Fiscal Regimes and Fiscal Sustainability in Sri Lanka

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Abstract

This paper employs the regime-switching model-based fiscal sustainability test of Aldama and Creel (2017, 2018) which extends Bohn's (1998) fiscal reaction function approach. There is evidence of a regime-switching fiscal rule in Sri Lanka for the period 1961-2017. Non-sustainable fiscal regime is identified only in two periods - 1978-1983 and 1986-1990 - while the other periods are defined by sustainable regimes. By considering the regime-specific feedback coefficients of the fiscal policy rule and the average durations of fiscal regimes, we find that Sri Lanka's fiscal policy satisfies the No-Ponzi game condition. Nevertheless, the country's long-term fiscal sustainability is in question given that the stricter debt-stabilizing condition is violated. Our results pose concerns for the credibility of adopting an inflation targeting framework in the absence of long-term fiscal sustainability.

JEL: C2; E6, H6

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1. Introduction

Sri Lanka's central bank is geared to adopt a flexible inflation targeting framework from 2020 by generating around 4-6 percent inflation a year, while the bank also seeks to relinquish its role of printing money to cover budget deficits. However, the country's fiscal outlook has never been bright and there has been increased pressure for the country to undertake fiscal consolidation as an important pre-condition for implementing an inflation targeting framework. This paper's aim is to assess the fiscal sustainability in Sri Lanka for the period 1961 to 2017 which covers half a century of fiscal data. Studies on fiscal sustainability of the Sri Lankan economy are limited with recent literature primarily focusing on the fiscal debt (Ekanayake, 2011) and government budget deficit dynamics (Dayaratna-Banda and Riyadarshanee, 2014).[1] In this paper, we provide new evidence on the sustainability of Sri Lanka's fiscal stance based on a widely adopted Bohn's (1988) model-based sustainability framework of fiscal policy rules and underpinned by the government intertemporal budget constraint.

According to Bohn's (1998) seminal contribution, primary budget balance must increase after an increase of the public debt-to-GDP ratio, for the purpose of ensuring the government's budget is sustainable and satisfies the government intertemporal budget constraint. Canzoneri et al. (2001) examine theoretically a time-varying fiscal policy rule in which public debt feedback effect on primary surplus is positive or null. They demonstrate that the government intertemporal budget constraint can be satisfied even when primary surplus reacts positively but infrequently to public debt as long as this condition occurs "infinitely often". Be that as it may, the model devised by Canzoneri et al. (2001) is at odds with empirical evidence which shows primary surplus can respond negatively to public debt (Favero and Monacelli, 2005; Davig and Leeper, 2007; Afonso and Tofanno, 2013). One implication of these observations is that a regime-switching policy rule which characterizes the response of primary surplus to changes in public debt could emerge with the public debt feedback effect on primary surplus permitted to be either positive or negative. Another concern which arises from the fiscal sustainability condition

[1] Ekanayake (2011) employs a structural vector auto regression (SVAR) model which is used to project endogenous variables which are related to debt dynamics. At the same time, the SVAR model is estimated to study the joint dynamic of structural shocks arising from real effective exchange rates, real GDP growth and real interest rates on relevant macro variables which affect the debt level. It was found that positive economic growth shocks yield the largest decline in the debt to GDP ratio from the baseline scenario of 2015 followed by negative real interest rate shocks and positive exchange rate shocks.

espoused in the literature is that it does not ensure a stationary public debt-to-GDP ratio, which is an important fiscal sustainability condition when there is a fiscal limit facing an economy. While studies like Davig (2005) have examined the periodic unit-root property of discounted public debt in a Markov-switching framework, such an approach has encountered criticisms. The main issue concerns the lack of micro-foundation in testing fiscal sustainability since the unit root test provides no information about fiscal policy behavior (Bohn, 1995 and 2007).

In this paper, we estimate the model of Aldama and Creel (2017) who develop a regime-switching model-based sustainability test for fiscal policy. Their proposed Markov-switching fiscal policy rule permits stochastic switches between sustainable and unsustainable regimes. The unsustainable regime is defined by periodic and persistent negative or null feedback effect of initial public debt on primary surplus. In this regime, Bohn's sustainability condition is violated, which means that the public debt-to-GDP ratio becomes periodically and persistently explosive. The sustainable regime is defined by periodic and positive effect of initial public debt on primary surplus, which is associated with Bohn's sustainability condition. The notion of sustainable and unsustainable regimes is consistent with evidence that sustainable regimes tend to occur during good economic conditions whereas unsustainable regimes occur during bad economic conditions (Cassou et al. 2017). An important contribution made by the Aldama and Creel (2017) model is that fiscal regimes (which may or may not satisfy local fiscal sustainability condition) matter for global fiscal sustainability analysis. Their framework provides a formal test of global fiscal sustainability which depends on two things: fiscal regimes' transition probabilities and their respective durations.

The regime-switching fiscal policy approach of Aldama and Creel (2017, 2018) is particularly useful for analyzing Sri Lanka's fiscal sustainability. From a policy perspective, we can identify when the periodic unsustainable regime has occurred. Having identified this unsustainable regime, we can determine the length of time for delaying the necessary fiscal adjustment without jeopardizing the global sustainability of public debt. On the other hand, in a sustainable fiscal regime we can identify the properties of the regime in terms of the reaction of fiscal policy towards public debt and/or in terms of frequency that adequately guarantees the long-run sustainability of public debt. In the case that the government is reacting weakly and/or very infrequently to debt variations, the debt-to-GDP ratio may not decline and this could pose a

threat for the economy with the emergence of a crisis which pushes debt into unsustainable territories in the long-run.

