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Assessing monetary policy targeting regimes for small open economies

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Harsha Paranavithana
Business School, University of Western Australia
Central Bank of Sri Lanka

Leandro Magnusson
Business School, University of Western Australia

Rod Tyers
Business School, University of Western Australia
Research School of Economics, ANU
Centre for Applied Macroeconomic Analysis, ANU

Abstract

This paper quantifies the performance of five monetary policy regimes in controlling macroeconomic volatility triggered by a variety of supply, demand and external shocks in small open economies. While the proposed macroeconomic model is generic, the application is to the case of Sri Lanka. The investigated regimes separately target the exchange rate, a monetary aggregate, nominal GDP, the CPI inflation rate and a Taylor composite of output gaps and inflation. The results suggest that inflation targeting offers the least macro-economic volatility overall. Consistent with earlier research and Mundell's financial trilemma, its stabilising power is greatest under demand and external shocks, which have grown more prominent as product and financial markets have opened.

Keywords

Macroeconomic volatility, Monetary policy, Mundell's trilemma, Sri Lanka

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Address for correspondence:

(E) cama.admin@anu.edu.au

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Harsha PARANAVITHANA
Business School
The University of Western Australia and
Central Bank of Sri Lanka

Leandro MAGNUSSON
Business School
The University of Western Australia

Rod TYERS
Business School
The University of Western Australia and
Research School of Economics,
Centre for Applied Macroeconomic Analysis (CAMA)
Australian National University

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Author contact details:

Harsha Paranavithana
UWA Business School, Crawley, WA 6009, Australia
paranavithana.paranavithana@reserach.uwa.edu.au

Leandro Magnusson
Senior Lecturer of Economics, UWA Business School, Crawley, WA 6009, Australia
leandro.magnusson@uwa.edu.au

Rod Tyers
Winthrop Professor of Economics, UWA Business School, Crawley, WA 6009, Australia
rod.tyers@uwa.edu.au

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** The results and views enunciated in this paper are those of the authors alone and in no way represent those of the Central Bank of Sri Lanka.

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Abstract

This paper quantifies the performance of five monetary policy regimes in controlling macroeconomic volatility triggered by a variety of supply, demand and external shocks in small open economies. While the proposed macroeconomic model is generic, the application is to the case of Sri Lanka. The investigated regimes separately target the exchange rate, a monetary aggregate, nominal GDP, the CPI inflation rate and a Taylor composite of output gaps and inflation. The results suggest that inflation targeting offers the least macro-economic volatility overall. Consistent with earlier research and Mundell's financial trilemma, its stabilising power is greatest under demand and external shocks, which have grown more prominent as product and financial markets have opened.

1. Introduction

Because outcomes depend on the levels of current and capital account openness and financial maturity,[1] monetary authorities in small open economies have often chosen exchange rate targeting regimes instead of other monetary policy regimes.[2] Indeed, prior to the 1990s, monetary authorities in small open economies mostly maintained US$ exchange rate regimes as nominal anchors. Beyond openness and financial maturity, this also depended on beliefs consistent with the spirit of the Bretton Woods Agreement (BWA), that exchange rate stability is essential for promoting trade and investment.[3]

Yet financial globalisation has made exchange rate targeting regimes increasingly difficult to sustain as governments in these economies have come under pressure to liberalise their capital accounts.[4] After the Asian Financial Crisis (AFC, 1997-98) and the Argentine crisis (2001-02) the International Monetary Fund (IMF) supported inflation targeting monetary policies, or, simply, inflation targeting (IT). It claimed that IT would be the best stabiliser of domestic prices, thereby reducing the risk of external balance crises and financial instability (International Monetary Fund, 2006).[5] Considerable empirical evidence has since come

[1] Mundell (1961), McKinnon (1963) and Kenen (1969) highlight the roles of openness and financial maturity in monetary policy choice.
[2] For surveys of the more general literature on the choice of regime, see Tavlas (1993), Frankel (1999) and Rose (2011).
[3] See Bleany and Fielding (2002), Husain, Mody and Rogoff (2005) and Tamgac (2013).
[4] See the research by Devereux (2004), Edwards and Levy-Yeyati (2005), Combes, Kinda and Plane (2012) and Mathur and Subramanian (2016).
[5] The appropriateness of IT regimes in small open economies is also discussed by Masson, Savastano and Sharma (1997), Amato and Gerlach (2002) and Mishkin (2004). In the Sri Lankan context, discussion of this

available that stabilising the domestic price level via IT regimes has facilitated a record low level of macroeconomic volatility in adopting small developing and transitional economies.[6]

Notwithstanding the empirical evidence, a more limited set of studies has offered quantitative evidence in support of alternative approaches in small open economies. McKibbin and Singh (2003) and Bhandari and Frankel (2015) all demonstrate that targeting nominal GDP could be more helpful in balancing the conflicting policy goals of stability and sustainable economic growth. It has even been argued that the targeting of monetary aggregates has proved flexible in practice, while rigid adherence to exchange rate or inflation target has not always delivered good inflation outcomes (Mishkin & Savastano 2001, Gebregiorgis & Handa 2005 and Amarasekara, 2008). Meanwhile, Moura and De Carvalho (2010), Perera and Jayawikrema (2013) and Beju and Ciupac-Ulici (2015) suggest that Taylor (1993) rules are 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 monetary policy targeting regimes is Mundell's (1963) financial trilemma,[7] 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, Shambaugh and Taylor (2005, 2010), Aizenman, Chinn, and Ito (2008, 2010a, 2016), Hutchison, Sengupta and Singh (2012) and Aizenman and Sengupta (2013).

The purpose of this paper is to supplement this extensive literature on the evaluation of alternative monetary policy regimes for small open economies by simulating transitions from exchange rate targeting to a wide range of monetary policy regimes in a consistent modelling framework. Data from the Sri Lankan economy is used to calibrate the model and to analyse the statistical properties of the off-trend supply, demand and external shocks to which it has been subject. Then, the response of each monetary policy regime to these shocks is evaluated for its effects on the volatility of prices, output and economic welfare, measured as real disposable income. A quadratic central bank loss function is further used to consolidate price

possible transition is offerred by Thenuwara (1998), Jayamaha et al. (2002), Perera (2008) and Anand, Ding and Peiris (2011).

[6] Accounts of this evidence are provided by Goncalvez and Salles (2008), Lin and Ye (2009), as well as by Anan, Ding and Peiris (2011).

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

level and output effects. Additionally, Sri Lanka's performance against the financial trilemma is assessed over the course of its monetary policy transitions.

Our results suggest that, under supply side shocks, a nominal GDP targeting regime would provide the most stable output path but welfare measure, measured as real disposable income, is best stabilised by IT. Indeed, IT is seen to perform most consistently in controlling the volatility of welfare and the quadratic loss function, in the face of both demand and external shocks. Consistent with Mundell's trilemma, the increase in Sri Lanka's financial integration and its associated exchange rate flexibility after 2012 is shown to have made external shocks more prominent, further supporting the transition to an IT monetary policy framework.

The remainder of the paper is organized as follows: Section 2 summarises the key monetary and financial policy transitions in the case of Sri Lanka, the experience of which is common to many small open developing economies; Section 3 outlines the macro-model employed; Section 4 describes the analysis and simulation of shocks; Section 5 presents the numerical results obtained; and Section 6 formulates and assesses the trilemma in the Sri Lankan case. Conclusions are outlined in the final section.

2. Monetary and Financial Transitions in Sri Lanka

There have been several regime transitions over the past seven decades in Sri Lanka. 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 BWA.[8] In the mid-1960s, the country faced a balance of payments crisis and, in 1968; the CBC introduced the Foreign Exchange Entitlement Certificate System of dual exchange rates. This taxed outflows 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 exchange rate regime (hereafter, managed float) as part of its

[8] 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 Lanka's 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.

trade liberalization and financial market reform process.[9] This set the stage for the Central Bank of Sri Lanka (CBSL) to move away from direct controls towards more market-oriented instruments in monetary policy management.

