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Article

What Effect does Foreign Aid have on the Fiscal Framework of Sri Lanka?

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Abstract

The purpose of this paper is to analyze how the fiscal framework has deviated from the intended development objectives in the presence of foreign aid in Sri Lanka. The nation's low credit rating is a sign that its fiscal position is in trouble, and the Official Development Assitance (ODA) influx is partly to blame. We consider the overall influence of aid on the fiscal sector by regressing the fiscal response model. We estimated the model by employing the Three-Stage Least Squares method (3SLS). According to the estimation results, bilateral aid redirects resources from consumption whereas multilateral aid displaces. Additionally, it shows that multilateral aid favors socioeconomic consumption by diverting more of the aid intended for consumption, while bilateral aid favors civil administration consumption by taking less away from it. In the case of bilateral assistance, tax revenues continue to decrease, often more rapidly than the reduction in consumption. Whereas in the presence of multilateral aid, tax revenue declines while consumption increases. As a result, it is anticipated that the budget deficit and domestic borrowing will grow more than they would have without aid. Thus, the declining investment which is bounded to expanding trend of domestic borrowings will negatively affect the economy's long-term growth prospects.

Key words: aid effectiveness, economic growth, fiscal behavior, fiscal policy, foreign aid, public consumption, public investment, 3SLS
JEL code: E62, F35, H4, H5, H6, O530

1. Introduction

Since 1960, billions of Official Development Assistance (ODA) have been continuously transferred to Sri Lankan development objectives. As a result, Sri Lanka has reached a critical debt crisis. The public debt to GDP ratio increased to 105 percent at the end of

2021 from 84 percent at the end of 2018, reflecting the impact of higher net borrowing to finance the enlarged budget deficit[1]. Furthermore, the 'gap model' argument predicts that foreign aid[2] is used not only to temporarily fill three gaps namely the domestic resource gap, the foreign resource gap, and the fiscal gap. Foreign aid is used to reduce the gaps over time and thereby accelerating and sustaining economic growth without aid. However, the trends of those gaps in Sri Lanka shown in Figure 1 illustrate these controversial claims. The country is straying from the path created by the gap model predictions, and as a result, the gaps are tremendously expanding instead of closing over time. Figure 2 precisely shows that the fiscal authority is shifting from an investment-oriented policy to a consumption-oriented policy, supporting the criticism that aid is given to the recipient government, reshuffled in the budget, and redirected to non-productive activities. Mavrotas (2002) mentioned that any effect of ODA on the macroeconomy depends on fiscal behavior. Thus, aid does not have a direct effect; instead, aid operates via transmission mechanisms, such as public investment, government consumption, and tax revenue. The controversy regarding the gap model predictions and fiscal policy directions in Sri Lanka motivates to shed light on how the fiscal framework is affected by foreign aid.

The general form of aid growth specifications ignores the causal path of the aid–growth nexus. Jena & Sethi (2020) ascertains that a positive relationship exists between aid and the per capita GDP in South Asian countries by including both investment and aid in a Panel Dynamic OLS approach (PDOLS). According to Sethi et al. (2019), there is no significant impact of foreign aid on growth in Sri Lanka, in terms of the long-run and the short-run. Their estimate based on the VAR model suggests that foreign aid has a negative association with short-term growth and this decreases in subsequent periods.

Burnside and Dollar, (2000) argued that foreign aid is added to investment, while policy determines the productivity of investment. Therefore, these authors include an 'aid-policy' interaction term but exclude investment from the empirical specification. Similarly, Roodman (2004) did not include investment in any regressions. However, by citing Hansen & Tarp (2001), Gomanee, Girma & Morrissey (2005) stated that the implicit growth theory addresses investment rather than aid as an argument and mentioned that not all aid is intended for investment and not all investment is financed by aid. The issue with this concept is that if one omits investment, there is potential omitted variable bias, i.e., any effect of investment on growth is attributed to

[1] Source: Annual Report Central Bank Sri Lanka 2021

[2] Author use DAC Definition of ODA/Foreign aid up to 2017 data: "those flows to countries and territories on the DAC list of ODA recipients and to multilateral institutions which are i) provided by official agencies, including state and local governments, or by their executive agencies; and ii) each transaction of which: a) is administered with the promotion of the economic development and welfare of developing countries as its main objectives; and b) is concessional in character and conveys grant element of at least 25%.

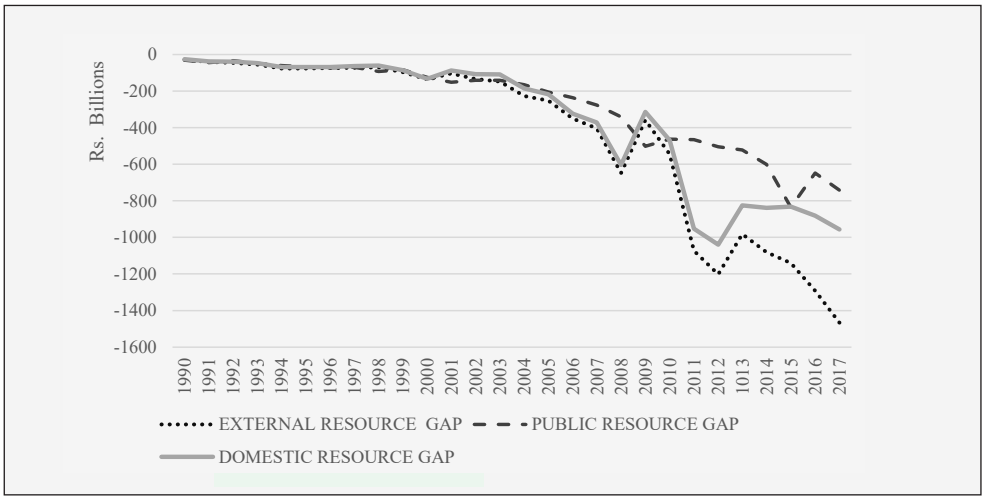

Figure 1: Three major gaps in the macroeconomy in Sri Lanka
Source: Data extracted from the Central Bank Annual Reports, 2018

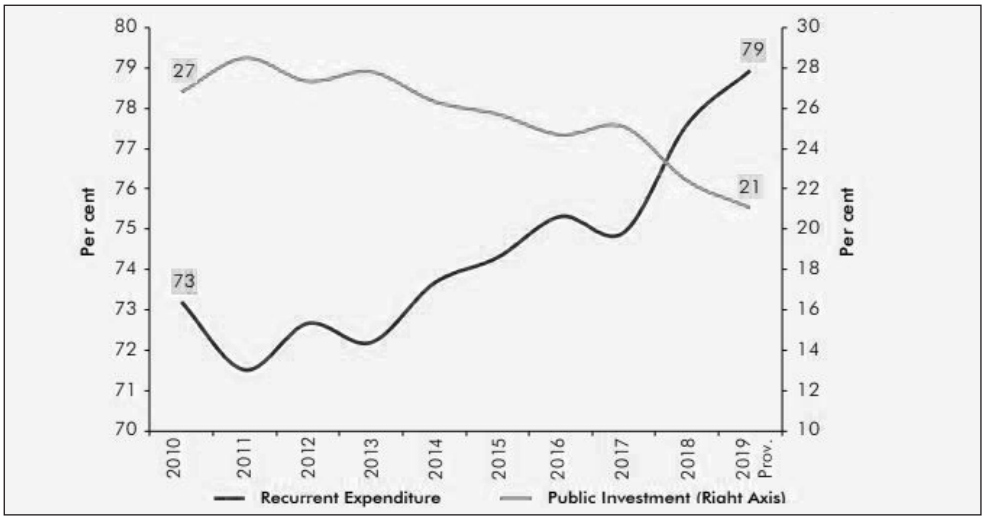

Figure 2: Relative share of recurrent expenditure and public investment in Sri Lanka
Source: Central Bank Annual Report, 2019

other variables (especially aid). It is double counting if one counts both investments and aid. This situation represents a stimulating research gap that we found in the empirical front in the aid-growth literature.

The controversial argument regarding the direct effect approach is that any effect of aid on growth transmits via fiscal decisions affected by the presence of foreign aid. However, the traditional empirical approach to the aid-growth nexus fails to explicitly recognize that aid has an indirect effect that operates via mediating mechanisms, such

as public investment, government spending, and taxation. Heller (1975) conducted studies based on the fiscal response paradigm to attempt to explicitly recognize how fiscal framework is affected by foreign assistance and beyond fiscal responses; the impact of aid on growth is indirectly assumed. Some earlier works in the fiscal response literature have considered the effects of aid on fiscal variables in the Sri Lankan scenario; Otim (1996) uses panel data from India, Pakistan, and Sri Lanka during the 1977-1990 period; Khan & Hoshino (1992) use a pooled time series and cross-sectional data during the 1955-1976 period from five countries, including Sri Lanka. However, these works discuss the situation occurring three decades ago or earlier. Another limitation observed in earlier studies is that the data used consists of a few time series observations.

The controversy regarding the gap model predictions shown in Figure 1 uncover that foreign aid has failed to meet the intended development objectives in Sri Lanka. The fungibility literature argues that any effect of aid on growth transmits is transmitted through mediation mechanisms, such as public investment, public spending, and taxation. In such a context, the fungibility phenomenon is due to the reallocation of domestic resources by a government receiving aid in the presence of foreign aid. Such a process of reallocation over time could lead to fiscal mismanagement directed toward the macroeconomic crisis. The current fiscal and macroeconomic crisis, which was related to these controversies, prompted us to look at aid effectiveness in Sri Lanka. Therefore, the purpose of this paper is to analyze how the fiscal framework deviates from the development objectives expected in the presence of foreign aid to Sri Lanka. Accordingly, we are impelled to use the Heller-type fiscal response model developed by Binh, and McGillivray (1993) that simultaneously considers the association of fiscal achievements against policy planning while dealing with endogenous variables within the model in the presence of exogenous foreign aid. This model addresses the fungibility issue and its impact on the fiscal framework. Simultaneous equations were estimated by commissioning a 3SLS estimation procedure using consistent time series data during the 1962-2017 period from a single country (Sri Lanka), leading to more general conclusions necessary for policy purposes.

The estimation results explained how, with foreign aid present in Sri Lanka, budgetary choices diverged from the desired development goals. We expect public investment to increase if foreign aid is increased. But in contrast, we found evidence that public investment decreases while foreign aid increases. Further, we found that Sri Lankan fiscal policymaker substitutes tax revenue and increases consumption in the presence of foreign aid. Accordingly, the budget deficit and domestic borrowings are expected to increase. Thereby, in the next turn, the authority faces a critical problem due to the dispossessed of required domestic resources that need to mobilize public investment.

