The Transition from Exchange Rate Targeting: The Case of Sri Lanka [*] [†]

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Abstract

This paper uses an elemental macro model to quantify the effect of a range of alternative Sri Lankan monetary policy regimes to which its transition from exchange rate targeting might be directed. Faced with a variety of supply, demand and external shocks, the inflation targeting regime is shown to offer lower macro-economic volatility than the alternatives, most strongly under demand and external shocks. This is notwithstanding the sensitivity of real purchasing power to inflation targets, even where employment is stabilised. Consistent with Mundell's financial trilemma, the increase in Sri Lanka's financial integration after 2012 is shown to have made external shocks more prominent, further supporting the transition to inflation anchored monetary policy framework.

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1 Introduction

Monetary authorities are constrained in their choice between targeting exchange rates and the independence that is implied by the variety of alternative targets. This is because outcomes depend on the levels of current and capital account openness and financial maturity (Mundell 1961, McKinnon 1963, Kenen 1969).[1] Prior to the 1990s, monetary authorities in developing and emerging economies mostly maintained fixed exchange rate regimes against the US$ as nominal anchors. This depended on the belief that exchange rate stability is essential for promoting trade and investment (Edwards 1996, Calvo & Vegh 1999, Bleany & Fielding 2002, Ghosh et al. 2003, Husain et al. 2005, Tamgac 2013).

Financial globalisation has made those regimes increasingly difficult to sustain as governments in these economies have come under pressure to liberalise their capital accounts.[2] After the Asian Financial Crisis (AFC, 1997-98) and the Argentine crisis (2001-02) the International Monetary Fund (IMF) supported inflation targeting (IT); which it claimed to be the best stabiliser of domestic prices and so would reduce the risk of disruptions to external balance and financial stability (International Monetary Fund 2006).[3] Considerable empirical evidence has since come available that stabilising the domestic price level via IT regimes has facilitated a record low level of macroeconomic volatility in adopting developing and transitional economies (Goncalvez & Salles 2008, Lin & Ye 2009, Anan et al. 2011).

This empirical evidence notwithstanding, a much more limited set of studies have offered quantitative comparisons between alternative targets, including those not adopted, particularly for developing and transitional economies. McKibbin & Singh (2003), Frankel et al. (2008) and Bhandari & Frankei (2015) all demonstrate, for example, that targeting nominal GDP could be more helpful in these economies to balance the conflicting policy goals of stability and sustainable economic growth. It has even been

[1] For surveys of this literature see Tavlas (1993), Frankel (1999), De Grauwe (2007) and Rose (2011).

[2] See Devereux (2004), Edwards & Levy-Yeyati (2005), Combes & Plane (2012) and Mathur & Subramanian (2016).

[3] The appropriateness of adopt IT regime in these economies have also previopusly discussed by Masson et al. (1997), Amato & Gerlach (2002) and Mishkin (2004).

shown that monetary aggregate targeting has proved flexible in practice and rigid adherence to an exchange rate or inflation target has not been necessary to obtain good inflation outcomes (Mishkin & Savastano 2001, Gebregiorgis & Handa 2005). Meanwhile, Moura & De Carvalho (2010) and Beju & Ciupac-Ulici (2015) show that the Taylor-type monetary policy rule (Taylor 1993) is most effective in developing economies at reducing social loss defined over inflation and output variance.

A central concern in evaluating transitions in capital account openness and targeting regimes is Mundell's (1963) financial trilemma[4], which states that a country may simultaneously choose any two, but not all three of the following policy goals - monetary independence, exchange rate stability and financial integration. Associated empirical verifications include those by Obstfeld et al. (2005, 2010), Aizenman et al. (2008, 2010a, 2011, 2016), Hutchison et al. (2012) and Aizenman & Sengupta (2013). These reinforce the importance of the choice of Sri Lanka's monetary target given its increasing financial openness.

The purpose of this paper is to supplement the literature on the evaluation of alternative monetary policy regimes for the case of Sri Lanka. This is done by simulating the responses of the Sri Lankan economy to stylised combinations of demand, supply and external shocks under alternative monetary policy targeting regimes. An elemental macro model is formulated and subjected to these shocks, which are constructed from historical records and applied in combinations that elucidate extreme cases, thus setting bounds on the associated levels of volatility. Additionally, by further examining historical data, Sri Lanka's performance against the financial trilemma is assessed over the course of its monetary policy targeting regime transitions.

The remainder of the paper is organized as follows: Section 2 summarises the key transitions in Sri Lanka's monetary policy framework; Section 3 outlines the macro model employed; Section 4 describes the construction of one standard deviation shocks; Section 5 presents the numerical results obtained; Section 6 formulates and assesses the trilemma in Sri Lanka. Conclusions are outlined in the final section.

[4]Mundell's trilemma is also known as the "impossible trinity".

2 Monetary Policy Framework in Sri Lanka

Sri Lanka's monetary policy has made a number of regime transitions over the past seven decades. At the time of independence in 1948, the Sri Lankan currency was issued and managed by the Currency Board System, hard-pegged to the pound sterling. This system was replaced in 1950 by a central banking model, embodied in the Central Bank of Ceylon (CBC), though the exchange rate remained to central policy target in accord with the Bretton Woods Agreement.[5] In the mid-1960s, the country faced a balance of payment (BOP) crisis and, in 1968; the CBC introduced the Foreign Exchange Entitlement Certificate System of dual exchange rates, to tax outflows so as to restore external balance while retaining the exchange rate target (Central Bank of Sri Lanka 2006). In 1977, the country moved from a dual exchange rate regime to a managed float with a crawling band (hereafter, managed float) as part of its trade liberalization and financial market reform process (Athukorala & Jayasooriya 1994, Athukorala & Rajapatirana 2000, Athukorala et al. 2011). This set the stage for the CBSL to move away from direct controls towards more market-oriented instruments in monetary policy management.

In early 1980s, the CBSL formally adopted a monetary targeting policy framework for monetary management directed at maintaining reserve money, the Central Bank's operating target, at a level that is consistent with the desired growth of broad money, the Central Bank's intermediate target. Financial flows both into and out of the Sri Lankan economy have risen gradually after the 1990s, with the relaxation of restrictions on foreign investment in the stock market, the privatisation of State-owned Enterprises (SOEs) and foreign loan inflows to the SOEs. The CBSL took a landmark step on 23 January 2001, in allowing the exchange rate to be determined by market conditions, albeit with the customary reserve power to intervene. Prior to this float the exchange rate had played a key role in fixing inflation expectations. The liberalising financial environment had challenged the monetary targeting regime, however, since a strong

[5]The CBC was established under the Monetary Law Act No. 58 of 1949 (MLA) with the following objectives: 1) to stabilise the home price level and the exchange rate, 2) the promotion of high levels of production, employment and real income, and more generally, 3) the advancement of full utilisation of Sri Lankas resources. In 1985, the CBC was renamed as the Central Bank of Sri Lanka (CBSL) and these objectives were streamlined through an amendment of the MLA in 2002, which emphasised price and financial stability.

relationship between the money supply and inflation appeared not to develop, due to rising volatility in the money multiplier and velocity. This has complicated the targeting and communication strategies of many central banks in developing countries, leading to the more widespread adoption of IT Central Bank of Sri Lanka (2015). At present, as an interim arrangement, the CBSL employs an enhanced monetary policy framework with features of both monetary targeting and flexible IT, aiming toward fully-fledged IT in the future. In Sri Lanka's case the transitions are summarised in Table 1.

Table 1: Evolution of Monetary and Financial Framework in Sri Lanka

Period	**Measures or Actions**
Pre 1977	Fixed exchange rate regime
1977	Introduced open economic policy Established managed floating exchange rate regime
1980s	Established monetary targeting framework
1991	Liberalised trade and payment systems
1992	Granted approval for foreign residents to purchase 100 per cent of the issued share capital in the listed companies subject to certain eliminations and boundaries
1993	Fully liberalized current account transactions
1994	Started gradually liberalize capital account transactions
2001	Established floating exchange rate regime
2003	Established more "active" open market operation (OMO) from "passive" OMO
2006	Opened the T-bond market to foreign investors
2007	Started to issue sovereign bonds to the international markets
2008	Opened the T-bill market to foreign investors
2012	The Central Bank decided to limit its intervention in the domestic foreign exchange market
2013	Allowed non-bank financial institutions to accept foreign currency deposits
2015	Allowed the exchange rate to be determined by the market conditions Established monetary policy framework with features of both monetary targeting and IT frameworks

Source: Central Bank of Sri Lanka (1998, 2000, 2006, 2009, 2015)
Ministry of Finance - Sri Lanka (2000, 2015)

3 Modelling Shocks and the Monetary Policy Transition

There is a long tradition in applying economy-wide models to analyse policy issues in Sri Lanka.[6] De Melo (1978) formulated the first such model of the Sri Lankan economy,

[6]See the review by Bandara (1991).

based on a Social Accounting Matrix (SAM) compiled by Pyatt & Roe (1977) for the year 1970.[7] The focus of most such modelling, however, has been on trade liberalisation[8], links between trade policy and poverty[9], income distribution[10], and the role of tourism in post-war development[11]. There is, however, no study applying analysis of this type to macro-economic responses to the alternatives under consideration in the current monetary policy transition.

Here we introduce an elemental macro model for this purpose.[12] The objective is, first, to use the model to calculate the effects of a variety of supply, demand and external shocks, constructed based on historical volatility, under the exchange rate targeting regime. Imposing these positively and negatively, and in combination, allows us to form bounds on the effects of these shocks. The "best case" and "worst case" combinations of these shocks are then imposed under alternative monetary policy targeting regimes to evaluate each regarding the volatility it allows. To calculate size of the individual variables one-standard deviation shocks, we have considered cross correlations between variables based on the correlation matrix, $R(\underline{\nu})$ and variance-covariance matrix, $\Sigma(\underline{\nu})$, which is more descriptively describe in Section 4. The model is of the Mundell (1963)-Fleming (1962) type with a Keynesian supply side and reduced form consumption behaviour, with exogenous expectations over prices, the exchange rate, the financing interest rate and the investment yield.[13]

3.1 The Model

The markets for two products (aggregated goods and services, differentiated as home and foreign produced) are represented, along with three primary factors (production labour, L, skill, S_K, and capital, K). Production is Cobb-Douglas in the factors,

[7] This model was used to analyse the repercussions of designated agricultural policies on the Sri Lankan economy (De Melo 1979) and, subsequently, the consequences of growth strategies (De Melo 1982).

[8] See Bandara & Coxhead (1999), Somaratne (2000), Liyanaarachchi et al. (2014).

[9] See Naranpanawa et al. (2011) and Liyanaarachchi et al. (2016).

[10] See Perera et al. (2014).

[11] See Fernando et al. (2013b).