We undertake the following empirical approach. We first estimate constant parameter fiscal policy rules. We then relax the assumption of linearity by allowing for nonlinearities to be modelled using quadratic, cubic, and a kinked specification of Bohn's fiscal rule. The quadratic and cubic specifications are motivated by the idea that primary surplus may react more to lagged public debt below some debt levels and become less responsive at higher public debt levels. This is a phenomenon known as "fiscal fatigue". The kinked specification is also used to capture possible "fiscal fatigue" following the approach of Ghosh et al. (2013 a,b) in which debt limits are defined by the maximum level of public debt beyond which primary balance cannot adjust to stabilize debt. In addition, we model possible nonlinearities in the fiscal reaction function by using the time-varying parameter model of Nguyen et al. (2017) in which Bohn's (1998) original parametric specification is cast in a state-space framework to accommodate a possible time-varying relationship between the primary surplus-GDP ratio and the debt-GDP ratio. We do this because we take into account the fact that the reaction of the primary surplus to variations in debt need not be constant but may be time-varying for Sri Lankan fiscal aggregate series which span over five decades. They are likely to be subjected to shifts in their mean and/or trend as a consequence of gradual or abrupt changes in fiscal policy resulting from, for example, war or economic crisis. Our prediction of a time-varying reaction function is in fact well supported by the data.

Finally, we estimate a two-state Markov-switching fiscal policy rule to account for differentiated responses of primary surplus to public debt. Our results show significant evidence of a sustainable regime that displays a positive and strongly significant feedback effect of public debt. There are two episodes of an unsustainable regime which is characterized by a non-significant negative feedback effect, one of which coincides with the negative feedback effect identified by the time-varying parameter model estimates. Based on the estimated Markov-switching fiscal rule, we directly assess the global sustainability conditions developed in Aldama and Creel (2017), which point to the Sri Lankan fiscal policy as satisfying the no-Ponzi game condition. However, it is found that Sri Lanka's debt is not stable. The stronger sustainability constraint which requires a stable public debt-to-GDP ratio along a long-run value and an adequate margin with respect to the fiscal limit is not satisfied.

The paper is organized as follows. Section 2 reviews the literature. Section 3 presents the methodological framework and describes the dataset. Section 4 presents the empirical results and presents policy implications from the analysis. Section 5 concludes the paper with a summary of the main themes covered here.

2. Literature review

2.1 Intertemporal Government Budget Constraint Approach to Testing Debt Sustainability

The literature on public debt sustainability is a long-established one and it focuses on the long-run implications of a deterministic version of the intertemporal government budget constraint. This approach uses the government budget constraint that is evaluated at steady state and relates the long-run primary fiscal balance as a share of GDP and the debt-output ratio. The latter is defined as the sustainable debt (see Buiter, 1985; Blanchard, 1990). To obtain this outcome, a pre-requisite is to remove uncertainty from the government budget constraint with non-state contingent debt to arrive at:

$$b_t = -pb_t + (1 + r_t)b_{t-1} \quad (1)$$

where $pb_t = \frac{\tau_t - g_t}{Y_t}$ is the primary fiscal balance expressed as a ratio of real GDP, b_t is the real government debt to real GDP ratio and r_t is the real interest rate adjusted for real output growth rate. Here, τ_t and g_t are tax revenue and government spending at period *t*, respectively. For simplicity, we assume that the real interest rate adjusted for real output growth rate is positive and constant over time $r_{t-1} = r_t = r$. It can be shown that the future path of public debt for an arbitrary sequence of government spending and taxes is given by:

$$b_t = -\sum_{j=0}^{n}(1 + r)^j E_t\left(pb_{t+j}\right) + \lim_{n\to\infty}(1 + r)^{-n} E_t(b_{t+n}). \quad (2)$$

Fiscal solvency is satisfied provided that the second term in equation (2) is zero. This is also known as the transversality condition which means that the government does not

accommodate Ponzi games. In other words, the government cannot continuously rely on the issue of new debt to pay maturing old debts. This condition is also known as the bondholders' transversality condition because bondholders are willing to hold public debt provided they are assured about the government's solvency. This means the ability to redeem the entire debt at a future date without printing money and/or reneging on the commitment. The empirical test for the sustainability of the government's IBC is usually based on the analysis of the past behavior of the fiscal policy variables. Specifically, the sustainability of the fiscal debt can be tested empirically using standard unit-root tests on stock of debts as a proportion of GDP or the deficit-GDP ratio with deficit including interest payment, or an analysis of cointegration between public expenditure and revenue.

2.2. Fiscal Reaction Function Approach to Testing Debt Sustainability

Through a series of influential papers published between 1995 and 2011, Henning Bohn made important contributions to the empirical literature on debt sustainability tests. The intertemporal government budget constraint tests that discount future primary balances at the risk free rates are misspecified because the correct discount factors depends on the state-contingent equilibrium pricing kernel (Bohn 1995). This misspecification of the risk free rates cast doubt on several key empirical studies like Hamilton and Flavin (1986), Hansen, Roberds and Sargent (1991), and Gali (1991). Bohn (1995) showed that the misspecification error leads to incorrect inferences which reject fiscal solvency despite the actual existence of fiscal solvency. A second criticism is that testing for debt sustainability is futile given that the intertemporal government budget constraint holds under very weak conditions. The constraint holds if either debt or revenue and spending inclusive of debt service are integrated of finite but arbitrarily high order (Bohn 2007). Again, this finding invalidates several fiscal solvency tests based on specific stationarity and cointegration conditions, for instance in Hamilton and Flavin (1986), Trehan and Walsh (1988), and Quintos (1995). This is the case since neither a particular order of integration of the debt data, nor the cointegration of revenues and government outlays is necessary for debt sustainability. Referring to the no-Ponzi game condition in equation (2), the term $E_t(b_{t+n})$ is at most a polynomial of order n if b is integrated of order n. However, the discount factor is exponential in j such that exponential growth dominates polynomial growth. Given the drawback of the traditional debt sustainability approach, Bohn (2007) concluded that identifying in the data

the dynamics of fiscal reaction functions which support fiscal solvency is a natural approach to understanding deficit problems.