In the early 1980s, the CBSL formally adopted a monetary targeting policy framework directed at maintaining reserve money, its operating target, at a level that is consistent with the desired growth of broad money, its intermediate target. Inward and outward financial flows increased 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 23rd 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 aggregate targeting regime 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. At present, as an interim arrangement, the CBSL employs an enhanced monetary policy framework with features of both monetary aggregate targeting and flexible IT, aiming toward a formal flexible IT regime in the future (Central Bank of Sri Lanka 2015). These transitions are summarised in Table 1.

[Table 1 here]

3. Modelling the Effects of Shocks

There is a long tradition in applying economy-wide models to analyse policy issues in small open developing economies.[10] The focus of most such modelling, however, has been on trade liberalisation[11], links between trade policy and poverty[12], and income distribution[13]. At least in the Sri Lankan case, there is no study applying an approach of this type to macro-economic responses to shocks under alternative monetary regimes.

[9] See Athukorala and Jayasuriya (1994); Athukorala and Rajapatirana (2000); Athukorala, Bandara and Kelegama (2011).
[10] For an early review of applications to Sri Lanka, see the review by Bandara (1991).
[11] Sri Lankan applications to trade issues included those by Liyanaarachchi, Bandara and Naranpanawa (2014).
[12] Sri Lankan applications to distributional issues include Naranpanawa et al. (2011) and Liyanaarachchi, Bandara and Naranpanawa (2016).
[13] See Perera, Siriwardana and Mounter (2014).

Here we introduce an elemental macro model for this purpose.[14] The objective is, first, to use the model to calculate the effects of a variety of off-trend supply, demand and external shocks under an exchange rate targeting regime. These shocks are constructed based on historical data, and are denoted by the vector $\underline{v}$. We later consider the correlation matrix of these shocks, $R(\underline{v})$ and the variance-covariance matrix, $\Sigma(\underline{v})$ to account for interlinkages between the shock variables as described in Section 4.

The underlying macroeconomic model has open financial and product markets with a complete production and factor market structure along with reduced form consumption behaviour and exogenous expectations over prices, the exchange rate, the net yield on installed capital and nominal disposable income.[15]

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, and real consumption depends on current levels and expectations over the consumer price level, P_C, the exchange rate, E, the real 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 aggregate, M_T, the level of nominal GDP, Y_N, the consumer price level, P_C (which embodies inflation over a base value)[16] or a Taylor monetary policy rule, 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 yields on savings in the simulated financial market.

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[14] Progenitors include Tyers (2001, 2015) and Azwar and Tyers (2015).

[15] This model is not of the "new Keynesian" type since we prefer to retain Phillips curve behaviour with endogenous employment. There is a related new Keynesian literature that includes contributions by Yasmin (2012) and Airauudo, Nistico and Zanna (2015).

[16] The analysis is short run comparative static and can be thought of as representing short run departures from steady state path. In this case there is no substantive difference between consumer price level and IT (therefore hereafter in this analysis we interpret consumer price level target as IT regime).

3.1.1. The Supply Side

Output volume, y, is Cobb-Douglas with three primary factors, labour, L, skill stocks, S_K, and capital, K, and total factor productivity, A, so that the production of local goods and the local marginal product of capital are:

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

where $\beta_L + \beta_{S_K} + \beta_K = 1$, and total factor productivity, A: $\nu_1 \sim N(0,\sigma_1^2)$, skilled stock, S_K: $\nu_2 \sim N(0,\sigma_2^2)$ and capital stock, K: $\nu_3 \sim N(0,\sigma_3^2)$, are supply side shocks, normally distributed, with standard deviation σ_1 to σ_3, respectively.

The marginal products are conventionally derived, that for capital being:

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

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, $\theta(= P_P / P_K)$, which can be shocked to represent differences in the trend of capital and final goods cost of production.

$$r_c = \frac{P_P MP_K}{P_K} - \delta = \theta MP_K - \delta, \quad (3)$$

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, $(r_c \neq r)$.[17]

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

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

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

[17] Notably, (expected) rate of return from investment in new capital is larger the larger is the expected number of effective workers in employment.

$$u = \frac{F - S_K\left(1+v_2\right) - L}{F} \tag{5}$$

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 in the model were it not for indirect taxes. In their presence we have:

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

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. 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.

$$T^D = t_W\left[WL + W_S S_K\left(1+v_2\right)\right] + t_K r_C P_P K\left(1+v_3\right) \tag{9}$$

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. The disposable income Y_D depends on the nominal GDP, $Y = P_Y y$, combined with net factor income from abroad, less direct tax:

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

Here, N^F represents the 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*, then 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 are – the consumption expenditure, C: $\nu_4 \sim N\left(0, \sigma_4^2\right)$, the expected nominal disposable income, Y_D^e: $\nu_5 \sim N\left(0, \sigma_5^2\right)$, the expected rate of capital net return, r_C^e: $\nu_6 \sim N\left(0, \sigma_6^2\right)$, and expected domestic price level, π^e: $\nu_7 \sim N\left(0, \sigma_7^2\right)$- are included, and C is current consumption expenditure.

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

To capture the home household’s substitution between home-produced goods, which it consumes in volume c_H, and foreign goods, consumed as imports of real volume m, aggregate real consumption is a constant elasticity of substitution composite of the two. In (11), ε^{CR} is the elasticity of consumption to interest rate and ε^{CY} is elasticity of consumption to disposable income.

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

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

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

Here, the first external shocks are introduced, to the foreign price level, P^*: $\nu_7 \sim N\left(0, \sigma_7^2\right)$. 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 consumption tax and the import tariff, 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 depend on the "powers" of the consumption tax and import tariff and the prices:

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

Given these consumption volumes, the composite price of all consumption emerges 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, ΔR. 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, $\hat{e}^e$:[18] The remaining external shock variables, foreign bond yield, r^*: $\nu_8 \sim N(0,\sigma_8^2)$, and expected real exchange rate, e^e: $\nu_9 \sim N(0,\sigma_9^2)$, are applied to this relationship.

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

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.[19]

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[18] 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.

[19] 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.

Investment: This comprises real break-even investment, $\delta\overline{K}$ 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.[20] 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 financing cost, which drives the current replacement value.

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

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

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:

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

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:

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

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.

[20] 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).

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

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 export tax revenue since foreigners pay the export tax, at a rate t_X with the associated 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.

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

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.

$$M_B S_M = a_T u^{\varepsilon^U} \left[\frac{P_T}{P_C}\right]^{\varepsilon^P}, \quad \varepsilon^U, \varepsilon^P > 0, \tag{29}$$

where S_M is a slack variable that has initial value unity. It is set as exogenous when this rule is functional, and endogenous when there is a different target of monetary policy. The unemployment 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 preferences, which embody the minimisation of the loss to society arising from instability in the target variables.[21] The form is conventionally quadratic and it covers both domestic inflation and real GDP.

$$L = -\left[\Omega\left(\hat{P}_C\right)^2 + \left(1-\Omega\right)\left(\hat{Y}_R\right)^2\right] \text{ where } 0 \le \Omega \le 1 \tag{30}$$

The parameter Ω indicates the relative weights assigned to output and price stability.

3.2. Model Closures and Database

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 labour market clearance, fiscal balance, and the choice of monetary policy targets; along with the determinants of expectations affecting the price level, the real exchange rate and the rate of return on investment. They specify which variables are to be held as exogenous in any model solution. The alternatives are detailed in Table 2 and 3.