[12] Progenitors include Tyers (2001, 2015, 2016), Rees & Tyers (2004) and Azwar & Tyers (2015).

[13] While there is a growing literature applying "new Keynesian" models to transition mechanisms, we believe the assumed Keynesian supply side best suits the applications in this paper. The new Keynesian literature includes the contributions by Patra & Kapur (2012), Yasmin (2012), Airaudo et al. (2015) and Gozgor (2015).

and real consumption depends on current levels and expectations over the consumer price level, P_C, the exchange rate, E, the financing rate, r, and nominal disposable income, Y_D. Model closures define labour market clearance, fiscal balance and the target of monetary policy. The money market is represented conventionally, except that inflation expectations are explicit. The Central Bank adjusts the money supply endogenously so as to target either the exchange rate, E, the monetary base, $\mathrm{M_B}$, the level of nominal GDP, $\mathrm{Y_N}$, the consumer price level, P_C (which embodies inflation over a base value - IT) or a Taylor-type monetary policy target, $\mathrm{T_R}$, that combines output, the interest rate and inflation.

The simulated economy is not in a steady state, and so the expected rates of return that drive investments need not equal the real equilibrium rates of return on installed capital in the simulated financial market.

3.1.1 The Supply Side

Output volume, y, is Cobb-Douglas in the three above mentioned primary factors and total factor productivity, A, so that the production of local goods and the local marginal product of capital are:

$$y = A(1+\nu_1)L^{\beta_L}[S_K(1+\nu_2)]^{\beta_{S_K}}[K(1+\nu_3)]^{\beta_K} \tag{1}$$

where $\beta_L + \beta_{S_K} + \beta_K = 1$, and $\nu_{1-3} \sim N(0, \sigma^2_{1-3})$ are supply side shocks with standard deviation σ_i. The marginal products are conventionally derived, that for capital being:

$$MP_K = \beta_K \frac{y}{K(1+\nu_3)} = \left[A(1+\nu_1)\beta_K[S_K(1+\nu_2)]^{\beta_{S_K}}[K(1+\nu_3)]^{\beta_K - 1}\right]L^{\beta_L} \tag{2}$$

The realised rate of return on installed capital, r_c, is then the ratio of the value of the marginal product of capital, $P_P MP_K$, and the price of capital goods net of depreciation. If the producer price level is P_P and P_K is the corresponding price of capital goods, the ratio of these can be applied to (2) to obtain a gross rate of return. Since only a single home good is modelled, the two prices are linked exogenously via a constant ratio, θ ($=P_P/P_K$), which can be shocked to represent differences in the trend of capital and final goods cost of production.

$$r_c = \frac{P_P MP_K}{P_K} - \delta = \theta MP_K - \delta, \tag{3}$$

where δ is the depreciation rate. Recall, from above, that the simulated economy is not in a steady state and so, in general, this net return does not equal the real financing rate, r ($r_c \neq r$).[14]

The product real wages of low-skill, w, and high-skill, w_S, workers depend on the corresponding marginal products, evaluated at the producer price level.

$$w = \frac{W}{P_P} = MP_L = \beta_L \frac{y}{L} \quad \text{and} \quad w_S = \frac{W_S}{P_P} = MP_{S_K} = \beta_{S_K} \frac{y}{S_K(1+\nu_2)} \tag{4}$$

The unemployment rate (u) is calculated for all workers, where the labour force is F.

$$u = \frac{F - S_K(1+\nu_2) - L}{F} \tag{5}$$

3.1.2 The Demand Side

Both direct and indirect tax revenues, $T^D$and T^I, respectively, play key roles in the formulation. GDP at factor cost (or producer prices), Y^{FC}, is the total of direct payments to the collective household in return for the use of its factors. Nominal GDP is then:

$$Y = Y^{FC} + T^I, \quad Y^{FC} = C + T^D + S^P \tag{6}$$

This is the standard disposal identity for GDP, or the collective household budget, where C is the total value of final consumption expenditure at consumer prices, including indirect taxes paid, and S^P is private saving. The GDP price, P_Y, and the producer price, P_P, would be the same were it not for indirect taxes. In their presence we have:

$$Y = P_Y y = Y^{FC} + T^I = P_P y + T^I, \quad \textit{so that} \quad P_Y = P_P + \frac{T^I}{y} \tag{7}$$

[14]Notably, this net rate of return is larger the larger is the quantity of effective labour to go with it. So the (expected) return from investment in new capital must also be larger the larger is the expected number of effective workers in employment.

Conventionally, overall balance on expenditure is constrained by

$$Y = C + I + G + X - M \tag{8}$$

where I is expenditure on investment, G is government spending on goods and services (net of transfers), X is export revenue (including export tax revenue), and M is the landed cost of imports (pre-tariff) in domestic currency.

Income tax: A constant marginal direct tax rate, t_W, is assumed to apply to all labour income, while the marginal tax rate on capital income is t_K. The corresponding "powers" of these rates are $\tau_W = (1 + t_W)$ and $\tau_W = (1 + t_K)$ and these appear in the coding of the model. There is no distinction between home goods and capital and no consumption tax is assumed to be applied to capital goods, so the capital goods price is P_P.

$$T^D = t_W[WL + W_S S_K(1 + \nu_2)] + t_K r_c P_P K(1 + \nu_3) \tag{9}$$

Capital income is taxed based on its measured net (of depreciation) rate of return, r_c, rather than the market interest rate, r. Indirect tax revenue, T^I, depends on consumption and trade and it will emerge later.

Consumption: Aggregate consumption, here volume, c, corresponding with expenditure, C, depends negatively on the real after-tax return on savings and positively on disposable money income. This is nominal GDP, $Y = P_Y y$, combined with net factor income from abroad, less direct tax:

$$Y_D = Y + \frac{N^F}{E} - T^D, \tag{10}$$

where N^F is nominal net factor income from abroad, which is set as constant in foreign currency and E is the nominal exchange rate in foreign currency per unit of home currency. Real consumption volume, c, depends positively on the present and expected future levels of disposable income, Y_D and Y_D^e, respectively, deflated by the corresponding consumer price level, which depends as indicated in (13) below, on the home producer price and the import price, marked up by the ad valorem consumption tax. Here, demand side shocks $\nu_{4-6} \sim N(0, \sigma_{4-6}^2)$ are included and C is current

consumption expenditure.

$$c = \frac{C}{P_C} = A^C(1+\nu_4)\left[\frac{r}{\tau_K}\right]^{-\varepsilon^{CR}}\left[\frac{Y_D}{P_C}\right]^{\varepsilon^{CY}}\left[\frac{Y_D^e(1+\nu_5)}{P_C[1+\pi^e(1+\nu_6)]}\right]^{\varepsilon^{CY}} \tag{11}$$

To capture the home household's substitution between home produced goods, which it consumes in volume c_H, and foreign goods, consumed as imports the real volume m, aggregate real consumption is a constant elasticity of substitution (α) composite of the two [15].

$$c = \left[\alpha_H c_H^{-\rho} + \alpha_M m^{-\rho}\right]^{-\frac{1}{\rho}} \tag{12}$$

The home household then solves the following problem for given aggregate consumption, c: choose c_H and m to minimise consumption expenditure [16];

$$P_C c = P_P(1+t_c)c_H + \frac{P^*(1+\nu_7)}{E}(1+t_M)(1+t_C)m = P_P\tau_C c_H + \frac{P^*(1+\nu_7)}{E}\tau_M\tau_c m \tag{13}$$

Here, the first external shock is introduced ($\nu_{7-9} \sim N(0, \sigma^2_{7-9})$), to the foreign price level, P^*: $\nu_7 \sim N(0, \sigma_7^2)$. To obtain the prices home consumers face, the volumes, c_H and m, are each multiplied by their respective domestic prices as augmented by the "powers" of the consumption tax and the import tariff, τ_c and τ_M, respectively. Note that the foreign price level is also the foreign currency price of foreign goods before any import tariff is paid.

Optimum consumption yields an elasticity of substitution between home goods and imports of $\sigma = 1/(1+\rho)$ and the initial expenditure shares of each in the composite of consumption are $s_H = \alpha_H^\sigma$ and $1 - s_H = \alpha_M^\sigma$. The volumes of the two product varieties consumed then depend on the "powers" of the consumption tax and import tariff and the prices:

$$c_H = s_H c\left[\frac{P_P\tau_C}{P_C}\right]^{-\sigma}, \quad m = (1-s_H)c\left[\frac{\frac{P^*(1+\nu_7)}{E}\tau_M\tau_C}{P_C}\right]^{-\sigma} \tag{14}$$

Given these consumption volumes, the composite price of all consumption emerges

[15] In (11), ε^{CR} is the elasticity of consumption to interest rate and ε^{CY} is elasticity of consumption to disposable income.

[16] In (12), ρ is the elasticity substitution between home goods and imports.

from the combination of (11), (12) and (13) as:

$$P_C = \tau_c \left[\alpha_H^{\sigma} P_P^{1-\sigma} + \alpha_M^{\sigma} \left\{ \frac{P^*(1+\nu_7)}{E} \tau_M \right\}^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \tag{15}$$

Private savings: This is the residual after direct tax and consumption expenditure (gross of consumption tax) are deducted from the nominal value of GNP, which includes both nominal GDP ($P_Y y$) and net factor income from abroad, N^F, set as constant in foreign currency. We can also expand the final term by substituting from (12), above:

$$S^P = P_Y y + \frac{N^F}{E} - T^D - P_C c = P_Y y + \frac{N^F}{E} - T^D - P_P \tau_C c_H - \frac{P^*(1+\nu_7)}{E} \tau_M \tau_C m \tag{16}$$

Indirect tax revenue, T^I: This includes that from import and export taxes:

$$T^M = t_M \frac{P^*(1+\nu_7)}{E} M = (\tau_M - 1) \frac{P^*(1+\nu_7)}{E} M \quad \text{and} \quad T^X = t_X P_P X = (\tau_X - 1) P_P X \tag{17}$$

and from a consumption tax, which is levied on both home goods and imports:

$$T^C = t_c P_P c_H + t_C \frac{P^*(1+\nu_7)}{E} (1+t_M) M = (\tau_c - 1) P_P c_H + (\tau_c - 1) \frac{P^*(1+\nu_7)}{E} \tau_M M \tag{18}$$

Government (including central bank) revenue: This is government revenue less the sum of government expenditure and the annual increment to the holdings of official foreign reserves. So the dollar value of government savings is then:

$$S^G = T^D + T^C + T^M + T^X - P_P G - \Delta R \tag{19}$$

To simplify the demand side, government spending is assumed to be directed only at home goods free of consumption tax, whose home price is P_P. Domestic savings (S^D) then depends on the (value) sum of private and government savings in the home economy.