Then, the fiscal authority prioritizes eradicating the pressure on domestic borrowing rather than increasing investment, indicating that investment decreases due to the pressure on domestic borrowing.

The remaining sections of the essay are structured as follows. Section II provides an overview of the related literature. Section III presents a discussion of the model development and estimation procedure. Section IV provides a discussion of the estimation results, and in Section V, we propose our conclusion.

II. Literature review

II.I. Fiscal issues in Sri Lanka

The Central Bank of Sri Lanka (Annual report 2021, p.178) mentioned that "…. the anticipated fiscal outcomes were not fully realized during 2021 primarily due to challenging macroeconomic conditions and optimistic fiscal targets which were not sufficiently buttressed by sufficient and consistent policies". The statement directly suggests that there is a gap between targeted and actual fiscal variables which denotes a loss to the policy maker. It also implies that fiscal operations fail on the planning and implementation front. By the way, the overall picture of the statement is that fiscal outcomes and reverse-causal macroeconomic conditions are deteriorating the national economy. Therefore, this controversy calls for an overview of the fiscal situation to analyze the impact of foreign aid on Sri Lanka.

Government tax revenues continued to grow, while its share of GDP declined until 2019. According to the 2021 Central Bank Annual Report, tax revenues as a share of GDP in 2021 have fallen to a record low of 7.7% since independence. This is attributable to low taxes, import restrictions, and the modest recovery of the economy. The government maintains a low tax regime through rates, base, and exemptions.

Figure 4 shows that the highest share of expenditures on wages and salaries contributed to the highest steady rate of recurring expenditures. The ad hoc recruitment policy, particularly as regards the recruitment of graduates over the past three decades, has caused salary increases. Meanwhile, expenditure on salaries and wages increased to 58% of government revenue in 2021 from 36 percent of government revenue in 2019. This means that it intends to expand the institutional framework rather than capital and socioeconomic consumption. Because such fiscal avenues end up sacrificing social-economic services such as health, education, agriculture, and irrigation in terms of capital and recurrent expenditures.

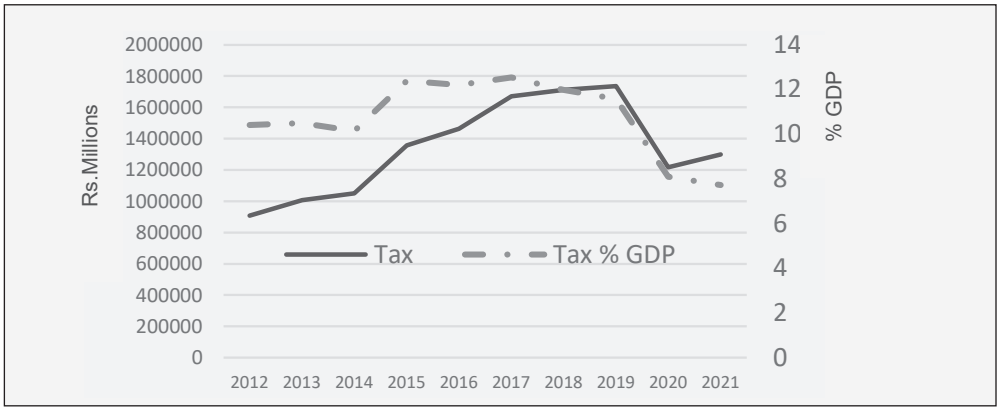

Figure 3: Tax revenue
Source: Author generated figure based on Central Bank Annual Report, 2021

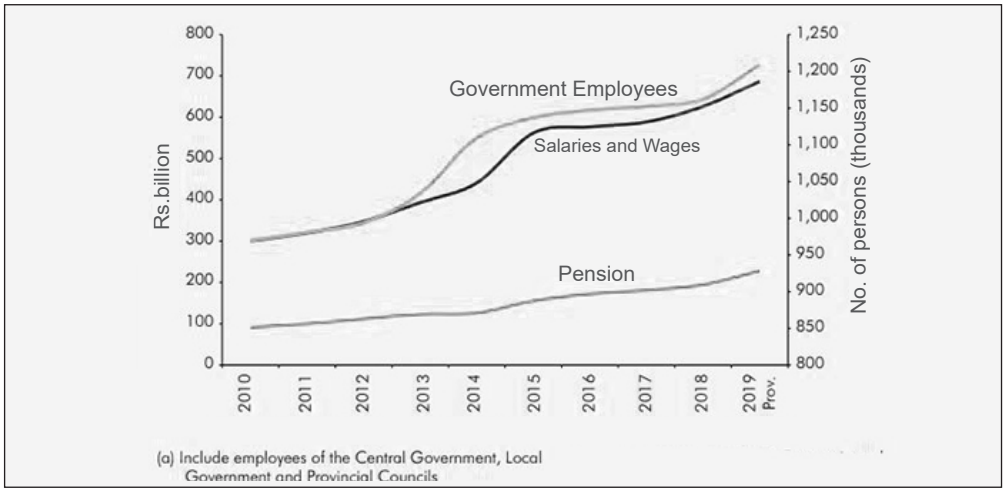

Figure 4: Government employees and expenditure
Source: Central Bank Annual Report, 2019

According to the Central Bank's 2018 and 2019 annual reports, Figures, 2 and 5 indicate that the increasing share of recurring expenses limits the space available for public investments. As a result, capital spending is maintained at a low level to offset recurring expense overruns. Figures 3, 4, and 6 indicate that, although the improvement in the primary surplus does not lead to the possibility of stimulating public investment while reducing government revenue and increasing recurrent expenditure. On the other hand, the rigidity of revenues and expenses allows for a constant and structural budget deficit in the primary balance throughout the period after independence, except for a few years. The Central Bank annual report 2018 (p.202) pointed out that "If the primary surplus is mainly supported by a reduction in public investment instead of robust revenue reforms, such an outcome would compromise the growth prospects of the economy, hence would be unsustainable over the medium term".

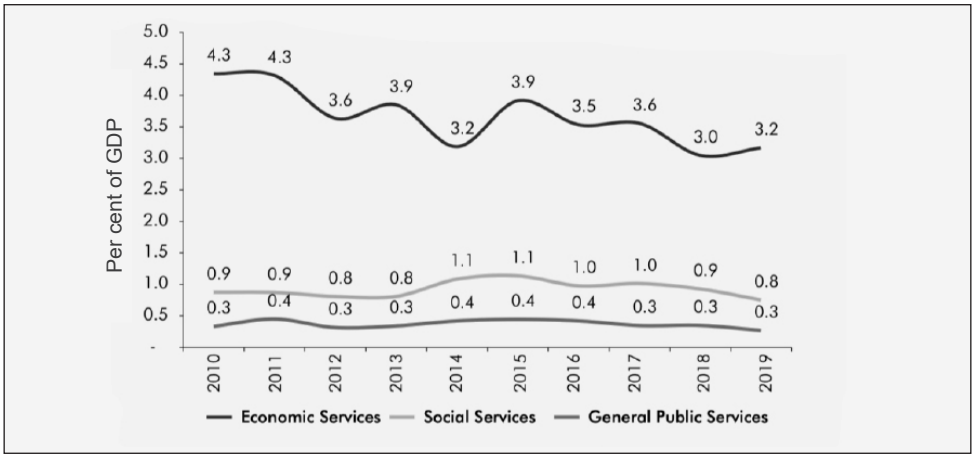

Figure 5: Composition of public investment
Source: Central Bank Annual Report, 2018

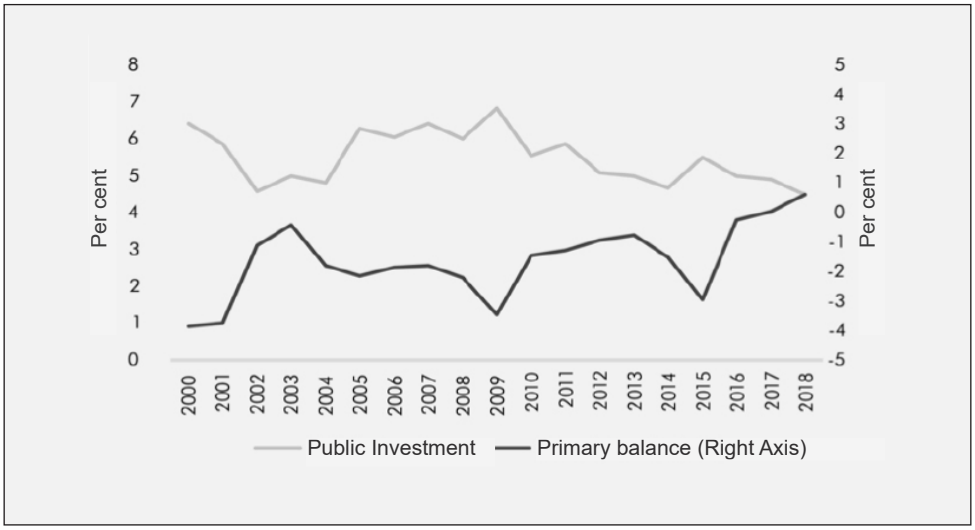

Figure 6: Primary balance vs public investment as a percent of GDP
Source: Central Bank Annual Report, 2019

By implying the limited access to foreign sources owing to the trend of downgrading the country by credit rating agencies namely Moody, S & P, and Fitch continuously from 2015, foreign assistance dropped drastically. Instead, the Government has decided to finance the overall budget deficit mainly from domestic sources (Figures 7 and 8). As per the Central Bank report, 2021 net finance from domestic sources accounted for 12.3 percent of the GDP 2021 (Figure 7). Interest payments also exceeded the trillion rupees mark in 2021 by focusing on insufficient revenue mobilization efforts and reflecting the ongoing drawbacks of financial management.