[Tables 2 and 3 here]

Two 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 Off-Trend Shocks

Supply, demand and external to shocks are introduced to the model via the set of zero-mean random variables, ν_i, indicated in Section 3.1. Since our interest is in transient departures

[21] Applications of quadratic loss functions to assess central bank performance include those by Svensson (1999, 2009) and Walsh (2010).

[22] In 2000, the CBSL monetary policy structure was focused on monetary targeting framework and monetary aggregate became the key nominal anchor in this framework. 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 together with relaxing some capital controls and flexible exchange rate policies. In this year, the CBSL enhanced their monetary policy framework with features of both monetary aggregate targeting and flexible IT.

from steady state growth trends, the statistical properties of these random variables are first estimated from deviations around log-linear trends. For the version of the model calibrated on 2015, seasonally adjusted quarterly data from 2002Q1 to 2016Q4 are used, from which we construct a correlation matrix, $R(\underline{v})$. Table 4 indicates the correlation coefficients for the nine shock variables.

[Table 4 here]

It is readily seen that supply side shocks (v_1 to v_3), are positively correlated with each other and that each correlation is significant at the one per cent level. The shocks to consumption, v_4, and expected nominal disposable income, v_5, which represent the demand side, are also positively correlated, with each other as well as with the supply side shocks. These correlations are significant at the one per cent level. As expected, the domestic price level shock, v_6, negatively correlates with the other 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. The external shocks, which are to the foreign price level, v_7, the foreign bond yield, v_8 and the expected real exchange rate, v_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 calibrated correlation matrix, $R'(\underline{v})$, is then constructed to represent these statistically significant results (Table 5). Insignificant correlations (ten per cent and below) are ignored in this new matrix, $R'(\underline{v})$.[23]

[Table 5 here]

The next step is to use these correlations to represent the simultaneity of the shocks. For this, we construct a variance-covariance matrix, $\Sigma(\underline{v})$, based on our calibrated correlation matrix, $R'(\underline{v})$. When standard deviation shocks are imposed on each component of $\underline{v}$, associated shocks are constructed to other elements of $\underline{v}$ based on the individual column vectors of $\Sigma(\underline{v})$ as follows:

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

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

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

$$var\begin{bmatrix} \nu_1 \\ U_2 \end{bmatrix} = \begin{bmatrix} \sigma_1^2 & \Sigma_{12} \\ \Sigma_{21} & \Sigma_{22} \end{bmatrix},$$

where Σ_{12} is 1×8; Σ_{21} is 8×1; Σ_{22} is 8×8. We then define the conditional expectation of U_2, given ν_1, to be:

$$E\left[U_2 \mid \nu_1\right] = \frac{\Sigma_{21}}{\sigma_1^2}\nu_1 \tag{31}$$

The links between the first shock, ν_1, and the other variables' standard deviation shocks are then obtained from (31). For $\nu_1 \in \left[0, \sigma_1\right]$, $E\left(U_2 \mid \nu_1\right) = \left(0, \frac{\Sigma_{21}}{\sigma_1}\right)$.

The final step is to use the shock vector, (Σ_{21} / σ_1), associated with the shock to ν_1, to construct the complete shock vector, ν_1^S, thus allowing for the interaction between shocks.[24] This procedure is then followed to construct combined shock vectors, $\underline{\nu}^S$ for all of the remaining eight components of the original vector $\underline{\nu}$. Table 6 summarises the resulting supply, demand and external composite shocks.

[Table 6 here]

In addition to use of these shocks to analyse the modern Sri Lankan economy, we calibrate a model database for 2000, in order to examine how changes to the Sri Lankan economy since then have altered the relative merits of alternative monetary policies. For this, we use seasonally adjusted quarterly data from 1995Q1 to 2000Q4 to formulate a new correlation matrix, $R_1\left(\underline{\nu}\right)$. In this case, we find that none of the correlations are 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 considering the correlation between

[24] Shock vector, ν_1^S, is a 9×1 column vector including a one-standard-deviation shock to ν_1 and its related shocks to other variables, Σ_{21} / σ_1.

elemental shocks. Table 8 summarises the supply, demand and external shocks that follow from Table 7.

[Tables 7 and 8 here]

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 one-standard-deviation shocks are applied to each of the nine random variables, $\underline{v}$, 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

Transient short run shocks are applied to the model over a baseline growth path of the economy. To achieve this, a set of baseline shocks are imposed that are common throughout the analysis. These are to the supply side variables: total factor productivity, v_1, the skilled labour force, v_2 and the capital stock, v_3. They allow a baseline inflation rate and GDP growth rate that make sensible positive central bank target inflation and nominal GDP targets. The focal off-trend shocks, $\underline{v}^S$, which are derived from volatility around trends, are then implemented over and above the baseline shocks.

To reiterate for clarity, positive supply side shocks most often offer the positive effects of real growth, though these can be reflected in standard measures of volatility. In this case, all shocks are imposed around a fixed set of positive supply side trends that represent Sri Lanka's underlying growth path. It is therefore appropriate that monetary policy should be directed at stabilisation against those shocks that constitute deviations from this path. The constructed one standard deviation supply side shocks v_1^S to v_3^S therefore represent departures from the baseline drivers of growth and so are true sources of volatility around the trend.[25]

[25] The only caveat is that, when positive, even though transient *ex post*, these shocks may be indistinguishable from well-founded real growth surges that monetary authorities would be unlikely to resist *ex ante*.

Further as to these baseline shocks, while this paper is focused on monetary policy effectiveness against off-trend volatility, an alternative question is, for given steady state growth shocks, which monetary policy best facilitates the growth of output and economic welfare? The results suggest that, while the differences across monetary policies are not large, the IT regime proves to be a comparatively strong facilitator of real GDP expansion. The nominal GDP and monetary aggregate targeting regimes, on the other hand, emerge as marginally better facilitators of growth in real disposable income.

5.2. Volatility in the 2015 Economy

The simulation results for one-standard deviation off-trend shocks are summarised in Figure 1. The supply side shocks (ν_1^S to ν_3^S) are shown to cause higher volatility in real GDP under the IT regime relative to the others. It is well known that, sustaining price level stability in the face of supply side shocks can exacerbate volatility in output and "accommodating" changes in monetary policy are required in practice when such shocks occur. Frankel (2018) explains this and observes that nominal GDP targeting offers a possible improvement in this regard, and this is indeed what we find. From Figure 1 it can be seen that the nominal GDP targeting regime offer comparative output stability in the face of supply side shocks. This is mainly due to the nominal GDP targeting regime's accounting simultaneously for output and price level effects. 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. The IT regime delivers the most stabilising welfare outcomes.

When imposing the demand side shocks (ν_4^D to ν_6^D) the nominal GDP targeting regime emerges as particularly strong in stabilising real output in the case of the consumption shock, ν_4^D. The expected disposable income shock, ν_5^D, causes lower volatility in real GDP with IT and Taylor monetary policy regimes than with the alternatives. Moreover, the shocks to the expected domestic price level, ν_6^D, correlate negatively with the 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 (ν_7^E to ν_9^E), suggest ambiguity at first sight. The foreign price level shock, ν_7^E, creates particularly high volatility in both real GDP and welfare under the exchange rate targeting regime. This is because central bank defence of the exchange rate creates volatility of domestic employment, investment and the price level. Shocks to the foreign interest rate, ν_8^E and the expected real exchange rate, ν_9^E, also cause particularly 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 because the flexibility of the exchange rate acts as an absorber of external shocks and the associated benefit small economies like Sri Lanka enjoy in that exchange rate volatility tends not to elicit strategic reactions in trading partner economies.