Capital and financial account flows: On the inflow side, these are associated with acquisitions of home assets by foreigners, while on the outflow side; they represent acquisitions of foreign assets by home residents. These flows are assumed to depend on the extent of the departure from uncovered interest parity, which links the yield

from the collective home portfolio to the yield required by those abroad to invest in the home economy. This link is based on changes in a parity ratio, λ, that depends on the financing interest rate, or the after tax yield on the collective home portfolio, r, and the expected (and presumed after-tax) rate of return on foreign assets, which in turn depends on the current real bond yield abroad, r^*, a risk premium, ρ_R, and the expected rate of change in the real exchange rate, $\hat{e}^e$:[17] The remaining external shock variables are applied to this relationship, $\nu_i \sim N(0, \sigma_i^2)$.

$$\lambda = \frac{r(1 - t_K)}{[(r^* + \rho_R)(1 + \nu_8) + \hat{e}^e(1 + \nu_9)]} \tag{20}$$

Home to foreign flows, S^{FH} and foreign to home flows, S^{HF}, are then:

$$S^{HF} = S^D \phi \left[\frac{\lambda_0}{\lambda}\right]^{\sigma_H} \quad \text{and} \quad S^{FH} = S_0^{FH} \left[\frac{\lambda}{\lambda_0}\right]^{\sigma_F} \tag{21}$$

where the subscript *0* refers to initial equilibrium conditions, ϕ is the initial proportion of home saving that is directed abroad, σ_H is the elasticity of substitution between home and foreign assets, viewed from the home economy, and σ_F is the corresponding elasticity, as viewed from abroad.[18]

Investment: This comprises real break-even investment, $\delta \bar{K}$ and real net investment, i^N. Real net investment depends on the (expected) profitability of new physical capital, which depends in turn on the expected value of the net real rate of return on installed capital, r_C, from (3), compared with its opportunity cost, the real rate of return on the collective home portfolio, r.[19] Here the ratio of these determines real net investment. This is a Q-style ratio, γ, in which the numerator is the expected rate of return driving the current value of new capital and the denominator its current financial cost, which drives the current replacement value.

[17] A version of the model is in use that has the parity ratio dependent on the expected rate of return on installed capital, r_c^e, rather than r. This version is very sensitive shocks to the parameter θ, which indicates changes in the difference between capital goods and final product prices. Conventionally, however, cross border flows are seen to depend on yield differences between whole portfolios, as is assumed here.

[18] It is assumed that the elasticity viewed from home is smaller given the comparatively idiosyncratic nature of home assets and investors and of home capital market distortions.

[19] Note that the equilibrium real yield from the home portfolio is influenced by the risk premium imposed by financial investors, via (S^D) and (20).

$$i = i^N + \delta\bar{K} = i_0^N \left[\frac{\gamma}{\gamma_0}\right]^{\varphi} + \delta\bar{K}, \quad \gamma = \left[\frac{r_c^e}{r}\right] \tag{22}$$

where φ is an elasticity of response to changes in the ratio of the ex post and ex ante levels of γ.[20]

Financing domestic investment: This is financed from domestic savings and net foreign savings. Nominal expenditure on investment is I and its real volume is i:

$$I = P_K i = \theta P_P i = S^D + S^{FH} - S^{HF} \tag{23}$$

Real exchange rate: This is defined as the ratio of the home currency price of home goods to the (before import tax) home currency price of foreign goods:

$$e_R = \frac{P_Y}{\left[\frac{P^*(1+\nu_7)}{E}\right]} = E\frac{P_Y}{P^*(1+\nu_7)} \tag{24}$$

Exports: The quantity of home goods demanded by foreigners is x while its nominal value is X. These depend negatively on the (after export tax) foreign currency price of home goods relative to the foreign currency price of foreign goods:

$$x = a_X - b_X\left[\frac{EP_Y(1+t_X)}{P^*(1+\nu_7)}\right] = a_X - b_X e_R(1+t_X) = a_X - b_X e_R\tau_X, \quad X = xP_P\tau_X \tag{25}$$

Imports: The quantity of foreign goods demanded by home consumers is m, from (14), while its nominal value is M, which is the landed value of imports and so excludes tariff and consumption taxes.

$$M = \frac{P^*(1+\nu_7)}{E}m \tag{26}$$

The balance of payments: This sets private and public net inflows on the capital account, KA, equal to net outflows on the current account (the current account deficit--*CA*). Note that inflows on the current account associated with exports incorporate

[20] To allow the expected net return on installed capital to be fixed exogenously (for example, reflecting a change in expectations not determined within the model) we add a slack variable, so $r_c^e = r_c.RCSLK$. If expectations require an exogenous shock to the expected net return on installed capital, $RCSLK$ is made endogenous and the link between the net returns in the current and future periods is severed. If, on the other hand, the current and expected future net returns are to be the same, then $RCSLK$ is made exogenous and set to unity.

export tax revenue since foreigners pay the export tax, at a rate t_X or with power τ_X. Import tax revenue does not appear since this is a transfer between the domestic household and the government. Inflows on the current account also include net factor income from abroad, N^F, which is held constant in foreign currency.

$$KA = S^{FH} - S^{HF} - \Delta R = -CA = M - X - \frac{N^F}{E} \tag{27}$$

3.1.3 The Money Market and Monetary Policy

An LM equation defines money market equilibrium, with transactions demand for home money driven by GDP and the opportunity cost of holding home money set at the nominal yield on the home portfolio (long maturity, since the aggregate portfolio comprises mainly long-term assets), which is the real yield plus the expected inflation rate, π^e. The short-maturity interest rate is not modelled directly but it is embodied in the monetary base, M_B, which is represented, rendering M_B the active monetary policy variable. It is, in turn, linked to the money supply, M_S, by the money multiplier, μ. Both sides of the LM equation are measured in terms of purchasing power over home goods and services. In (28), ε^{MY} and ε^{MR} denote income and interest elasticity of money demand, respectively.

$$m^D = \alpha^{MB}(y)^{\varepsilon^{MY}} \left[\frac{r[1+\pi^e(1+\nu_6)]}{\tau_K}\right]^{-\varepsilon^{MR}} = m^S = \frac{M^S}{P_Y} = \frac{\mu M_B}{P_Y}, \tag{28}$$

where the money multiplier is

$$\mu = \frac{1+c_D}{\rho_D + c_D}, \tag{29}$$

and c_D is the households cash to deposit ratio and ρ_D is the reserve to deposit ratio of financial institutions, which is a policy instrument in many developing countries. Both these parameters rise during financial crises as households mistrust their financial institutions (raising c_D) and those institutions become more prudent (raising ρ_D).

Mixed monetary policy rule: This offers a composite target, in the tradition of the Taylor-rule, where the central bank's mandate extends beyond price or exchange rate stability to include the output gap as reflected in the rate of unemployment.

$$M_B S_M = \alpha_T u^{\varepsilon_U} \left[\frac{P_T}{P_C}\right]^{\varepsilon_P}, \quad \varepsilon_U, \varepsilon_P > 0, \tag{30}$$

where S_M is a slack variable that has initial value unity and is set as exogenous when this rule is functional and endogenous when there is a differnt target of monetary policy. The unemployement rate is u, which affects monetary policy via the elasticity ε_U, and P_T is a target consumer price level towards which P_C is drawn by changes in the monetary base. The extent of this attraction depends on the elasticity ε_P.

Central bank loss function: This represents the central bank's preference with regards to its monetary policy objectives. It is essentially an expression of the central bank's targets and objectives, where the bank is charged with minimising the loss to society arising from instability in the target variables. Central bankers extensively use quadratic loss function to understand the behaviour of the central bank and the volatility of main objectives.[21] Here also we consider quadratic form loss function and its preferences over domestic inflation and real GDP.

$$L = -[\gamma(\hat{P}_C)^2 + (1-\gamma)(\hat{Y}_R)^2] \qquad \text{where } 0 \leq \gamma \leq 1 \tag{31}$$

Policy makers weight allocation for each goals stabilisation is represent in γ.

3.2 Model Closures and Policy Instruments

A variety of macroeconomic closures and policy instruments are incorporated in the model analytics. These are all available to construct responses to supply, demand and external shocks based on length of run and policy orientation. Model closures indicate assumptions as to whether the labour market clears, there is fiscal balance, there are exogenous expectations affecting the price level, the real exchange rate or the rate of return on investment, and the choice of monetary policy targets. They specify which variables are to be held as exogenous in any model solution. The alternatives are detailed in Table 2 and 3.

[21] See Svensson(1999, 2000, 2009),Rudebusch & Svensson (1999), Walsh (2010).

Table 2: Simulation Closures[a]

Closure	
Labour market:	Exogenous nominal production (unskilled) wage with endogenous production employment
Fiscal policy:	Exogenous nominal government spending and endogenous government revenue at exogenous rate of tax (or subsidy) on income, consumption, and trade
Monetary policy target[b]:	1. Exchange rate, E 2. Monetary aggregate, M_T 3. Nominal GDP, Y_N 4. Taylor rule, T_R 5. Consumer price level, IT

a. Since the model is a system of non-linear simultaneous equations and more variables are specified than equations in the system, there is flexibility as to the choice of those to make exogenous.
b. Alternative monetray policy regimes.

Source: Analysis and simulations of the model described in the text.

Table 3: Monetary Policy Targeting Regimes and Closures

Monetary Policy Target	**Closures**
Exchange rate, E	Monetary policy closure: *Exogenous*: Exchange rate, E *Endogenous*: Other monetary policy targets Labour market closure: *Exogenous*: Nominal wage, W *Endogenous*: Employment, L Fiscal policy closure: *Exogenous*: Governmnet expenditure, G *Endogenous*: Real government expenditure, G^R *Endogenous*: Government savings, S^G
Monetary aggregate, M_T	Monetary policy closure: *Exogenous*: Monetary aggregate, M_T *Endogenous*: Other monetary policy targets Labour market and fiscal policy closures: same as E
Nominal GDP, Y_N	Monetary policy closure: *Exogenous*: Nominal GDP, Y_N *Endogenous*: Other monetary policy targets Labour market and fiscal policy closures: same as E
Taylor-rule, T_R	Monetary policy closure: *Exogenous*: Taylor-rule, T_R *Endogenous*: Other monetary policy targets Labour market and fiscal policy closures: same as E
Consumer price level, IT	Monetary policy closure: *Exogenous*: Consumer price level, IT *Endogenous*: Other monetary policy targets Labour market and fiscal policy closures: same as E

Source: Analysis and simulations of the model described in the text.