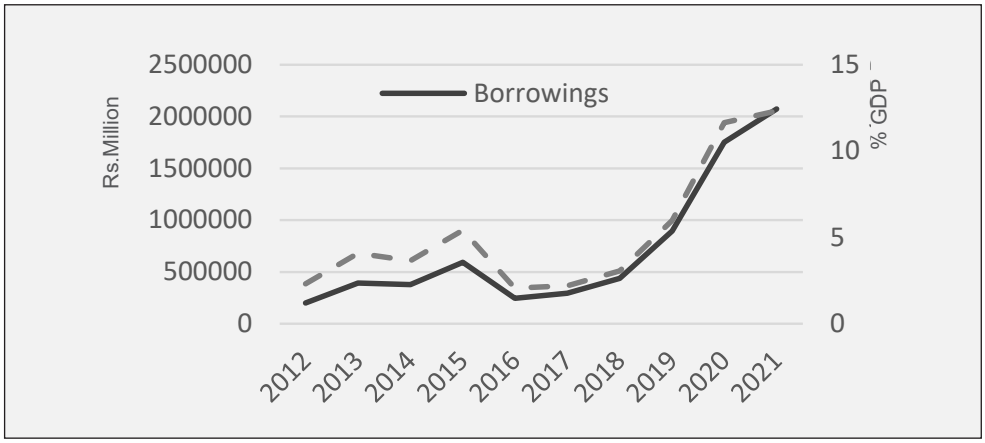

Figure 7: Domestic burrowings
Source: Author generated figure based on Central Bank Annual Report, 2021

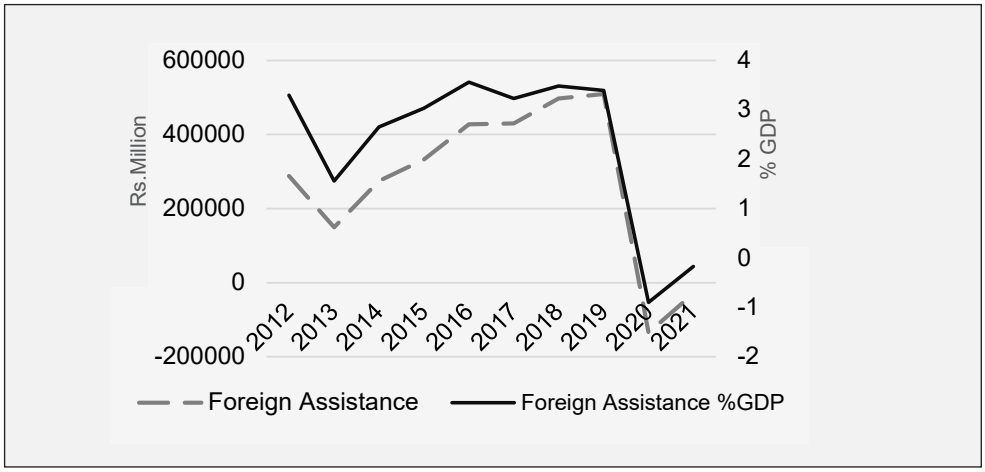

Figure 8: Foreign assistance
Source: Author generated figure based on Central Bank Annual Report, 2021

The behavior of fiscal policy since independence has accumulated enormous and unsustainable debt (as shown in Figure 9). The outstanding debt could be attributable to unproductive public investments, public investments that do not contribute to the production of foreign resources, corruption, a narrow tax base, biased tax exemption policy, strengthening institutional settings rather than improving the socio-economic welfare of the general public, etc.

Sri Lanka's budgetary operations reflect a significant structural budget deficit, worsening the budgetary situation nearly throughout the post-independence period.

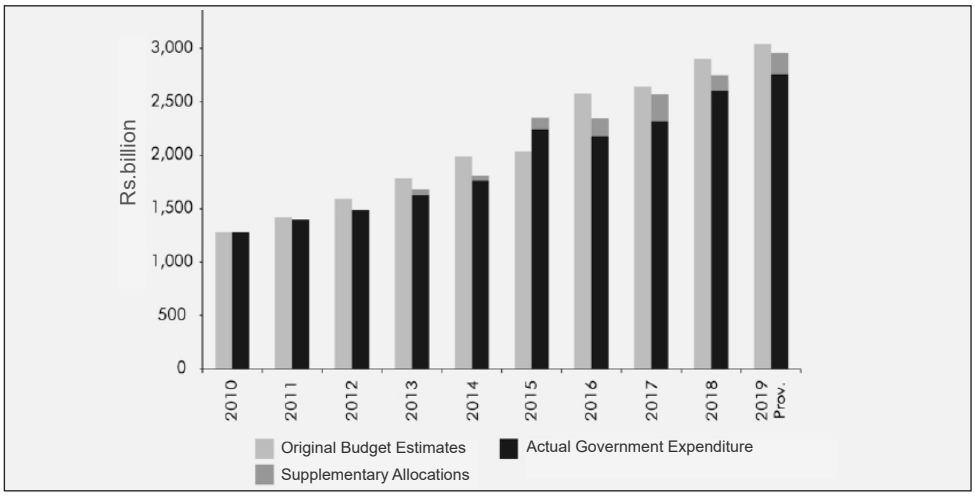

Figure 9: Outstanding central government debt
Source: Central Bank Annual Report, 2021

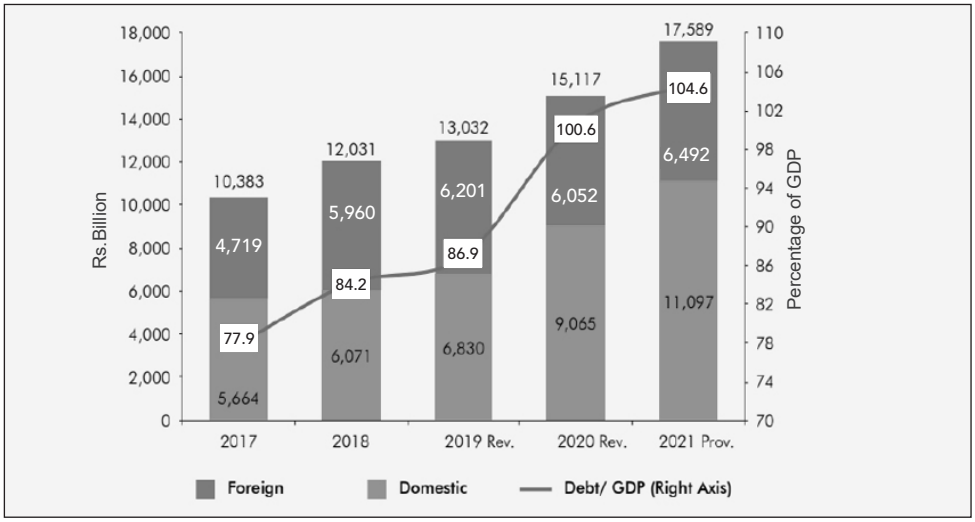

Figure 10: Government expendiure actual vs. budgeted
Source: Central Bank Annual Report, 2019

In the context of the welfare economy, the expansion of public consumption continued, often faster than the mobilization of public revenues. In addition to this fiscal stance, the Central Bank Annual Report 2019 (p.224) has focused on the central argument of the present paper. It says "As recurrent expenditure rises continuously, capital expenditure tends to fall short of the estimates, adversely impacting long-term growth prospects of the economy". The basic argument in the paper is that any deviation from fiscal targets with either undershooting or overshooting is undesirable and a loss to

the policymaker. For instance. "Although the actual government expenditure remained below the budget estimates, the effectiveness of the management of government expenditure is called into question by the frequent submission of supplementary allocations…Such practice often demands a curtailment of expenditure from other areas, mostly capital expenditure, thereby affecting the country's growth prospects. Therefore, it is often argued that issues relating to fiscal operations of Sri Lanka are not only related to revenue shortfall; rather, they also represent the impact of sub-optimal management of expenditure (p.224).

II.II. The aid - fiscal policy nexus

The Harrod-Domar and Solow growth models emphasize physical capital formation as a main driving force of economic performance. These output models depend on the investment rate and productivity. Broadly, these growth models assume that growth is constrained by the availability and productivity of capital. The availability of capital or the level of investment is determined by domestic savings. Any gap between the level of domestic savings and the level of investment required to achieve the target growth rate is described as a savings gap (Rosenstein, 1961; Fei & Paauw, 1965). In such a scenario, we can assume that foreign aid exogenously contributes to increasing the capital stock of the recipient country. Hence, aid allows investments by exceeding the limits set by the domestic savings rate in the recipient country. Pronk (2001) argues that "… economic growth higher than would have been possible given the domestic saving rate would lead to higher income and production and increase future savings and exports, making aid less necessary to reach a given target in later years" [p.618].

Pronk (2001) drew attention to Keith Griffin's critique of the two-gap model created by Chenery, Strout, and others, which asserts that all aid will lead to higher investment. Further, he claimed the controversy regarding the gap model argument. According to him, aid might just serve as a substitute for domestic savings, which would then be diverted to consumption. Aid won't result in more investment, growth, or savings as a result. Griffin, whom Pronk cited, further expounded on the various ways that aid can be ineffective, such as by favoring unproductive or underproductive public investment or investments with a long gestation period. Aid may favor capital-intensive technologies, which raises the recipient nation's later capital requirements. In light of this, Pronk suggested that foreign aid acts as a hindrance rather than a catalyst. Because in a such case, aid will fall short of the expected level of growth and investment. Instead of accelerating growth, projects supported by aid may experience a subsequent increase in maintenance and operational costs that exceed the project's planned return. Then, Pronk (2001) turn to Friedman and argued that there is no necessity for aid. As mentioned, according to Freidman, "if other conditions for economic development are

ripe, capital will be readily available through the market; if not, for instance, because of inadequate policies of the government concerned, capital made available would be likely to be wasted. Thus, a lack of domestic savings reflects a lack of opportunities rather than income" (p.8).

Bacha (1990) and Taylor (1990) mentioned that as a part of the domestic saving gap, the fiscal gap imposes a limit on public spending and may become a binding constraint. Thus, aid recipients do not have sufficient public revenue sources to meet the intended investment level, which is directly related to capacity utilization as a major aspect of growth. This fiscal gap could be filled by direct foreign aid to the government budget, and as a result, capacity utilization can be increased due to spending on infrastructure and social services. Furthermore, a major criticism is that recipient governments may reallocate aid to non-productive activities or sharply reduce the tax effort by lowering tax rates, granting tax exceptions, constricting the tax base, restricting imports, and so on. Therefore, the budget deficit may increase in another round. As a result, over time, aid causes government savings to be lower than those possible without aid rather than closing the fiscal gap. Therefore, if the recipient government spends foreign assistance on development purposes at the margin, aid is successful as expected in the gap model predictions. Otherwise, foreign aid is not successful. An influential paper published by Burnside & Dollar (2000) sheds light on this explanation and concludes that aid only functions well in a good policy environment.