[Figure 1 here]

When applying shocks more independently, without considering cross correlations affecting the 2015 model economy, supply side shocks (ν_1 to ν_3) still cause less real GDP volatility in the nominal GDP targeting regime than the alternatives. Demand (ν_4 to ν_6) and external (ν_7 to ν_9) shocks cause less real GDP volatility under the IT regime, with the Taylor-type monetary policy regime second best. It remains particularly important that, when there are demand side shocks, the IT framework acts as an automatic stabiliser for the economy. For example, a negative demand side shock leads to interest rates being lower than they otherwise would have been. This has the effect of moving output back towards its potential and inflation back to its target midpoint. In this regard, it is important to note the role of the roughly symmetric responses to positive and negative demand side shocks, facilitated by the emphasis on the target midpoint. In the welfare context, the stable domestic price level achieved under the IT regime minimises volatility in the face of most shocks.

[Figure 2 here]

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 (ν_1 to ν_3). These elicit similar responses to the 2015 economy, though magnitudes differ, largely because of the independence of the shocks. Importantly, the IT target performs best on welfare grounds, with the exchange rate target monetary policy regime a close second.

Demand side shocks (ν_4 to ν_6) elicit the most volatile effects on output and welfare under the nominal GDP and monetary aggregate targeting regimes, due to the positive correlation between price level and real output. These shocks also allow a stable level of real GDP under the IT and Taylor-type monetary policy regimes, but the IT regime is uniquely superior in the effects on our welfare measure.

Under the external side shocks (ν_7 to ν_9), and particularly for the shock to the real exchange rate, ν_9, the exchange rate targeting regime seems most stabilising overall. Under this regime, however, volatility is large in response to changes in the foreign price level, ν_7 and foreign interest rate, ν_8, 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 regime offers the most favourable response to external shocks.

[Figure 3 here]

5.4. The 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 quadratic central bank loss function (30), which integrates output and price level volatility.

5.4.1. The 2015 Economy

The welfare losses that stem from cross-correlated supply, demand and external shocks in all five monetary policy regimes are shown in Table 9. When policymakers allocate more weight to domestic output stability (if Ω = 0.2), supply side shocks (ν_1^S to ν_3^S) record comparatively smaller welfare losses under the nominal GDP targeting regimes than the alternatives. This is mainly due to smaller responses of employment and investment. If, on the other hand, their preference gives the greater weight to domestic price level stability (say, if Ω = 0.8), exchange rate and monetary aggregate targeting regimes show reduced losses according to the central bank loss function. If policymakers allocate equal weight (Ω = 0.5) to both goals the Taylor-type monetary policy regime appears to minimise losses compared with the others.

For the demand side shocks, that to consumption, ν_4^D, appears to favour the nominal GDP targeting regime so long as if policymakers allocate most weight to domestic output stability.

On the other hand, the other demand side shocks (ν_5^D and ν_6^D) yield most favourable impacts under the Taylor-type monetary policy regime. If preferences are weighted to domestic price stability, the IT regime yields the smallest loss function outcome. As in the case of supply side shocks, however, if the policy weights are equal, the Taylor-type monetary policy regime provides minimises losses. External shocks (ν_7^E to ν_9^E) cause the least welfare loss in the central bank loss function when the monetary policy regime is IT and this result is robust to policymaker preferences that weight the stability of either domestic output or domestic price level.

[Table 9 here]

We now turn to the application of shocks to the 2015 economy without interdependence. The results are shown in Table 10. As previously, supply side shocks (ν_1 to ν_3) cause the least welfare loss in under the nominal GDP targeting regime. If policymakers preferences weight price stability most heavily, the IT regime performs best. Demand (ν_4 to ν_6) and external (ν_7 to ν_9) shocks provide fewer losses under the IT regime.

[Table 10 here]

5.4.2. The 2000 Economy

In the economy of 2000 all shocks were independent in any case. The simulation results are displayed in Table 11. In this case, as in the 2015 economy, the supply side shocks yield the least welfare loss under nominal GDP targeting regime when policymakers allocate most weight to domestic output stability. However, when policymakers allocate more weight to domestic price level stability, the IT regime is the best stabiliser, yielding smaller changes in employment and investment. When policymakers allocate same weight, overall the Taylor monetary policy regime records the least losses. As previously, demand and external shocks are most favourably managed under the IT regime.

[Table 11 here]

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:

1990-2000: monetary aggregate targeting (with "managed" floating exchange rate)
2001-2011: monetary aggregate targeting (with "floating" exchange rate)

2012-2015: enhanced monetary policy framework[26] (with "independent floating" exchange rate[27])

We follow the approach of Aizenman, Chinn and Ito (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 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 quarterly correlation of the monthly 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).

$$I_t^M = 1 - \left[\frac{corr(i_i, i_j) - (-1)}{1 - (-1)} \right] \tag{32}$$

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

[Figure 4 here]

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

This index 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 base country (here the US). The index is calculated as:

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[26] Even though the CBSL informally enhanced their monetary policy framework in 2015 including both features of monetary aggregate targeting and flexible IT aiming formal flexible IT regime in future, prior to that, they have considered several measures to align with it consultation with the IMF. Therefore, in this study, we have identified this period as an enhanced monetary policy framework regime.

[27] On 09th February 2012 and 03rd September 2015, greater flexibility in the determination of the exchange rate was allowed by the CBSL. Therefore, in this study, we have identified this period as an independent floating exchange rate regime.

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

[29] More details on the construction of the I^M and I^{ER} indices can be found in Aizenman, Chinn and Ito (2008, 2010a).

$$I_t^{ER} = \frac{0.01}{0.01 + SD\left[\Delta log\left\{E_{US}\right\}\right]} \tag{33}$$

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.[28]

[Figure 4 here]

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. First, define financial capital flows as being of four types, *i*: 1) Bank and money market flows, 2) Portfolio debt and equity flows, 3) Changes in official reserves, and 4) Foreign direct investment. A suitable index for flow type i depends in every quarterly period (t) on the ratio of gross capital outflows, S^{HF} (21) to total domestic savings, S^{D}, on the one hand and that of the gross value of financial capital inflows S^{FH} (21) to the level of gross domestic investment, *I* (23), as follows:

$$I_{it}^{FC} = \frac{1}{2}\left[\frac{|S_{it}^{HF}|}{|S_{it}^{D}|} + \frac{|S_{it}^{FH}|}{|I_t|}\right] \tag{34}$$

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

[Figure 4 here]

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 (we use the value two). If the trilemma is binding, then a country that implements any two of the three policy goals will have to forego the third. To ensure that this behaviour is captured, the constant term is omitted on the right-hand side of the following estimation equation.[30]

[30] See Hutchison, Sengupta and Singh (2012) and Aizenman and Sengupta (2013).

$$2 = \alpha I_t^M + \beta I_t^{ER} + \gamma I_{it}^{FC} + \varepsilon_t \tag{35}$$

The estimated coefficients in the above regression give us an idea as to the weights attached by policy-makers to the three policy goals. Moreover, a 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 12.[31]

[Table 12 here]

The key measure of the trilemma policy configuration is obtained by examining the contribution of each policy dimension. We calculate this by multiplying the coefficients by means for each sub-period. The contributions of the indices are of great interest in terms of the trilemma policy configuration and how it changes with transitions in monetary and exchange rate policies. Until the third sub-period, Sri Lankan policy makers adopted a heavy weight on exchange rate stability. But, during the final sub-period they appear to have attached greater priority to the financial openness goal. Moreover, during the last two and half decades, Sri Lankan policy makers have gradually increased the weight they attach to monetary independence.[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 monetary independence and exchange rate stability when financial openness is given. In Figure 5 we present the evolution of trilemma policy objectives with the reserves/GDP, I^R, ratio.[33]

[Figure 5 here]

The story in Figure 5 is the same as that of Table 12, with the addition of official foreign reserves. The overall shift in policy orientation brings increased emphasis on monetary independence and financial openness, along with a moderated reserve accumulation as

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[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.