3.3 Model Database and Operation

The model databases are built from national accounts as well as international trade and financial data for the Sri Lankan economy in 2000 and 2015. The data used and their compilation is detailed in Appendix (Table A.1 and A.2). [22]

4 The Construction of Shocks

For each supply, demand and external variables in the model are subjected to shocks via the set of zero-mean random variables, ν_i, as described in Section 3.1. Hereafter supply side (A, S_K and K), demad side (C, Y_D^e and π^e) and external side (P^*, r^* and e^e) shocks are represnted as ν_1 to ν_3, ν_4 to ν_6 and ν_7 to ν_9, respectively as Section 3.1. The standard deviations of these random variables are first estimated from deviations around log-linear trends. Seasonally adjusted quarterly data from 2002Q1 to 2016Q4 is used. Their variability is further examined so as to construct the correlation matrix, $R(\underline{\nu})$. This sample period is used to construct the shocks to apply to the version of the model constructed on the 2015 model database. Table 4 indicates the correlation coefficients of each of the variables shocked.

It is readily seen that supply side shocks (ν_1 to ν_3), are positively correlated with each other and that each correlation is significant at the one per cent level. The shocks to consumption, ν_4 , and expected nominal disposable income, ν_5, which represent the demand side, are also positively correlated, with each other as well as with the supply side shocks. These correlations are also significant at the one per cent level. As expected, the domestic price level shock, ν_6, negatively correlates with the demand side and the supply side shocks. The relationships between the expected domestic price level and the other demand side variables are also significant at the one per cent level, while that with the physical capital stock is significant at the five percent level.

[22] In 2000, the CBSL monetary policy structure was focused on monetary targeting framework and monetary aggregates became the key nominal anchor in the conduct of monetary policy. In this period, financial flow to the Sri Lankan economy was limited due to some restrictions imposed by the Government (Table 1). In contrast, in 2015 the country experienced a surge in capital flows subsequent to mid-2009 as a result of the achievement of sustainable peace following the defeat of civil war. Also, relaxing some capital controls and flexible exchange rate policies have supported further to improve financial flows to the Sri Lankan economy. In 2015, the CBSL enhanced their monetary policy framework with features of both monetary targeting and flexible inflation targeting frameworks.

Table 4: Correlation Coefficients and Significance Level (2002-2016)

Shock Variable			$R(\underline{\nu})$								
			ν_1	ν_2	ν_3	ν_4	ν_5	ν_6	ν_7	ν_8	ν_9
Supply Side	Total factor productivity	ν_1	1.00								
	Skilled labour force	ν_2	0.64***	1.00							
			(0.00)								
	Capital stock	ν_3	0.63***	0.64***	1.00						
			(0.00)	(0.00)							
Demand Side	Consumption	ν_4	0.48***	0.44***	0.42***	1.00					
			(0.00)	(0.00)	(0.00)						
	Exp. nominal disposable income	ν_5	0.31***	0.41***	0.36***	0.29**	1.00				
			(0.01)	(0.00)	(0.00)	(0.03)					
	Exp. domestic price level	ν_6	-0.22*	-0.17	-0.30**	-0.37***	-0.38***	1.00			
			(0.09)	(0.20)	(0.02)	(0.00)	(0.00)				
External Side	Foreign price level	ν_7	-0.10	-0.11	-0.16	-0.30**	0.01	0.34***	1.00		
			(0.46)	(0.40)	(0.24)	(0.02)	(0.99)	(0.01)			
	Foreign bond yield	ν_8	-0.06	0.02	0.03	0.07	-0.24*	0.40***	0.12	1.00	
			(0.62)	(0.90)	(0.83)	(0.57)	(0.07)	(0.00)	(0.36)		
	Exp. real exchange rate	ν_9	-0.01	-0.10	-0.18	0.05	-0.34***	0.24**	-0.20	0.40***	1.00
			(0.98)	(0.43)	(0.18)	(0.72)	(0.01)	(0.05)	(0.13)	(0.00)	

p values are in parentheses ***p<1% **p<5 % *p<10%

Source: Analysis and simulations of the model described in the text.

The external shocks, which are to the foreign price level, ν_7, the foreign bond yield, ν_8 and the expected real exchange rate, ν_9, are not significantly correlated with those affecting the supply side. Yet significant relationships are observed with demand side shocks. The foreign price level negatively correlates with consumption at the five per cent significant level and positively correlates with domestic price level at the one per cent significant level. A matrix of correlations is then constructed to represent these statistically significant results (Table 5). Insignificant correlations (including 10 per-cent significant level) are ignored in this new calibrated matrix, $R'(\underline{\nu})$.[23]

Table 5: Calibrated Correlation Matrix and Variance-covariance Matrix (2002-2016)

$R'(\underline{\nu})$									
	ν_1	ν_2	ν_3	ν_4	ν_5	ν_6	ν_7	ν_8	ν_9
ν_1	1.0								
ν_2	0.6	1.0							
ν_3	0.6	0.6	1.0						
ν_4	0.5	0.4	0.4	1.0					
ν_5	0.3	0.4	0.4	0.3	1.0				
ν_6	-0.2	0.0	-0.3	-0.4	-0.4	1.0			
ν_7	0.0	0.0	0.0	-0.3	-0.1	0.3	1.0		
ν_8	0.0	0.0	0.0	0.0	-0.2	0.4	0.0	1.0	
ν_9	0.0	0.0	0.0	0.1	-0.3	-0.2	0.0	0.4	1.0
$\Sigma(\underline{\nu})$									
	ν_1	ν_2	ν_3	ν_4	ν_5	ν_6	ν_7	ν_8	ν_9
ν_1	2.9								
ν_2	1.1	1.2							
ν_3	1.7	1.1	2.7						
ν_4	3.6	1.8	2.9	17.6					
ν_5	2.0	1.7	2.7	4.9	15.2				
ν_6	-1.8	0.0	-2.7	-8.7	-8.3	28.1			
ν_7	0.0	0.0	0.0	-3.9	-1.2	4.9	9.6		
ν_8	0.0	0.0	0.0	0.0	-1.6	4.2	0.0	4.0	
ν_9	0.0	0.0	0.0	0.7	-2.0	-1.8	0.0	1.4	2.9

Source: Analysis and simulations of the model described in the text.

The next step is to represent the simultaneity of these shocks. For this we construct a variance-covariance matrix, $\Sigma(\underline{\nu})$, based on our calibrated correlation matrix, $R'(\underline{\nu})$. The errors link to each variable to be shocked and these are calculated considering the individual column vectors of $\Sigma(\underline{\nu})$ as follows,[24]

[23] Exceptions are the relationships between foreign price level and expected disposable income as well as expected real exchange rate and consumption.

[24] Here shows the way we calculate the errors link to first shock, ν_1 (considering first column vector), and the same method we apply for calculating errors of the rest of the shocks.

$$\begin{bmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \\ \vdots \\ \nu_9 \end{bmatrix} = \begin{bmatrix} \nu_1 \\ U_2 \end{bmatrix} \text{ where } \nu_2,\ \nu_3,\ \nu_4,\ \ldots,\ \nu_9 = U_2$$

The variance of the vector $[\nu_1\ U_2]^T$ can be written as follows;

$$var \begin{bmatrix} \nu_1 \\ U_2 \end{bmatrix} = \begin{bmatrix} \sigma_1^2 & \Sigma_{12} \\ \Sigma_{21} & \Sigma_{22} \end{bmatrix} \text{ where } \Sigma_{12} \text{ is } 1\times\ 8;\ \Sigma_{21} \text{ is } 8\times\ 1;\ \Sigma_{22} \text{ is } 8\times\ 8$$

We then define the conditional expectation of U_2 given ν_1:

$$E[U_2|\nu_1] = \frac{\Sigma_{21}}{\sigma_1^2}\nu_1 \tag{32}$$

The links between the shock, ν_1, and the other errors are as follows;

From (32), for $\nu_1 \epsilon [0,\sigma_1]$. Then $E(U_2|\nu_1) = \left[0, \frac{\Sigma_{21}}{\sigma_1}\right]$.

The final step is to use this error vector, $[\Sigma_{21}/\sigma_1]$, associated with the shock to ν_1, and construct shock vector, ν_1^S, for simultaneous shocks.[25] Similar method we follow for construct individual shock vectors, ν_i^S, for each of the eight other shock variables. Table 6 summarises the internal and external one-standard deviation shocks.

[25]Shock vector, ν_1^S, is a 9×1 column vector including a one-standard deviation shock to ν_1 and its related error vector, $[\Sigma_{21}/\sigma_1]$, as previouly discussed.

Table 6: Internal and External Shocks[abc] (2002-2016)

Shock Variable		**One-standard Deviation Shocks**								
		ν_1	ν_2	ν_3	ν_4	ν_5	ν_6	ν_7	ν_8	ν_9
Supply	Total factor productivity, ν_1	**1.7**	0.6	0.9	2.2	1.4	-1.1			
Side	Skilled labour force, ν_2	1.0	**1.1**	1.0	2.2	1.4				
	Capital stock, ν_3	1.0	0.7	**1.7**	2.1	1.4	-1.6			
Demand	Consumption, ν_4	0.9	0.6	0.8	**4.2**	1.0	-1.6	-0.9		0.2
Side	Exp. nominal disp. income, ν_5	0.7	0.4	0.6	1.3	**3.9**	-1.6	-0.3	-0.4	-0.5
	Exp. domestic price level, ν_6	-0.3		-0.5	-1.3	-1.0	**5.3**	0.9	0.8	-0.3
External	Foreign price level, ν_7				-1.3	-0.4	1.5	**3.1**		
Side	Foreign interest rate, ν_8					-0.7	2.1		**2.0**	0.7
	Exp.real exchange rate, ν_9				0.4	-1.0	-1.1		0.8	**1.7**

a. The zero values in the individual shock vectors, ν_i^S, are ignored to compile this table.
b. Clousers vary with the cases, as indicated, but are selected from the list in the Table 2.
c. These shocks are applied for the all the regimes listed in Table 3.

Source: Analysis and simulations of the model described in the text.

In addition to our use of these shocks to analyse the modern Sri Lankan economy, we calibrate a database for the model for 2000, in order to compare the effectiveness of Sri Lanka's earlier monetary policy regime. For this we use seasonally adjusted quarterly data from 1995Q1 to 2000Q4 to formulate a new correlation matrix, $R_1(\underline{\nu})$. In this case we find that none of the correlations is statistically significant at the one per cent or five per cent levels (Table 7), suggesting that in the lead-up to 2000 the various shocks were independent. So in the case of the 2000 economy we impose one-standard division shocks to the vector $\underline{\nu}$ without correlation between elemental shocks. Table 8 summarises the internal and external one-standard deviation shocks that follow from Table 7.