However, the empirical evidence regarding the aid-growth nexus appears rather mixed, and there is no one-to-one relationship. Mavrotas (2002) notes that the traditional specification of the aid-growth nexus fails to identify that aid has an indirect effect on the macroeconomy through public expenditures. This finding is a supporting concept in the fiscal response literature that focuses on how foreign aid may affect government fiscal behavior that weakens the anticipated growth effect of aid. Therefore, fiscal response analyses are vital as they shed light on an underpinning area in the aid-growth nexus. The potential negative effects of foreign aid could be viewed within the context of the fungibility literature, which is based on the fiscal response paradigm. However, Binh & McGillivray (1993) criticized the faulty specification of the utility function employed by Heller (1975) and some scholars who followed the fiscal response model with his specification such as Gang & Khan (1991); Khan & Hoshino (1992); Otim, (1996), etc. Binh & McGillivray (1993) reveal that the specification of the utility function they employed is not compatible with the concept that deviating from the target is undesirable. Therefore, either underestimating or overestimating the target amounts is a loss to the policymaker, and as a result, such amounts cannot truly be considered targets. To ensure consistency with the above claim, these authors introduced a more consistent specification for the utility function that is well matched

with the representation that deviating from the target is undesirable. Movrotas (2002) follows this specification by using time series data from India and Kenya.

Another problem with the fiscal response model is related to the centrality of the target variables. Empirical works in this field have been blinded regarding how these variables might be formulated. All studies cited above did not use actual target variables due to difficulties in obtaining data regarding optimum targets. In the literature, we observed that the fitted values of a supplementary equation involving endogenous variables are treated as estimates of the targets. This procedure is not free from the problem of using generated regressors in an empirical model (Pagan,1984). Simon & McGillivray (2010) use expenditure appropriations and revenue estimates as target variables. However, such estimations are based on an incremental budgeting procedure performed using a previous period's budget or actual performance as a basis, and the marginal change is based on incremental assumptions regarding the new budget period. Therefore, such appropriations and revenue estimates are also full of weaknesses as they fail to consider changing circumstances.

II.III. Fiscal response paradigm

Griffin (1970) and Griffin & Enos (1970) note the general tendency of more aid and less growth in recipient countries. The authors emphasize the concept of aid fungibility, which is the fraction of foreign aid allocated to unproductive consumption rather than savings and investment, as a prominent interacting reason for this phenomenon. The idea is that aid is first allocated to the recipient government's national budget, and in turn, fiscal decisions regarding taxation and expenditure are affected. This phenomenon, i.e., the so-called fiscal response paradigm in the presence of foreign aid, is illustrated more precisely in Figure 11.

Pack & Pack (1993) express that the recipient government stands on its own indifference curve, which reflects the choice of preferences for public goods subject to the budget constraint comprising domestic revenues and foreign aid. Accordingly, public policymakers allocate aid to coincide with their own preferences without considering the donor's intention.

Suppose that the recipient government spends its total domestic resources on public investment (I_g) and the following two consumption goods: civil administration consumption (G_c) and socioeconomic consumption (G_s), such as health and education. All three goods are normal (non-inferior). The government finances these goods by means of domestically generated resources. BB represents domestically financed allocation choices, and point E_1 represents the preferred resource allocation of the recipient country.

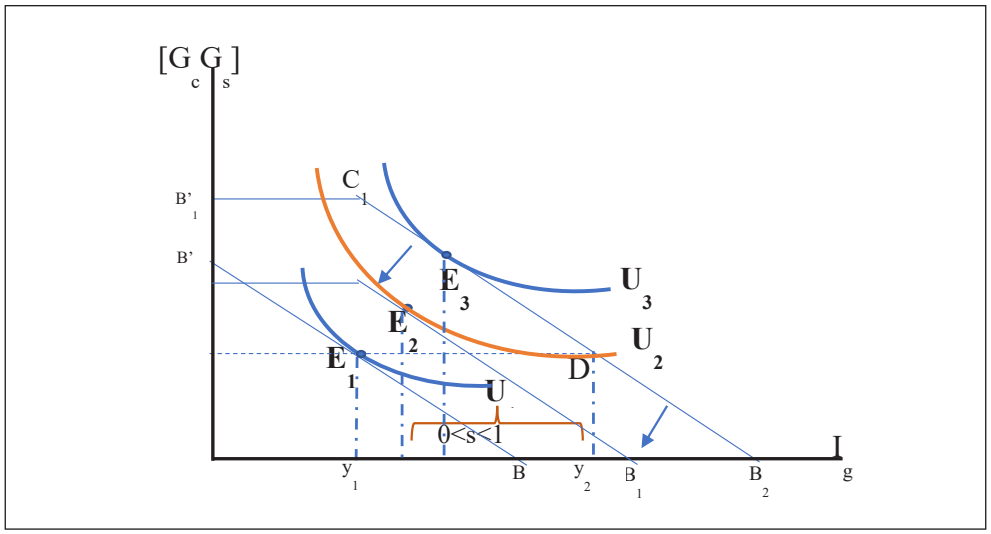

Figure 11: Public consumption and revenue responses in the presence of foreign aid
Source: Author developed the figure based on Pack, H & Pack, J.R. 1993

In addition to its own resources, the country receives an amount of y_1 -y_2 of earmarked foreign aid for good I_g. For simplicity, it is assumed that the aid has no impact on the relative prices of the two goods. Then, the post-aid budget constraint is B_2C B'_1, and y_1-y_3 shows that the aid amount has to be spent on I_g. However, suppose that the recipient government does not divert any of its resources from I_g and spends the earmarked aid on it. In this case, the post-aid consumption combination, point D, is on a higher indifference curve U_2. Therefore, foreign assistance to I_g increases the overall utility in the short run. Point D is an inefficient resource allocation combination that does not satisfy the maximum current utility level of the general public. Therefore, we presume that the two parties, i.e., the donor and the recipient government, do not have identical preferences in the case of aid spending. Therefore, upon receiving aid, the recipient government mixes such aid with domestic resources and changes the pattern of public spending and the pattern of revenue effort in terms of both the level and composition of the government budget. In such situations, while the donor agency would prefer that the aid funds are spent on Ig at the margin, it is unable to monitor the intended pattern of public spending. If the public policymaker can treat a portion of aid (0<s<1) as a resource supplement, the government diverts some of its own resources from I_g to G_c and G_s by spending the acquired foreign aid resources on I_g and/or imposing a tax reduction policy. Accordingly, the most efficient new resource allocation equilibrium points are given by points E_2 and E_3, which are located in higher indifference curves U_2 and U_3, respectively. This outcome shows the intention of policymakers to maximize the utility level of the general public in the short run.

However, beyond the fiscal response model, the impact of aid on growth is indirectly assumed to be that aid funds are spent on I_g at the margin, leading to a higher production possibility and, in turn, much higher economic growth than would have been possible given the domestic resource level. This phenomenon leads to higher income, which increases the motivation for domestic savings and, therefore, reduces the aid requirement to reach a higher indifference curve; thus, the aid is successful.

III. Modeling the aid-fiscal policy nexus

In this section, we demonstrate the empirical model[3] to identify the influence of foreign aid on fiscal variables through a three-step procedure.

First, we follow the public policymaker's utility function developed by Binh & McGillivray (1993), including bilateral and multilateral aid, by focusing on the heterogeneous character of aid. It is assumed that the policymaker followed a welfare function during time period t, which is called the fiscal response model.

$U = f(I_g, G_c, G_s, T, B, A_1, A_2)$

Table 1 provides a description of the variables. Three expenditure categories, i.e., I_g, G_c and G_s, reflect the functional classification in the budget of Sri Lanka. Multilateral and bilateral ODA are viewed as exogenous variables.

Table 1: Description of variables

Variable	Description
I_g	Public investment expenditure on social services and economic services in the real term (excluding capital expenditures on general public services).
G_c	General public services in the real term (including both recurrent and capital expenditures on civil administration, defense, and public order and safety).
G_s	Government socio-economic consumption expenditure in the real term (including social services, such as education, health, and community services, and welfare and economic services, such as agriculture, irrigation, energy, water supply, transport, and communication).
T	Total tax revenue (including direct and indirect taxes) in the real term.
B	Public domestic borrowings in real term

[3] See Appendix A for the complete details.

A_1	Multilateral ODA in real terms (including loan and grant components).
A_2	Bilateral ODA in real terms (including loan and grant components).
GDP	Gross domestic product in real term.
POP	Total mid-year population

We suppose that the fiscal authority maximizes the following quadratic welfare function to obtain the maximum benefit for the general public. Equation (1) shows that the policymaker has a predetermined target level of revenue and expenditure, and any deviation from the defined target levels is considered an undesirable loss to the fiscal authority.

$$U = \propto_0 - \left(\frac{\propto_1}{2}\right)(I_g - I_g^*)^2 - \left(\frac{\propto_2}{2}\right)(T-T^*)^2 - \left(\frac{\propto_3}{2}\right)(G_c - G_c^*)^2 - \left(\frac{\propto_4}{2}\right)(G_s - G_s^*)^2 - \left(\frac{\propto_5}{2}\right)(B-B^*)^2 \quad (1)$$

Where, the variables with an asterisk (*) represent the target level of each endogenous variable. The target level is the optimal level of each variable that reaches the maximum utility. Then, the maximum value of U is$\propto_0$, which is obtained when the actual variables I_g,G_s,G_c,Tand B are set equal to their targets. Accordingly, we assume that the targeted domestic borrowing is zero (B*=0) as it is the optimum level which public policy maker need to reach.[4] Further, we assume the estimated values of each endogenous variable as the target levels by regressing the following supplementary equations (2) – (5).

$$I_g = \rho_a + \rho_1 GDP_{t-1} + \rho_2 Ig_{t-1} + e_1 \quad (2)$$

$$G_c = \rho_b + \rho_1 Gc_{t-1} + \rho_2 T + \rho_3 POP + e_2 \quad (3)$$

$$G_s = \rho_c + \rho_1 Gs_{t-1} + \rho_2 GDP_{t-1} + e_3 \quad (4)$$

$$T = \rho_d + \rho_1 GDP_{t-1} + \rho_2 T_{t-1} + e_4 \quad (5)$$

The time subscript t-1 indicates the period before t, and e is a disturbance term. Before arriving at the above sparse empirical specifications, a number of specifications were tried for each endogenous variable by assessing the conformance of exhaustive specification errors. To represent the actual performance of the prior period, we incorporated a one - year lag into each dependent variable. This lag is also employed in the incremental budgeting approach to create estimates of income and expenditures. In order to account for the shifting conditions of the national economy, we added lag year GDP in all supplemental equations except G_c. The process of setting targets means the fiscal planning. Therefore, it is believed that policy makers rely on the lag information in case of targeting the following year, even though contemporaneous GDP explains the endogenous variable similarly to lag GDP.

