 months. The lending rates include various types of secured and non-secured loan interest rates. The study will look into the following aspects of the interest rate pass-through with regard to the above discussed retail bank rates, i) Speed of adjustment, ii) Completeness and iii) Asymmetric impact of monetary policy impulses. The study period covers a decade, from 2003 to 2013. The empirical analysis is done using econometrics tools such as Unit root test, Cointegration test, Error Correction Mechanism.

2 Monetary Policy and Commercial Banking in Sri Lanka

2.1 Introduction

Sri Lanka is a small open economy, which has experienced a series of political regime changes, and as a result, has adopted a wide range of economic regimes as well. However, the most influential economic regime began during the late 1970s with a pro-market economy regime gaining power in Sri Lanka. During the early years of this regime, the economic policies went through radical change, moving from a closed economy fixed (pegged) exchange rate policies (from 1970 – 1976) to semi-liberalised managed-floating exchange rate, known as 'crawling peg', with a sequence of actions to integrate Sri Lanka to the fast globalizing economy after 1977. Trade liberalization was another key policy initiative [Thenuwara (1998)].

Sri Lanka was not able to defend the crawling peg regime for long, as it was responsible for the depletion of foreign exchange reserves. Consequently, Sri Lanka was forced to abandon the policy in 2001 and to initiate a floating exchange rate regime with the monetary targeting framework. One of the key objectives of such monetary policy framework is price stability. The monetary targeting policy is being implemented presently by the monetary authority of Sri Lanka, the CBSL.

2.2 Monetary Policy Framework

2.2.1 Monetary Policy Objectives

Before the amendments to the Monetary Law Act in 2002, the CBSL's monetary policy objectives focused on economic stabilisation and enhancing economic development. After 2002, in line with the general global trend in conducting market oriented monetary policy, CBSL also began to place a greater reliance on OMO as its main instrument of monetary policy. As a major change in its policy thrust, in March 2003, the CBSL moved from a system called 'passive' OMO to a system of more 'active' OMO in order to improve the effectiveness of monetary policy operations.

2.2.2 Monetary Targeting

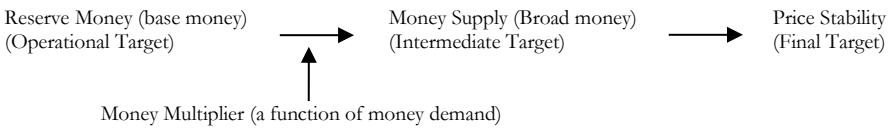
Under the monetary aggregate targeting monetary policy framework of the CBSL, the intermediate objective is to influence the broad money supply, more precisely M2b[1] through policy instruments. Money supply is linked to bank reserves that the CBSL calls 'reserve money' through the money multiplier. Accordingly, reserve money is the operating target while *broad money* supply is the intermediate target in the CBSL monetary framework. The *reserve money* target and the *broad money* targets are announced quarterly. The principal tools under the direct control of the central bank to achieve the path of the *reserve money* target are the volume of reserve money injected or withdrawn through the Open Market Operations (OMO), and the pair of official rates that forms the floor and the ceiling for eligible

[1] M2b is defined as the sum of currency, demand deposits, savings and time deposits.

commercial bank bidding rates in the auction organised for their 'overnight repo' or 'reverse repo' with the Central Bank [CBSL Annual Report (2014)]. These tools will be described in more details later.

The following Figure 2.1 summarizes the monetary policy targeting framework in Sri Lanka.

Figure 2.1: Monetary Targeting Framework of Sri Lanka



2.2.3 Monetary Policy Tools

There are several monetary policy tools such as OMO, official repo and reverse repo, central bank rates and statutory reserve requirement available to conduct monetary policy. However, at present OMO volume and official rates are actively utilized by the CBSL to achieve monetary policy goals. In line with the international trend of using more market oriented tools, the CBSL widely uses OMO as the primary policy tool, in addition to direct controls through non-market tools such as bank rates and credit controls. Amarasekara (2008) points out that the CBSL gradually moved away from the direct controls toward market-oriented mechanism during late 1970s with the liberalization of the domestic economy. Accordingly, the use of administratively determined bank rates and the use of credit controls were gradually abandoned.

OMO: The OMO are carried out mainly using government securities. The active OMO encourages competition in the money market and for participating institutions to improve their liquidity management. As explained above, the system operates within an explicit monetary targeting monetary policy framework. Monetary targeting has become more important with the floating of the rupee as the exchange rate no longer serves as a nominal anchor for monetary policy. In this framework, the final target of economic and price

stability is to be achieved through an intermediate target on the broad money supply which, in turn, is linked to a time path of operating targets on the reserve money. OMO are conducted to ensure the achievement of reserve money targets while maintaining interbank overnight interest rates, on which the impact of monetary policy decisions is reflected almost instantaneously, stable within a narrow range. Key elements of the OMO system are fourfold, and are given as follows; a) An interest rate corridor, b) Daily auction of either repo or reverse repo to maintain the interbank rate stable within the corridor, c) Standing facilities and d) Outright buying/selling of Treasury bills/bonds at the discretion of the Central Bank to either inject or absorb long-term liquidity.

2.3 Banking Activities in Sri Lanka

The banking activities in Sri Lanka are governed by the CBSL using three main acts; the Monetary Law Act, the Banking Act and the Exchange Control Act. The banking sector in Sri Lanka comprises of licensed commercial banks (LCBs) and licensed specialised banks (LSBs). The CBSL issues banking licenses for these two categories of banks. The difference between LCBs and LSBs lies in the range of activities they can undertake. LSBs are licensed to conduct specialised banking that includes specialised savings banks and development banks. LCBs have a broader scope compared to LSBs. LCBs are permitted to accept demand deposits from the public (operate current accounts for customers) and they are authorized dealers in foreign exchange which entitles them to engage in a wide-range of foreign exchange transactions. However LSBs are permitted limited engagements in foreign exchange with CBSL's approvals. These two sectors dominate the financial system and accounts for more than 55 per cent of the total assets of the financial system in Sri Lanka (CBSL Annual report 2013). The total assets and deposit liabilities of the LCBs and LSBs are given in Table 2.1.

Table 2.1: Total Assets and Deposit Liabilities of LCBs and LSBs

Financial Institution	2013			
	Assets		Deposits	
	Rs Bn	Share (%)	Rs Bn	Share (%)
LCBs	5,022.2	48.7	3,552.4	77.7
LSBs	919.3	8.9	617.1	13.5
Total	5,941.5	57.6	4,169.5	91.2

Source: Financial Stability Review of CBSL 2013

Banking sector play a central role within the financial system, as they have the capacity to provide liquidity to the entire economy. Also, banks are responsible for providing payment services, thereby facilitating all entities to carry out their economic transactions. Table 2.2 gives the banking sector network in Sri Lanka.

Table 2.2 gives the composition of assets and liabilities of the banking sector.

Table 2.2: Composition of Assets and Liabilities of Banking Sector

Year 2013	**% of Total**
Assets	
Loans	57.7
Investments	28.5
Other	13.8
Liabilities	
Deposits	70.2
Borrowings	17.1
Capital Funds	8.2
Other	4.5

Source: Financial Stability Review of CBSL-2013

2.3.1 Licensed Commercial Banks in Sri Lanka

As LCBs are the most significant category of the Sri Lankan financial sector, they are subject to examination by the CBSL in terms of the provisions of the Banking and Monetary Law Acts. Accordingly, examinations are conducted by the Bank Supervision Department of CBSL.

In terms of the asset base and the extent of services provided, the LCBs are the most significant category of financial institutions within the banking sector. In this study, the pass-through of money market rates to lending and deposit rates of LCB sector is analysed. As at the end of 2013, the LCBs dominated the financial system with a market share of around 48 per cent of the entire financial system's assets and around 86 per cent of the banking sector's assets. Therefore, the financial system's stability of Sri Lanka mostly depends on the soundness of the LCBs.

As at end of 2013, the commercial banking sector comprised of 24 LCBs. Even though a large number of LCBs exist in the country, the stability of the financial system primarily depends on the performance and financial strength of the six largest LCBs, consisting of the two state banks and the four largest domestic private commercial banks. These six banks are referred to as the Systemically Important Banks (SIBs), representing around 77 per cent of the LCB sector assets and around 66 per cent of the whole banking sector assets.

3 Interest Rate Pass-through Mechanism

3.1 Introduction

The monetary policy decisions by central banks regarding the official interest rates affect economic activities and inflation through several channels (i.e. interest rate channel, asset price channels, exchange rate channel, credit channels) which are collectively known as the 'transmission mechanism' of monetary policy. In this section, special attention is given to a particular type of channel: the interest rate channel.

3.2 The Monetary Policy Transmission Mechanism

Different degree and speed of pass-through and asymmetries are fundamental facts associated throughout the monetary policy transmission process. Therefore, it is difficult to predict the effect of monetary policy action on the economy. However, since then many economists have tried to understand the whole process of the monetary transmission mechanism in different ways. According to these analyses the monetary policy transmission mechanism can be decomposed into two stages.

Stage one is the change in the policy interest rate set by the central bank transmitted to the retail interest rates through various channels. For example, changes in the policy interest rate affect other retail interest rates such as loans and deposits rates offered by banks and other financial institutions through the changes in money market rates. This is called the interest rate channel of the monetary policy transmission. There are also several other channels that transfer the changes in policy interest rates to the economy. The monetary policy changes affect the prices of many assets such as shares, securities etc. and is referred to as asset price channel of the monetary policy transmission. Further, the monetary policy rate changes affect the foreign exchange rate of a country and this is called the exchange rate channel of the monetary policy transmission. Finally, it may also impact the expectations of economic agents such as firms, investors and individuals simultaneously, which describes the expectation channel of the monetary policy [(Ireland (2005)].

Stage two describes that these changes in retail interest rates will affect the consumption and investment spending patterns of the main economic agents, i.e. consumers and firms and thereby the whole economy. As an example, a higher interest rate will reduce the level of aggregate demand, as consumers and investors are affected by the increase in interest rates. This effect will reduce spending. There will also be an effect on aggregate demand due to imports and exports changing in response to changes in the exchange rate. The reduction in total demand will impact on overall economy as it reduces the production and thereby employment in the economy.