Table 7: Correlation Coefficients and Significance Level (1995-2000)

Shock Variable			$R_1(\underline{\nu})$								
			ν_1	ν_2	ν_3	ν_4	ν_5	ν_6	ν_7	ν_8	ν_9
Supply Side	Total factor productivity	ν_1	1.00								
	Skilled labour force	ν_2	0.19	1.00							
			(0.37)								
	Capital stock	ν_3	0.39*	0.08	1.00						
			(0.06)	(0.71)							
Demand Side	Consumption	ν_4	0.05	-0.35*	0.14	1.00					
			(0.81)	(0.09)	(0.50)						
	Exp. nominal disposable income	ν_5	-0.09	-0.38*	-0.30	0.25	1.00				
			(0.68)	(0.07)	(0.16)	(0.24)					
	Exp. domestic price level	ν_6	0.13	0.19	-0.11	-0.12	-0.32	1.00			
			(0.56)	(0.37)	(0.61)	(0.57)	(0.13)				
External Side	Foreign price level	ν_7	-0.30	-0.05	-0.52*	0.17	0.31	0.38*	1.00		
			(0.15)	(0.83)	(0.06)	(0.43)	(0.13)	(0.07)			
	Foreign bond yield	ν_8	-0.01	0.19	-0.12	-0.22	-0.08	0.18	0.24	1.00	
			(0.98)	(0.37)	(0.57)	(0.31)	(0.73)	(0.40)	(0.27)		
	Exp. real exchange rate	ν_9	0.17	0.16	0.22	0.14	-0.51*	0.29	-0.29	0.31	1.00
			(0.43)	(0.43)	(0.44)	(0.31)	(0.52)	(0.16)	(0.17)	(0.13)	

p values are in parentheses ***p<1% **p<5 % *p<10%

Source: Analysis and simulations of the model described in the text.

Table 8: Internal and External Shocks[abc] (1995-2000)

Shock Variable		**One Standard Deviation Shocks**								
		ν_1	ν_2	ν_3	ν_4	ν_5	ν_6	ν_7	ν_8	ν_9
Supply Side	Total factor productivity, ν_1	**1.4**								
	Skilled labour force, ν_2		**2.1**							
	Capital stock, ν_3			**2.4**						
Demand Side	Consumption, ν_4				**3.6**					
	Exp. nominal disp. income, ν_5					**3.1**				
	Exp. domestic price level, ν_6						**6.5**			
External Side	Foreign price level, ν_7							**2.5**		
	Foreign interest rate, ν_8								**1.7**	
	Exp.real exchange rate, ν_9									**2.3**

a. Clousers vary with the cases, as indicated, but are selected from the list in the Table 2.
b. These shocks are applied for the all the regimes listed in Table 3.

Source: Analysis and simulations of the model described in the text.

5 Simulation Results

The objective of the simulations is to examine the effects of the shocks analysed in the previous section under the variety of monetary policy regimes detailed in Table 3. Both positive and negative single standard deviation shocks are applied to each of the nine random variables, ν_i , in each case in combination with complementary shocks to others where correlations are significant. This exercise is undertaken, first, with the model calibrated to Sri Lankan data for 2015 and shocks based on seasonally adjusted quarterly data from 2002Q1 to 2016Q4. We then recalibrate the model to represent the economy in 2000 and impose shocks based on seasonally adjusted quarterly data from 1995Q1 to 2000Q4.

5.1 Implementation

The model is short run, comparative static. To implement shocks under all the monetary policy regime alternatives, including targeting nominal GDP and Taylor-type pilicy rule, they must be superimposed on a baseline growth path of the economy. To achieve this, a set of baseline growth shocks, total factor productivity, A or ν_1, skilled labour force, S_K or ν_2 and capital stock, K or ν_3, are first implemented, to the supply side variables only. These allow a baseline inflation rate and trend in financial variables to be established. The focal shocks are then implemented on the equilibrium

after baseline shocks. The scale of the baseline shocks is designed to represent the trends in the supply side variables that had been extracted in order to extract the standard deviation of the variance-covariance matrix, $\Sigma(\underline{\nu})$, of Section 4.

Table 9: Baseline Growth Path

Shock Variable	Standard Deviation Shock
Total factor productivity, ν_1	1.70
Skilled labour force, ν_2	1.10
Capital stock, ν_3	1.64

Source: Analysis and simulations of the model described in the text.

As a general matter, supply side shocks might be thought of as a special case in such studies. These most often offer the positive effects of real growth, which can be reflected in standard measures of volatility. In this case, however, all shocks are imposed around a fixed set of positive supply side shocks that are imposed to represent Sri Lankas underlying growth path. It is therefore appropriate that, amongst its other tasks, monetary policy should be directed at stabilisation in the face of such shocks. So that the supply side shocks ν_1 to ν_3 represent departures from the baseline drivers of growth and so are true sources of volatility around trend. The only caveat to add in the case of these shocks is that, when positive they can indicate well founded real growth surges that monetary authorities would be unlikely to resist in reality.

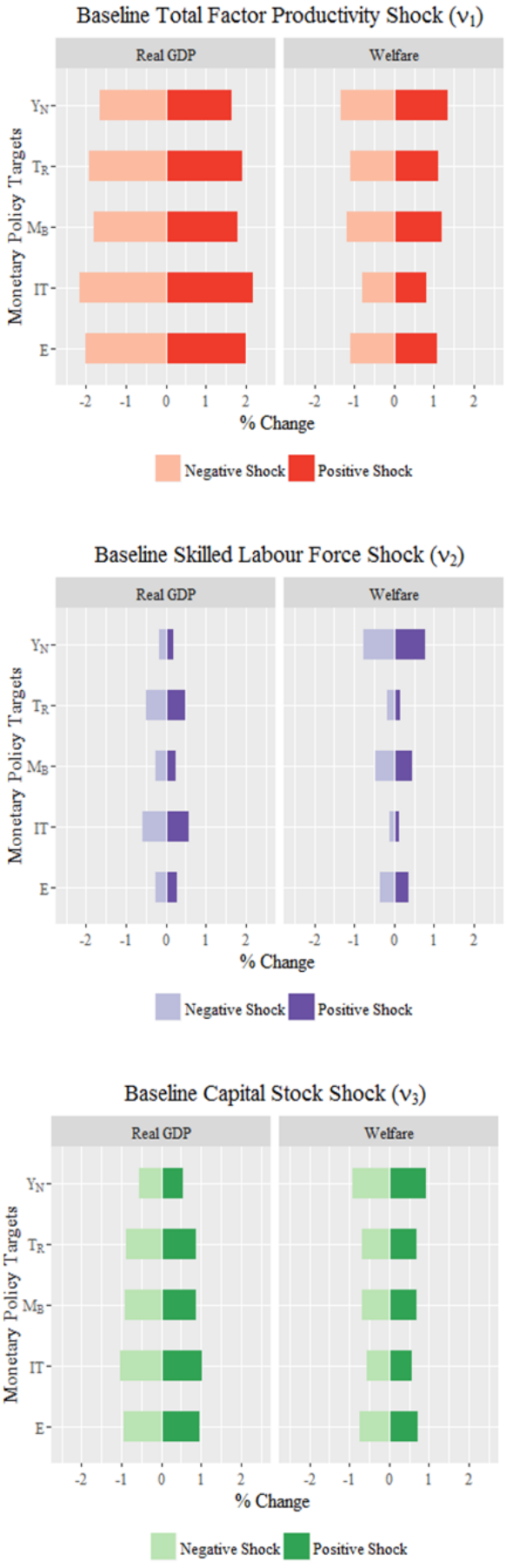

Figure 1: Baseline Supply Side Shocks and Macroeconomic Volatility (2015 Database)

5.2 Volatility in the 2015 Economy

The supply side shocks (A, S_K and K; or ν_1 to ν_3), outcomes from which are displayed in Figure 2, are shown to cause higher volatility in real GDP under the IT relative to the other regimes due to their comparatively strong influence over employment and investment. The nominal GDP targeting on the other hand, appears to offer comparative stability of real GDP. If stability in our welfare variable (the real purchasing power of disposable income at home consumer prices) is the priority, however, the regimes have the opposite ranking in the face of supply side shocks. IT delivers the most stabilising welfare outcomes.

When imposing the demand side shocks (C, Y_D^e and π^e; or ν_4 to ν_6) the nominal GDP targeting regime emerges as particularly strong in stabilising real output in consumption shock. Expected disposable income shock has caused low volatility in real GDP in Taylor-type monetary policy regimes than alternatives. Moreover, the shocks to the expected domestic price level correlate negatively with welfare level under all the regimes, due to the inverse relationship between the domestic price level and real purchasing power. Economic welfare, however, is best stabilised by the IT regime. This is due to its sensitivity to the consumer price level and the direct targeting of that level under the IT regime.

Responses to the external shocks (P^*, r^* and e^e; or ν_7 to ν_9) are also displayed in Figure 2. The results are ambiguous at first sight. The foreign price level shock creates particularly high volatility in both real GDP and welfare under the exchange rate and nominal GDP targeting regimes, due to high percentage responses by employment, investment and the domestic price level. Shocks to the foreign interest rate and the expected real exchange rate also cause high volatility under the monetary aggregate and nominal GDP targeting monetary policy regimes. Overall, external shocks cause the least volatility in the domestic economy under the IT regime. This is due to the flexibility of the exchange rate as an absorber of external shocks.

When applying shocks more independently without considering cross correlations, the results are almost similar as previous but magnitudes are different (Figure 3).