[4]Similar specifications were employed by Gang (1991), Khan (1992), Otim (1996), Franco (1998) and Mavrotas (2002)

We discovered that the general population's requirement for public services - which includes civil administration, defense, and public order and safety - does not statistically depend on GDP. Similar to previous cases, targeted G_c also primarily depends on the lag G_c. However, in the case of fiscal management, G_c has an unplanned component, such as disasters, riots, straggles, etc. We therefore presume that such an unexpected component is related to the population and available fiscal performance.

Movrotas (2002, p.543) pointed out that ''the derivation of the target variables in the present paper, as well as in the rest of the fiscal response literature, has not been without problems, and this is obviously a challenging area for future research. Since the value of the targets cannot be observed, it is important to choose some approximation for them; obviously, this will be crucial for the subsequent estimation of the model. However, given the lack of an established theory of target determination or data on actual values, we have no other option but to use this approach''. Accordingly, Movrotas (2002) used totally different specifications for I_g in case of India and Kenya in the same paper. For more clarity, he regressed I_g on contemporaneous GDP and lag I_g in case of India while regressing Ig on lag GDP and private investment in case of Kenya. However, this is basically the approach used by Gang & Khan (1991), Khan & Hoshino (1992), Otim (1996), Rodriguez, Morrissey & McGillivray (1998), and McGillivray (2000).

Then, the budget constraints considered here are given in equations (6) and (7), which indicate the feasible region for decision mapping by public policymakers.

$$G_s+G_c=p_1 T+p_2 A_1+p_3 A_2 \quad (6)$$

Where, $0\leq p_i\leq 1$, i=1,2,3 indicates the shares of tax revenue, multilateral ODA and bilateral ODA that are allocated to socioeconomic and general public services. Here we assume that public consumption is not financed by domestic borrowings, and it only goes to public investment. Therefore, public investments can be financed by domestic borrowing (B), and the remainder is financed by tax revenues (T), multilateral ODA (A_1) and bilateral ODA (A_2) as follows:

$$I_g=B+(1-p_1)T+(1-p_2)A_1+(1-p_3)A_2 \quad (7)$$

Then, we obtain the Lagrangian form in equation (8) as follows:

$$\begin{aligned}\text{MaxL} = \propto_0 &- \left(\frac{\propto_1}{2}\right)(I_g - I_g^*)^2 - \left(\frac{\propto_2}{2}\right)(T - T^*)^2 - \left(\frac{\propto_3}{2}\right)(G_c - G_c^*)^2 - \left(\frac{\propto_4}{2}\right)(G_s - G_s^*)^2 \\ &- \left(\frac{\propto_5}{2}\right)(B-B^*)^2 + \lambda_1\{I_g - B - (1-p_1)T - (1-p_2)A_1 - (1-p_3)A_2\} + \lambda_2\{G_s \\ &+ G_c - p_1 T - p_2 A_1 - p_3 A_2 \quad (8)\end{aligned}$$

From the first-order conditions, we derive the reduced-form equation in equations (9) to (12) as follows:

$$G_s=\beta_1 G_s^*-(1-\beta_1)G_C^*+(1-\beta_1)\, p_1 T+(1-\beta_1)\, p_2 A_1+(1-\beta_1)p_3 A_2 \quad (9)$$

$$G_c=(1-\beta_1)G_c^*-\beta_1 G_s^*+\beta_1 p_1 T+\beta_1 p_2 A_1+\beta_1 p_3 A_2 \quad (10)$$

$$T=\beta_3 p_1 (G_c^*-G_c)+\beta_2 T^*+\beta_4 (1-p_1)[I_g-(1-p_2) A_1-(1-p_3) A_2] \quad (11)$$

$$I_g=(1-\beta_5)I_g^*+\beta_5 [(1-p_1)T+(1-p_2) A_1+(1-p_3) A_2] \quad (12)$$

Where, $\beta_1=\propto_4/(\propto_4+\propto_3)$, $\beta_2=\propto_2/[\propto_2+\propto_5 (1-p_1)^2]$, $\beta_3=\propto_3/[\propto_2+\propto_5 (1-p_1)^2]$, $\beta_4=\propto_5/[\propto_2+\propto_5 (1-p_1)^2]$, $\beta_5=\propto_5/(\propto_1+\propto_5)$.

Here, β_1 is a parameter reflecting socio-economic consumption compared to total government consumption; this parameter shows the deviation of G_c if G_s deviated from its targets. β_2 reflects the relationship between tax revenues and total public receipt, including domestic public borrowing and shows the deviation of B if T deviated from its targets. β_3 indicates the relationship between general public services and total public receiving and shows the deviation of T if G_c deviated from its targets. β_4 represents the relationship between public borrowing and total public receiving and shows the deviation of T if B deviated from its targets. β_5 implies the association between public borrowings and investments and borrowing, thus showing the deviation of I_g if B deviated from its targets.

Regarding the estimation method, we regress equations (2) to (5) using OLS as the first step to use regressors as the target variables[5] following the approximating approach according to the literature, i.e., Mavrotas (2002); Gang & Khan (1991); Khan & Hoshino (1992); Otim (1996). Next, the target variables are inserted as independent variables in the simultaneous system of equations (equations (9) to (12)). We separately obtain each theoretical parameter, such as p and β, using the 3SLS method[6]. Here, we used time series data over fifty-five years (1962-2017) from Sri Lanka. All data were converted to real terms by deflating the current values using the GDP deflator based on 2010. The unit of the monetary values of the data is the Sri Lankan rupee. The data sources of all variables are annual reports of the Central Bank of Sri Lanka.

[5] For the approximation, several specifications were applied to each variable, and the results were confirmed using a serial correlation LM test and RAMSE RESET misspecification diagnostic test.

[6] See Appendix B

IV. Results and interpretations

In this section, we attempt to answer how fiscal framework is affected by foreign aid. All financial values are given in Sri Lankan rupees billions. Accordingly, we review the statistical properties of the variables before applying any time series analysis.

Table C1 in Appendix C presents the summary statistics during the period from 1962 to 2017. Bilateral aid and multilateral aid vary from Rs. 272 bn to Rs. -1.86 bn and from Rs. 72.3 bn to Rs. -0.31 bn, respectively, and the standard deviation provides evidence of aid volatility. Table C2 in Appendix C presents the correlation matrix. The correlation matrix shows that a strong positive relationship exists among the fiscal variables and aid measures we use in the fiscal response model.

The unit root and cointegration tests are a pre-requisite for analyzing time series data. Therefore, we apply the ADF unit root test to the 55 years of annual time series data, and Table C3 in Appendix C presents the test statistics at both level and first differences. Our variables are not stationary in their levels and became stationary after taking their first difference. The regression of one non-stationary variable on another results in a misleading regression, according to Engle & Granger (1987). If the series' linear combination is stationary, on the other hand, the variables are cointegrated and the regression is no longer erroneous. Since we discovered that our variables are non-stationary, we used the Johansen Cointegration Trace Test to determine whether the variables are cointegrated in each model. Results are reported in Table C4 in Appendix C. The test results reject the null hypothesis of no integration by suggesting the presence of long run relationship among the variables. In addition, by discussing the issues of identification, estimation, and statistical inferences of non-stationary time series and simultaneous equation models, Hsiao Fugiki (1998), argued that non-stationarity does not necessarily call for a different modeling strategy, such as simultaneous equation modeling, and system estimators, such as 3SLS. Given his argument, we estimate the fiscal response model with non-stationary data. However, we also report the estimation results obtained using the first difference stationary data in Table D1 in Appendix D as further information.

The estimation results of equations (2) – (5) used to decide the target variables (I_g*, G_c*, G_s*, and T*) are shown in Table 2, which shows that all coefficients of the predetermined variables are positive and statistically significant. Table 3 indicates the set of misspecification diagnostics used to properly test the empirical equations.

Table 2: Estimation results of equations (2) – (5) used to derive the target variables

Dependent variables	Regressions	Summary statistics
I_g	18.80* + 0.012GDP_{t-1}*** + 0.726Ig_{t-1}*** [1.79] [2.67] [6.63]	R^2 - 0.885 DW - 2.23
G_c	-121.09*** + 0.489$G_{c_{t-1}}$*** +0.33T*** +9120POP*** [-3.43] [3.67] [3.88]. [3.34]	R^2 - 0.99 DW – 1.99
G_s	26.78*** + 0.636$G_{s_{t-1}}$*** + 0.021GDP_{t-1}*** [2.65] [4.35] [2.71]	R^2 - 0.96 DW - 1.72
T	2.4.9** + 0.037GDP_{t-1}*** + 0.722T_{t-1}*** [2.18] [3.82] [8.00]	R^2 - 0.98 DW- 2.01

*Note: t-ratios are reported in square brackets below the coefficients. Significance levels are indicated as ***, ** and *, reflecting the 1 percent, 5 percent and 10 percent levels, respectively.*

Table 3: Estimation results of the misspecification diagnostic tests

	LM test	Ramsey's RESET test
I_g	$\chi^2(2)$: 1.56 [0.458] F(2,50) : 0.73 [0.486]	$\chi^2(1)$: 3.03 [0.081] F(1,51) : 2.89 [0.094]
G_c	$\chi^2(2)$: 0.04 [0.979] F(2,49) : 0.01 [0.981]	$\chi^2(1)$: 1.22 [0.268] F(1,50) : 1.12 [0.293]
G_s	$\chi^2(2)$: 2.60 [0.271] F(2,50) : 1.24 [0.296]	$\chi^2(1)$: 2.90 [0.088] F(1,51) : 2.76 [0.102]
T	$\chi^2(2)$: 1.07 [0.585] F(2,50) : 0.49 [0.611]	$\chi^2(1)$: 1.69 [0.193] F (1,51) : 1.59 [0.212]

Using the estimated values of each regression shown in Table 2 as target variables in the system of equations, we obtained all parameters of the equation system from equations (9) to (12) by 3SLS as shown in Table 4. Additionally, some combinations of each parameter in the model can be interpreted as the theoretical relation among the parameters shown in Table 5.

p_1 in Table 4 shows that the fraction of tax revenue allocated to public consumption is 1.32, indicating that there is tendency to withdraw funds from investment. The Central Bank's annual report in 2019 shows that the ratio between public consumption and tax revenue is approximately 1.22, indicating that consumption exceeds the total tax revenue by 22 percent. However, p_2 and p_3 in Table 4 suggest that multilateral aid is displaced by approximately 40 percent, while bilateral aid pull funds out of consumption by approximately 24 percent. Chatterjee, Giuliano & Kaya (2007) clearly mentioned that government consumption is more heavily substituted than domestic government investment by foreign aid. By estimating panel data set including Sri Lanka, they further mentioned that investment aid is more fungible. Similarly, Syed & Mukhtar (2021) also reported that significant portion of foreign aid is dispensed in non-development expenditures in Pakistan.