3.3 The Market Interest Rates

Market interest rates can be classified according to the maturity of the investment: they are either short-term interest rates or long-term interest rates. A change in the policy rate is immediately transmitted to other short-term money-market interest rates such as overnight interbank repo rates. However, these rates may not always move by the exact amount as the official rate change. Soon after the policy rate change, banks adjust their standard lending and deposit rates for short term maturities. This immediately affects the interest rates that banks charge their institutional customers on short term lending such as interest rates on overdrafts. And then it changes the interest rates charge for the other loans too. Accordingly it is clear that the loan rates are normally changed in response to policy rate changes although there can be many other factors that affect the pricing of loan rates. In addition, the rates offered to savers by the banks can be changed in order to maintain the margin between deposit and loan rates. However, this margin can vary over time, and also vary additionally from bank to bank due to many reasons such as competitive conditions in the markets and the size of the bank. Accordingly, it is clear that the deposit rates of the banks do not normally change in response to policy changes alone (Cevik S and Teksoz K, 2012).

Though the bank retail interest rates are considered as a very effective channel of transferring policy changes to the market interest rates, this pass-through might occur at different degrees and at different speeds for positive and negative monetary policy action. Therefore, the policy makers always have to be well aware about the speed and degree of interest rate pass-through and possible asymmetries in the process of transferring policy rate changes to bank interest rates for effective decision making. Identifying these asymmetries is also essential to have a stable financial sector in the economy as discussed above. Therefore, many studies have been conducted on 'degree' and 'speed' of pass-through and asymmetric behaviour of bank interest rates to changes in monetary policy rates. Moreover, asymmetric response of banking retail rates to money market rates also has major consequences for profit margins, interest rate risks and the overall performance of the banking industry.

3.4 Reasons for Incomplete Interest Rate Pass-Through

It is generally accepted that the success of monetary policy in achieving its goals will depend to a large extent on the *'stickiness'* of market retail interest rates. The stickiness of market retail rates is often regarded as an obstacle to the smooth transmission of monetary policy impulses. Therefore, the pass-through of money market rates to bank retail rates can be incomplete in practice [Hannan and Berger (1991) and Cottarelli and Kourelis (1994)]. The incompleteness may vary across economies and across different retail rates of the economy. Therefore, a systematic measure of the degree of response of market interest rates to changes in monetary policy stance is essential.

The bank retail rates are rigid in the short-run to changes in money market rates due to many reasons. One of the main reasons for the short-term stickiness is that the adjustment or menu costs. Adjustment or menu cost refers to the cost involve in changing the prices which the banks have already advertised. Such costs impact banks to react sluggishly towards changes in the money market rates.

Also, 'maturity mismatches of banks' loan and deposit portfolio impacts how they adjust their lending rates. Thus, the banks will have less pressure when more long term loans are covered by long term deposits, if their liabilities have less sensitivity towards market rates. The same explanation was given by Kobayashi. The short-term maturities are affected by the current change in monetary policy rates. However, the longer maturities are influenced by both current and expected future short-term rates (Kobayashi T, 2008). Market expectations of the future path of interest rates play a major role in this regard. For example, a rise in the official interest rate could generate an expectation of lower future interest rates. In this case the long-term interest rates might fall in response to a rise in the official interest rate. This is called the asymmetric impact of monetary policy changes on bank retail rates. On the other hand, if banks issue long-term loans mostly based on the short-term borrowings then this maturity mismatch tends to change the retail rate on long-term loans frequently following the changes of money market interest rates.

Bank retail interest rates are sticky due to the shifting/switching cost that can be associated when consumers or corporate attempt to shift the banking institution. For example, suppose

that lending rates are higher in bank A than bank B and that the borrower wants to settle the advance he obtained from bank A to shift to bank B. In this case there can be some settlement cost that reduces the motivation of borrower to shift to bank B. In such a scenario there is not much incentive to reduce the prevailing bank rates on the issued loans following a reduction in policy rate.

The market structure and the competitiveness of the banking sector also play a major role in the change in bank retail rates. If a bank has a potential market power, then it increases the retail rate on loans frequently even with a slight increase in the money market rate or policy rate (Bondt, 2002, Mojon, 2000). If the financial market is highly competitive, the banks cannot change the prices of their products at their discretion as customers may shift to another bank. Therefore, retail bank rates are mostly sticky in a competitive financial market. The degree of competition plays a more important role for the deposit rates pass through than for the lending rates pass through (Coricelly et al, 2006).

Size of the interest rate spread also plays a role in stickiness in bank retail rates. Interest rate spread is the difference between the interest rate charged by banks on loans to private sector customers and the interest rate paid by commercial banks for demand, time, or savings deposits. The bank spreads are determined by factors such as macroeconomic environment, the banking sector's market structure, bank-specific factors, and financial regulation (Brock and Rojas-Suarez, 2000). High spreads between deposit and borrowing rates can lead to inefficient financial sector intermediation as well as curtailing investments in the economy. It is supported by the studies that transmission in changes of policy rates is quicker in loan rates than in deposit rates.

For all these reasons, the interest rates pass-through process could be incomplete and could be disrupted.

3.5 The Role of Banks in the Interest Rate Transmission Mechanism

Commercial banks are traditionally the most important entities for the collection of savings and the financing of firms and households. Therefore, adjustments of retail lending and deposit rates by banks can significantly influence economic activity. In that sense, the bank

retail rates play an influential role (Peek J and Rosengren E S, 2013). Banking activities are also important as the financial products of the banks are considered non-substitutable products. Banking products still play a major role in most economies as non-bank financial markets cannot play such a role in those economies. However, this can be different for a market like the US financial market, where other financial institutions also play a major role in providing financial services to the economy.

Banking institutions are special as they are among the few participants of OMO activities with the central bank. The central bank indeed deals with a small group of counterparties, among which are commercial banks, in its OMO activities. In the OMO, banks have the ability to borrow funds from the daily auction at a rate decided based on the bids of OMO participants. Banks also lend fund in the money market to other counterparties who have short-term liquidity requirements.

Banks play a very important role in the payment system due to their ability to create money through the creation of deposits. The main way banks create money is through their loans to customers. Whenever a bank creates a loan, it creates a deposit in the borrower's bank account.

Accordingly, it is clear that banks are very special in the financial market in many ways. With these important roles, banks act in a special way to pass the monetary policy impulses to the real side of the economy. Accordingly the bank retail rates are always considered as a very influential and effective way to transmit monetary policy changes to the whole economy.

4 Literature Review of Empirical Studies on Interest Rate Pass- through

4.1 Introduction

The transmission of monetary policy impulses to bank retail interest rates, the interest rate pass-through process, occurs over various channels such as market interest rates, asset prices, market expectations, credit, etc. The cost channel or the market interest rate plays a major role among those channels as it describes how monetary policy changes are transferred to retail bank rates directly through the cost of funds. Policy makers are always

attentive to understand the monetary policy impulses on bank retail rates. Therefore, many studies have been conducted on the subject of the impact of policy rates to retail interest rates. These analyses have been done for various economies and using many types of methodologies and tools. They shed light on the completeness and speed of interest rate pass-through to bank retail rates as well as on the asymmetric impact of monetary policy on bank interest rates. During the course of this literature review, the main features of the significant studies on interest rate pass-through will be discussed in detail, while highlighting the determinants of the interest rates pass-through and the findings and the methodologies used in those studies.

4.2 The Degree, Speed and Asymmetry of the Transmission of Monetary Impulses to Bank Retail Rates

The speed of transmission of monetary impulses to retail interest rates can be slow and the degree of transmission can vary across financial institutions, retail rates and products maturities. Further, asymmetries in the transmission might occur in response to positive and negative monetary policy changes. The conclusions reached by empirical studies on each of these features are discussed below.

4.2.1 Incompleteness

Berstein and Fuentes (2003), Burgstaller (2003), De Bondt (2002) conducted studies on the hypothesis of bank lending rates sluggishness to changes in policy interest rates for the Chilean economy, Austria and Europe. They all reached the same conclusion for short-term stickiness of retail bank lending rates. The studies focused on the response of commercial banks' lending rate to a money market interest rate movement during this period. They were successful in proving the sluggishness of money market rates and the policy rate in those countries. Accordingly, the studies indicated several characteristics such as the size of the bank, structure of the financial market, type of customers, competitiveness of the banking sector, elasticity of the demand on banking services and information asymmetry in the economy and the loan risk level that makes stickiness of interest rate pass-through in the

short-run. Also, a cross country study to assess retail rate *stickiness* was conducted for Asia by Tai, Sek and Har (2012). This study consists of two periods: before the Asian financial crisis and after the financial crisis. The study reveals that the transmission rate from money market interest rate into deposit and lending rates was slow and sluggish across economies before the crisis. It continued to prevail after the Asian financial crisis of 1997/1998 due to low effectiveness of monetary policy, imperfect financial markets and the lower degree of financial integration of relevant economies. In general, the study concludes that the pass-through of policy rates to retail banking rates is sticky and thereby the effectiveness of the monetary policy in achieving policy targets is very low among the Asian economies studied.

Some contradictory results have been found by several studies. Those studies revealed that the interest rate pass-through tends to be full in the short run. For example, Crespo Cuaresma et al. (2004) empirically proved that the interest rate transmission to corporate lending rates was almost complete in the short run in five Central and Eastern European countries. They found that the deposit rate pass-through tends to be sticky in both short and long run. Further, in contrast to common finding of short-term stickiness of interest rate pass-through, some empirical studies have found evidence of an incomplete pass-through of the policy rate even in the long run. The empirical work by Mojon (2000), Heinemann and Schuler (2002), Hofmann (2003), and Sander and Kleimeier (2004) reported that the long-run pass-through of interest rates on loans to firms is complete. However, the empirical work by Donnay (2001) and Toolsema, Turm (2001) proved that the loan rate pass-through is incomplete in the long run.

4.2.2 Speed of Adjustment

Speed of adjustment of bank retail rates to policy rates refers the circumstance as the policy interest rate increases (decreases), correspondingly how quickly the standard-variable rate rises (drop) and vice versa. If there exists a significant asymmetry in speed of interest rate adjustments for deposit rates and lending rates, then banks are profiting from the policy rate changes. This may lead to developing a bad impression in the light of publicly held beliefs regarding increasing bank profits. Liu, Liu, Margaritis and Tourani-Rad (2011) found that

banks in Australia and New Zealand are very slow to pass on reductions in official interest rates and/or cost of funds to borrowers, as a result of which they are making profits at the expense of their customers.