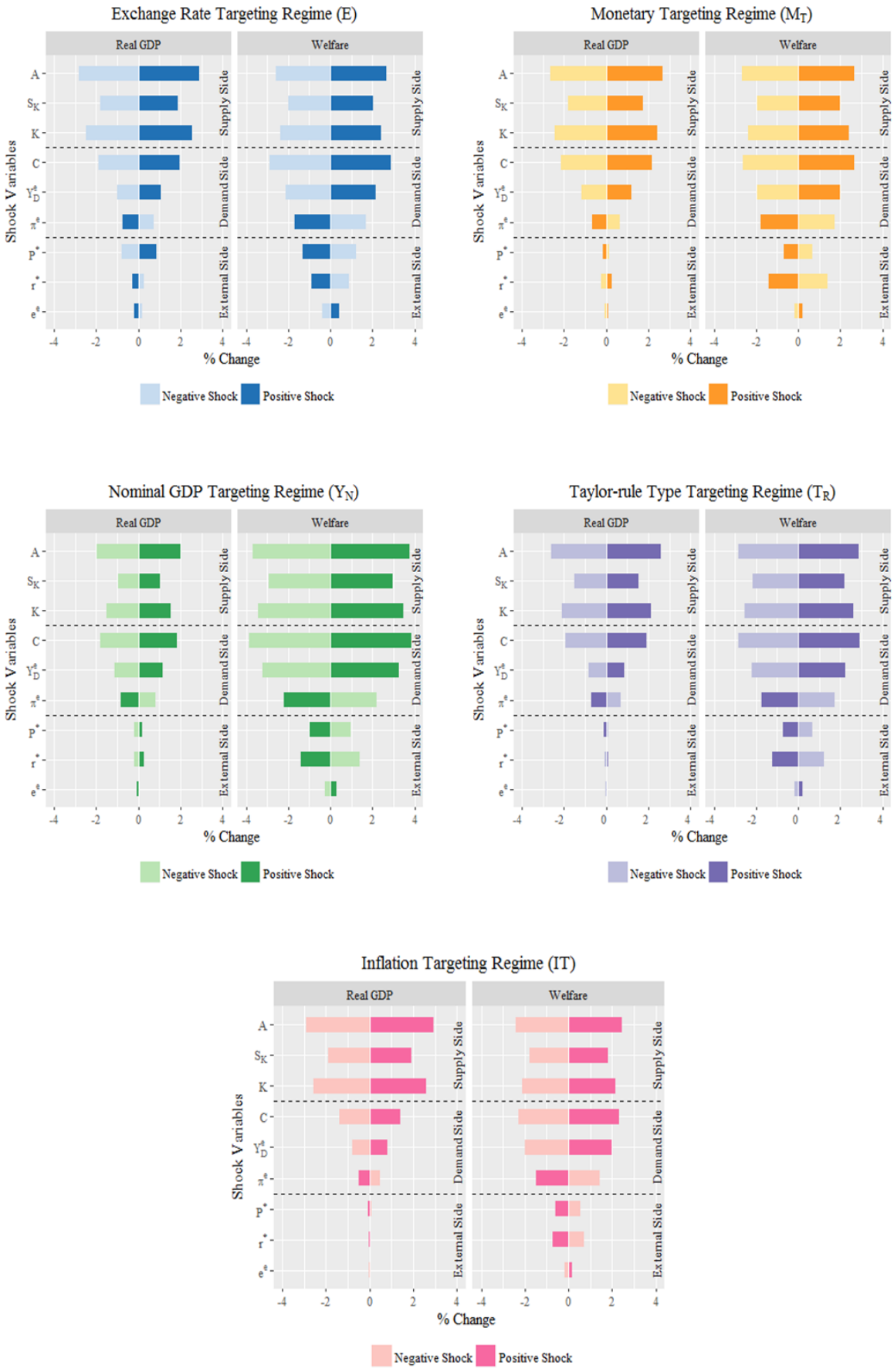

Figure 2: Supply, Demand and External Side Shocks and Macroeconomic Volatility (2015 Database, Shocks With Cross Correlations)

Figure 3: Supply, Demand and External Side Shocks and Macroeconomic Volatility (2015 Database, Shocks Without Cross Correlations)

5.3 Volatility in the 2000 Economy

In this more historical analysis we note that the shocks imposed interact with one another less than they did subsequently, as indicated in Section 4, and that the capital account was less open in this period, as discussed in Section 2. Consider, first, the supply side shocks (A, S_K and K; or ν_1 to ν_3). These elicit similar responses to the 2015 economy, though magnitudes differ, largely because the shocks are more independent. Importantly, the IT target performs best on welfare grounds, with the exchange rate targeting monetary policy regime a close second.

Demand side shocks (C, Y_D^e and π^e; or ν_4 to ν_6) elicit the most volatile effects on output and welfare under the nominal GDP target. Moreover, the shocks to the consumption, monetary aggregate targeting monetary policy regime offers stable level of real GDP, but this regime provides higher volatility effect on welfare. When imposing expected nominal disposable income shock, the IT and the monetary aggregate targets record stable level of real GDP but only IT target offer the least effects on welfare. The IT and Taylor-type targets offers least volatility effects on real GDP and welfare under the domestic price level shock.

Under external shocks (P^*, r^* and e^e; or ν_7 to ν_9), and particularly for shock to the real exchange rate, the exchange rate target regime seems most stabilising overall. Under this regime, however, volatility is large in response to changes in the foreign price level and foreign interest rate, which, at least ex post, require exchange rate adjustment. This offers a weak endorsement of the exchange rate targeting regime under the circumstances prevailing before the millennium. Overall, the IT target more favourably response to the external shocks.

Figure 4: Supply, Demand and External Side Shocks and Macroeconomic Volatility (2000 Database, Shocks Without Cross Correlations)

5.4 Central Bank Loss Function

This sub-section compares the policy regimes discussed in Tables 2 and 3 in terms of the welfare loss they generate, as measured by the central bank loss function (31) - the variation in the domestic inflation and real GDP. Here, loss function measures how well the central bank stabilises domestic inflation and real GDP subject to the shocks.

5.4.1 Central Bank Loss Function in 2015 Economy

Table 10 presents the welfare loss that stems from cross correlated supply, demand and external shocks in all five monetary policy regimes.

When policy makers allocate high weight on real GDP stability ($\gamma = 0.3$), supply side shocks more favourably impact to the nominal GDP and monetary aggregate targeting regimes than others recording less welfare loss due to their moderately influence over employment and investment. Nonetheless, when they changing their weight towards domestic price level stability ($\gamma = 0.7$), overall supply side shocks strongly stabilise both goals under the exchange rate targeting regimes. When policy makers allocating same weight for both objectives ($\gamma = 0.5$) show offset the effect of weight to the loss function. Accordingly, Taylor-rule type monetary policy regime has recorded less deviation of both central bank objectives than others.

Responses to the demand side shocks the exchange rate target monetary policy regime has recorded less welfare loss, if policy makers allocate more weight on real GDP stability ($\gamma = 0.3$). But policy makers change their preference towards domestic price level stability ($\gamma = 0.7$), IT regime is a best. When policy makers allocate same weight for both goals ($\gamma = 0.5$) results are ambiguous at first sight. Consumption shock more favourably record in exchange rate targeting regime and other demand side shocks more favourably stabilise both central bank objectives in IT and Taylor-type monetary policy regime due to stable domestic price and low responses of employment and investment.

Table 10: Central Bank Loss Function (2015: Shocks with Cross Correlations)

Shock variable	$\gamma = 0.3$					$\gamma = 0.5$					$\gamma = 0.7$				
	E	M_T	Y_N	T_R	IT	E	M_T	Y_N	T_R	IT	E	M_T	Y_N	T_R	IT
Total factor productivity, ν_1	-6.37	-6.26	-5.35	-5.70	-6.71	-4.58	-4.50	-6.36	-4.34	-4.79	-2.79	-2.75	-7.37	-2.97	-2.88
Skilled labour force, ν_2	-2.31	-2.46	-1.97	-2.18	-2.52	-1.65	-1.76	-2.61	-1.63	-1.80	-0.99	-1.06	-3.24	-1.09	-1.08
Capital stock, ν_3	-4.15	-4.51	-3.89	-4.01	-4.70	-2.97	-3.23	-4.89	-3.04	-3.35	-1.80	-1.95	-5.90	-2.06	-2.01
Consumption, ν_4	-2.47	-3.40	-3.32	-2.72	-3.15	-1.85	-2.44	-4.96	-2.04	-2.25	-1.24	-1.47	-6.61	-1.37	-1.35
Exp. nom. disp. income, ν_5	-0.82	-1.14	-2.70	-0.65	-0.70	-0.59	-0.93	-4.49	-0.47	-0.50	-0.36	-0.71	-6.29	-0.29	-0.30
Exp. domestic price level, ν_6	-0.46	-0.48	-1.45	-0.47	-0.57	-0.41	-0.49	-2.38	-0.45	-0.37	-0.31	-0.51	-3.31	-0.43	-0.24
Foreign price level, ν_7	-1.49	-0.15	-0.33	-0.11	-0.01	-2.29	-0.11	-0.53	-0.08	-0.01	-3.09	-0.06	-0.72	-0.05	-0.00
Foreign bond yield, ν_8	-0.08	-0.62	-0.59	-0.17	-0.02	-0.08	-0.98	-0.94	-0.28	-0.01	-0.09	-1.34	-1.29	-0.39	-0.01
Exp. real exchange rate, ν_9	-0.21	-0.02	-0.03	-0.01	-0.00	-0.31	-0.02	-0.04	-0.01	-0.00	-0.42	-0.01	-0.06	-0.01	-0.00

Table 11: Central Bank Loss Function (2015: Shocks without Cross Correlations)

Shock variable	$\gamma = 0.3$					$\gamma = 0.5$					$\gamma = 0.7$				
	E	M_T	Y_N	T_R	IT	E	M_T	Y_N	T_R	IT	E	M_T	Y_N	T_R	IT
Total factor productivity, ν_1	-2.91	-2.77	-2.68	-2.79	-3.33	-2.11	-2.19	-2.40	-2.17	-2.38	-1.41	-1.60	-2.12	-1.55	-1.43
Skilled labour force, ν_2	-0.05	-0.05	-0.05	-0.05	-0.06	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.04	-0.03	-0.03
Capital stock, ν_3	-0.71	-0.67	-0.66	-0.66	-0.79	-0.52	-0.52	-0.67	-0.51	-0.57	-0.33	-0.37	-0.68	-0.37	-0.34
Consumption, ν_4	-0.71	-0.67	-0.66	-0.66	-0.79	-0.52	-0.52	-0.67	-0.51	-0.57	-0.33	-0.37	-0.68	-0.37	-0.34
Exp. nom. disp. income, ν_5	-0.11	-0.35	-1.01	-0.06	-0.03	-0.12	-0.44	-1.61	-0.05	-0.02	-0.13	-0.53	-2.20	-0.04	-0.01
Exp. domestic price leve, ν_6	-0.16	-0.17	-0.26	-0.16	-0.06	-0.16	-0.17	-0.26	-0.16	-0.05	-0.16	-0.17	-0.27	-0.16	-0.03
Foreign price level, ν_7	-1.84	-0.17	-0.15	-0.01	-0.00	-2.76	-0.23	-0.17	-0.02	-0.00	-3.68	-0.28	-0.18	-0.03	-0.00
Foreign bond yield, ν_8	-0.07	-1.09	-0.49	-0.28	-0.02	0.07	-1.71	-0.79	-0.45	-0.01	-0.08	-2.32	-1.08	-0.62	-0.01
Exp. real exchange rate, ν_8	-0.01	-0.03	-0.09	-0.05	-0.00	-0.01	-0.03	-0.14	-0.08	-0.00	-0.01	-0.03	-0.19	-0.11	-0.00

Even though policy makers change their weigh either domestic price level stability or real GDP stability, external shocks have more favourably recorded in IT regime due to flexibility of the exchange rate act as an absorber of external shocks.