According to Table 5, bilateral aid tends to modestly reduce both types of consumption, whereas multilateral aid increases public consumption. Indicating that bilateral aid favors to strengthen the institutional setting rather than improving socioeconomic benefits, socioeconomic consumption and general public services fall by 15% and 8%, respectively, as bilateral aid grows. Contrarily, multilateral assistance often enhances socioeconomic benefits rather than supporting the establishment of civil government.

On the revenue side, both bilateral and multilateral aid negatively influence tax revenue. One frequent critique of foreign aid, according to Thornton (2014) is the decrease in domestic tax effort. Seyd & Mukhtar (2021), Benedek et al. (2014), Gang & Khan (1991) advocated for the same argument. Benedek et al. (2014) employed a penal data of 118 countries for the period 1980-2009. Gang, & Khan (1991) conducted a single country analysis on India using the fiscal response model. Combes, Ouedraogo & Tapsoba (2016, p.1), mentioned that "Large aid inflows undermine tax capacity and public investment while large reductions in aid inflows tend to keep recipients' tax and expenditure ratios unchanged". They employed a panel of 59 developing countries including Sri Lanka from 1960 to 2010. Remmer (2004) fairly argued that aid fails to mobilize domestic revenue but leads to aid dependence resulting in revenue short falls.

Table 4: 3SLS estimation results of the unknown parameters in the structural equations of the fiscal response model

Parameter	**Bilateral and multilateral aid**	
	Coefficient	**t-statistic**
p_1	1.320***	37.08
p_2	0.390*	1.69

p_3	-0.239*	-1.62
β_1	0.370***	5.93
β_2	0.947***	41.78
β_3	-0.426**	-2.14
β_4	-1.045***	-2.72
β_5	-0.214***	-3.69
Sample	1962-2017	
Observations	55	
No of iterations	8	

*Note: Significance levels are indicated as ***, ** and *, reflecting the 1 percent, 5 percent and 10 percent levels, respectively*

The obtained negative coefficients in our case, i.e., -0.41 and -0.2, [See table 5] suggest that tax revenue might substitute for other revenue sources, such as bilateral and multilateral aid, by respective amounts. Simultaneously, the coefficient of β_2, which is positive, significant and close to one in our case, indicates that actual tax collection is closely associated with the targeted tax level. This finding suggests that if a public policy maker intends to increase tax revenue, the process will eventually achieve the target. However, a negative β_3 is an indication that tax revenue increases if general public services exceed their targets and vice versa.

In keeping with the previous literature, our findings indirectly explain that the budget deficit is increasing while increasing pressure on domestic borrowing. Seyd & Mukhtar (2021) used a fiscal response model and data for a comparable time period in the example of Pakistan, which had considerably more similar fiscal behavior to Sri Lanka. They found that while aid increases both types of spending, it also has a negative impact on tax collection and domestic borrowing. In our case (Table 5), we also found on one hand, that tax revenues are reduced at a faster pace than consumption in the case of bilateral aid. On the other hand, multilateral aid increases consumption while declining tax revenue. Such moving trends, indirectly indicate that foreign assistance tends to increase the fiscal deficit while being forced to rely on domestic borrowing.

The intended development objectives and how they change when foreign aid is present must be the main topics of our debate. Combes, Ouedraogo & Tapsoba (2016) confirmed that public investment is undermined by aid inflows in their panel estimation, which included Sri Lanka. In terms of aid-financed public investments, we identified three type of scenarios. First, we examined the displacement of multilateral aid above. Then, we identified the policymaker's objective, which is illustrated by $1-\beta_5$ in equation 12.

It implies that when the policy maker intends to increase public investment by one percent, the process will end up exceeding the target by more than 21 percent. But foreign aid which diverted to investment ($1-p_i$) is controlled by the behavioral factor negative β_5 which symbolize the contradictory nature of borrowings and public investment. Together, the two parameters show that public investment falls by 26% and 13%, respectively, when both bilateral and multilateral aid increases. In other words, β_5suggest that when increase the targets of borrowing, public policy maker tends to reduce their planned investments as well. Then the core issue of declining investment is bound with expanding trend of domestic borrowings which we explained above.

Table 5: Coefficients of the revenue variables in the fiscal response model

Dependent variables	Treatment variables	Coefficient	Estimated values
General public service (G_c)	Bilateral aid (A_2)	$\beta_1 p_3$	-0.08863
Socio-economic consumption(G_s)		$(1-\beta_1) p_3$	-0.15086
Investment (I_g)		$\beta_5 (1-p_3)$	-0.26563
Tax(T)		$-(1-p_3) \beta_4 (1-p_1)$	-0.41514
General public service(G_c)	Multilateral aid (A_1)	$\beta_1 p_2$	0.14441
Socio-economic consumption (G_s)		$(1-\beta_1) p_2$	0.24581
Investment (I_g)		$\beta_5 (1-p_2)$	-0.13068
Tax (T)		$-(1-p_2) \beta_4 (1-p_1)$	-0.20423
General public service (G_c)	Tax (T)	$\beta_1 p_1$	0.48863
Socio-economic consumption (G_s)		$(1-\beta_1) p_1$	0.83174
Investment (I_g)		$\beta_5 (1-p_1)$	0.06866
Tax (T)	Gap between the target and actual levels of General public service (G_c)	$\beta_3 p_1$	-0.56282

The Central Bank report 2018 also noted that a notable slowdown in public investment has enabled the recent experience of maintaining a primary surplus despite declining government revenue and tight non-interest recurrent expenditure. Central Bank

Annual report 2019 further mentioned that the amount of room for public investment is limited by the growing percentage of recurring expenses. It implies that the fiscal authority places more emphasis on reducing the demand for domestic borrowing than it does on promoting investment, and as a result, public investment is more vulnerable to issues with fiscal management. As a result, the policy maker has a tendency to scale down, stop, or delay some investment activity when there is foreign aid since it encourages domestic borrowing. The paradoxical character of incomes and the pattern of spending during the time after independence, as stated in the Central Bank Annual Report 2019, has led to a significant structural budget deficit. Without the assistance of external resource flow, such structural phenomena cannot persist for more than 70 years. Therefore the fiscal behaviour driven by the aid mismanagement is worsening the fiscal situation and negatively affecting the long-term growth prospects of the economy.

Estimation results in terms of bilateral and multilateral assistance are largely consistent with the heterogeneity of foreign assistance. Bilateral aid is highly strategic and may reflect the commercial interests of the respective donor countries. However, the cost of multilateral aid is less than that of bilateral aid as multilateral agencies provide loans under a relatively lower interest rate. Multilateral aid has a relatively long gestation period. Grant component is also slightly higher. Even if bilateral assistance is tied, obtaining it is considerably simpler than doing so for multilateral assistance. According to the heterogeneous character of foreign aid, bilateral aid pulls funds out of consumption despite having similar negative effects of multilateral aid, most likely due to less aid absorption capacity.

The image we elaborate here provides insight suggesting that Sri Lankan public policymaker desire to maximize their utility within the utility function of U2, which we show in Figure 11. This finding suggests that the fiscal authority tends to maximize utility in the short run by sacrificing the long-run utility that is expected to be gained through improved production possibility, which is built by aid-financed investment at the margin.

Conclusion

Generally, external monetary sources, such as foreign aid, are expected to close the fiscal gap in developing countries over time. However, in Sri Lanka, the fiscal gaps have tremendously expanded, even though foreign aid has continuously entered the economy throughout the past seven decades. Further, the country is downgraded by world-famous three credit rating agencies such as Moody, S&P, and Fitch continuously

from 2015 to 2020 and is reached the level of 'substantial risk' by November 2020. The nation's repeated downgrades by credit rating agencies provides insight into its current fiscal situation, which is partially related to the foreign aid it receives. In this paper, I will explore the relationship between the nation's fiscal situation and the influx of foreign aid.Therefore, Sri Lanka provides a perfect case study to examine the ineffectiveness of aid, which is mediated through fiscal factors. Therefore, this paper attempts to reveal how fiscal veriables are affected by foreign aid in Sri Lanka. We assume that the Sri Lankan government is attempting to allocate resources, such as taxes and aid for public expenditures, to maximize its utility function subject to budget constraints. We also considered the heterogeneous nature of foreign aid, which can assume the form of bilateral and multilateral aid. The government is supposed to adjust the gap between the target level and actual level of each expenditure and revenue source. Regarding our empirical procedures, we estimated the parameters of the simultaneous reduced forms using 3SLS by using time series data from 1962 to 2017.

According to the estimation results, bilateral aid redirects resources from consumption whereas multilateral aid displaces. Additionally, it shows that multilateral aid favors socioeconomic consumption by diverting more of the aid intended for consumption, while bilateral aid favors civil administration consumption by taking less away from it. Further we found evidence that tax revenues continue to decrease, often more rapidly than the reduction in consumption due to the bilateral assistance. Whereas in the presence of multilateral aid, tax revenue increases while consumption decreases. As a result, it is anticipated that the budget deficit and domestic borrowing will grow more than they would have without aid, which will negatively affect the economy's long-term growth prospects. We expect public investment to increase if foreign aid is increased. But we found evidance that foreign aid which diverted to investment is controlled by negative β_5 which has a contradictory nature of behavior between domestic borrowings and public investment. Accordingly, public policy maker tends to reduce the investment in the presence of foreign aid.

Therefore, we conclude that Sri Lankan public policymakers desire to maximize their utility within the utility function of U2, which we show in Figure 11. It suggests that the fiscal authority tends to maximize utility in the short run by sacrificing the long-run utility that is expected to be gained through improved production possibility, which is built by aid-financed investment at the margin. Therefore, this article argues that foreign aid causes an imbalance in fiscal policy that is detrimental to Sri Lanka's economic performance. Therefore, reliance on foreign aid does not offer a better solution for sustainable growth given the prevailing fiscal behavior. It brings the economy from bad to worst.