4.2.3 Asymmetric Behaviour

The asymmetric nature of the interest rate pass-through process in size and speed is also an important aspect of the transmission mechanism. In terms of magnitude of the adjustment, it is observed that bank loan rates are 'rigid to tightening' of monetary policy while deposit rates are 'rigid to easing' of monetary policy. Explanations for such rigidities can be attributed to the customers' unfavourable reactions to unstable rates and the unwillingness of the banks to break collusive price arrangements [Hannan and Berger (1991) and Neumark and Sharpe (1992)]. In terms of speed of adjustment, retail rates depend on whether the perceived gap between the retail and the base rates is widening or narrowing [Sander and Kleimeier (2004)].

Gambacorta and Iannotti's (2007) intuition was that the interest rate adjustment may be asymmetric in size and speed. For example, in the case of a monetary tightening, if banks had some market power, they could increase their loan rate by a higher percentage more and faster than their deposit rate, and vice versa, in the case of an easy monetary policy. This behaviour implies asymmetric adjustment of bank rates both in magnitude and speed and in order to examine such asymmetry, the model allows for asymmetric behaviour. They observed that interest-rate adjustments, in response to positive and negative shocks, are asymmetric in the short-run, although not in the long-run for Italy during the period of 1985 to 2002. This is consistent with the idea that in the long-run, the equilibrium is unique and banks adjust their loans (deposit) prices at a faster rate during periods of monetary tightening (easing).

The market practice of adjusting lending rates to increases in monetary policy rates faster than adjusting lending rates to decreases in monetary policy rates is referred to in the literature as "Rockets and Feather Hypothesis" [Valadkhani and Anwer (2012)]. The "Rockets and Feather Hypothesis" was tested by Valadkhani and Anwer (2012), for the

speed of adjustments of 'mortgage lending rates' to 'cash rates' in Australia in the period of 1989 to 2011. They found that rate rises are passed onto the consumer faster than rate cuts. Conversely, when actual mortgage rates are above the equilibrium path, lenders usually hesitate to lower their rates.

4.3 Determinants of Interest Rate Pass-through

Heterogeneity in Strength of Interest Rate Pass-through in Cross Countries: The strength of the interest rate pass-through varies across countries and markets. Cross country heterogeneity has been revealed by pioneering work on determinants of interest rate pass-through covering 31 developed and emerging economies, Cottarelli and Kourelis (1994), which found that a higher inflationary environment, capital mobility, and money market development (proxied by volatility of money market rates or by the size of the market for short-term securities) result in a stronger pass-through. Similar results for inflation and money market volatility were obtained for different groups of European countries by Mojon (2000), and Sander and Kleimeier (2004).

Competition in the Banking Sector: The literature appears unanimous about the positive role of competition in the banking system for the pass-through process. Different researchers have used different measures of competition: Cottarelli and Kourelis (1994) used concentration of banking sector and a measure of private ownership of banks, Mojon (2000) used an index capturing the degree of banking deregulation in Europe, and Sorensen and Werner (2006) used banking concentration and market power measured by return on equity (ROE), also for a group of European countries. But all came to the conclusion that competition tends to improve pass-through.

Other Factors: Apart from these commonly used variables, Sorensen and Werner report a negative relationship of pass-through elasticity with banks' excess liquidity, excess capital, rigidity of bank funding costs (share of deposits in total liabilities), and interest rate risk (measured by maturity mismatch). They also find that portfolio diversification (share of noninterest income in total income) and credit risk (loan provisioning) improve pass-through. Sander and Kleimeier (2004) find that the financial health of the banking sector,

inversely proxied by nonperforming loans as a per cent of total loans, reduces interest rates stickiness. Mojon (2000) reports that high operating costs, measured as staff costs to gross income, impede pass-through.

In general, most of the studies have found that the strength of interest rate pass-through depends on a range of factors such as composition and the growth of GDP, inflation, interest rates, credit quality, overhead costs and competition among banks which facilitate the pass-through process; market volatility and excess liquidity in the banking system, on the other hand, impede it. Countries with fixed exchange rate arrangements tend to have weak pass-through [Gigineishvil N (2011)].

4.5 Econometric Methodologies to Measure Interest Rate Pass-through

Transmission of monetary policy changes to retail bank rates using money market rates occurs at different speeds and different degrees. Therefore, there should be a proper mechanism or a way to measure the degree and the speed of interest rates pass-through. As the matter is important, several advanced statistical and econometric tools have been developed by scholars to assess the degree and the speed at which bank retail rates adjust to changes in money market rates. Econometric models have become more popular in this regard during the past few decades. Such econometric tools and methodologies used by major studies are discussed in the following sections.

4.5.1 The Simple Regression Analysis using OLS Estimators

This is a very popular and simple approach to econometric modelling to formulate the simplest equation that is consistent with a certain economic theory. Under this method, the researchers first select the relevant variables. Then the coefficients are estimated using the regression analysis. The qualities of the estimated coefficients are then evaluated by performing certain tests such as significance of the coefficients using t-tests and f-tests, P-values and R squared as well as co-integration. Regression analyses are more common in estimation responses of bank retail rates to changes in money market interest rates.

4.5.2 The Vector Auto Regressive Models

The vector auto regression (VAR) model is one of the most successful, flexible, and easy to use models for the analysis of multivariate time series. It is an extension of the univariate autoregressive model to dynamic multivariate time series. The VAR model has proven to be especially useful for describing the dynamic behaviour of economic and financial time series and forecasting. It often provides superior forecasts to those from univariate time series models. It can model many equations at the same time. The VAR methodology is also used when the variables are integrated at levels.

The VAR equations describe a system in which each variable is a function of its own lag, and the lag of the other variables in the system. For an example, if the system contains two variables y and x, and maximum lag is of order one, we refer such VAR models as 2-VAR (1). If y and x are stationary, the system can be estimated using least squares applied to each equation. If y and x are not stationary in their levels, but stationary in differences (i.e., I(1)), then we take the first differences and estimate the model using least squares. In the VAR model we can consider all the variables as endogenous variable.

Let $Y_t = (y_{1t}, y_{2t}, ..., y_{nt})$ denote an (n×1) vector of time series variables. The basic p-lag vector autoregressive (VAR (p)) model has the following form

$$Y_t = c + \prod 1Y_{t-1} + \prod 2Y_{t-2} + \cdots \ldots \ldots \ldots + \prod pY_{t-p} + \varepsilon_t, \qquad t = 1, \ldots \ldots, T$$

Where Πi are (n×n) coefficient matrices and ε_t is an (n×1) unobservable zero mean white noise vector process (serially uncorrelated or independent) with time invariant covariance matrix Σ. For example, a bivariate VAR (2) model equation by equation has the form

$$\begin{pmatrix} Y_{1t} \\ Y_{2t} \end{pmatrix} = \begin{pmatrix} c_1 \\ c_2 \end{pmatrix} + \begin{pmatrix} \pi_{11}\, \pi_{12} \\ \pi_{21}\pi_{21} \end{pmatrix} \begin{pmatrix} Y_{1t-1} \\ Y_{2t-1} \end{pmatrix} + \begin{pmatrix} \pi_{11}\, \pi_{12} \\ \pi_{21}\pi_{21} \end{pmatrix} \begin{pmatrix} Y_{1t-2} \\ Y_{2t-2} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix}$$

Where cov (ε_{1t}, ε_{2s}) = σ12 for t = s; 0 otherwise. Each equation has the same regressors — lagged values of y_{1t} and y_{2t}. Hence, the VAR (p) model is just a seemingly unrelated regression (SUR) model with lagged variables and deterministic terms as common regressors.

The information criteria of Akaike Information Criteria and Schwarz Criteria and the log likelihood ratio are used to select the lag length in the VAR models.

De Bondt (2002) conducted a study using VAR model at levels, which is the data series stationary at levels to examine the retail bank interest rate pass-through process in the euro area during the period of January 1996 to May 2001. He observed the interest rate pass-through process according to the impulse responses using the VAR. The impulse responses explain how a temporary shock to the market interest rate is passed through to bank deposit and lending rates, respectively. He found that shocks in the market interest rates are not immediately reflected in retail bank interest rates. In other words, bank interest rates are sticky in the short term.

Although VAR models are popular in the empirical analysis of interest rate pass-through, there is some criticism on the grounds of that there is not much economic theory behind them [Stock and Watson (2001)]. This criticism was addressed by introducing a structural VAR (SVAR) method, which has the economic background that is widely used in empirical analysis of interest rate pass-through.

Sengupta (2013) conducted a study using SVAR to examine whether the interest rate pass-through process has changed due to the introduction of the Liquidity Adjustment Facility (LAF) in India in 2000. The LAF has been introduced to minimize volatility in the money market by ensuring the movement of short-term interest rates within a reasonable range. The study observed that the interest rate pass-through has been improved after the introduction of LAF in India.

4.5.3 The Error Correction Mechanism

Error Correction Models (ECMs) are a category of multiple time series models that directly estimate the speed at which a dependent variable returns to equilibrium after a change in an independent variable. The ECMs are useful for estimating both short-term and long-term effects of one time series on another. Thus, they often use a theoretically-driven approach to estimate time series models. The ECMs are useful models when dealing with integrated data series, but can also be used with stationary data series. The basic structure of an ECM is

$$\Delta \mathbf{Y}_t = \alpha + \alpha_0 \Delta \mathbf{X}_{t-1} - \beta_1 \mathbf{EC}_{t-1} + \varepsilon_t$$

Where EC = Y - β_0X is the error correction component of the model and measures the speed at which prior deviations from equilibrium are corrected. The short term effect of X on Y is β_1 which is the speed at which Y returns to equilibrium after a deviation has occurred. The long term effect of X on Y (long run multiplier) is α_0. The ECMs are used in economic analysis as there are a number of desirable properties such as estimates of short and long term effects together which provide an easy interpretation of short and long term effects. They provide applications to both integrated and stationary time series data, which can be estimated using OLS, where the model also has a theoretical relationship. Accordingly, using ECMs can be appropriate whenever the researcher uses time series data and is interested in both short and long term relationships between multiple time series.

ECM representations are widely used in empirical analysis of interest rate pass-through due to the advantages discussed above. The pass-through of money market interest rates to retail banking interest rates were modelled using ECM for Chile, the United States, Canada, Australia, New Zealand and Five European countries by Espinosa- Vega M A and Rebucci A, in 2003. Initially an ADL model was estimated which included a time trend to investigate the long run relationship among those rates.

$$RetailR_t = \alpha_0 + \alpha_1 t + \alpha_2 MMR_t + \alpha_3 RetailR_{t-1} + \alpha_4 MMR_{t-1}$$

The above indicates the relevant bank retail rate, MMR the money market rate while 't' represents the time trend. The trend was included to capture the disinflation process and other factors such as financial liberalization, structural liberalization that change slowly over time. And then they re-parameterized their ADL model by introducing an ECM term to the above ADL equation as follows.

$$\Delta RetailR_t = \alpha_2 \Delta MMR_t + \beta_3 (RetailR_{t-1} - \alpha_0 - \beta_1) + \beta_2 MMR_t$$

This ECM model allowed them to measure together the short-run speed of adjustment (error correction adjustment) of bank retail rates to its long-run equilibrium and the short-term pass-through of monetary policy changes to bank retail rates.