Bohn (2008) demonstrates that this linear fiscal reaction function is sufficient to satisfy the intertemporal budget constraint:

$$pb_t = \alpha_t + \beta b_{t-1} + \varepsilon_t \quad (3)$$

for all t and $\beta > 0$, where α_t is a vector of additional determinants of the primary balance, which normally include an intercept and proxies for temporary fluctuations in output and government expenditures. Here, ε_t is i.i.d. The intuition is that when pb changes by the positive factor β as debt increases, the growth of debt j periods ahead fall by $(1-\beta)^j$, so that as $j \to \infty$, then $(1-\beta)^j b_t \to 0$. This implies that the No-Ponzi Game (NPG) and thus the intertemporal government budget constraint hold. It is important to highlight that while debt sustainability holds for any $\beta > 0$, the long-run behavior of the debt-GDP ratio (i.e. the stationarity of this ratio) hinges on the relative value of the mean real interest rate and β. This can be easily seen from incorporating the fiscal reaction function of equation (3) into the government budget constraint which yields the law of motion of the debt-GDP ratio:

$$b_t = -\alpha_t + (1 + r_t - \beta) b_{t-1} + \varepsilon_t. \quad (4)$$

It is apparent that when $\beta > r$, b_t is stationary, otherwise it explodes. However, as long as $\beta > 0$, the pace is slow enough to ensure that the intertemporal government budget constraint is satisfied. However, if $\beta > r$ then debt converges to a higher long-run average as β falls. Further, the fiscal reaction function approach highlights the existence of a multiple well-defined long-run averages of debt which are consistent with debt sustainability if $\beta > r$, and even non-stationary debt is consistent with debt sustainability if $0 < \beta < r$.

Bohn's framework has been applied to cross-country datasets developed by Mendoza and Ostry (2008) and Daniel and Shiamptanis (2013), and augmented to allow for nonlinear specification and default risk by Ghosh et al. (2013b). Mendoza and Ostry (2008) found the response coefficient estimates for a panel of industrial countries are similar to those obtained for

the United States by Bohn (1998). Further, they found that the solvency condition is satisfied for a panel comprising both industrial and developing countries, and in a sub-panel which only accounts for developing economies. Interestingly, they found there are cross-section variations in the response coefficient contingent on the debt thresholds. In particular, they discovered that for high-debt country groups, the response coefficient is not statistically significantly different from zero. Ghosh et al. (2013a,b) also noted that the response coefficients fall acutely at high debt levels, thus pointing to evidence of "fiscal fatigue" in policy behavior. They contend that at high levels of public debt, the reaction of the primary surplus is "flatter".

The application of Bohn's fiscal reaction function approach to testing fiscal debt sustainability has further employed alternative specifications other than quadratic and cubic policy rules (Bohn, 1998). Nguyen et al. (2017) employ a time-varying parameter model by relaxing the time-invariant response coefficient; they also cast the fiscal reaction function regression in a state-space framework. Based on this method, they found that US fiscal sustainability was achieved until 2005 but not after that. To the best of the authors' knowledge, applying Bohn's debt sustainability testing framework has rarely been employed in developing economies except in the work of Mendoza and Ostry (2008) which focuses on a panel of developing countries. On this subject, the present study is the first to examine the issue of fiscal sustainability in a widely adopted Bohn's framework. Doing so is consistent in its approach with recent literature on fiscal sustainability analysis.

2.3 Fiscal Regimes and Fiscal Sustainability

Incorporating regime-switching to the analysis of fiscal policy and testing its implications for long-run fiscal sustainability have rarely been addressed. The seminal contribution of Canzoneri et al. (2001) explores a time-varying fiscal policy rule and derives a necessary and sufficient condition that will ensure that the intertemporal government budget constraint is satisfied in the long-run. Davig (2005) extends the unit root testing procedure of Wilcox (1989) in a Markov-switching framework and permits discounted debt to be periodically expanding. In a related literature on regime-switching monetary and fiscal policy, local equilibria have been identified in the data which are associated with "active" or "passive" policy (be it fiscal or monetary policy) (see Leeper, 1991). Nevertheless, these papers do not test whether fiscal policy

globally satisfies their intertemporal budget constraint or the debt-stabilizing condition in the long-run.

There is the work of Davig and Leeper (2007) which proposes a long-run Taylor principle to globally determine the price level despite permissible violations of the short-run Taylor principle. Aldama and Creel (2017) in their work precisely seek to provide an equivalent proposition for a globally sustainable fiscal policy within the Markov-switching fiscal policy framework. By applying their model to the U.S. data, Aldama and Creel (2018) find the government's fiscal behavior remain unstable over time. The fiscal behavior is characterized by periods of sustainable and unsustainable fiscal policies. When the fiscal data are evaluated based on the No-Ponzi game and debt stabilizing conditions, which are a function of fiscal regimes' transition probabilities and their respective durations, they find that the periodic stabilization of public debt by the government is manifested in sufficiently tight reaction of primary surplus to initial debt increases which give rise to stability in public debt over the entire horizon. Finally, the existence of sustainable and unsustainable fiscal regimes has been studied by Cassou et al. (2017) who find frequent shifts between two regimes which relate closely with the economic conditions. When economic conditions are weak, fiscal sustainability fails to hold but fiscal sustainability prevails when economic conditions improve and become strong.

3. Data and Methodological framework

3.1 Sri Lanka's Fiscal Data

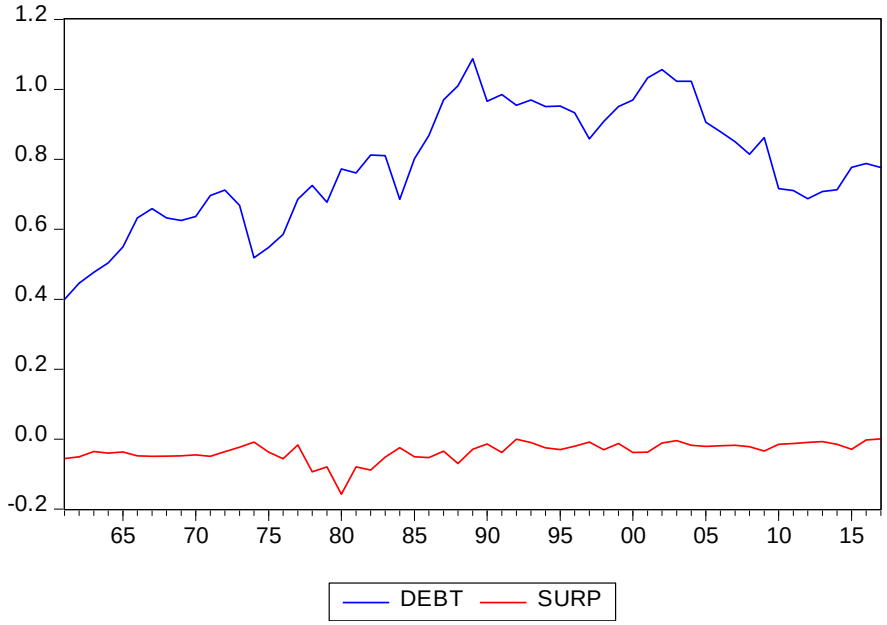
Fiscal data are obtained from annual reports of the Central Bank of Sri Lanka (CSBL) throughout the period 1961 and 2017. The data largely originate from the Public Debts Bulletin compiled by CBSL.[2] The two series of interest are the debt-GDP ratio and the primary surplus to GDP ratio. The former is the ratio of public debt at the end of a fiscal year divided by the GDP of the same fiscal year. Primary surplus is constructed by subtracting outlays (or government expenditures) from government revenues excluding interest payment.[3] The base years of national accounts estimates were revised in 1970, 1982, and 1996 by the CBSL and in 2002 and 2010 by