When shocks applying more independently, outcomes from which are displayed in Table 11, nominal GDP targeting regime has recorded less welfare loss under the supply side shocks (if $\gamma = 0.3$). Nevertheless, these responses are changed toward IT and exchange rate targeting regimes, when policy makers allocate more weight to the domestic price level stability ($\gamma = 0.7$). Under the demand and external shocks IT regime has recorded less welfare loss. It does not affect policy makers weight on both central banks goals.

5.4.2 Central Bank Loss Function in 2000 Economy

In 2000 model economy also we impose shocks more independently, as indicated in Section 4. Consider, first, the supply side shocks has recorded less welfare loss under nominal GDP targeting regime when policy makers consider more real GDP stability ($\gamma = 0.3$). However, when policy makers allocate more weight on domestic price level stability ($\gamma = 0.7$), surprisingly, exchange rate targeting regime has recorded as a best stabiliser due to less response of employment and investment in the economy. When policy makers allocate same weight, overall, Taylor-type monetary policy rule has recorded low value in central bank loss function. As previous, demand and external shocks more favourably impact to the IT regime than alternatives (Table 12).

Table 12: Central Bank Loss Function (2000: Shocks without Cross Correlations)

Shock variable	$\gamma = 0.3$					$\gamma = 0.5$					$\gamma = 0.7$				
	E	M_T	Y_N	T_R	IT	E	M_T	Y_N	T_R	IT	E	M_T	Y_N	T_R	IT
Total factor productivity, ν_1	-2.03	-1.91	-1.83	-1.94	-2.36	-1.51	-1.51	-1.64	-1.50	-1.69	-0.99	-1.11	-1.45	-1.06	-1.01
Skilled labour force, ν_2	-0.23	-0.22	-0.21	-0.21	-0.27	-0.17	-0.17	-0.19	-0.17	-0.19	-0.11	-0.13	-0.17	-0.13	-0.11
Capital stock, ν_3	-1.23	-1.12	-1.09	-1.13	-1.38	-0.89	-0.88	-1.12	-0.88	-0.99	-0.56	-0.64	-1.15	-0.63	-0.59
Consumption, ν_4	-0.11	-0.26	-0.98	-0.05	-0.03	-0.11	-0.31	-1.54	-0.04	-0.02	-0.12	-0.35	-2.10	-0.03	-0.01
Exp. nom. disp. income, ν_5	-0.08	-0.20	-0.73	-0.04	-0.02	-0.09	-0.23	-1.14	-0.03	-0.02	-0.09	-0.26	-1.55	-0.02	-0.01
Exp. domestic price level, ν_6	-0.09	-0.10	-0.10	-0.09	-0.06	-0.09	-0.10	-0.10	-0.09	-0.05	-0.09	-0.10	-0.10	-0.09	-0.03
Foreign price level, ν_7	-1.22	-0.03	-0.01	-0.01	-0.00	-1.79	-0.05	-0.02	-0.01	-0.00	-2.36	-0.06	-0.03	-0.02	-0.00
Foreign bond yield, ν_8	-0.07	-0.42	-0.19	-0.10	-0.01	-0.09	-0.65	-0.29	-0.17	-0.01	0.10	-0.88	-0.40	-0.23	-0.00
Exp. real exchange rate, ν_8	-0.00	-0.03	-0.01	-0.01	-0.00	-0.00	-0.05	-0.02	-0.01	-0.00	-0.00	-0.06	-0.03	-0.02	-0.00

6 The Financial Trilemma in Sri Lanka

Here we analyse Sri Lanka's experience in relation to Mundell's impossible trilemma, focussing on the monetary and exchange rate policy regimes and transitions during the sample period 1990-2015. As discussed in Section 2, there have been three distinct phases:[26]

1990-2000: monetary aggregate targeting (with "managed" float exchange rate)
2001-2011: monetary aggregate targeting (with "independent floating" exchange rate)
2012-2015: monetary aggregate targeting (with "floating" exchange rate)[27]

We follow the approach of Aizenman et al. (2008, 2010a) in formulating indices for monetary independence and exchange rate stability. To measure openness to financial capital flows an index is constructed that is the quotient of capital inflows (outflows) to domestic savings (investments).[28] The main concept governing the trilemma hypothesis is that an increase in any one of the three indices (the other two representing monetary policy and exchange rate flexibility) is balanced by a corresponding decrease in one or two of the other indices. More detail as to the three indices used is offered in the following.

6.1 Monetary Independence (I^M) Index

This index is defined as the reciprocal of the correlation of the quarterly correlation of the mothly interest rate, r^S, on 91-day government securities in the home country (here Sri Lanka, i) and a base country (here the United States, j).

[26] Here, we basically follow IMF de facto classification on Si Lanka's monetary and exchange rate. Highest number of frequency of their classification in each year is considered as Sri Lanka's monetary and exchange rate regime in each sub-period).

[27] Even though IMF identified Sri Lanka had a monetary aggregate targeting and floating exchange rate regimes in most of the times during 2012-15 period, as an interim arrangement, the CBSL enhanced their monetary policy framework with the features of monetary aggregate targeting and flexible IT in 2015. Since 2012 they have been researching the viability of a flexible IT framework, under consultation with the IMF. In particular, 09$^{\text{th}}$ February 2012 and 03$^{\text{rd}}$ September 2015 greater flexibility in determination of the exchange rate was allowed by the CBSL.

[28] Aizenman, Chinn, and Ito used the Chinn-Ito index (Chinn & Ito 2008) to calculate openness of capital flows. For Sri Lanka this shows little or no variation over time and hence might not be a suitable measure of such openness.

$$I_t^M = 1 - \left[\frac{corr(i_i, i_j) - (-1)}{1 - (-1)}\right] \tag{33}$$

It takes values between zero and one, where a higher value represents a greater degree of monetary independence.[29]

6.2 Exchange Rate Stability (I^{ER}) Index

This is measured using the quarterly standard deviation (SD) of the monthly log-change in the exchange rate between the home country (here Sri Lanka) and the base country (here the US). The index is calculated as:

$$I_t^{ER} = \frac{0.01}{0.01 + SD[\Delta log\{E_{US}\}]} \tag{34}$$

Again the scaling ensures that the index can take any value between zero and one, where the highest value represents a greater degree of exchange rate stability.[27]

6.3 Financial Capital Openness (I^{FC}) Index

Capital flow openness, or financial integration, means an easing of restrictions on capital flows across a country's borders, usually in both directions (inflows and outflows). The level of gross financial flows indicates the degree of capital account openness. That for every type of capital flow[30] (i) depends in every quarterly period (t) on the average index value of gross capital outflows, S^{HF}(21), to total domestic savings, S^D, and the gross capital inflows S^{FH} (21), to the total domestic investments, I (23), as follows:

$$I_{it}^{FC} = \frac{1}{2}\left[\frac{\left|S_{it}^{HF}\right|}{\left|S_{it}^{D}\right|} + \frac{\left|S_{it}^{FH}\right|}{\left|I_t\right|}\right] \tag{35}$$

When the value of gross capital inflows is close to the value of total domestic investments and the value of gross capital outflows is close to the total domestic savings, the average I^{FC} value tends towards unity. The most extreme case would be where gross capital outflows represent very low values compared to total domestic savings and gross capital inflows represent very low values compared to total domestic invest-

[29] More details on the construction of the and indices can be found in Aizenman et al. (2008, 2010a).

[30] In this study we have considered four types of capital flows: Bank and money market flows, portfolio debt and equity flows, changing official reserves and foreign direct investment.

ment expenditure. This will occur if non-resident and resident flows are controlled, in which case I^{FC} is near zero.

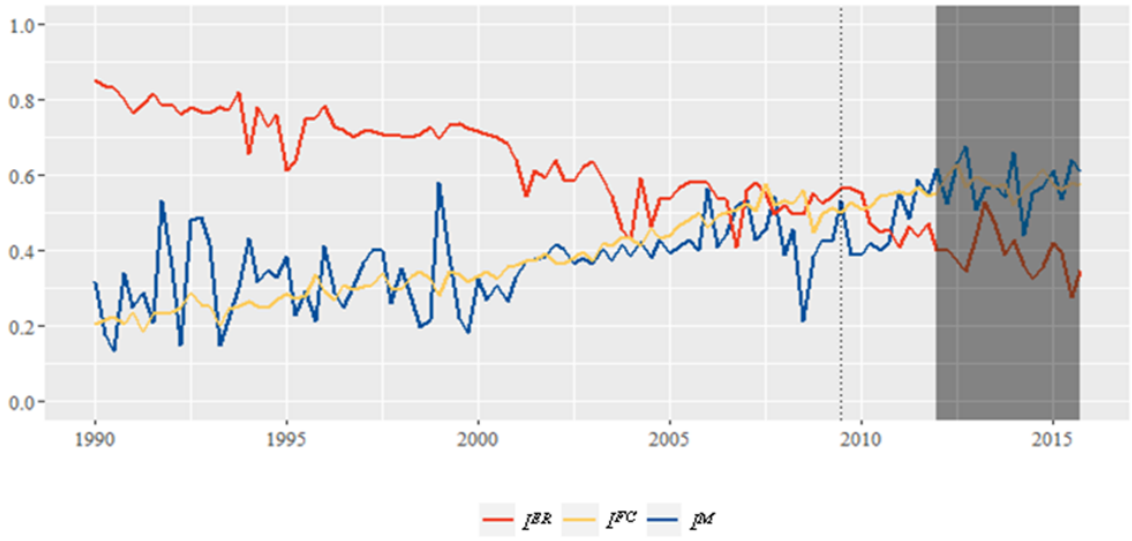

Figure 5: The Financial Trilemma Policy

The soundness of the trilemma framework in Sri Lanka is estimated by testing whether the weighted sum of the three trilemma policy variables adds up to a constant. If the trilemma is binding then a country that implements any two of the three policy goals perfectly will have to completely forego the third.

$$2 = \alpha I_t^M + \beta I_t^{ER} + \gamma I_{it}^{FC} + \varepsilon_t \tag{36}$$

The estimated coefficients in the above regression give us some approximate ideas regarding the weights attached by policy-makers to the three policy goals. Moreover, strong goodness of fit would suggest that a linear specification is rich enough to explain the trade-off faced by policy-makers among the three policy objectives. Indeed, the fit of the model does turn out to be extremely good, as reflected in the high R^2 numbers in Table 13.[31]

[31]Since there is no constant term on the right-hand side, the R^2 is non-centred. The goodness of fit is to be interpreted just as that and does not imply any desirable statistical properties.