The short-run and long-run interest rates pass-through behaviour of Malaysia were analysed by Zulkhibri in 2012 using the ECM representation. The study compared the behaviour interest rate pass-through of various financial institutions that is banks and non-bank financial institutions. The results showed that both deposit and lending pass-throughs were incomplete and the speeds of adjustments would vary across financial institutions and retail rates.

5 Data and Methodology

5.1. Introduction

This section describes the variables, present statistics and methodology of the analysis to be used in the paper. Monthly data are used covering the period from January 2003 to December 2013. Data from 2003 are used because the CBSL introduced more active OMO in 2003. Under this more active OMO is conducted where market participants play a major role in setting the effective rate in the auction which directly impacts call money market rates. The source of the data is the CBSL. The main interest of this study is not in the implementation of monetary policy but its transmission under the new operations. Leaving out data prior to 2003 avoids confounding the effects of changes in the conduct of monetary policy upon the transmission.

5.2. Description of Data

5.2.1 Definition of Data and Stylised Facts

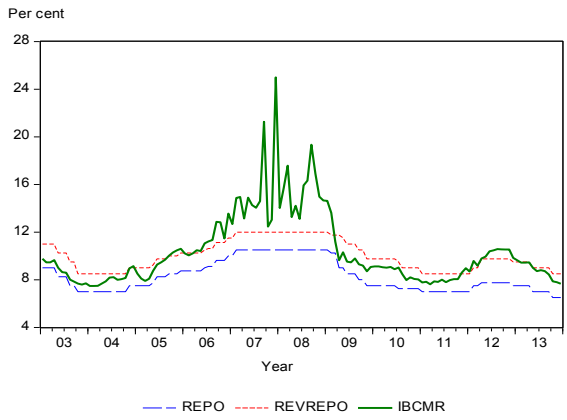
The variables used in this analysis are the policy interest rates (the repo and reverse repo rates of the central bank), the call money market rate, various types of retail lending rates and various types of retail deposit rates. A description of the data is given below.

CBSL Policy Rates and Inter-bank Call Money Market Rates

The CBSL sets the repo and reverse repo rates. In a normal period of operation the inter-bank overnight call money market rate (IBCMR) is bound below by the overnight repo rate (REPO) and bound above by the overnight reverse repo rate (REVREPO). In periods of excess liquidity or illiquidity these bounds do not hold. The data on the REPO and REVREPO are monthly averages of the daily repo and reverse repo rates respectively. The data on the IBCMR is the monthly average of the daily weighted average of overnight inter-bank call money market rates. A plot of the REPO, REVREPO and the IBCMR of the period of study is given in the Figure 5.1. It is clear from this figure that IBCMR has been bounded by the policy rates most of the time. The exception is the period where the global financial crisis prevailed. The internal war experienced by Sri Lanka could be another reason for this unusual behaviour. Further, the CBSL conducted a relatively tight monetary policy during this period.

It has been shown in previous studies that there is generally a close relationship between the CBSL policy rates – the REPO and the REVREPO rates – and the IBCMR [Amarasekara (2005)]. Therefore, as mentioned before, in this analysis only secondary stage of pass-through is considered, i.e. from the IBCMR to the other bank retail rates.

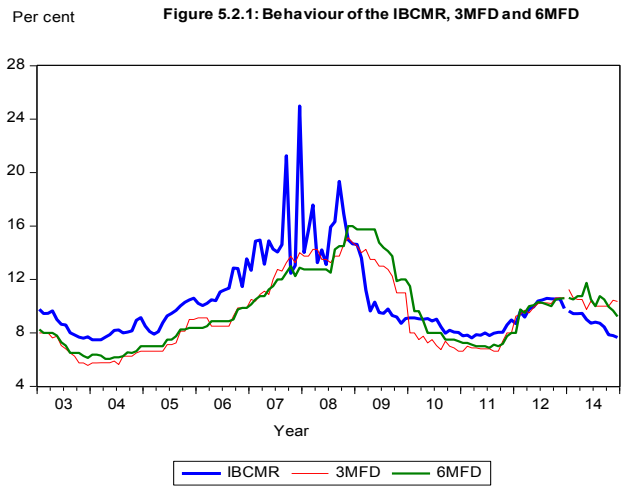
Figure 5.1: Behaviour of CBSL Policy Rates and IBCMR



Commercial Banks' Deposit Rates

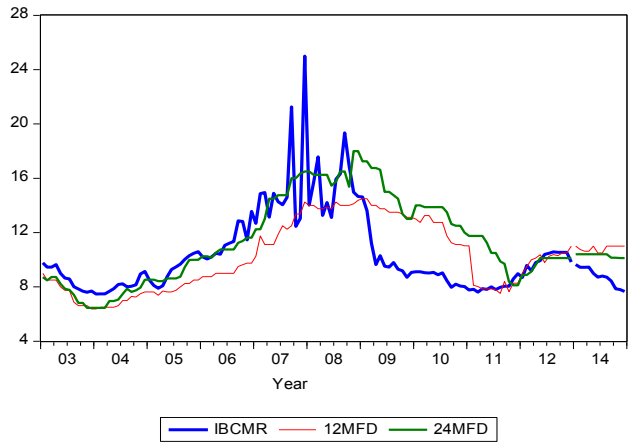
Various types of retail interest rates are considered to analyse the impact of the monetary policy on bank rates. The study contains four maturities of fixed deposits. They are the fixed deposit rates offered by the commercial banks on their three month fixed deposits (3MFD), six month fixed deposits (6MFD), twelve month fixed deposits (12MFD) and twenty four months fixed deposits (24MFD). Further, it was decided to analyse the commercial bank savings deposit rate (SD). The measurements of these variables used in the data are the middle rates of the commercial bank deposit rates as reported by the CBSL. In addition, the average weighted deposit rate (AWDR) of the commercial banks is also analysed. The AWDR is calculated by the CBSL monthly based on the weighted average of all outstanding interest bearing deposits of commercial banks and the corresponding interest rates on the deposit. The plots of these rates, with the IBCMR, over the sample period are shown in the plots in Figure 5.2.

Figure 5.2: Behaviour of the Bank Deposit Rates



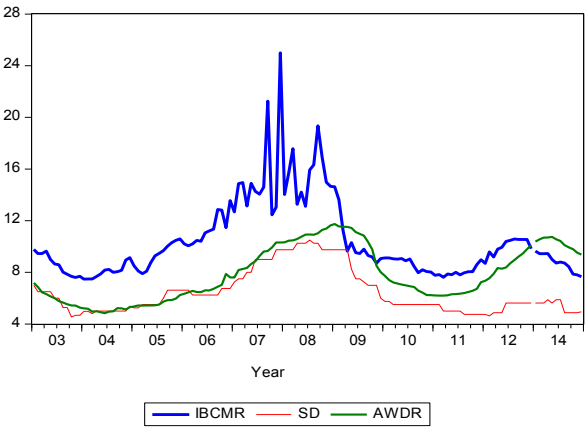
Per cent

Figure 5.2.2: Behaviour of the IBCMR, 12MFD and 24MFD



Per cent

Figure 5.2.3: Behaviour of the IBCMR, SD and AWDR



All of the deposit rates have followed the broad pattern of high interest rates which prevailed in the money market interest rates during the period of 2007-2009.

Commercial Banks' Lending Rates

Various types of commercial bank lending rates are also considered in the analysis of the impact of the monetary policy. Two lending rates that are secured by collateral are considered. One of them is interest rates on loans secured by immovable properties

(LSECIMPR). This is the middle rate of commercial banks' lending secured by property mortgages. It is rational to assume that this data series mainly comprises interest rates on long-term loans such as housing loans. The other series is interest rates on loans secured by other properties (LSECOTH). This is also the middle value data as reported by the CBSL.

It was decided, in addition, to consider interest rates on unsecured loans (LUNSEC) such as temporary overdraft facilities to analyse the monetary policy impact on those rates. The middle rate as reported by the CBSL is considered here as well.

The average weighted prime lending rate (AWPLR) is also considered. This rate is calculated by the CBSL weekly, based on commercial banks' lending to their prime customers during the week. The monthly figures are average values of weekly rates. This rate is useful to study the behaviour of prime lending rates.

The behaviour of these variables during the period under study is depicted in the plots in Figure 5.3.

Figure 5.3: Behaviour of the Bank Lending Rates

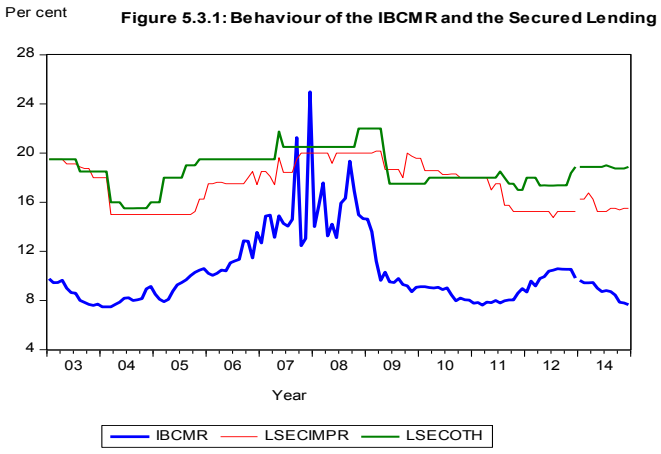


Figure 5.3.2: Behaviour of the IBCMR and the Unsecured Lending

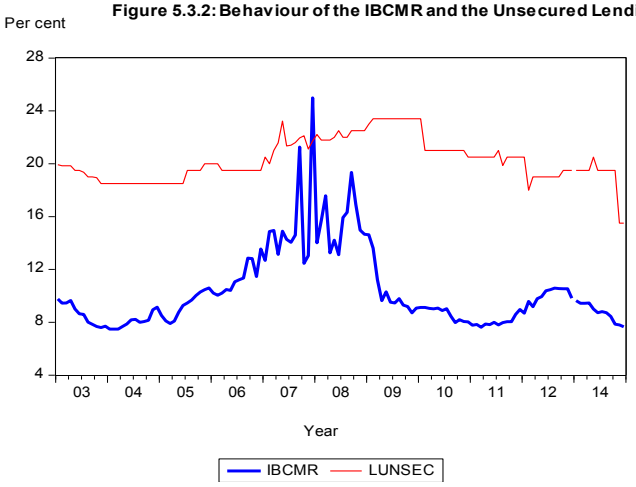
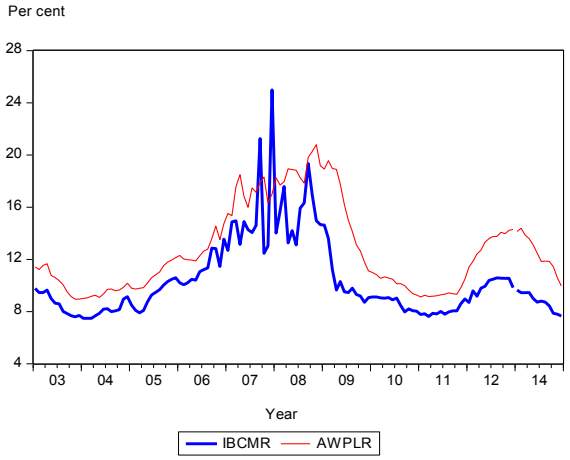