[2] Some of the data can be obtained online from www.cbsl.gov.lk.
[3] Revenues data are obtained from CBSL annual reports and from the Ministry of National Policies and Economic Affairs (MNPEA). See URL http://www.mnpea.gov.lk.

the Department of Census and statistics (DCS). The GDP deflator with a base year in 1996 was used to obtain real GDP and real fiscal data.[4]

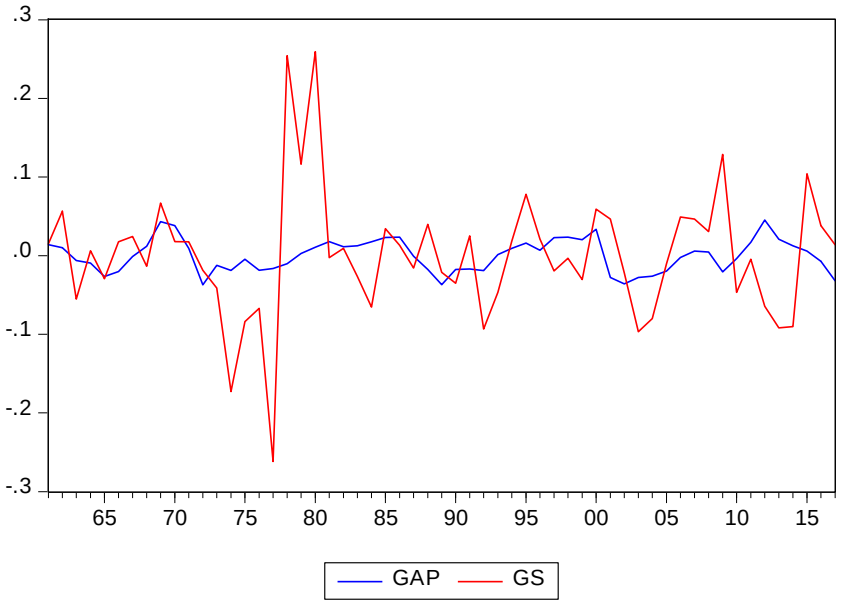
Figure 1 displays the Sri Lankan public debt-GDP ratio and the primary surplus (non-interest payment surplus) to GDP ratio for the period 1961–2017. It is apparent that the primary surplus has never registered a positive figure. The highest budget deficit occurred in 1980 which sits at 19% of GDP. At the same time, public debt-to-GDP ratio has displayed a positive trend for most of the sample period as is evident from 1961 to about 2002. This ratio only starts to decline after 2002. During 1983–2009 the Sri Lankan economy continued to be burdened by a massive military expenditure due to the long-lasting civil war, which explains the new record level of debt in the economy as displayed by the graph labelled "debt". Interestingly, the increase in public debt around the period 1975-1985 was associated with a fall in the surplus-income ratio. This pattern is further confirmed by the dramatic increase in the cyclical real public spending depicted in Figure 2, which depicts a steep fall in real public spending around 1973-1977; it is followed by a sharp increase around 1977-1982. Both debt-GDP ratio and primary surplus-GDP series are found to be stationary based on the Augmented Dickey-Fuller test statistic, which produces figures of -4.17 and -4.48, respectively. The 5% critical value is -3.49 which suggests that the test overwhelmingly rejects the null hypothesis of a unit root.

Figure 1. Debt-GDP ratio and Primary Surplus-GDP ratio (1961-2017)



[4] URL for GDP deflator data is http://www.statistics.gov.lk.

Figure 2. HP filtered output gap and cyclical real public spending (1961–2017)



3.2 Bohn's (1998) model based sustainability test

We estimate the following fiscal policy rule

$$ps_t = \alpha + \beta b_{t-1} + \alpha_x x_t + \alpha_z z_t + u_t \quad (5)$$

where ps_t is the primary surplus-GDP ratio, b_{t-1} is the end of period public debt-GDP ratio, z_t is the output gap, and x_t is the cyclical real government spending. Estimates of linear fiscal policy rules tend to show a strong auto-correlation in the residuals so we estimate equation (1) with first-order autoregressive residuals $u_t = (1-\rho L)^{-1} e_t$ such that $e_t \sim i.i.d.N(0, {\sigma_e}^2)$. We use nonlinear least squares, the Cochrane-Orcutt procedure to estimate equation (5). In addition to estimating model (5), we estimate nonlinear specifications (6), (7) and (8) of the fiscal policy rule by incorporating quadratic and cubic terms and a kinked specification where the primary surplus only reacts to positive deviations of lagged public debt from its mean $\bar{b}$:

$$ps_t = \alpha + \beta_1 b_{t-1} + \beta_2 {b_{t-1}}^2 + \alpha_x x_t + \alpha_z z_t + u_t \; ; \quad (6)$$

$$ps_t = \alpha + \beta_1 b_{t-1} + \beta_2 {b_{t-1}}^2 + \beta_3 {b_{t-1}}^3 + \alpha_x x_t + \alpha_z z_t + u_t \; ; \quad (7)$$

$$ps_t = \alpha + \beta_m \max(b_{t-1} - \bar{b}, 0) + + \alpha_x x_t + \alpha_z z_t + u_t. \quad (8)$$

The polynomial specifications which include quadratic and cubic terms characterize the increasing or decreasing response of primary surplus to changes in the level of public debt as it increases. In equation (6), a positive coefficient of squared debt-GDP ratio would indicate that the response of the primary surplus increases with the level of public debt whereas a negative coefficient would testify to "fiscal fatigue". With reference to the cubic specification (7), "fiscal fatigue" would be associated with a negative coefficient of the cubic lagged debt-GDP ratio. Finally, the kinked specification (8) is motivated by the non-linear specification estimated by Bohn (1998), who assumes that fiscal policy increases the primary surplus, satisfying the government's intertemporal budget constraint only when the public debt-GDP ratio is above its long-run average $\bar{b}$.