Table 13: Testing the Validity and the Contributions of the Trilemma Framework

	1990-2000	2001-2011	2012-2015
Mean:			
I^M	0.31	0.43	0.58
I^{ER}	0.74	0.54	0.39
I^{FC}	0.28	0.47	0.57
Coefficients:			
I^M	0.22*	0.44*	0.60**
	(0.12)	(0.25)	(0.26)
I^{ER}	1.93***	1.96***	1.52*
	(0.08)	(0.14)	(0.28)
I^{FC}	1.76***	0.159***	1.83***
	(0.21)	(0.23)	(0.32)
Observations	44	44	16
R^2	0.998	0.997	0.998
Contributions:			
I^M	0.07	0.19	0.35
I^{ER}	1.41	1.05	0.59
I^{FC}	0.49	0.75	1.06
Sum of contributions	1.97	1.99	1.98

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

Following Aizenman et al. (2008, 2010a), the key measure of the trilemma policy configuration is obtained by examining the contribution of each policy dimension to the total here set to two. We calculate this by multiplying the coefficients by the means of each sub-period. The contributions of the indices are of great interest in terms of the trilemma policy configuration and how it changes with the monetary and exchange rate regimes transition. Until the third phase, Sri Lankan policy maker provided high weight to strength exchange rate stability. But, final sub-period their weights move towards the I^M and I^{FC}, while weakening I^{ER}.[32]

In practice, official foreign reserve accumulation offers an extra dimension to the trilemma problem. It provides policymakers with more flexibility in dealing with the short-run trade-offs between I^M and I^{ER} when I^{FC} is a given. In Figure 5 we present

[32]The story that appears from Table 13 is consistent with the broad picture of what occurred in Sri Lanka over past two and half decades.

the evolution of trilemma policy objectives with the reserves/GDP, I^R , ratio.[33]

The story in Figure 6 is that of Table 13, with the addition of character of the official reserves. Given the overall shift in policy orientation with an increased emphasis on I^M and I^{FC}, and a moderated I^R due to reduced focus on I^{ER}, the CBSL would appear to confront the superiority at this point of Inflation anchored monetary policy regime.[34]

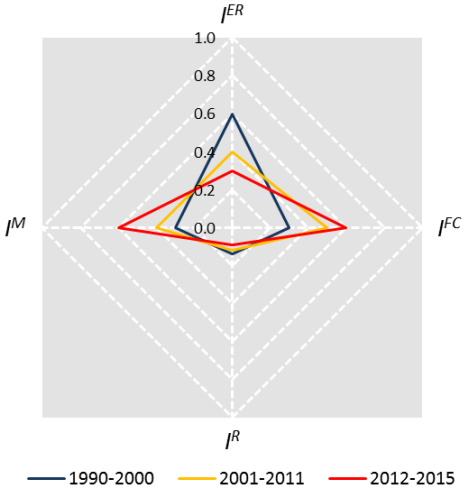

Figure 6: The Financial Trilemma Evolution and International Reserve Accumulation

7 Conclusion

This paper focuses on the responses of the Sri Lankan macro-economy to stylised individual supply, demand and external shocks under alternative monetary policy targeting regimes. Driven in part by a trend increase in capital account openness, the results show support for regimes that offer unfettered exchange rate flexibility, most strongly supporting a transition to Inflation anchored monetary policy regime. Further support for this transition is suggested by a subsequent analysis of indices under the impossible trilemma, focussing on the course of Sri Lankas monetary policy regime transitions since 1990.

[33] In this study we consider change of official reserve, which comprise Central Bank and Government own reserves, as a percentage of GDP as an explanatory variable.

[34] A flexible nominal exchange rate constitutes, at least from a theoretical standpoint, a requirement for a well-functioning full-fledged IT regime (Masson et al. 1997, Mishkin & Schmidt-Hebbel 2001, McCallum 2007). On the other hand, great monetary independence could permit policy makers to stabilise the economy through monetary policy without being subject to others economies macroeconomic management, thus it allows increasing transparency of the monetary policy strategy, one of the main element of the IT.

Amongst the additional results to emerge is that regimes that reduce output volatility frequently raise the volatility of welfare, measured as the real purchasing power of disposable income at home consumer prices. Faced with supply side shocks, for example, a nominal GDP targeting monetary policy regime provides the most stable output path, but the corresponding welfare measure is best stabilised by inflation targeting. Indeed, while it is not always the best regime, inflation targeting is seen to perform most consistently in controlling welfare volatility in the face of both demand side and external shocks.

Furthermore, central bank loss function indicates inflation anchored monetary policy regime would be superior, mainly because it would allow the exchange rate to absorb more of the shocks hitting the economy and would thus stabilize output and domestic inflation.

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Table A.1: Database and Parameters for the Sri Lankan Economy in 2000

Variables and base values Bn(2010) US$(LKR/US$=80.06)		**Key parameters**	
Volumes:		*Production shares*:	
GDP, Y	48.32	β_L	0.34
Consumption, C	36.44	β_S	0.23
Investment, I	12.36	β_K	0.42
Government spending, G	6.88[a]		
Exports, X	19.60	*Money market parameters*:	
Imports, M	26.96	Elasticity, money demand to	
Net foreign factor income, N^F	-0.21	Y	1.00
		r	1.00
Values:		Reserve to deposit ratio	0.11
Tax revenue	1.99[b]		
Direct, T^D	1.43[a]	*Taylor rule parameters*:	
Consumption, T^C	-1.31[b]	Elasticity of r to U_R	1.60
Import, T^M	1.82[c]	Elasticity of r to P_C target (P_T)	-0.46
Export, T^X	0.02[d]	$P_T = P_C$*1.025	0.95
Other	0.03		
M_S	5.34	*Power of marginal tax rates*:	
M_B	1.39	$(1 + t_W) = \tau_W$	1.04
K stock	54.86	$(1 + t_K) = \tau_K$	1.04
Private savings, S^P	0.68	$(1 + t_C) = \tau_C$	0.91[b]
Government savings, S^G	0.27	$(1 + t_M) = \tau_M$	1.27[c]
Total domestic savings, S^D	0.95	$(1 + t_X) = \tau_X$	1.01[d]
Financial outflows, S^{HF}	0.09		
Financial inflows, S^{FH}	0.71	*Consumption parameters*:	
Reserve growth, ΔR	-0.59	Elasticity of C to Y_D	1.00
		Elasticity of C to r	-0.50
Price, initial calibrated levels:		Elasticity of X to e_R, σ	1.00
Domestic interest rate, r	0.19		
Foreign interest rate, r^*	0.05	*Trade parameters*:	
Consumer price level, P_C	0.92	Elasticity of substitution C_H to m	3.50
Producer price level, P_P	0.94	Elasticity of X to e_R	1.00
GDP price level, P_Y	1.00		
Foreign price level, P^*	0.76	*Financial flows parameters*:	
Exchange rate, E	1.00	Elasticity of S^{HF} to parity ratio λ	1.30
Real exchange rate, e_R	1.31	Elasticity of S^{FH} to to parity ratio λ	1.90
		Initial share of home savings	
Labour:		Invested in abroad, ϕ	0.02
Skill share of L	0.07		
Initial skill premium, W_S/W	8.00	*Investment parameters*:	
Participation rate, F/N	50.30	Elasticity of I_N to r_c^e/r	1.00
Population, million, N	19.10	Depreciation rate, δ	0.05

a. G_X is governmnet expenditure on good and services. this and direct tax revenue are both net of transfers.
b. Consumption tax revenue represents after deducting consumption related subsidies provided by the Government for the items such as infant milk food, wheat flour, canned fish, paddy fertiliser, etc.
c. Value represents import duties and excise taxes.
d. Sri Lanka Customs export charges (Terminal handling, documentation, etc.) have considered as export taxes.

Source: Parameter values are indicative. Flows and levels from the raw data are draw from; International Monetary Fund (2001); Central Bank of Sri Lanka (2000); Ministry of Finance (2000).

Table A.2: Database and Parameters for the Sri Lankan Economy in 2015

Variables and base values Bn(2010) US$(LKR/US$=135.94)		**Key parameters**	
Volumes:		*Production shares*:	
GDP, Y	63.43	β_L	0.31
Consumption, C	48.16	β_S	0.21
Investment, I	11.95	β_K	0.48
Government spending, G	10.45[a]		
Exports, X	11.62	*Money market parameters*:	
Imports, M	18.75	Elasticity, money demand to	
Net foreign factor income, N^F	-1.45	Y	1.00
		r	1.00
Values:		Reserve to deposit ratio	0.07
Tax revenue	6.41[b]		
Direct, T^D	2.38[a]	*Taylor rule parameters*:	
Consumption, T^C	-0.39[b]	Elasticity of r to U_R	1.60
Import, T^M	4.31[c]	Elasticity of r to P_C target (P_T)	-0.84
Export, T^X	0.11[d]	$P_T = P_C$*1.025	0.96
Other	0.01		
M_S	29.85	*Power of marginal tax rates*:	
M_B	4.95	$(1 + t_W) = \tau_W$	1.04
K stock	136.50	$(1 + t_K) = \tau_K$	1.04
Private savings, S^P	7.45	$(1 + t_C) = \tau_C$	0.97[b]
Government savings, S^G	-4.04	$(1 + t_M) = \tau_M$	1.23[c]
Total domestic savings, S^D	3.42	$(1 + t_X) = \tau_X$	1.01[d]
Financial outflows, S^{HF}	0.36		
Financial inflows, S^{FH}	3.23	*Consumption parameters*:	
Reserve growth, ΔR	-0.90	Elasticity of C to Y_D	1.00
		Elasticity of C to r	-0.50
Price, initial calibrated levels:		Elasticity of X to e_R, σ	1.00
Domestic interest rate, r	0.08		
Foreign interest rate, r^*	0.02	*Trade parameters*:	
Consumer price level, P_C	0.93	Elasticity of substitution C_H to m	3.50
Producer price level, P_P	0.94	Elasticity of X to e_R	1.00
GDP price level, P_Y	1.00		
Foreign price level, P^*	0.77	*Financial flows parameters*:	
Exchange rate, E	1.00	Elasticity of S^{HF} to parity ratio λ	1.30
Real exchange rate, e_R	1.30	Elasticity of S^{FH} to to parity ratio λ	1.90
		Initial share of home savings	
Labour:		Invested in abroad, ϕ	0.10
Skill share of F	0.09		
Initial skill premium, W_S/W	6.80	*Investment parameters*:	
Participation rate, F/N	53.80	Elasticity of I_N to r_c^e/r	1.00
Population, million, N	20.97	Depreciation rate, δ	0.05

a. G_X is governmnet expenditure on good and services. This and direct tax revenue are both net of transfers.
b. Consumption tax revenue represents after deducting consumption related subsidies provided by the Government for the items such as infant milk food, wheat flour, canned fish, paddy fertiliser, etc.
c. Value represents import duties and excise taxes.
d. Sri Lanka Customs export charges (Terminal handling, documentation, etc.) have considered as export taxes.

Source: Parameter values are indicative. Flows and levels from the raw data are draw from; International Monetary Fund (2016); Central Bank of Sri Lanka (2015); Ministry of Finance (2015).