Figure 5.3.3: Behaviour of the IBCMR and Prime Lending Rate



The main difference between the behaviour of deposit and lending rates (as shown in Figures 5.2 and 5.3) is that changes in lending rates (except in the case of prime lending rate) are not as frequent as deposit rates in response to monetary policy actions. This pattern suggests a greater rigidity of lending rates compared to deposit rates. However, the plots in Figure 5.2 and 5.3 show overall patterns in both of high interest rates during 2007-2009 periods.

5.2.2 Descriptive Statistics

Descriptive statistics give a general overview of the data series aggregated over the sample period. The descriptive statistics of all monthly time series data are reported in Table 5.1.

Table 5.1: Descriptive Statistics of Monthly Interest Rates

	Mean	Median	Maximum	Minimum	Std. Dev.
CBSL Policy Rates					
REPO	8.29	7.75	10.50	6.50	1.32
REVREPO	10.02	9.75	12.00	8.50	1.27
Money Market Rate					
IBCMR	10.36	9.45	24.99	7.48	2.99
Deposit Rates					
3MFD	9.37	9.13	15.13	5.57	2.70
6MFD	9.62	8.95	16.00	6.06	2.70
12MFD	10.25	10.28	14.50	6.38	2.49
24MFD	11.36	10.40	18.00	6.46	3.11
SD	6.45	5.63	10.50	4.55	1.71
AWDR	7.85	7.20	11.74	4.84	2.12
Lending Rates					
LSECIMPR	17.42	18.00	20.17	14.75	1.85
LSECOTH	18.67	18.63	22.00	15.50	1.51
LUNSEC	20.29	19.90	23.40	15.50	1.63
AWPLR	12.76	11.84	20.79	8.94	3.31

The results in Table 5.1 show that, on average, the IBCMR has not remained between Repo and Reverse Repo rates, contrary to expectations. However, as depicted in Figure 5.1 the IBCMR remains in between policy rates of REPO and REVREPO except for the period of March 2006 to February 2009. The high volatility of the inter-bank market rate can be recognised as due to the market circumstances that prevailed during the period of financial turmoil around the world.

All deposit rates are on average below the IBCMR rate with the exception of the interest rate on 12 MFD and 24MFD. The high rates for longer term maturity of fixed deposits are expected, since long-term deposits are compensated by a risk premium.

On average, with the exception of the AWPLR, the lending rates are high relative to the deposit rates. The AWPLR is the lending rate for prime customers and therefore it is expected to be lower than the other interest rates. Further, the standard deviation of the AWPLR is higher compared to other lending rates. This shows that the AWPLR is more variable than other lending rates. Note that the standard deviations of the deposit rates are generally higher than those of the lending rates except AWPLR. This behaviour is evident in the plots discussed above and indicates that the lending rates are more rigid than the deposit rates.

5.2.3 Correlation Structure

Correlations between variables indicate the strength and direction of contemporaneous bivariate relationships among those variables. Table 5.2 depicts the correlations between all pairs of deposit rates including the IBCMR. All of the deposit rates have a positive correlation above 0.55, with IBCMR. The interest rate on SD has the strongest correlation with IBCMR compared to others. The 3MFD is the next most strongly correlated with the IBMCR. On the other hand, the AWDR shows the lowest correlation with inter-bank call money market rate compared to the others.

Table 5.2: Correlation Matrix for Bank Deposit Rates

	IBCMR	3MFD	6MFD	12MFD	24MFD	SD	AWDR
IBCMR	1	0.736452	0.646773	0.578995	0.667879	0.824835	0.555968
3MFD	0.736452	1	0.955114	0.828454	0.81879	0.844159	0.923688
6MFD	0.646773	0.955114	1	0.866302	0.848602	0.80665	0.927474
12MFD	0.578995	0.828454	0.866302	1	0.920117	0.713526	0.83513
24MFD	0.667879	0.81879	0.848602	0.920117	1	0.816937	0.746823
SD	0.824835	0.844159	0.80665	0.713526	0.816937	1	0.676189
AWDR	0.555968	0.923688	0.927474	0.83513	0.746823	0.676189	1

Table 5.3 presents the correlation matrix for the bank lending rates and the IBCMR. The AWPRL shows the strongest correlation with inter-bank call money market rate. The LSECOTH also shows a strong correlation with IBCMR compared to the other two lending rates. The other lending rates do not show such strong correlations with IBCMR.

Table 5.3: Correlation Matrix for Bank Lending Rates

	IBCMR	LSECIMPR	LSECOTH	LUNSEC	AWPLR
IBCMR	1	0.504242	0.656183	0.466217	0.819293
LSECIMPR	0.504242	1	0.663615	0.715508	0.522853
LSECOTH	0.656183	0.663615	1	0.467393	0.737138
LUNSEC	0.466217	0.715508	0.467393	1	0.613653
AWPLR	0.819293	0.522853	0.737138	0.613653	1

5.3. Description of Methodology

When discussing the deposit and lending rates described in Section 5.2, I will refer to these collectively as the bank retail rates. The IBCMR will be referred to as the money market interest rate.

5.3.1 The Model

Much of the literature on interest rate pass-through starts from the mark-up pricing model on the grounds of Rousseas (1985). The model can be written as;

$$r^b_t = \alpha_0 + \beta r^m_t + \varepsilon \quad \textbf{(1)}$$

where r^b_t is the retail lending rate charged by banks and the r^m_t is the marginal cost approximated by the money market interest rate of the time t. α is the constant mark-up and β is the pass-through parameter. ε indicates the error term. As interest rates are usually found to be cointegrating non-stationary I (1) processes, Equation (1) can be estimated in the form of an error correction model capturing both the long-run equilibrium between retail rates and market rates as well as the short-run adjustment dynamics.

As discussed in the theories on interest rate pass-through, there are two approaches that can explain the above relationship. The first is the "monetary policy approach" that addresses the linkage between bank lending rates and the policy rate (or short-term money market interest rate that is considered as a proxy to policy interest rate). The other is the "cost-of-funds approach" that addresses the relationship between bank lending rates and money market interest rates. In this study, I follow the cost-of-funds approach.

The study focuses on three main issues. First, the study considers the completeness of the long-run pass-through. Second, it considers the short-run speed of adjustment and, finally, the asymmetries in the interest rate pass-through process.

The Long-run Relationship: The long-run relationship between bank retail rates and the money market rate can be modelled in the following way using a regression analysis among each pair of variables. This equation is the cointegrating relationship among those variables as it is considered that all the variables are cointegrated with money market rate.

$$r_t^b = \alpha_0 + \alpha_1 IBCMR_t + \varepsilon_t \quad \textbf{(2)}$$

where $\mathbf{r^b_t}$ represents the particular bank retail interest rates at time t and $IBCMR_t$ represents the overnight money market rate at time t. As with the expression (1) for the deposit rates, the coefficient α_0 is the constant mark-up and the coefficient α_1 is the long-run interest rate pass-through parameter. These coefficients can be estimated using generalized method of moment (GMM) with the first lagged values of bank retail rate and first lagged value of money market rate as instruments. The GMM approach and choice of instruments are used to account for potential endogeneity, heteroskedasticity and auto correlation.

The Short-run Dynamics (ECM): The short-run dynamics of interest rate pass-through can be modelled in the following way using an error correction model [following Hefferman (1997), Scholnick (1996) and Winker (1999)]

$$\mathbf{\Delta\,(r^b_t) = \mu + \varrho\,(r^b_{t-1} - \alpha_0 - \alpha_1 IBCMR_{t-1}) + \delta\,\Delta\,IBCMR_{t-1} + \varepsilon_t} \quad \textbf{(3)}$$

Error correction adjustment is given by the coefficient ϱ and the short-run pass-through is given by the coefficient δ.

The Asymmetric Model: To measure whether there is an asymmetry in the short-term dynamics in response to monetary easing and tightening, the following model is used [based on Scholnick (1996)];

$$\Delta (r^b_t) = \delta_0 + \delta_1 \Delta IBCMR_{t-1} + \delta_2 \varsigma_{t-1}(\varepsilon'_{t-1}) + \delta_3(1-\varsigma_{t-1})(\varepsilon'_{t-1}) + \upsilon_t \quad (4)$$

Where ε'_{t-1} is the estimated lagged ε_t in equation (2). ς is a dummy variable defined as follows;

$\varsigma_{t-1} = 1$ if $\varepsilon'_{t-1} > 0$ and 0 otherwise. Asymmetric mean lags (AML) are defined as follows;

$AML^+ = (1- \delta_1)/ \delta_2$ and $AML^- = (1- \delta_1)/ \delta_3$

Asymmetry is examined using a Wald test with Chi-square (1) distribution for the null hypothesis $\delta_2 = \delta_3$. A rejection of this hypothesis means that there is an asymmetric effect on pass-through depending on the direction of the policy change.

5.3.2 Description of Econometric Tools used in the Analysis

Unit Root Tests (ADF and KPSS tests): Augmented Dickey-Fuller (ADF) and the KPSS unit root tests are used to test for examine stationary property of variables.

i) ADF Test

There are three versions of ADF tests based on the role of the constant term and the time trend included in the stochastic process.