Here, z_t which is the cyclical real government spending and x_t which is the output gap are computed following Barro (1986):

$$z_t = (g_t - {g_t}^*)/y_t \quad (9)$$

$$x_t = (1 - y_t/{y_t}^*)/({g_t}^*/y_t) \quad (10)$$

where ${g_t}^*$ and ${y_t}^*$ are government spending and income at their trend levels and are computed using the Hodrick-Prescott (HP) filter with a smoothing parameter of λ=100 for annual data.

3.3 Nguyen et al.'s (2017) time-varying parameter model-based sustainability test

The time-varying fiscal policy rule of Nguyen et al. (2017) relaxes the constant parameter model by allowing the coefficient of interest β in equation (5) to be time-varying based on the following:

$$ps_t = \alpha + \beta_{t-1} b_{t-1} + \alpha_x x_t + \alpha_z z_t + u_t \quad (11)$$

$$\beta_{t-1} = \beta_{t-2} + \varepsilon_{t-1} \quad (12)$$

where $u_t \sim N(0, {\sigma_u}^2)$ and $\varepsilon_t \sim N(0, {\sigma_\varepsilon}^2)$ such that both u_t and ε_t are uncorrelated with each other. The estimation of the signal equation (11) and the state equation (12) involves utilizing the

Kalman filter (see Nguyen et al. (2017) for a discussion of the estimation method). It can be shown that the mean of β_{t-1} estimates obtained from this time-varying parameter model (i.e. equations (11) and (12)) is equal to the least squares estimate of the β coefficient in the linear model given by equation (5).

3.4 Aldama and Creel (2017, 2018) regime-switching model based sustainability test

One drawback of constant parameter linear or nonlinear fiscal policy rules is that they are subject to possible biases in favor of an unsustainable fiscal regime in the presence of regime-switching properties of fiscal policy rules' estimates (Aldama and Creel, 2018). For this reason, they propose estimating the following regime-switching model of fiscal rule:

$$ps_t = \alpha(s_t) + \beta(s_t)b_{t-1} + \alpha_x(s_t)x_t + \alpha_z(s_t)z_t + u_t \quad (13)$$

where s_t is an unobserved two-state Markov process with time-invariant transition probabilities. Employing a Markov-switching model rather than endogenous or threshold-switching models is an agnostic approach of modelling fiscal policy regime changes and it does not rely on any assumptions about what drives fiscal regime shifts. Like equation (5), equation (13) is estimated with first order auto-correlated residuals $u_t = (1-\rho L)^{-1}e_t$ such that $e_t \sim i.i.d.N(0, {\sigma_e}^2)$ in which σ_e is the regime invariant standard error of the residuals. Equation (13) is estimated by direct maximization of the log-likelihood method of Hamilton (1989). In order to avoid choosing a local maximum and ensure our results are robust to the choice of initial values, we use 10,000 random draws of initial values for the maximum likelihood algorithm. We compute a long-run estimate of the parameters (or unconditional expectations of the parameters) from their regime-switching parameter estimates and their respective ergodic probabilities as follows:

$$\alpha = \pi_1\alpha_1 + \pi_0\alpha_0 \quad (14)$$

where π_1 (π_0) is the ergodic probability of a sustainable (S) (non-sustainable (NS)) regime, and α_1 (α_0) is the parameter associated with the sustainable (S) (non-sustainable (NS)) fiscal regime. The ergodic probabilities are defined as:

$$\pi_i = \frac{1-p_{jj}}{(1-p_{ii})+(1-p_{jj})} \tag{15}$$

for all $(i,j) \in \{0,1\}$ and p_{ij} is the transition probability from state i to state j. The estimated standard deviation is computed as follows:

$$\sigma_\alpha = \sqrt{(\pi_1\sigma_{\alpha 1})^2 + (\pi_0\sigma_{\alpha 0})^2 + 2Cov(\alpha_1, \alpha_0)} \tag{16}$$

Aldama and Creel (2017) derive a sufficient condition for a regime-switching fiscal policy rule which satisfies the No-Ponzi Game (NPG).[5] The NPG condition requires that the initial public debt-to-GDP ratio is backed by the sum of future expected and discounted real primary surpluses-to-GDP. The condition is $\beta > 0$, which is the unconditional expectations of β given by $\beta_1\pi_1 + \beta_0\pi_0$. It can be shown that this condition is equivalent to:

$$\beta_1 > |\beta_0| \frac{d_0}{d_1} \tag{17}$$

where $d_i = \frac{1}{1-p_{ii}}$ is the expected duration of regimes. This condition states that a regime-switching fiscal policy has to satisfy the NPG condition on *average*. In other words, sustainable regimes have to be frequent enough to counterbalance unsustainable regimes in the long-run. To rule out any possibility of a Ponzi scheme, a trade-off occurs between the relative duration of sustainable regime vis-à-vis unsustainable regime and the magnitude of the required reaction of primary surplus to debt during sustainable regimes. The longer is the duration of the unsustainable regime relative to that of sustainable regime, the larger is the required reaction of primary surplus to debt during sustainable regimes. Satisfying equation (17), a condition of NPG, means that fiscal policy can be periodically unsustainable while satisfying its present-value budget constraint (Aldama and Creel, 2017).