Issues relating to fiscal management of Sri Lanka are not only related to the shortfall of tax revenue but also related to the drawbacks of credible budgeting and low abiding fiscal management. Unrealistic fiscal targets, according to Central bank Annual Report 2019, led to cutting down the expenditure from other areas, mostly from capital expenditures. Therefore, regarding the policy implications, we emphasize the requirement of establishing realistic and scientifically assessed fiscal targets in fiscal planning. Whereas, aid should be directly diverted to industrialization and livelihood activities that can generate income in the short run rather than investing projects which has long gestation period. Along with our estimation results, the same central bank's annual report also noted that public investment is declining as a result of offsetting recurring expenditure overruns. In order to increase domestic revenue, fiscal authorities should broaden the tax base and severely rationalize tax exemptions. Furthermore, there is a need to review, rationalize, and minimize spending on general public services. Whereas, We firmly advise the Sri Lankan government to keep receiving foreign aid as long as it maintains a specific level of tax and consumption to GDP ratio. On the institutional side, we emphasize the requirement of empowering the fiscal responsibility act (2003) with legally binding constraints and proper enforcement mechanism to ensure rational and realistic budget planning, corruption free target-oriented budget implementation, and thereby mitigate the spillover effects on the entire macroeconomy.

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Appendix A

In this appendix, we show the derivative process of the fiscal response model used in chapter 3 in detail. We assume that the public policymaker maximizes the following quadratic utility function to obtain the maximum benefit for the general public:

$$U = \propto_0 - \left(\frac{\propto_1}{2}\right)(I_g - I_g^*)^2 - \left(\frac{\propto_2}{2}\right)(T-T^*)^2 - \left(\frac{\propto_3}{2}\right)(G_c - G_c^*)^2 - \left(\frac{\propto_4}{2}\right)(G_s - G_s^*)^2 - \left(\frac{\propto_5}{2}\right)(B-B^*)^2 \quad \text{(A1)}$$

where I_g represents public investment expenditure for development purposes; T represents tax revenues; B represents public borrowing from domestic sources; G_c represents general public services; G_s represents socioeconomic expenditure; A_1 represents bilateral foreign aid; A_2 represents multilateral foreign aid; $\propto \geq 0$; and '*' represents the target level of each variable we defined. We maximize the above utility function (A1) subject to the budget constraints given in equations (2) and (3) faced by public policymakers. Accordingly, the policymakers' feasible region of decision mapping is based on the following institutional constraints:

$$I_g = B + (1-p_1)T + (1-p_2)A_1 + (1-p_3)A_2 \quad \text{(A2)}$$
$$G_s + G_c = p_1T + p_2A_1 + p_3A_2 \quad \text{(A3)}$$

where $(1-p_1)$ = the fraction of tax revenues directed to government investment
$(1-p_2)$ = the fraction of bilateral aid directed to government investment
$(1-p_3)$ = the fraction of multilateral aid directed to government investment
Then, we form the following Lagrangian by maximizing the utility function (A1) of the public policymaker subject to budget constraints (A2) and (A3):

$$\text{MaxL} = \propto_0 - \left(\frac{\propto_1}{2}\right)(I_g - I_g^*)^2 - \left(\frac{\propto_2}{2}\right)(T - T^*)^2 - \left(\frac{\propto_3}{2}\right)(G_c - G_c^*)^2 - \left(\frac{\propto_4}{2}\right)(G_s - G_s^*)^2 - \left(\frac{\propto_5}{2}\right)(B-B^*)^2$$
$$+ \lambda_1\{I_g - B - (1 - p_1)T - (1 - p_2)A_1 - (1 - p_3)A_2\} + \lambda_2\{G_s + G_c - p_1T - p_2A_1 - p_3A_2\} \quad \text{(A4)}$$

The Lagrangian multiplier yields the following first-order conditions (FOC):

$$\partial L/\partial I_g = -\propto_1 (I_g - I_g^*) + \lambda_1 = 0 \quad \text{(A5)}$$
$$\partial L/\partial G_c = -\propto_3 (G_C - G_C^*) + \lambda_2 = 0 \quad \text{(A6)}$$
$$\partial L/\partial G_s = -\propto_4 (G_s - G_s^*) + \lambda_2 = 0 \quad \text{(A7)}$$
$$\partial L/\partial T = -\propto_2 (T-T^*) - \lambda_1(1-p_1) - \lambda_2 p_1 = 0 \quad \text{(A8)}$$
$$\partial L/\partial B = -\propto_5 (B-B^*) - \lambda_1 = 0 \quad \text{(A9)}$$
$$\partial L/\partial \lambda_1 = I_g - B - (1-p_1)T - (1-p_2)A_1 - (1-p_3)A_2 = 0 \quad \text{(A10)}$$
$$\partial L/\partial \lambda_2 = G_s + G_c - p_1T - p_2A_1 - p_3A_2 = 0 \quad \text{(A11)}$$

Then, by solving equations (A5) – (A11), we derived the following set of structural equations:

The derivation of G_s

From (A7), we obtain

$-\propto_4 (G_s-G_s^*) + \lambda_2 = 0$

$-\propto_4 G_s + \propto_4 G_s^* + \lambda_2 = 0$

$\propto_4 G_s = \propto_4 G_s^* + \lambda_2$

Then, λ_2 can be derived from (A6)

$-\propto_3 (G_C-G_C^*) + \lambda_2 = 0 \lambda_2 = \propto_3 (G_C-G_C^*)$

We obtain Gc from equation (A11).

$G_s + G_c - p_1T - p_2A_1 - p_3A_2 = 0$

$G_c = p_1T + p_2A_1 + p_3A_2 - G_s$

Substituting the previous equation, we obtain

$\propto_4 G_s = \propto_4 G_s^* + \lambda_2$

$\propto_4 G_s = \propto_4 G_s^* + \propto_3 (G_C-G_C^*)$

$\propto 4G_s = \propto_4 G_s^* + \propto_3 (p_1T + p_2A_1 + p_3A_2 - G_s) - \propto_3 G_C^*$

$\propto_4 G_s = \propto_4 G_s^* + \propto_3 (p_1 T + p_2 A_1 + p_3 A_2) - \propto_3 G_s - \propto_3 G_C^*$

$\propto_4 G_s + \propto_3 G_s = \propto_4 G_s^* + \propto_3 (p_1T + p_2A_1 + p_3A_2) - \propto_3 G_C^*$

$$G_s = \frac{\propto_4}{(\propto_4+\propto_3)} G_s^* - \frac{1-\propto_4}{(\propto_4+\propto_3)} G_C^* + \frac{1-\propto_4}{(\propto_4+\propto_3)} p_1T + \frac{1-\propto_4}{(\propto_4+\propto_3)} p_2A_1 + \frac{1-\propto_4}{(\propto_4+\propto_3)} p_3A_2 \quad \text{——} \quad \text{(A12)}$$

The derivation of G_c

From (A6), we obtain

$-\propto_3 (G_c-G_c^*) + \lambda_2 = 0$

$-\propto_3 G_c + \propto_3 G_c^* + \lambda_2 = 0$

$\propto_3 G_c = \propto_3 G_c^* + \lambda_2$

λ_2 can be derived from (A7) $-\propto_4 (G_s-G_s^*) + \lambda_2 = 0$

$\lambda_2 = \propto_4 (G_s-G_s^*)$

We obtain Gs from equation (A11).

$G_s = p_1T + p_2A_1 + p_3A_2 - G_c$

Substituting the previous equation, we obtain

$\propto_3 G_c = \propto_3 G_c^* + \lambda_2$

$\propto_3 G_c = \propto_3 G_c^* + \propto_4 (G_s-G_s^*)$

$\propto_3 G_c = \propto_3 G_c^* + \propto_4 (p_1T + p_2A_1 + p_3A_2 - G_c) - \propto_4 G_s^*$

$\propto_3 G_c = \propto_3 G_c^* + \propto_4 (p_1T + p_2A_1 + p_3A_2) - \propto_4 G_c - \propto_4 G_s^*$

$\propto_3 G_c + \propto_4 G_c = \propto_3 G_c^* + \propto_4 (p_1T + p_2A_1 + p_3A_2) - \propto_4 G_s^*$

$$G_s = \frac{1-\propto_4}{(\propto_4+\propto_3)} G_c^* - \frac{\propto_4}{(\propto_4+\propto_3)} G_s^* + \frac{\propto_4}{(\propto_4+\propto_3)} p_1T + \frac{\propto_4}{(\propto_4+\propto_3)} p_2A_1 + \frac{\propto_4}{(\propto_4+\propto_3)} p_3A_2 \text{———} \quad \text{(A13)}$$

The derivation of T from (A8) yields

$-\propto_2 (T-T^*) - \lambda_1(1-p_1) - \lambda_2 p_1=0$

λ_2 can be derived from (A6)

$\lambda_2 = \propto_3 (G_c-G_c^*)$

λ_1 can be derived from (A9) under the assumption of $B^* = 0$,

$-\propto_5 (B-B^*) - \lambda_1=0$

$\lambda_1 = -\propto_5 B$

B can be derived from (A10)

$I_g - B - (1-p_1)T - (1-p_2)A_1 - (1-p_3)A_2=0$

$B = I_g - (1-p_1)T - (1-p_2)A_1 - (1-p_3)A_2$

Then, we can rewrite equation (A8) as follows:

$-\propto_2(T-T^*) - \{-\propto_5[I_g-(1-p_1)T - (1-p_2)A_1 - (1-p_3)A_2]\}(1-p_1) - \propto_3(G_c-G_c^*)p_1=0$

$-\propto_2 T + \propto_2 T^* - \propto_5(1-p_1)^2 T + \propto_5[I_g-(1-p_2)A_1 - (1-p_3)A_2](1-p_1) - p_1[\propto_3(G_{\_c}-G_c^*)]=0$

$\propto_2 T + \propto_5(1-p_1)^2 T = \propto_2 T^* + \propto_5 [I_g-(1-p_2)-(1-p_3)A_2](1-p_1) + \propto_3 p_1(G_c^*-G_c)$

$$T = \frac{\propto_3 p_1(G_c^*-G_c)}{\propto_2 + \propto_5(1-p_1)^2} + \frac{\propto_2 T^*}{\propto_2+\propto_5(1-p_1)^2} + \frac{\propto_5(1-p_1[I_g-(1-p_2)A_1-(1-p_3)A_2]}{\propto_2+\propto_5(1-p_1)^2} \quad \text{(A14)}$$

The derivation of I_g

From (A5), we obtain

$-\propto_1(I_g-I_g^*) + \lambda_1=0$

$\propto_1 I_g = \propto_1 I_g^* + \lambda_1$

λ_1 can be derived from (A9) under the assumption of $B^* = 0$:

$\lambda_1 = -\propto_5 B$

B can be derived from (A10)