ADF @ Level with Intercept and Trend: The following equation is estimated for each variable to test whether the series is stationary and to test whether there is a significant role for trend and the intercept to play in this analysis.

$$\Delta y_t = \alpha + \gamma y_{t-1} + \sum_{s=1}^{m} a_s \Delta y_{t-s} + \lambda t + \upsilon_t \qquad Constant\ and\ trend$$

$$H0:\ \gamma = 0, or\ Series\ has\ a\ unit\ root,$$
$$\alpha = 0\ or\ No\ constant\ and \quad \lambda = 0\ or\ No\ trend$$

ADF @ Level with Intercept and No Trend: The following equation is estimated for each variable to test whether the series are stationary and to test whether there is a significant role for the intercept in the series.

$$\Delta y_t = \alpha + \gamma y_{t-1} + \sum_{s=1}^{m} a_s \Delta y_{t-s} + \upsilon_t \qquad Constant\ only$$

$$H0:\ \gamma = 0, or\ Series\ has\ a\ unit\ root, \qquad \alpha = 0\ or\ No\ constant$$

ADF @ Level with No Intercept and No Trend: The following equation is estimated for each variable to test whether the series are stationary without including the trend and the intercept terms into the equation.

$$\Delta y_t = \gamma y_{t-1} + \sum_{s=1}^{m} a_s \Delta y_{t-s} + \upsilon_t \qquad No\ Constant\ or\ trend$$

$$H0: \gamma = 0, or\ Series\ has\ a\ unit\ root$$

ii) The KPSS Test with Intercept and Trend

The KPSS test is conducted to check whether the results given by the ADF test is valid in terms of another analysis.

Cointegration Tests (CRDW and Johansen tests): It is possible for there to be a linear combination of integrated variables that is stationary. Such variables are said to be cointegrated. Cointegration refers to a linear combination of non-stationary variables that is stationary. The residual based Durbin Watson and the Johansen procedure can be used to test the cointegration.

i) CRDW Test for Cointegration

The steps to test cointegration with CRDW can be given as follows;

- Consider the given variables x_t , $y_t$and z_t

- Estimate $x_t = \alpha + \beta_1 y_t + \beta_2 z_t + e_t$ (by OLS)
- Test the residuals, e_t for a unit root. If e_t is I (0) then x_t $y_t$and z_t are cointegrated.

ii) Johansen Test for Cointegration

Johansen test for cointegration is based on VAR approach. It estimates the VEC model and test for the cointegration rank according to the following equation;

$$\Delta x_t = \pi_0 + \pi x_{t-1} + \pi_1 \Delta x_{t-1} + \ldots + \pi_{p-1} \Delta x_{t-p+1} + e_t$$

Where $e_t \sim NID(0, \Sigma)$.

The number of cointegrating vectors is equal to the rank of π denoted by r.

The Johansen approach is to estimate the above equation for a given value of r. The rank of a matrix is equal to the number of its non-zero characteristic roots. This means we can test hypotheses concerning *r* using the estimated characteristic roots of π.

There are two test statistics that can be used in Johansen test.

(a) Trace Test Statistic

We reject H0: r=r* in favour of H1: r>r* if the value of a trace test statistic is greater than critical values found in Johansen-Juselius tables.

(b) Maximum Eigenvalue (Lambda Max) Test Statistic

We reject H0: r=r* against H1: r=r*+1 if the value of a maximum eigenvalue test statistic is greater than critical values in Johansen-Juselius tables.

Both tests have a non-standard chi-squared distribution.

6 Empirical Analysis and Results

6.1 Introduction

The preceding section discussed the data used in the analysis and the methodology to be used in this section to conduct the analysis. The analysis begins with the unit root tests. If the series are integrated, I use two tests – CRDW test and Johansen test – to examine whether they have a long-run relationship (cointegration tests). Subsequently the short-run adjustment for long-run equilibrium would be analysed using the error correction model. Then the asymmetry of the monetary policy impact will tested. Finally the results will be summarised in the conclusion.

6.1 Unit Root Tests

The results of the ADF tests are given in the Table 6.1.

The test equations for the ADF test are as follows;

$$\Delta y_t = \alpha + \gamma y_{t-1} + \sum_{s=1}^{m} a_s \Delta y_{t-s} + \lambda t + \upsilon_t \qquad Constant\ and\ trend$$

$$\Delta y_t = \alpha + \gamma y_{t-1} + \sum_{s=1}^{m} a_s \Delta y_{t-s} + \upsilon_t \qquad Constant\ only$$

$$\Delta y_t = \gamma y_{t-1} + \sum_{s=1}^{m} a_s \Delta y_{t-s} + \upsilon_t \qquad No\ Constant\ or\ trend$$

Table 6.1: Summary Results of ADF Test for Unit Root

Series	Lag Length	ADF Test									
		At Level					At 1st Differences				
		Ho: ϒ=0, unit root and α=0, No constant and λ=0, No Trend)					Ho: ϒ=0 (Series has a UR)				
		Deterministic Component	UR Test for Trend				No Constant or Trend				
		Constant or Trend	P-Value	ADF Test Stat	Critical Value at 5%	Conclusion	P-Value	ADF Test Stat	Critical Value at 5%	Conclusion	Oder Of Integration
Money Market Rate											
IBCMR	2	Not significant	0.91	-1.16	-3.45	Unit Root	0.00	-17.80	-1.94	No UR	I (1)
Bank Deposit Rates											
3 Month-FD	2	Not significant	0.90	-1.24	-3.45	Unit Root	0.00	-12.95	-1.94	No UR	I (1)
6Month-FD	2	Not significant	0.54	-2.10	-3.45	Unit Root	0.00	-2.95	-1.94	No UR	I (1)
12 Month-FD	2	Not significant	0.89	-1.27	-3.45	Unit Root	0.00	-12.49	-1.94	No UR	I (1)
24 Month-FD	2	Not significant	0.96	-0.83	-3.45	Unit Root	0.00	-5.01	-1.94	No UR	I (1)
Savings Deposit	2	Not significant	0.95	-0.93	-3.45	Unit Root	0.00	-10.52	-1.94	No UR	I (1)
AWDR	2	Not significant	0.29	-2.59	-3.45	Unit Root	0.01	-2.72	-1.94	No UR	I (1)
Bank Lending Rates											
LSECIMPR	2	Not significant	0.71	-1.77	-2.88	Unit Root	0.00	-13.68	-1.94	No UR	I (1)
LSECOTH	2	Not significant	0.27	-2.04	-2.88	Unit Root	0.00	-10.54	-1.94	No UR	I (1)
LUNSEC	2	Not significant	0.96	-0.85	-2.88	Unit Root	0.00	-13.42	-1.94	No UR	I (1)
AWPLR	2	Not significant	0.27	-2.62	-2.88	Unit Root	0.03	-2.19	-1.94	No UR	I (1)

It is evident that all the time series have one unit root and are therefore stationary in first differences. This means that all the variables are integrated at degree of one, I(1). These results are confirmed by the KPSS test (Figure 6.2) and compatible with past studies.

Table 6.2: Summary results of KPSS Test for unit root

Series	KPSS Test						
	At Level with Constant and Trend			1st Difference with Constant and Trend			
	H0: No UR			H0: No UR			
	KPSS Test Stat	Critical Value @ 5%	Conclusion	KPSS Test Stat	Critical Value @ 5%	Conclusion	Order of Integration
Money Market Rate							
IBCMR	0.2292	0.1460	Unit Root	0.0793	0.1460	No UR	I (1)
Bank Deposit Rates							
3 Month-FD	0.2051	0.1460	Unit Root	0.1055	0.1460	No UR	I (1)
6Month-FD	0.2091	0.1460	Unit Root	0.0887	0.1460	No UR	I (1)
12 Month-FD	0.2538	0.1460	Unit Root	0.1192	0.1460	No UR	I (1)
24 Month-FD	0.3079	0.1460	Unit Root	0.1169	0.1460	No UR	I (1)
Savings Deposit	0.2441	0.1460	Unit Root	0.1251	0.1460	No UR	I (1)
AWDR	0.1568	0.1460	Unit Root	0.1062	0.1460	No UR	I (1)
Bank Lending Rates							
LSECIMPR	0.2218	0.1460	Unit Root	0.1300	0.1460	No UR	I (1)
LSECOTH	0.1607	0.1460	Unit Root	0.0663	0.1460	No UR	I (1)
LUSEC	0.2980	0.1460	Unit Root	0.0806	0.1460	No UR	I (1)
AWPLR	0.2088	0.1460	Unit Root	0.0937	0.1460	No UR	I (1)

Since all the variables are I (1), it is possible to see whether they are cointegrated. If the variables are not cointegrated, it is not possible to examine the long-run relationships as it could be a spurious relationship.

6.2 Testing for Cointegration

Since all money market and bank interest rates are considered as I (1), cointegration analyses were conducted based on both CRDW Test and Johansen procedure to examine whether there is a long-run relationship among the IBCMR and other variables.

Accordingly, the results of CRDW test are given in Table 6.3.

Table 6.3: Summary of the CRDW Test Results

Bank Lending Rate	DW Statistic	Critical Value at 5%	Conclusion
3FD c IBCMR	0.5647	0.200	Cointegrated
6FD c IBCMR	0.3340	0.200	Cointegrated
12FD c IBCMR	0.2452	0.200	Cointegrated
24FD c IBCMR	0.3612	0.200	Cointegrated
SD c IBCMR	0.9764	0.200	Cointegrated
AWDR c IBCMR	0.2032	0.200	Cointegrated
Bank Deposit Rates			
LSECIMPR c IBCMR	0.2579	0.200	Cointegrated
LSECOTH c IBCMR	0.5212	0.200	Cointegrated
LUNSEC c IBCMR	0.2886	0.200	Cointegrated
AWPLR c IBCMR	0.9821	0.200	Cointegrated

The CRDW test results suggest that all the pairs of variables (IBCMR with other variables) are cointegrated. The rank of the cointegration relation is one as there are only two variables in each test. The Johansen cointegration test with maximum eigenvalue and trace statistics are also conducted to examine these results (Table 6.4 and Table 6.5 respectively).

These tests confirm the above results of CRDW test except for two variables at 10 per cent significant level. Johansen Test-Maximum Eigen value does not conclude that there is a cointegration relationship between IBCMR with AWDR and LUNSEC. However, Johansen test-Trace Statistics concludes all the variables are cointegrated with IBCMR except LUNSEC. However, since CRDW concludes that all the variables are cointegrated with IBCMR, I consider that result for further analysis.