It is important to recognize that the NPG condition does not impose any stationarity restriction (see Bohn, 2007). If the public debt-to-GDP ratio is ever increasing, it will eventually

[5] The non-Ponzi scheme requires that the present value budget constraint and the transversality condition must hold with equality (see Aldama and Creel, 2017 equations (6) and (7)). These conditions are also discussed in Bohn (1995) for the case of a linear, non-regime-switching fiscal policy rule.

reach the fiscal limit on the level of primary surplus governments can run (Daniel, 2014; Daniel and Shiamptanis, 2013). As such, a stronger constraint on fiscal policy would require the debt-output ratio must be stationary at a sufficiently low level, below some fiscal limit. Aldama and Creel (2017) show that a sufficient condition for a (strictly) stationary debt-output ratio is

$$\beta\pi > \frac{r-y}{1+y} \tag{18}$$

which can be expressed in terms of the expected durations of the regimes as follows:

$$\beta_1 > |\beta_0| \frac{d_0}{d_1} + \frac{r-y}{1+y} \frac{d_0+d_1}{d_1} \ . \tag{19}$$

where r and y are the long-run average real interest rate and the growth rate of real GDP, respectively.

Equation (19) which stipulates the condition of debt stability states that as long as the growth-adjusted real interest rate is positive, a debt-stabilizing condition is stricter than the NPG condition. This condition suggests that during sustainable regimes, the required reaction of primary surplus to initial debt must be sufficiently large to compensate for both primary deficits during unsustainable regimes, weighted by the ratio of expected durations, and the growth-adjusted real interest rate, weighted by the inverse fraction of (expected) time spent in sustainable regimes. Importantly, should $r < y$ (i.e. long-run real interest rate is lower than the long-run growth rate), the condition given by equation (19) could eventually lead to government violating the NPG condition, which is the minimum requirement for fiscal sustainability. For this reason, a stronger sustainability constraint requires a stable public debt-to-GDP ratio along a long-run value and an adequate margin with respect to the fiscal limit. Finally, it is important to view the NPG condition and debt-stabilizing condition as complements rather than substitutes. In other words, a stationary public debt-output ratio does not rule out Ponzi schemes.

4. Empirical results

Column (1) in Table 1 reports the results of the baseline specification (5). We find significant evidence for a strictly positive feedback effect of public debt on primary surplus. The

coefficient of interest is β_1 which is statistically significant at 5% level and it has the correct sign to suggest that fiscal policy is sustainable. The coefficient of z_t which is the cyclical real government spending is also statistically significant at the 1% level. The negative sign indicates that greater cyclicality in real government spending has a deleterious effect on maintaining or improving the primary surplus. As for the non-linear specifications (6)–(8), results are shown in columns (2)–(4). Overall, we find no evidence in favor of fiscal sustainability. In fact the coefficient β_1 is not statistically significant and fails to reject the null hypothesis which is zero. In the quadratic specification, the coefficient β_2 term is negative but not statistically different from zero. The cubic specification displays a negative quadratic term β_2 and a positive cubic term β_3, but again both are not statistically significant at any conventional significance level. As these coefficients are not significant, point estimates of quadratic and cubic specifications do not provide any evidence of "fiscal fatigue" in Sri Lanka's fiscal policy. Finally, the estimated kinked fiscal rule does not reveal a statistically significant positive reaction to deviations of lagged public debt from its long-run average (i.e. β_m estimate is not statistically significant). In all regressions (5) to (8) it was found that the cyclicality in real government spending has a statistically significant and negative effect on the primary surplus-to-GDP ratio, which accords with the intuition that greater variability in real government spending will hamper primary surplus.

It can be inferred from the constant-parameter estimates of fiscal policy rules, that there is a lack of evidence in the nonlinear specifications other than the linear one in support of a sustainable fiscal regime in Sri Lanka between 1961 and 2017. Using similar specifications, Aldama and Creel (2017) do not find significant evidence in favor of a sustainable fiscal regime in the US between 1940 and 2016. Focusing on the US economy, Cassou et al. (2017) also find similar shortcomings with a linear specification based on a longer sample than the one used in Bohn (2008). Aldama and Creel (2017) attribute the lack of evidence for fiscal sustainability to the instability driven by regime-switching properties of fiscal policy rules' estimates. For this reason, we turn to the results of the regime-switching model based sustainability test results in column (5) to verify whether the same reason applies to the results for the Sri Lanka economy.

Table 1: Empirical results of various fiscal rule models

	(1)	(2)	(3)	(4)	(5) Markov Switching			(6)
	Linear	**Quadratic**	**Cubic**	**Kinked**	**Regime1 ($s_t = 0$)**	**Regime 2 ($s_t = 1$)**	**Long-run estimates**	**TVP**
α	-0.087***	-0.131	-0.181	-0.035***	0.031	-0.078***	-0.066***	-0.072***
	(0.026)	(0.083)	(0.255)	(0.009)	(0.140)	(0.018)	(0.022)	(0.023)
β_1	0.068**	0.181	0.375		-0.142	0.064***	0.042*	
	(0.030)	(0.204)	(0.977)		(0.166)	(0.021)	(0.024)	
β_2		-0.071	-0.318					
		(0.126)	(1.227)					
β_3			0.102					
			(0.504)					
β_m				0.040				
				(0.050)				
α_x	0.028	0.026	0.026	0.000	-1.358*	0.024	-0.127	0.012
	(0.113)	(0.110)	(0.112)	(0.114)	(0.742)	(0.078)	(0.093)	(0.138)
α_z	-0.188***	-0.189***	-0.189***	-0.190***	-0.430***	-0.160***	-0.190***	-0.188***
	(0.018)	(0.019)	(0.019)	(0.020)	(0.063)	(0.015)	(0.013)	(0.021)
ρ	0.768***	0.762***	0.760***	0.783***	0.669***			
	(0.092)	(0.091)	(0.091)	(0.094)	(0.091)			
σ	0.013***	0.013***	0.013***	0.014***	0.009***			
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)			
$Adjusted\ R^2$	0.7468	0.7431	0.7376	0.7267				
DW stat	2.1647	2.1699	2.1648	2.1771				

Notes: Figures in parentheses are standard errors. *** is significance at the 1% level, ** at the 5% level and * at the 10% level.