[32] The story that appears from Table 12 is consistent with the broad picture of what occurred in Sri Lanka over past two and half decades.

[33] In this study we use as an explanatory variable changes in official foreign reserves, which comprise Central Bank and Government owned reserves, as a percentage of GDP.

increased exchange rate volatility is tolerated. These are the precise prerequisites for a transition to an IT regime.[34]

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 and at different stages of development. 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 an inflation targeting monetary policy framework. Further support for this transition is suggested by a subsequent analysis of indices under the "impossible trilemma", focussing on the course of Sri Lanka's transitions between monetary policy regimes since 1990.

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 and external shocks. Moreover, a quadratic central bank loss function indicates that an inflation targeting monetary policy framework would be superior, mainly because it would allow the exchange rate to play a role as shock absorber, thus stabilising domestic output and inflation.

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[34] A flexible nominal exchange rate constitutes, at least from a theoretical standpoint, a requirement for a well-functioning IT regime (Masson, Savastano & Sharma 1997 and Mishkin & Savastano, 2001). On the other hand, strong monetary independence could permit policy makers to stabilise the economy through monetary policy without being subject to other economies' macroeconomic management. Thus it allows increasing transparency of monetary policy strategy, which is a central element of IT regimes.

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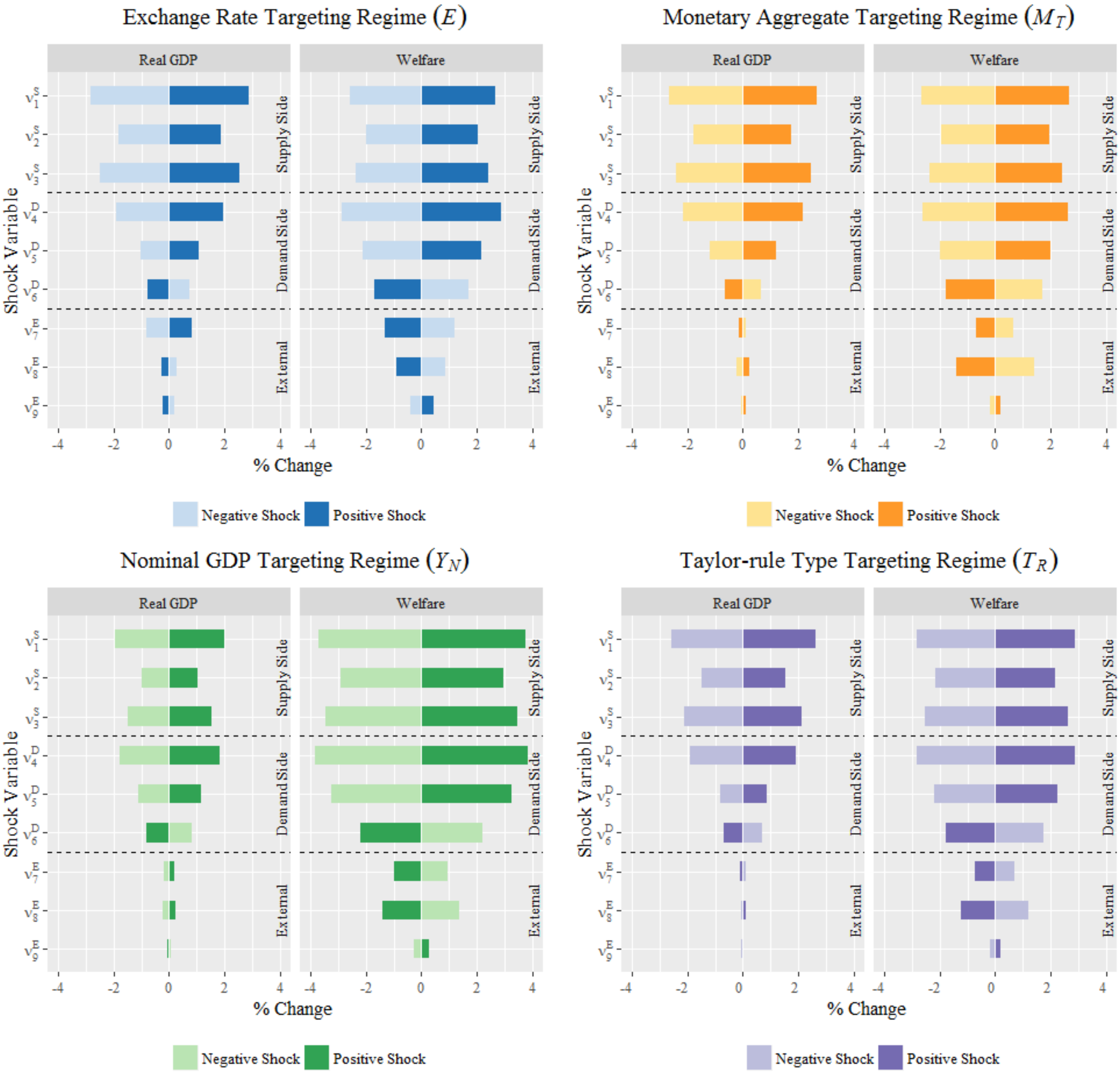
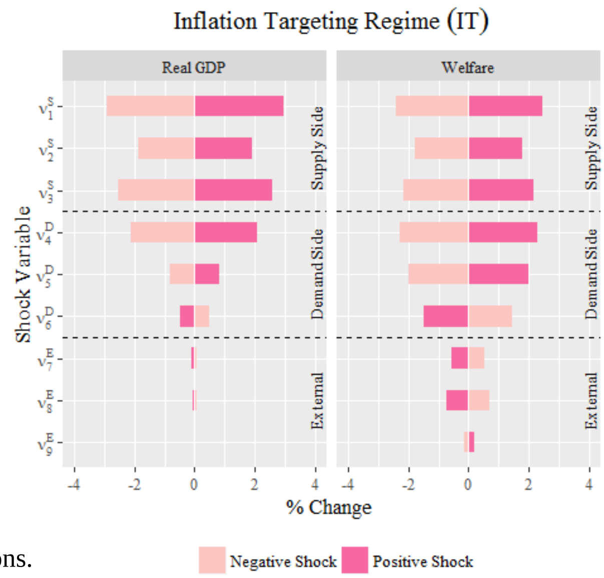
Figure 1: Supply, Demand and External Shocks and Macroeconomic Volatility: With Cross Correlation (2015 Model Database)



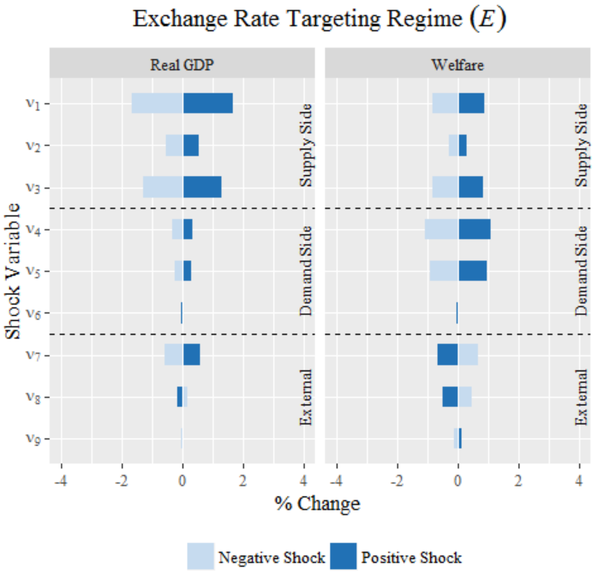


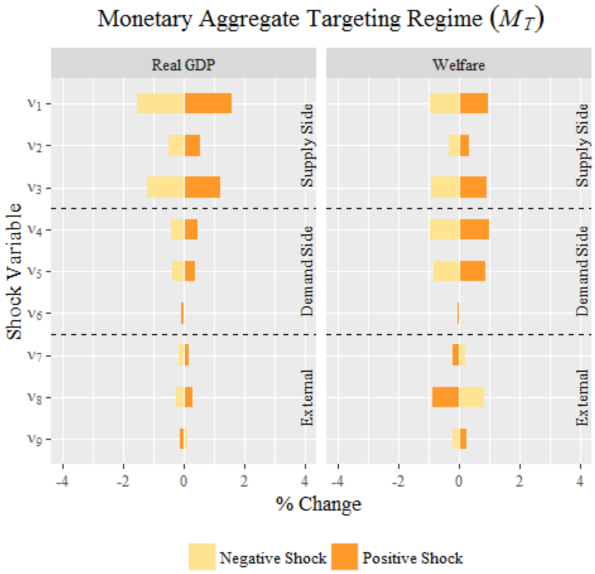
Source: Authors' calculations.