Table 6.4: Summary of the Johansen Test Procedure with Maximum Eigen Value

Variables Tested	Hypothsis (H0: r=r*; H1:r>r*)	Max-Eigenvalue	P-value	Decision	Conclusion
Bank Deposit Rates					
3FD & IBCMR	H0: r=0	16.981	0.018	Reject H0	Cointegrated
	H0: r<=1		0.074	Do not Reject H0*	
6FD & IBCMR	H0: r=0	22.940	0.002	Reject H0	Cointegrated
	H0: r<=1		0.018	Do not Reject H0**	
12FD & IBCMR	H0: r=0	12.841	0.083	Reject H0	Cointegrated
	H0: r<=1		0.023	Do not Reject H0**	
24FD & IBCMR	H0: r=0	24.355	0.001	Reject H0	Cointegrated
	H0: r<=1		0.047	Do not Reject H0**	
SD & IBCMR	H0: r=0	32.411	0.000	Reject H0	Cointegrated
	H0: r<=1		0.086	Do not Reject H0*	
AWDR & IBCMR	H0: r=0	12.222	0.103	Do not Reject H0	Not Cointegrated
Bank Lending Rates					
LSECIMPR & IBCMR	H0: r=0	15.496	0.032	Reject H0	Cointegrated
	H0: r<=1		0.065	Do not Reject H0*	
LSECOTH & IBCMR	H0: r=0	22.573	0.002	Reject H0	Cointegrated
	H0: r<=1		0.172	Do not Reject H0*	
LUSEC & IBCMR	H0: r=0	8.038	0.375	Do not Reject	Not Cointegrated
AWPLR & IBCMR	H0: r=0	24.221	0.001	Reject H0	Cointegrated
	H0: r<=1		0.091	Do not Reject H0*	

Table 6.5: Summary of the Johansen Test Procedure with Trace Statistics

Variables Tested	Hypothsis (H0: r=r*; H1:r=r*+1)	Trace Statistics	P-value	Decision	Conclusion
Bank Deposit Rates					
3FD & IBCMR	H0: r=0	20.167	0.009	Reject H0	Cointegrated
	H0: r=1		0.074	Do not Reject H0*	
6FD & IBCMR	H0: r=0	28.506	0.000	Reject H0	Cointegrated
	H0: r=1		0.018	Do not Reject H0**	
12FD & IBCMR	H0: r=0	17.982	0.021	Reject H0	Cointegrated
	H0: r=1		0.023	Do not Reject H0**	
24FD & IBCMR	H0: r=0	28.287	0.000	Reject H0	Cointegrated
	H0: r=1		0.047	Do not Reject H0**	
SD & IBCMR	H0: r=0	35.355	0.000	Reject H0	Cointegrated
	H0: r=1		0.086	Do not Reject H0*	
AWDR & IBCMR	H0: r=0	17.037	0.029	Reject H0	Cointegrated
	H0: r=1		0.028	Do not Reject H0**	
Bank Lending Rates					
LSECIMPR & IBCMR	H0: r=0	18.903	0.015	Reject H0	Cointegrated
	H0: r=1		0.065	Do not Reject H0*	
LSECOTH & IBCMR	H0: r=0	24.437	0.002	Reject H0	Cointegrated
	H0: r=1		0.172	Do not Reject H0*	
LUSEC & IBCMR	H0: r=0	12.067	0.154	Do not Reject H0	Not Cointegrated
AWPLR & IBCMR	H0: r=0	27.074	0.001	Reject H0	Cointegrated
	H0: r=1		0.091	Do not Reject H0*	

* Cointegrated at 5 p.c. level
** Cointegrated at 1 p.c. level

Although there are some exceptions, the above cointegration tests suggest it is reasonable to conclude that there is a long-run relationship among inter-bank call money rates and interest rate on commercial bank deposit and lending rates.

6.3 Long-run Relationship among Inter-bank Call Money Market Rates and other Rates

The long-run relationship is examined using a regression analysis among each pair of variables, as I consider that all the pairs of variables are cointegrated. In this analysis, I use generalized method of moments (GMM) to account for potential endogeneity, heteroskedasticity, and autocorrelation. Table 6.6 shows the results of the regressions.

Table 6.6: Long-run Relationship among Variables

Bank Interest Rates	Mark up (α0)	Pass-through (α1)	Average
Deposit Rates			
3MFD	0.67	0.92	0.86 (Avg. Of FDs)
6MFD	0.94	0.78	
12MFD	1.80	0.75	
24MFD	0.21	0.99	
SD	0.10	0.06	
AWDR	1.04	0.06	
Lending Rates			
LSECIMPR	12.03	0.50	0.42
LSECOTH	14.99	0.36	
LUNSEC	15.84	0.39	
AWPLR	0.22	1.18	

Where the coefficients of α0 and α1 are given by the following long-run relationship:

$$r_t^b = \alpha_0 + \alpha_1 IBCMR_t + \varepsilon_t$$

and are estimated by GMM.

Long-run pass-through is equal to one if the pass through to demand for deposits or loans is one for one. According to Table 6.6, average pass through for fixed deposit rates is as high as 0.86. However, the pass-through is almost nil (0.06) for savings rates and AWDR. This is expected as the savings rate is almost a fixed rate in Sri Lanka which does not change frequently. The AWDR is the weighted average rate of all outstanding interest bearing deposits of commercial banks and the corresponding interest rates on the deposit. Therefore, it cannot reflect a clear picture of deposit rates.

Conversely, bottom panel of Table 6.6 shows that pass-through to the loan rates is much lower compared to the deposit rates. On average, the pass-through rate to loan rates is 0.42, which is almost one half of the deposit rate. In this case also, AWPLR is different, the pass-through is more than 100 per cent. This shows that prime lending rate is mostly affected by the changes of money market rates in Sri Lanka.

According to Table 6.6 the pass-through is below one for almost all interest rates showing that markets are imperfect in the sense information asymmetries. Further, information switching costs may also be a factor for low pass-through. However, the banks have better information of their prime lenders and the pass-through of AWPLR is greater than 1.

6.4 Short-Run Dynamics

Table 6.7: Bi-Variate Error Correction Model- Testing for Short-run Dynamics

Variables	Short-term Pass-through (δ)	Error Correction Adjustment (ϱ)	Average
Deposit Rates			
3FD	-0.140868	-0.124876	
6FD	-0.131177	-0.106086	
12FD	-0.143148	-0.065836	
24FD	-0.035269	-0.092424	
SD	0.012663	-0.201772	
AWDR	0.390581	-0.032646	-0.10394
Lending Rates			
LSECIMPR	-0.203323	-0.108224	
LSECOTH	0.122985	-0.211577	
LUNSEC	-0.153851	-0.079621	
AWPLR	0.068714	-0.183556	-0.14574

Where δ and ϱ are given by following error correction model:

$$\Delta \text{(Bank retail rate)} = \mu + \varrho \text{ (Bank retail rate}_{t-1} - \alpha_0 - \alpha_1 \text{call money market rate}_{t-1})$$

$$+ \delta \Delta \text{ call money market rate}_{t-1} + \varepsilon_t$$

All the estimates of the error correction adjustment are negative, which means that the retail rates exhibit mean reversion to the long-run equilibrium. On average, short-run adjustment speed of deposit rates is less compared with the lending rates. Further, the short-run adjustment speed is higher for shorter maturities.

6.5 Asymmetry in Pass-through

The results of the empirically evaluated asymmetric model are given in Table 6.8.

Table 6.8: Asymmetric Model of Short-Run Dynamics

Bank Interest Rates	δ1	δ2	δ3	AML+	AML-	Wald Test (p-value)
Deposit Rates						
3MFD	0.05	-0.18	-0.15	-5.30	-6.21	0.90
6MFD	0.03	-0.15	-0.10	-6.47	-9.83	0.78
12MFD	0.01	-0.11	-0.13	-8.83	-7.58	0.59
24MFD	0.00	-0.32	0.09	-3.12	11.57	0.05
SD	0.00	-0.24	-0.08	-4.24	-13.18	0.45
AWDR	0.00	0.46	0.13	2.19	7.56	0.18
Lending Rtaes						
LSECIMPR	0.02	-0.35	-0.28	-2.85	-3.46	0.75
LSECOTH	-0.01	-0.13	-0.06	-7.59	-18.43	0.69
LUNSEC	0.06	-0.15	-0.26	-6.47	-3.57	0.57
AWPLR	0.13	-0.12	0.03	-7.02	27.71	0.46

Note: The model is given by the following equation:

$$\Delta(r^b_t) = \delta_0 + \delta_1 \Delta \text{IBCMR}_{t-1} + \delta_2 \varsigma (\varepsilon'_{t-1}) + \delta_2 (1-\varsigma) (\varepsilon'_{t-1}) + \nu_t \; ; \text{AML}^+ = (1-\delta_1)/\delta_2 \; ; \text{AML}^- = (1-\delta_1)/\delta_3.$$

The Wald test confirms that there is no asymmetric effect of monetary policy tightening or easing on interest pass-through for all the interest rates apart from twenty four month fixed deposit rate.

7 Conclusion

An efficient transmission of monetary policy impulses to the retail interest rates of the economy is undeniably important to achieve the ultimate goals of monetary policy. Sri Lanka is mainly a bank funded economy. Therefore, bank retail rates on lending and deposits have the ability to influence major economic activities such as investment and consumption. While most of the assets of the banking sector are loans, the liabilities of banks are mainly deposits. Therefore, interest rate pass-through from money market rates to lending and deposit rates of commercial banks are essential to understand the MTM of the country. This study attempts to understand the essential component of MTM in Sri Lanka. In this regard,

Error Correction Mechanism is used in the current study as the main technique to analyse the interest rate pass through mechanism empirically. The data is during the 10 years period from 2003 to 2013.

The key conclusion is that, in general, there is no one for one interest rate pass-through to the long-run commercial bank rates from the money market rate. Nevertheless, there is a sizable pass-through in the long-run to fixed deposit rates. In contrast, the long-run pass-through is not satisfactory with regard to retail loan interest rates. All the variables; the considered deposit and lending rates showed a significant long-run relationship with interbank call money market rates.

In the short-run, bank retail rates that deviated from the equilibrium were adjusted to their equilibrium levels in the long-run. Also it was found that, on average, short-run adjustment speed of deposit rates is less compared with the lending rates. Further, the short-run adjustment speed is higher for shorter maturities.