Column (5) shows that the estimated Markov-switching fiscal policy rule identifies two regimes. Regime 2 is characterized by a strongly significant positive response of primary surplus to lagged public debt hence this regime is classified as a sustainable regime. On the other hand, regime 1 is characterized by the response of primary surplus to lagged public debt which is not statistically significant and it is negative, thus this regime is classified as unsustainable. Turning to Table 2, the sustainable regime appears to be more persistent than the unsustainable one. The transition probability of remaining in a sustainable regime is high at 0.94 while that of remaining in an unsustainable regime is slightly lower at 0.58. Based on these transition probabilities, the expected duration of the sustainable regime is about 19.5 years relative to about 2.4 years for the unsustainable regime. It is possible that the evidence concerning a persistent sustainable regime and some evidence of regime switches may explain ex-post why the nonlinear constant-parameter estimates of fiscal policy rules fail to identify a significant positive reaction of the primary surplus to lagged public debt. Figure 3 illustrates the filtered and smoothed transition probability in the unsustainable regime 1. It is apparent from this plot that the Sri Lankan economy experienced two episodes of unsustainable regime: 1978-1983 and 1986-1990.

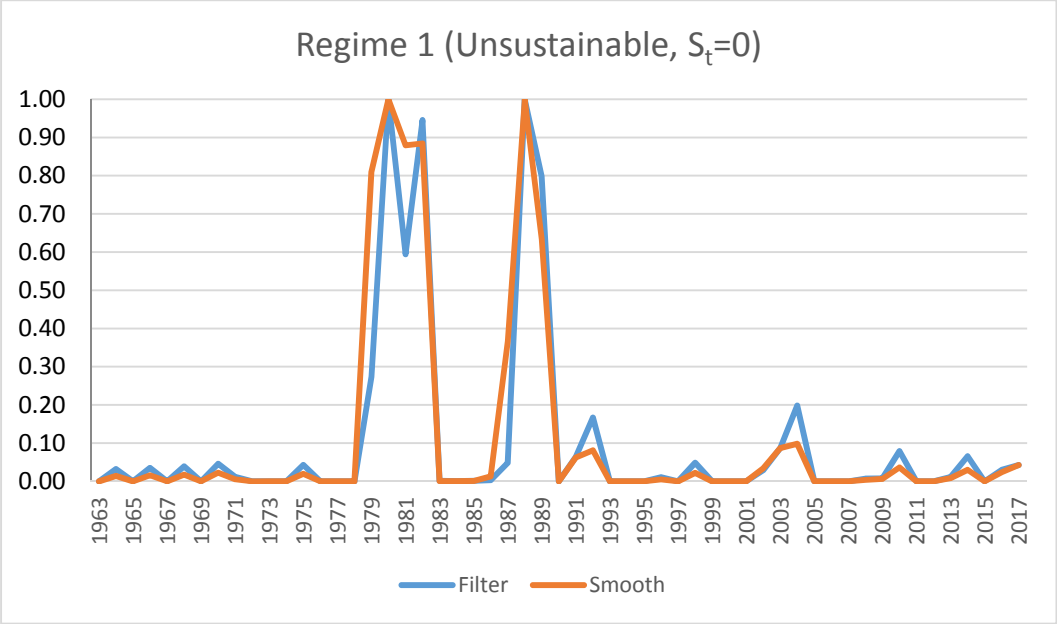
Looking at the first episode of unsustainable fiscal regime (1978-1983), this period coincides with the dip in primary surplus-to-GDP ratio and the rise in debt-to-GDP ratio as seen in Figure 1. This period is associated with a massive economic liberalization process which took place in Sri Lanka. In addition to trade policy changes in 1977-1979 and opening up the economy to FDI, policies were developed to liberalize the economy along free market principles. These policies included the constitutional guarantee against nationalization of foreign assets without compensation, introduction of limits on direct public sector participation in the economy, and massive deregulation of market activities. Despite efforts to liberalize the economy, Sri Lanka experienced a sharp devaluation of its exchange rate which hampered the confidence of foreign investors. Consequently, post-1977, the increase in government expenditures was not covered by a corresponding increase in revenue, which subsequently resulted in public debt rapidly increasing. The sharp devaluation of the rupee also implied that the accumulated foreign debt tended to increase annually in local currency terms in the 1980s. The bleak economic outlook translated into the highest budget deficit in 1980 which amounted to 19% of the country's GDP. In the second episode of fiscal unsustainable regime (1986-1990), the economy continued to be burdened by massive military expenditure. Given the government's concerns with the civil war,

Sri Lanka failed to capture the full benefits of economic liberalization as a result of delays and inconsistencies in the implementation of the reform processes.

Table 2: Transition and Ergodic Probabilities, and expected duration of regimes

	Regime 1 (Unsustainable)	Regime 2 (Sustainable)
Transition prob	0.58	0.94
Ergodic prob	0.10	0.89
Expected Duration (d_t)	2.40	19.46

Figure 3: Filtered and Smoothed Transition Probability of being in an Unsustainable Fiscal Regime



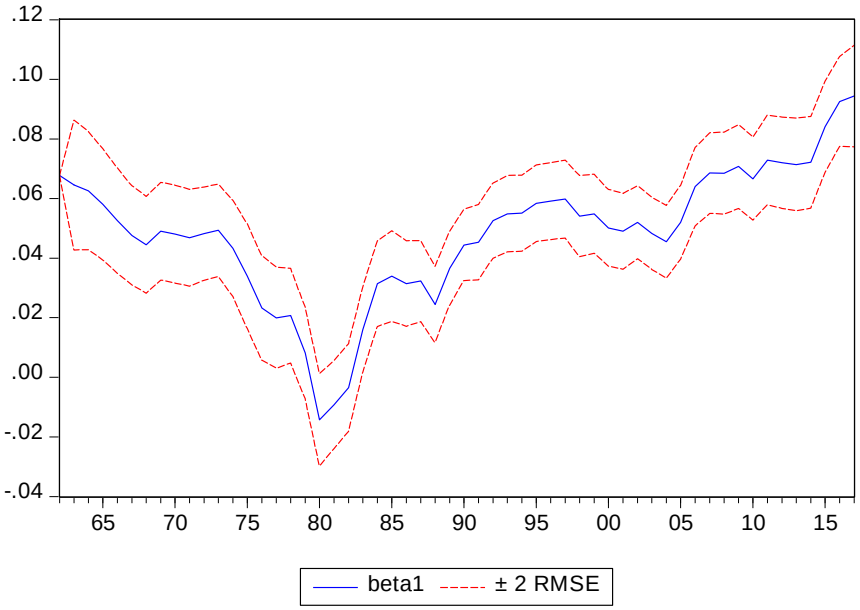
We turn to the sufficient condition for a regime-switching fiscal policy rule, which satisfies the No-Ponzi Game (NPG) derived by Aldama and Creel (2017). The NPG condition requires that the initial public debt-to-GDP ratio is backed by the sum of future expected and discounted real primary surpluses-to-GDP. This condition is equivalent to $\beta_1 > |\beta_0| \frac{d_0}{d_1}$ where $d_i = \frac{1}{1-p_{ii}}$ is the expected duration of regimes. Based on the parameter estimates of β_1 (sustainable regime 2) and β_0 (unsustainable regime 1) in column (5) of Table 1, and the expected durations of both regimes in Table 2, it can be inferred that this NPG condition is satisfied (i.e.