$I_g - B - (1-p_1)T - (1-p_2)A_1 - (1-p_3)A_2 = 0$

$B = I_g - (1-p_1)T - (1-p_2)A_1 - (1-p_3)A_2$

By substituting equation (A5) and then rewriting, we obtain

$\propto_1 I_g = \propto_1 I_g^* - \propto_5[Ig-(1-p_1)T - (1-p_2)A_1 - (1-p_3)A_2]$

$\propto_1 I_g = \propto_1 I_g^* - \propto_5 I_g + \propto_5[(1-p_1)T + (1-p_2)A_1 + (1-p_3)A_2]$

$\propto_1 I_g + \propto_5 I_g = \propto_1 I_g^* + \propto_5[(1-p_1)T + (1-p_2)A_1 + (1-p_3)A_2]$

$$I_g = 1 - \frac{\propto_5}{\propto_2+\propto_5} I_g^* + \frac{\propto_5}{\propto_2+\propto_5}[(1-p_1)T + (1-p_2)A_1 + (1-p_3)A_2] \quad \text{(A15)}$$

We let

$\beta_1=\propto_4/(\propto_4+\propto_3)$ $\beta_2=\propto_2/[\propto_2+\propto_5(1-p_1)^2]$

$\beta_3=\propto_3/[\propto_2+\propto_5(1-p_1)^2]$ $\beta_4=\propto_5/[\propto_2+\propto_5(1-p_1)2]$

$\beta_5=\propto_5/(\propto_1+\propto_5)$

We simplify the above structural equations as follows:

$G_s = \beta_1 G_s^* - (1-\beta_1)G_C^* + (1-\beta_1)p_1 T + (1-\beta_1)p_2 A_1 + (1-\beta_1)p_3 A_2$ ——— (A16)

$G_c = (1-\beta_1)G_c^* - \beta_1 G_s^* + \beta_1 p1\ T + \beta_1\ p_2\ A_1 + \beta_1 p_3 A_2$ ——— (A17)

$T = \beta_3 p_1\ (G_c^* - G_c\ ) + \beta_2\ T^* + \beta_4\ (1-p_1\ )[Ig\ -(1-p_2)A_1 - (1-p_3\ )A_2]$ ——— (A18)

$I_g = (1-\beta_5)I_g^* + \beta_5[(1-p_1)T + (1-p_2)A_1 + (1-p_3)A_2]$ ——— (A19)

Appendix B

Here, we describe the 3SLS estimation procedure employed in the fiscal response model. If endogenous variables appear in the system of equations, it is necessary to combine the instrumental variable method of 2SLS with the SUR estimation procedure to obtain the best efficiency by considering the endogeneity problem and correlation of error between various equations.

Consider a general linear model containing G jointly dependent endogenous variables with K predetermined variables, where the i^{th} equation is

$y_i = Y_i\beta_i + X_i\gamma_i + \mu_i$ ——— (B1)

where y_i is an n x1 vector of sample observations of the dependent variable in the i^{th} equation, Y_i is an n xg matrix of observations of the other endogenous variables in the equation, and X_i is an n x k matrix of the predetermined variables included in the i^{th} equation. μ_i is an n x 1 vector of disturbances satisfying $E(\mu_i)= 0$, $Cov(X_i/\mu_i) = 0$, $Cov(Y_i/\mu_i) \neq 0$ and $E(\mu_i\ \mu_j') = \sigma_{ii}I$.

Then, we find the instrumental variable called P_i, which is correlated with Y_i, and derive the linear-form equations of all g endogenous variables.

$\hat{Y}_i = \pi_0 + Z_i\pi_i + e_i$ ——— (B2)

where $Z_i = [P_i, X_i]$, $E(e_i)= 0$, $Cov(P_i/\mu_i) = 0$,

We estimate the fitted values $[\hat{Y}_i]$ of each endogenous variable by using the OLS estimator

$\hat{\pi}_i = [(Z'Z)^{-1} Z'XY_i]$ ——— (B3)

$\hat{Y}_i = Z[(Z'Z)^{-1} Z'Y_i]$ ——— (B4)

We use the fitted values $[\hat{Y}_i]$ and include them in endogenous regressions of the structural equation.

$y_i = \hat{Y}_i\beta_i + X_i\gamma_i + \mu_i$ ——— (B5)

Simply, $y_i = \hat{Z}_i\delta_i + \mu_i$ ——— (B6)

where $\hat{Z}_i = [\hat{Y}_i, X_i]$, $\delta_i = \begin{pmatrix}\beta_i \\ \gamma_i\end{pmatrix}$

We estimate the δ_i of the structural equations by using OLS

$$\delta_{2SLS} = [(\hat{Z}_i'\hat{Z}_i)^{-1}\hat{Z}_i y_i] \quad \text{(B7)}$$

$$\hat{y}_i = \hat{Z}[(\hat{Z}_i'\hat{Z}_i)^{-1}\hat{Z}_i y_i] \quad \text{(B8)}$$

However, the limited-information method focuses on a single equation. Hence, the simultaneous correlations between various equations' error terms are ignored. Therefore, we obtain the residual vector of the 2SLS estimator of δ_i

$$\hat{\mu}_i = \hat{y}_i - Z_i\hat{\delta}_i \qquad (i = 1....g) \quad \text{(B9)}$$

We estimate the system of equations jointly in the SUR model using the GSL estimator. A collection of the full system of G structural equations together is given as follows:

$$\begin{bmatrix} \hat{y}_1 \\ \hat{y}_2 \\ \hat{y}_g \end{bmatrix} = \begin{bmatrix} \hat{Z}_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \hat{Z}_G \end{bmatrix} \begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_g \end{bmatrix} + \begin{bmatrix} \hat{\mu}_1 \\ \hat{\mu}_2 \\ \hat{\mu}_g \end{bmatrix} \quad \text{(B10)}$$

Or more compactly,

$$\hat{y}_i = \hat{Z}_i\delta_i + \hat{\mu}_i \quad \text{(B11)}$$

The variance matrix of vector μ is

$$E(\hat{\mu}\hat{\mu}') = \begin{bmatrix} \sigma_{11}I & \cdots & \sigma_{1G}I \\ \vdots & \ddots & \vdots \\ \sigma_{G1}I & \cdots & \sigma_{GG}I \end{bmatrix} = \sum \otimes I \quad \text{(B12)}$$

[Our basic assumptions are as follows: each structural equation has a homoscedastic non-auto correlated error term, and the disturbances in different structural equations may be contemporaneously correlated, i.e., the error terms of the i^{th} and j^{th} equations are correlated. Accordingly, if all var=0, the error terms of the i^{th} and j^{th} equations are not correlated. Therefore, there is no need for stage 3].

Assuming that at least some σ_{ii} are nonzero, the SUR model provides a natural candidate for the 3SLS estimator as follows:

$$\delta_{3SLS} = [\hat{Z}'(\sum \otimes I)^{-1}\hat{Z}]^{-1}\ \hat{Z}(\sum \otimes I)^{-1})\hat{y} \quad \text{(B13)}$$

Appendix C

Table C1: Summary statistics

	A1	A2	Ig	Gs	Gc	T	B	GDP	POP (000')
Mean	25.84	65.61	169.84	209.47	295.45	384.41	129.37	2858.4	16900
Median	28.04	52.52	159.49	170.04	247.40	343.32	100.04	1820	16825
Max	72.31	272.0	437.59	582.56	812.89	1110.71	468.11	10084.6	22200
Min	-0.32	-1.86	30.34	77.20	42.49	100.84	16.08	500.5	10400
St. Dev.	18.78	64.37	110.67	124.49	213.35	255.25	104.22	2551.8	3654.69
Obs.	55	55	55	55	55	55	55	55	55

Table C2: Corelation matrix

	A1	A2	Ig	Gs	Gc	T	B	GDP	POP
A1	1								
A2	0.4124	1							
Ig	0.5386	0.8681	1						
Gs	0.53	0.8022	0.8465	1					
Gc	0.6084	0.7671	0.8625	0.965	1				
T	0.5707	0.8221	0.8786	0.9835	0.9843	1			
B	0.4346	0.4939	0.7254	0.828	0.8583	0.8105	1		
GDP	0.4854	0.8325	0.8733	0.967	0.9605	0.9816	0.7864	1	
POP	0.7274	0.6068	0.7776	0.8549	0.9249	0.8747	0.8402	0.8162	1

Table C3: ADF test results of the existence of unit root

	I(0)				I(1)	
	Without trend		With trend		Without trend	
A1	-2.868	0.0493			-10.297	0.000
A2	-1.798	0.3815	-3.255	0.74	-11.922	0.000
Ig	-0.722	0.8409	-2.346	0.408	-9.581	0.000
Gs	0.841	0.9923	-1.415	0.856	-6.956	0.000
Gc	1.94	0.9986	-1.122	0.925	-7.718	0.000
T	2.891	1.00	0.462	0.9968	-6.740	0.000
B	-2.600	0.093	-5.922	0.000	-11.86	0.000
GDP	8.721	1.00	3.693	1.000	-3.566	0.000
pop	-1.65	0.457	-0.824	0.9636	-7.14	0.000

Table C4: Johansen tests for cointegration

Models	Maximum rank	Trace statistics	Critical value (0.05)
Equation 2	0	11.71 *	15.41
	1	3.11	3.76
	2		
Equation 3	0	30.72	29.68
	1	12.073*	15.41
	2	0.0035	3.76
	3		
Equation 4	0	22.45	15.41
	1	1.18*	3.76
	2		
Equation 5	0	31.46	18.17
	1	1.83*	3.74
	2		
Equations 9-12	0	376.19	250.84
	1	254.62	208.97
	2	152.88*	170.80
	3	99.13	136.61
	4	67.99	104.94
	5	41.14	77.74
	6	18.93	54.64
	7	7.16	34.55
	8	0.000	18.17
	9	0.000	3.74
	10		

** denotes rejection of the null hypothesis at the 0.05 level*

Appendix D

Table D1: 3SLS estimation results based on the 1st difference data

Parameter	Coefficient	t-statistic
$\mathbf{p_1}$	1.02***	7.419398
$\mathbf{p_2}$	0.53**	2.061185
$\mathbf{p_3}$	0.45***	6.299744
$\mathbf{\beta_1}$	0.58***	10.27861
$\mathbf{\beta_2}$	0.49***	3.638205
$\mathbf{\beta_3}$	-0.74***	-3.432102
$\mathbf{\beta_4}$	-4.20*	-0.147722
$\mathbf{\beta_5}$	-0.75**	-2.053144
Observations	55	
No of iterations	16	

*significance levels are indicated as ***, ** and *, reflecting the 1 percent, 5 percent and 10 percent levels, respectively*