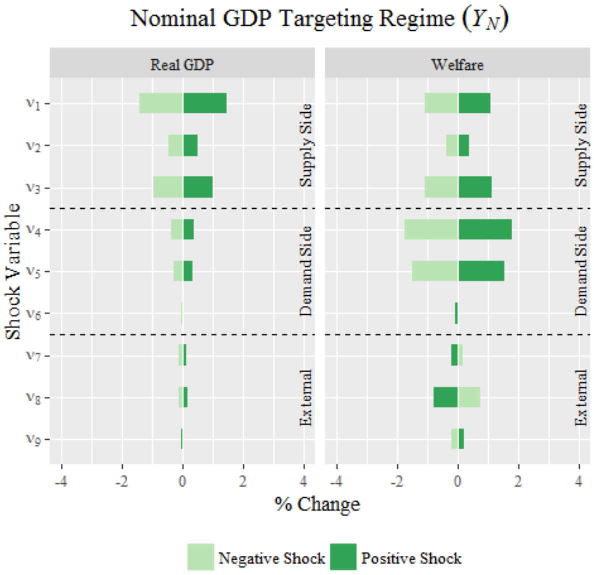
Figure 2: Supply, Demand and External Shocks and Macroeconomic Volatility: Without Cross Correlation (2015 Model Database)

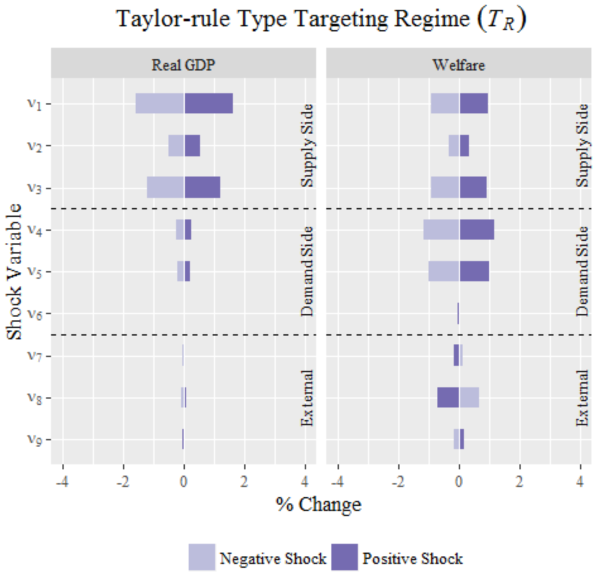
Source: Authors' calculations.

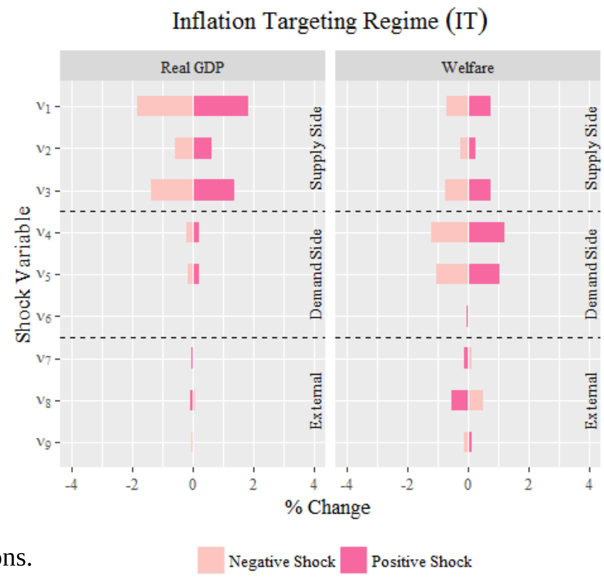
Figure 3: Supply, Demand and External Shocks and Macroeconomic Volatility: Without Cross Correlation (2000 Model Database)









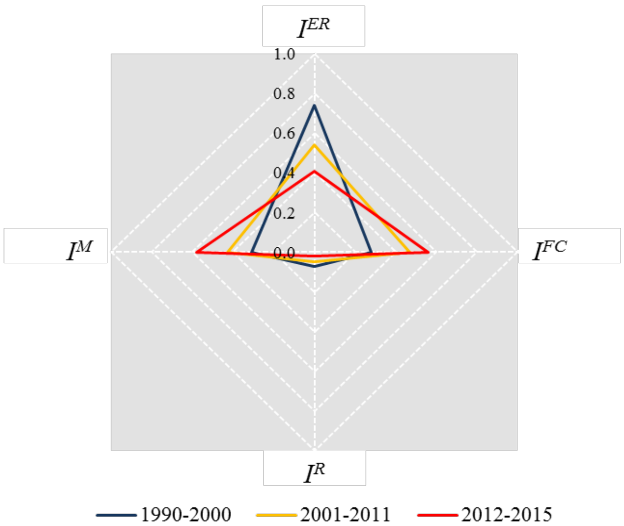


Source: Authors' calculations.

Figure 4: The Financial Trilemma Policy

Source: Authors' calculations.

Figure 5: The Financial Trilemma Evolution and International Reserve Accumulation



Source: Authors' calculations.

Table 1: Evolution of Sri Lanka's Monetary and Financial Frameworks

Period	Measures or Actions
Pre 1968	Fixed exchange rate regime
1968	Established dual exchange rate regime
1977	Introduced open economic policy
	Established managed floating with crawling band 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	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	Limited to intervene in the domestic foreign exchange market
2013	Allowed non-bank financial institutions to accept foreign currency deposits
2015	Allowed the exchange rate to be largely determined by the market conditions Established monetary policy framework with features of both monetary aggregate targeting and flexible IT frameworks

Source: Central Bank of Sri Lanka (1998, 2005, 2009, 2015).

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. Policy rule (Taylor), T_R
	5. Consumer price inflation, $\pi = \hat{P}_C$,(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. This choice mirrors assumptions about the behaviour of labour markets, fiscal deficits and monetary policy targets.

b Alternative monetary policy regimes. The Taylor monetary policy rule target combines canges in output, the interest rate and inflation.