β_1=0.064 and $|\beta_0|\frac{d_0}{d_1}$=0.0175). This implies that the regime-switching fiscal policy rule found in Sri Lanka satisfies the No-Ponzi Game. In other words, Sri Lanka's initial public debt-to-GDP ratio is backed by the sum of future expected and discounted real primary surpluses-to-GDP. Having established the minimum requirement for fiscal sustainability is satisfied, we proceed to determine whether the stricter debt stability condition given by equation (15) is supported by the data. The left-hand-side of the equation indicates β_1=0.064 while the right-hand-side of the equation reports $|\beta_0|\frac{d_0}{d_1}+\frac{r-y}{1+y}\frac{d_0+d_1}{d_1}=0.294$. It is apparent that the debt-stabilizing condition fails to be satisfied. The primary cause here is that the real interest rate is lower than the growth rate of output. While the NPG condition does not rule out an explosive path for Sri Lanka's debt-output ratio, a necessary and sufficient condition for fiscal sustainability, in the presence of a fiscal limit on the debt-output ratio, it would require a debt-stabilizing fiscal rule around a steady-state level that is below the fiscal limit. In this case, a violation of the debt-stabilizing condition implies that the debt-stabilizing fiscal rule fails to operate around a steady-state level that is below the fiscal limit.

On balance, one important implication of our results is that the concern about the need for the government to undertake fiscal consolidation if the country plans to implement an inflation targeting framework is clearly warranted. While it can be seen that the long-run estimate of the feedback effect of public debt on the primary surplus is positive (0.042) and statistically significant, and there is evidence that the NPG condition is satisfied, the stricter debt stabilizing condition fails to hold. Therefore the Sri Lankan government should urgently adopt fiscal discipline to ensure that the ballooning debt-output ratio does not escalate to violate the debt-stabilizing condition. More importantly, in the context of implementing a strategy that targets inflation, it is mandatory for it to be effective so that the central bank does not resort to printing money to meet its persistent primary deficit. The results from the debt stabilizing condition suggest that the government must react more to initial debt increases by increasing primary surplus during sustainable regimes to ensure that the long-run debt steady-state level remains below the fiscal limit. This may take the form of fiscal austerity (or contraction) as the optimal policy to ensure that public debt is sustainable in the long-run.

Finally, we turn to the time-varying parameter (TVP) model based sustainability test of Nguyen et al. (2017). Column (6) in Table 2 reveals that only the coefficient of the cyclical real government spending is statistically significant at the 1% level. The plot of the time-varying coefficient $\beta_{1,t}$ is shown in Figure 4 below. It can be seen from the smoothed estimates that there was fiscal unsustainability in the period 1978-1983 during which $\beta_{1,t} < 0$. However, the $\beta_{1,t}$ estimate falls within the 95% confidence interval which includes $\beta_{1,t} = 0$ thus implying that primary surplus fails to respond to lagged public debt. The result in this period is identical to and coincides with the first episode of the unsustainable regime identified by the fiscal regime-switching model. In addition, the mean of the $\beta_{1,t}$ estimate is 0.048 which is close to the long-run estimate of β_1 in the fiscal regime-switching model (i.e. 0.042). It is worth highlighting that the non-regime-switching fiscal rule models cannot differentiate the different fiscal regimes. The models also yield a simple fiscal rule of sustainability that does not take into consideration the trade-off between the duration of the regimes and the reaction of surplus to debt. As such, these models may fail to highlight the condition associated with fiscal regimes, particularly one that permits public debt-output ratio to periodically follow an explosive path.

Figure 4: Smoothed $\beta_{1,t}$ Estimates



5. Conclusion

In this paper, we evaluated the fiscal sustainability of the Sri Lanka economy. Using the model based fiscal sustainability approach developed by Bohn (1998) which adopts a linear model, and variants of the model which allow for possible nonlinearities, we find that primary surplus-GDP ratio responds positively to increases in public debt-GDP ratio. This evidence is statistically significant for a linear specification but not for nonlinear models. Given evidence of a rising debt-GDP ratio in Sri Lanka and the possibility of a periodically explosive path for this ratio, we accommodate different fiscal regimes in the model-based test of fiscal sustainability. The regimes are characterized by sustainable and unsustainable fiscal rules, which we incorporate into the linear model by allowing the coefficients governing the reaction of primary surplus to public debt to be regime dependent along with the coefficients of the other control variables. The results point to overwhelming evidence of a regime-switching fiscal rule in Sri Lanka with the sustainable fiscal regime showing greater persistence and longer duration than the non-sustainable regime. There were two episodes when the economy exhibited non-sustainable fiscal regime. Specifically, one episode coincided with the negative estimate of the feedback coefficient obtained from a time-varying parameter fiscal sustainability model.

When the duration of the regimes is factored in to determine whether Sri Lanka's fiscal debt supports the No-Ponzi Game (NPG) condition, we find evidence indicating that Sri Lanka's initial public debt is supported by the sum of future expected and discounted real primary surpluses. However, when the real interest rate and output growth rate are also considered, the stricter debt stabilizing condition derived under the regime-switching framework fails to hold, thus implying that the debt-stabilizing fiscal rule does not operate around a steady-state level that is below a fiscal limit on the debt-output ratio. Sri Lanka's lack of debt stability may jeopardize the implementation of a strategy that targets inflation. Without a sense of urgency in fiscal consolidation, the temptation to print money to cover budget deficits may blunt the effectiveness of inflation targeting as a monetary policy tool.

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