It was also found that there is no asymmetric effect of monetary policy tightening or easing on interest pass-through for all the interest rates apart from twenty four month fixed deposit rate in Sri Lanka.

7.1 Policy Recommendations

According to the current analysis, although long-run interest pass-through is satisfactory with deposit rates, it is not the case for loan rates. However, loan rates are the most influential to the aggregate demand. Therefore, to conduct the monetary policy successfully, the impact of monetary policy impulses should be satisfactory with regard to loan rates. Therefore, the CBSL should consider ways and means of affecting loan interest rates effectively in the long run. One suggestion to achieve this task is to consider regulatory measures to impose maximum and minimum loan rates based on the official policy rate. However, this recommendation is subject to further studies with more compatible data as this study was based on the middle rates of bank deposits and loans.

7.2 Limitations of the Study

This analysis was conducted using monthly data from 2003. This is due to the introduction of active OMO process in Sri Lanka in 2003. However, it would have been more satisfactory to conduct a comparison of interest rate pass-through before and after the introduction of active OMO process. It was impossible to conduct such a comparison due to the unavailability of monthly data before 2003.

Further, most of the retail interest rates on loans and deposits were middle rates as there were no average rates found for them. If monthly average rates were available it would have given a much better idea of the retail rate behaviour of the commercial banking sector.

7.3 Directions for Further Research

This study opened up several areas for further research. Firstly, the study did not pay special attention to the determinants of interest rate pass-through in Sri Lanka. For example, it is found in the literature that the level of non-performing loans is an influential factor in the determination of interest rate pass-through to bank retail rates. The annual periodical of CBSL, Financial System Stability Review -2013 states that "Banks in Sri Lanka are facing relatively higher credit risk as indicated by the rising non-performing loans (NPLs)". Studying the effect of nonperforming loans on the pass-through process is therefore relevant. It is also worth conducting a study to identify the specific factors that determine the interest rate pass through in the Sri Lankan economy as well as factors that can limit the impact of monetary policy on bank retail rates.

Further, the banking sector is highly concentrated in Sri Lanka as six major banks have a systematically important role in the Sri Lankan financial market. This could have an impact on the interest rate pass-through in Sri Lanka. Therefore, it may be useful to study the determinants of interest rates pass-through in the Sri Lankan context. Also, the Sri Lankan commercial banking sector consists of states banks as well as private banks. A study can be conducted to measure the response of retail bank interest rates to changes in monetary policy rates in these two sectors separately.

Further, this study did not consider the behaviour of retail interest rates of LSBs in Sri Lanka. This study only considered the impact on interest rates in LCBs. However, the total banking sector includes both the LCBs and the LSBs. More importantly, the LSBs play an increasingly important role in the Sri Lankan banking sector. Therefore, considering retail rates of LSBs would give a better understanding of the interest rate pass-through process.

References

Amarasekara, C 2005, "Interest Rate Pass-through in Sri Lanka", Staff Studies, Vol. 35, Central Bank of Sri Lanka.

—— 2008, "The Impact of Monetary Policy on Economic Growth and Inflation in Sri Lanka", Staff Studies, Vol. 38, Central Bank of Sri Lanka.

Aziakpono, MJ & Wilson, MK 2010, "Interest Rate Pass-Through and Monetary Policy Regimes in South Africa", Paper for presentation at the CSAE Conference, 21-23 March 2010, Oxford University, UK.

Berstein, J S & Fuentes S, R 2003, "From Policy Rates to Bank Lending Rates: The Chilean Banking Industry.", Economia Chilena, vol. 6, no. 1, pp. 49-67.

Brock, P L & L Rojas-Suarez 2000, "Understanding the Behavior of Bank Spreads in Latin America," Journal of Development Economics, Vol. 63, pp. 113–34.

Burgstaller, J 2003, "Interest Rate Transmission to Commercial Credit Rates in Austria", Economics Working Papers, Johannes Kepler University, Linz, Austria.

CBSL Annual Reports, 2000, 2002, 2011, 2013 and 2014, Central Bank of Sri lanka.

CBSL 2014, Central Bank of Sri Lanka Web Site, <Available Online: www.cbsl.gov.lk: [Date Accessed 10-01-2013].

Cevik, S & Teksoz, K 2012, "Lost in Transmission? The Effectiveness of Monetary Transmission Channels in the GCC Countries", IMF Working Paper/12/191.

Coricelli, F, Egert, B, & MacDonald, R 2006, "Monetary Transmission Mechanism in Central and Eastern Europe: Surveying the Empirical Evidence", In Finance and Consumption Conference, European University Institute.

Cottarelli, C & Kourelis, A 1994, "Financial Structure, Bank Lending Rates, and the Transmission Mechanism of Monetary Policy", IMF Staff Paper 41.

Crespo-Cuaresma, J, Egert, B & Reininger T 2006, "Interest Rate Pass Through in Central and Eastern Europe: Reborn from Ashes Merely to Pass Away", Oesterreichische Nationalbank, Focus on Europen Economic Integration No. 1.

De Bondt, G 2002, "Retail Bank Interest rate Pass-through: New evidence at the Euro Area Level", European Central Bank, Working Paper Series, vol. Working Paper no.136.

De Bondt 2005, "Interest Rate Pass-through: Empirical Results for the Euro Area", German Economic Review, vol. 6, no. 1, pp. 37-78.

Donnay, MHD 2001, "Bank Lending Rate Pass-Through and Differences in the Transmission of a Single EMU Monetary Policy", Discussion Paper No. 0117, Katholicke Universiteit Leuven Center for Economic Studies.

Espinosa-Vega, M & Rebucci, A 2003, "Retail Bank Interest Rate Pass-through: is Chile Atypical", Central Bank of Chile Working Paper, no. 221.

Financial System Stability Review, 2013, The Central Bank of Sri Lanka.

Gambacorta, L & Iannotti, S 2007, "Are there asymmetries in the response of bank interest rates to monetary shocks?", Applied economics, vol. 39, no. 19, pp. 2503-17.

Gigineishvili, N. 2011, "Determinants of interest rate pass-through: Do macroeconomic conditions and financial market structure matter?", IMF Working Papers, International Monetary Fund, no. 11/176, pp.16.

Hannan, T & Berger, A 1991, "The Rigidity of Prices: Evidence from the Banking Industry." American Economic Review, 81:938-945.

Hefferman, S A 1997, "Modelling British Interest Rate Adjustment: An Error Correction Approach", Economica, Volume 64, Issue 254, pages 211–231.

Heinemann, F & Schuler, M 2002, "Integration Benefits on EU Retail Credit Markets—Evidence from Interest Rate Pass-Through."", ZEW Discussion Paper no. 02-26.

Hofmann, B 2003, "EMU and the Transmission of Monetary Policy: Evidence from Business Lending Rates", ZEI University of Bonn.

Ireland, P N 2005, "The Monetary Transmission Mechanism", Federal Reserve Bank of Boston, Working Paper, no. 06-1.

—— 2006, 'Inflation Targeting & Central Bank Independence - New Directions for Sri Lanka's Monetary Policy?', *Sri Lanka Economic Journal Vol.7 No. 1 & 2. , pp. 65-90.*

Kobayashi, T 2008, "Incomplete Interest Rate Pass-Through and Optimal Monetary Policy," International Journal of Central Banking, Vol 4(3), pp 77-118.

Liu, MH, Margaritis, D & Tourani-Rad, A 2011, "Asymmetric Information and Price Competition in Small Business Lendin", *Journal of Banking and Finance.*

Mishkin, F 2013, "The economics of money, banking, and financial markets", Pearson, Harlow.

Mojon, B 2000, "Financial Structure and the Interest Rate Channel of ECB Monetary Policy", ECB Working Paper no. 40.

Neumark, D & Sharpe, S A 1992. "Market Structure and the Nature of Price Rigidity: Evidence from the Market for Consumer Deposits." Quarterly Journal of Economics, 107(2), pp. 657-680.

Peek, J & Rosengren, E S 2013, "The Role of Banks in the Transmission of Monetary Policy", Public Policy Discussion Papers, Federal Reserve Bank of Boston, no. 13-5.

Sander, H & Kleimeier, S 2004, "Convergence in Euro-Zone Retail Banking? What Interest Rate Pass-Through Tells Us about Monetary Policy Transmission, Competition and Integration", Journal of International Money and Finance, vol. 23 (3): 461–92.

Scholnick, B 1996, 'Asymmetric adjustment of commercial bank interest rates: Evidence from Malaysia and Singapore', Journal of International Money and Finance 15, 485–496.

Sengupta, N 2013, "Interest Rate Pass-Through in India", Macroeconomic and Finanace in emerging Market Economies.

Sorensen, C K & Werner, T 2006, "Bank Interest Rate Pass-Thorough in the Euro Area: A Cross Country Comparison", European Central Bank, Working Paper Series, no. 580.

Stiglitz, J & Weiss, A 1981 "Credit Rationing in the Markets with Imperfect Information", American Economic Review, no.71, pp. 393-410.

Stock, JH & Watson, MW 2001, "Vector Autoregressions", The journal of economic perspectives, vol. 15, no. 4, pp. 101-15.

Tai, PN, Sek, SK & Har, WM 2012, "nterest rate pass-through and monetary transmission in Asia", International journal of economics and finance, vol. 4, no. 2, pp. 163-74.

Taylor, JB 1995, "The Monetary Transmission Mechanism: An Empirical Framework", The journal of economic perspectives, vol. 9, no. 4, pp. 11-26.

Thenuwara, HN 1998, "The Scope for Inflation Targeting in Sri Lanka; a Focus on Transmission Mechanism", Staff Studies, Vols 27-28, Central Bank of Sri Lanka.

Toolsema, LA, Turm, J & J, DH 2001, "Convergence of Monetary Transmission in EMU: New Evidence", CESifo Working Paper no. 465.

Valadkhani, A & Anwer, S 2012, "Interest rate pass through and the asymmetric relationship between the cash rate and the mortgage rate", The Economic Record, University of Wollongon, vol. 88 (282), , pp. 341-50.

Winker, P 1999, "Sluggish Adjustment of Interest Rates and Credit Rationing: an Application of Unit Root Testing and Error Correction Modelling", Applied Economics Journal, 31, pp. 267-277.

Zulkhibri, M 2012, "Policy rate pass-through and the adjustment of retail interest rates: Empirical evidence from Malaysian financial institutions", Journal of Asian Economics, vol. 23, no. 4, pp. 409-22.

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