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*: Government expenditure, G *Endogenous*: Real government expenditure, G^R *Endogenous*: Government savings (surplus), S^G
Monetary Aggregate, M_T	Monetary policy closure: *Exogenous*: Monetary aggregate, M_T *Endogenous*: Other monetary policy variables Labour market closure: same as above Fiscal policy closure: same as above
Nominal GDP, Y_N	Monetary policy closure: *Exogenous*: Nominal GDP, Y_N *Endogenous*: Other monetary policy variables Labour market closure: same as above Fiscal policy closure: same as above
Taylor-rule, T_R	Monetary policy closure: *Exogenous*: Taylor rule, T_R *Endogenous*: Other monetary policy variables Labour market closure: same as above Fiscal policy closure: same as above
Consumer Price inflation, IT	Monetary policy closure: *Exogenous*: Change in consumer price level, $\pi = \hat{P}_C$ *Endogenous*: Other monetary policy variables Labour market closure: same as above Fiscal policy closure: same as above

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

Table 4: Correlation Coefficients and Significance Level (2002Q1-2016Q4)[a]

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	ν_1	1.00								
	ν_2	0.64*** (0.00)	1.00							
	ν_3	0.63*** (0.00)	0.64*** (0.00)	1.00						
Demand Side	ν_4	0.48*** (0.00)	0.44*** (0.00)	0.42*** (0.00)	1.00					
	ν_5	0.31*** (0.01)	0.41*** (0.00)	0.36*** (0.00)	0.29** (0.03)	1.00				
	ν_6	-0.22* (0.09)	-0.17 (0.20)	-0.30** (0.02)	-0.37*** (0.00)	-0.38*** (0.00)	1.00			
External	ν_7	-0.10 (0.46)	-0.11 (0.40)	-0.16 (0.24)	-0.30** (0.02)	0.01 (0.99)	0.34*** (0.01)	1.00		
	ν_8	-0.06 (0.62)	0.02 (0.90)	0.03 (0.83)	0.07 (0.57)	-0.24* (0.07)	0.40*** (0.00)	0.12 (0.36)	1.00	
	ν_9	-0.01 (0.98)	-0.10 (0.43)	-0.18 (0.18)	0.05 (0.72)	-0.34*** (0.01)	0.24** (0.05)	-0.20 (0.13)	0.40*** (0.00)	1.00

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

Source: Authors' calculations.

Table 5: Calibrated Correlation Matrix and Variance-covariance Matrix

$R'(\underline{v})$

	v_1	v_2	v_3	v_4	v_5	v_6	v_7	v_8	v_9
v_1	1.0								
v_2	0.6	1.0							
v_3	0.6	0.6	1.0						
v_4	0.5	0.4	0.4	1.0					
v_5	0.3	0.4	0.4	0.3	1.0				
v_6	-0.2	0.0	-0.3	-0.4	-0.4	1.0			
v_7	0.0	0.0	0.0	-0.3	-0.1	0.3	1.0		
v_8	0.0	0.0	0.0	0.0	-0.2	0.4	0.0	1.0	
v_9	0.0	0.0	0.0	0.1	-0.3	-0.2	0.0	0.4	1.0

$\Sigma(\underline{v})$

	v_1	v_2	v_3	v_4	v_5	v_6	v_7	v_8	v_9
v_1	2.9								
v_2	1.1	1.2							
v_3	1.7	1.1	2.7						
v_4	3.6	1.8	2.9	17.6					
v_5	2.0	1.7	2.7	4.9	15.2				
v_6	-1.8	0.0	-2.7	-8.7	-8.3	28.1			
v_7	0.0	0.0	0.0	-3.9	-1.2	4.9	9.6		
v_8	0.0	0.0	0.0	0.0	-1.6	4.2	0.0	4.0	
v_9	0.0	0.0	0.0	0.7	-2.0	-1.8	0.0	1.4	2.9

Source: Authors' calculations.

Table 6: Supply, Demand and External Shocks (For 2015 Model Database)[a]

Shock Variable		**One-standard-deviation and its Related Shocks**								
		v_1	v_2	v_3	v_4	v_5	v_6	v_7	v_8	v_9
Supply Side	v_1	**1.1**	0.6	0.9	2.2	1.4	-1.1			
	v_2	1.0	**1.1**	1.0	2.2	1.4				
	v_3	1.0	0.7	**1.7**	2.1	1.4	-1.6			
Demand Side	v_4	0.9	0.6	0.8	**4.2**	1.0	-1.6	-0.9		0.2
	v_5	0.7	0.4	0.6	1.3	**3.9**	-1.6	-0.3	-0.4	-0.5
	v_6	-0.3		-0.5	-1.3	-1.0	**5.3**	0.9	0.8	-0.3
External	v_7				-1.3	-0.4	1.5	**3.1**		
	v_8					-0.7	2.1		**2.0**	0.7
	v_9				0.4	-1.0	-1.1		0.8	**1.7**

a The zero values in the individual v_i^S are ignored in compiling this table. Closures vary with the cases, as indicated, but are selected from the list in Table 2. Shocks are applied for all the regimes listed in Table 3.

Source: Authors' calculations.

Table 7: Correlation Coefficients and Significance Level (1995Q1-2000Q4)[a]

Shock Variable		$R_1(\underline{v})$								
		v_1	v_2	v_3	v_4	v_5	v_6	v_7	v_8	v_9
Supply Side	v_1	1.00								
	v_2	0.19 (0.37)	1.00							
	v_3	0.39* (0.06)	0.08 (0.71)	1.00						
Demand Side	v_4	0.05 (0.81)	-0.35* (0.09)	0.14 (0.50)	1.00					
	v_5	-0.09 (0.68)	-0.38* (0.07)	-0.30 (0.16)	0.25 (0.24)	1.00				
	v_6	0.13 (0.56)	0.19 (0.37)	-0.11 (0.61)	-0.12 (0.57)	-0.32 (0.13)	1.00			
External	v_7	-0.30 (0.15)	-0.05 (0.83)	-0.52* (0.06)	0.17 (0.43)	0.31 (0.13)	0.38* (0.07)	1.00		
	v_8	-0.01 (0.98)	0.19 (0.37)	-0.12 (0.57)	-0.22 (0.31)	-0.08 (0.73)	0.18 (0.40)	0.24 (0.27)	1.00	
	v_9	0.17 (0.43)	0.16 (0.44)	0.22 (0.31)	0.14 (0.52)	-0.51* (0.06)	0.29 (0.16)	-0.29 (0.17)	-0.31 (0.13)	1.00

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

Source: Authors' calculations.

Table 8: Supply, Demand and External Shocks (For 2000 Model Database) [a]

Shock Variable		One-standard-deviation Shocks								
		v_1	v_2	v_3	v_4	v_5	v_6	v_7	v_8	v_9
Supply Side	v_1	**1.4**								
	v_2		**2.1**							
	v_3			**2.4**						
Demand Side	v_4				**3.6**					
	v_5					**3.1**				
	v_6						**6.5**			
External	v_7							**2.5**		
	v_8								**1.7**	
	v_9									**2.3**

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

Source: Authors' calculations.

Table 9: Central Bank Loss Function (The 2015 Economy: Shocks With Cross Correlations)

Shock Variable		Ω = 0.2					Ω = 0.5					Ω = 0.8				
		E	M_T	Y_N	T_R	IT	E	M_T	Y_N	T_R	IT	E	M_T	Y_N	T_R	IT
Supply Side	v_1^S	-6.27	-6.13	**-3.84**	-5.39	-6.67	-3.58	-3.50	-5.36	**-3.34**	-3.79	-0.90	**-0.88**	-6.88	-1.29	-0.92
	v_2^S	-2.64	-2.81	**-1.66**	-2.46	-2.88	-1.65	-1.76	-2.61	**-1.63**	-1.80	**-0.66**	-0.71	-3.56	-0.81	-0.72
	v_3^S	-4.73	-5.15	**-3.38**	-4.50	-5.37	**-2.97**	-3.23	-4.89	-3.04	-3.35	**-1.21**	-1.31	-6.40	-1.57	-1.34
Demand Side	v_4^D	-2.78	-3.88	**-2.49**	-3.05	-3.60	**-1.85**	-2.44	-4.96	-2.04	-2.25	-0.93	-0.99	-7.43	-1.03	**-0.90**
	v_5^D	-0.93	-1.25	-1.80	**-0.74**	-0.80	-0.59	-0.93	-4.49	**-0.47**	-0.50	-0.25	-0.61	-7.18	-0.20	**-0.20**
	v_6^D	-0.50	-0.49	-0.98	**-0.47**	-0.65	**-0.39**	-0.49	-2.38	-0.45	-0.40	-0.27	-0.52	-3.78	-0.42	**-0.16**
External	v_7^E	-1.09	-0.17	-0.24	-0.13	**-0.01**	-2.29	-0.11	-0.53	-0.08	**-0.01**	-3.50	-0.04	-0.82	-0.04	**0.00**
	v_8^E	-0.08	-0.44	-0.41	-0.12	**-0.02**	-0.08	-0.98	-0.94	-0.28	**-0.01**	-0.09	-1.52	-1.47	-0.45	**-0.01**
	v_9^E	-0.15	-0.03	-0.02	-0.01	**0.00**	-0.31	-0.02	-0.04	-0.01	**-0.00**	-0.48	-0.01	-0.06	0.00	**0.00**

Source: Authors' calculations.

Table 10: Central Bank Loss Function (The 2015 Economy: Shocks Without Cross Correlations)

Shock Variable		Ω = 0.2					Ω = 0.5					Ω = 0.8				
		E	M_T	Y_N	T_R	IT	E	M_T	Y_N	T_R	IT	E	M_T	Y_N	T_R	IT
Supply Side	v_1	-2.28	-2.06	**-1.82**	-2.10	-2.81	**-1.16**	-1.18	-1.40	-1.17	-1.38	-0.54	-0.81	-1.48	-0.74	**-0.45**
	v_2	-0.06	-0.06	**-0.05**	-0.06	-0.07	-0.04	-0.04	-0.04	**-0.04**	-0.04	-0.02	-0.02	-0.04	-0.03	**-0.02**
	v_3	-0.81	-0.74	**-0.65**	-0.74	-0.91	-0.52	-0.52	-0.67	**-0.51**	-0.57	-0.23	-0.30	-0.69	-0.30	**-0.23**
Demand Side	v_4	-0.13	-0.35	-0.83	-0.07	**-0.04**	-0.14	-0.51	-1.87	-0.06	**-0.02**	-0.15	-0.67	-2.90	-0.04	**-0.01**
	v_5	-0.11	-0.30	-0.72	-0.06	**-0.03**	-0.12	-0.44	-1.61	-0.05	**-0.02**	-0.13	-0.58	-2.50	-0.04	**-0.01**
	v_6	-0.16	-0.17	-0.26	-0.16	**-0.07**	-0.16	-0.17	-0.26	-0.16	**-0.05**	-0.16	-0.17	-0.27	-0.16	**-0.02**
External	v_7	-1.38	-0.15	-0.14	-0.01	**0.00**	-2.76	-0.23	-0.17	-0.02	**-0.00**	-4.13	-0.30	-0.19	-0.03	**-0.00**
	v_8	-0.06	-0.78	-0.35	-0.19	**-0.02**	-0.07	-1.71	-0.79	-0.45	**-0.01**	-0.08	-2.63	-1.23	-0.71	**-0.00**
	v_9	-0.01	-0.03	-0.06	-0.03	**0.00**	-0.01	-0.03	-0.14	-0.08	**-0.00**	-0.01	-0.03	-0.22	-0.12	**-0.00**

Source: Authors' calculations.

Table 11: Central Bank Loss Function (The 2000 Economy: Shocks Without Cross Correlations)

Shock Variable		**Ω = 0.2**					**Ω = 0.5**					**Ω = 0.8**				
		E	M_T	Y_N	T_R	**IT**	***E***	M_T	Y_N	T_R	**IT**	***E***	M_T	Y_N	T_R	**IT**
Supply Side	ν_1	-2.29	-2.10	**-1.92**	-2.16	-2.70	-1.51	-1.51	-1.64	**-1.50**	-1.69	-0.73	-0.92	-1.36	-0.84	**-0.68**
	ν_2	-0.26	-0.24	**-0.22**	-0.24	-0.31	-0.17	-0.17	-0.19	**-0.17**	-0.19	-0.08	-0.10	-0.16	-0.11	**-0.08**
	ν_3	-1.39	-1.24	**-1.07**	-1.26	-1.58	-0.89	-0.88	-1.12	**-0.88**	-0.99	-0.40	-0.52	-1.17	-0.50	**-0.39**
Demand Side	ν_4	-0.11	-0.24	-0.70	-0.06	**-0.04**	-0.11	-0.31	-1.54	-0.04	**-0.02**	-0.12	-0.38	-2.37	-0.03	**-0.01**
	ν_5	-0.08	-0.18	-0.52	-0.04	**-0.03**	-0.09	-0.23	-1.14	-0.03	**-0.02**	-0.09	-0.28	-1.76	-0.02	**-0.01**
	ν_6	-0.09	-0.10	-0.10	-0.09	**-0.07**	-0.09	-0.10	-0.10	-0.09	**-0.05**	-0.09	-0.10	-0.11	-0.09	**-0.02**
External	ν_7	-0.93	-0.02	-0.01	-0.01	**-0.00**	-1.79	-0.05	-0.02	-0.01	**-0.00**	-2.65	-0.07	-0.03	-0.02	**-0.00**
	ν_8	-0.06	-0.31	-0.13	-0.07	**-0.01**	-0.09	-0.65	-0.29	-0.17	**-0.01**	-0.11	-1.00	-0.45	-0.26	**-0.00**
	ν_9	-0.00	-0.02	-0.01	-0.01	**-0.00**	-0.00	-0.05	-0.02	-0.01	**-0.00**	-0.00	-0.07	-0.03	-0.02	**-0.00**

Source: Authors' calculations.

Table 12: Testing the Validity and the Contributions of the Trilemma Framework[a]

	1990-2000		2001-2011		2012-2015		1990-2015	
Mean: I^M	0.31		0.43		0.58		0.31	
I^{ER}	0.74		0.54		0.41		0.74	
I^{FC}	0.28		0.47		0.56		0.28	
Coefficients: I^M	0.22*		0.44*		0.95**		0.41***	
	(0.12)		(0.25)		(0.30)		(0.10)	
I^{ER}	1.93***		1.96***		0.82*		1.85***	
	(0.08)		(0.14)		(0.50)		(0.03)	
I^{FC}	1.76***		1.59***		1.97***		1.75***	
	(0.21)		(0.23)		(0.44)		(0.10)	
Observations	44		44		16		104	
R^2	0.998		0.997		0.998		0.997	
Contributions:	Value	%	Value	%	Value	%	Value	%
I^M	0.07	3.50	0.19	9.50	0.55	27.50	0.13	6.50
I^{ER}	1.41	70.50	1.05	52.50	0.34	17.00	1.38	69.00
I^{FC}	0.49	24.50	0.75	37.50	1.10	55.00	0.49	24.50

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

Source: Authors' calculations.

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

Variables and Base Values Billion (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 saving, S^P	0.68	$(1+t_C) = \tau_C$	0.91[b]
Government saving, S^G	0.27	$(1+t_M) = \tau_M$	1.27[c]
Total domestic saving, 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 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, L/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 is government 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.

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

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

Variables and Base Values Billion (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)	-0.46
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 saving, S^P	7.45	$(1+t_C) = \tau_C$	0.97[b]
Government saving, S^G	-4.04	$(1+t_M) = \tau_M$	1.23[c]
Total domestic saving, 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 parity ratio λ	1.90
		Initial share of home savings	
Labour:		Invested in abroad, ϕ	0.12
Skill share of L	0.09		
Initial skill premium, W_S/W	6.80	*Investment Parameters*:	
Participation rate, L/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 is government 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.

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