Government Tax Revenue, Expenditure, and Debt in Sri Lanka : A Vector Autoregressive Model Analysis

Uthajakumar S.S[1] and Selvamalai. T[2]

[1] Department of Economics, University of Jaffna.
[2] Faculty of Economics, South Asian University, New Delhi, India

Abstract
The study has applied Vector Autoregressive (VAR) model of times series econometric techniques to examine the relationship between government tax revenue, expenditure and debt in Sri Lanka from 1950 to 2015. The data were gathered from Annual Report of Central Bank of Sri Lanka, 2015. The study was found several interesting results. Results of variance decomposition analysis concluded that impact of the external shock on forecast error in tax can be negligible but it can be negligible in the case of government expenditure and debt. Further, the impact of the own shock on forecast error in all cases can not be negligible. The results of impulse response function concluded that responses of the system to standard deviation shock in a single variable were meaning full only in the short-run (up to five periods). The results of Granger Causality test concluded that government tax revenue did Grange cause government expenditure and debt in Sri Lanka not vice versa at 5% significant level. And there was a uni-directional causal relation from government expenditure to debt at 5% significant level. Further, at 10% significant level, there was a bi-directional Granger Causality between government tax revenue and debt in Sri Lanka.

Keywords: Tax, Expenditure, Debt, Vector Autoregressive (VAR) Model, Impulse Response Function.

Introduction

The Sri Lanka have been unable to constrain the growth of its debt to ensure that sufficient revenues remain available after debt service payments to finance other vital government recurrent and development expenditures. In 1960, government tax revenue, expenditure and debt were 17%, 27% and 34% as a percentage of GDP respectively. In 2015, government tax, expenditure and debt were 12%, 20% and 76% respectively (Annual Report of Central Bank of Sri Lanka (ARCBSL), 2015). The tax revenue and government expenditure as a percentage of GDP have decreased by 5% and 7% between 1960 and 2015, but the government debt as a percentage of GDP has increased by 42 % during the same period. Between 1950 and 2015, the highest value of tax revenue as a percentage of GDP was 24% in 1978 while the highest value of government expenditure was 42.6% as a percentage of GDP in 1980, but the highest value of government debt was 109% as a percentage of GDP in 1989. When considering the contemporary issues of economics the study should focus the relationship between these macroeconomic variables, tax revenue, government expenditure, and government debt.

Review of Literature

Keynesian economist says that government can control aggregate demand and the level of national income through spending and tax policies. Government current budget balance is the difference between its spending and revenues. It is given by the following formula.

$$\boldsymbol{B_t = G_t - T_t} \qquad (\mathbf{1})$$

Where B_t is the balance at time *t*, G_t is the level of government expenditure at time *t,* and is the tax revenue at time *t*. Government debt can be expressed by the following equation.

$$\boldsymbol{D_t = (1 + r)D_{t-1} + B_t} \qquad (\mathbf{2})$$

Where D_t denotes government debt at time *t* and *r* denotes rate of interest. The equation (2) can be rewritten as equation (3) by subsituting equation (1) for $\boldsymbol{B_t}$.

$$\boldsymbol{D_t = (1 + r)D_{t-1} + G_t - T_t} \qquad (\mathbf{3})$$

The equation (3) explains that government debt is the accumulated total of all its budget deficits and surplus and associated interest payment involved in serving the debt.
Gisele Mah et al (2013) found that there was a significant positive relationship between gross government debt and gross national expenditure. Ravinthirakumaran, K (2011) showed that bidirectional causality exists between government revenue and expenditure and there is a long-run equilibrium between these two variables in Sri Lanka. In India, there was also bidirectional Granger causality between expenditure and revenue over the period of 1980-2008 (Sikdar, S., & Mukhopadhayay, 2011). In Pakistan, there was a uni-directional causality between government expenditure and revenue over the period 1979-2010 (Subhani, M.I, et al, 2012).

Objective of Study
The main objectives of the study are to find the impact of tax revenue on government expenditure and debt and to find the causal relationships between these study variables. The study used times series data from 1950 to 2015 and it was gathered from Annual Report of Central Bank of Sri Lanka, 2015.

Methodology: VAR Model

Vector autoregressive (VAR) models were popularized in econometrics by Sims (1980) as a natural generalization of univariate autoregressive models. A VAR is a systems regression model that can be considered a kind of hybrid between the univariate time series models and the simultaneous equations models. VARs have often been advocated as an alternative to large-scale simultaneous equations structural models.

VAR models have several advantages. The researcher does not need to specify which variables are endogenous or exogenous (all are endogenous). VARs allow the value of a variable to depend on more than just its own lagged or combinations of white noise terms. There are no contemporaneous terms on the right-hand side (RHS) of the equations of VAR; it is possible to simply use OLS separately on each equation. When considering the interpretations of VAR model the both variance decomposition analysis and impulse response function are very important.

The purpose of this paper is to investigate the effect of tax revenue on government expenditure and debt in Sri Lanka between 1950 and 2015. An '*n*' periods lagged, the three-variable standard or restricted VAR model is specified:

$$TX = p_0^{TX} + \sum_{i=1}^{n} \alpha_i^{TX}\, TX_{t-i} + \sum_{i=1}^{n} \theta_i^{TX}\, EP_{t-i} + \sum_{i=1}^{n} \delta_i^{TX}\, DT_{t-i} + u_t^{TX} \qquad (1)$$

$$EP = p_0^{EP} + \sum_{i=1}^{n} \alpha_i^{EP}\, TX_{t-i} + \sum_{i=1}^{n} \theta_i^{EP}\, EP_{t-i} + \sum_{i=1}^{n} \delta_i^{EP}\, DT_{t-i} + u_t^{EP} \qquad (2)$$

$$DT = p_0^{DT} + \sum_{i=1}^{n} \alpha_i^{DT}\, TX_{t-i} + \sum_{i=1}^{n} \theta_i^{DT}\, EP_{t-i} + \sum_{i=1}^{n} \delta_i^{DT}\, DT_{t-i} + u_t^{DT} \qquad (3)$$

Where TX, EP, and DT denote tax revenue, government expenditure and government debt respectively. u_t^r is random errors and p_0^r is constant where r= TX, EP and DT. The equation 1, 2 and 3 shows the standard VAR model because there are no contemporaneous terms as explanatory variables in the right hand side (RHS). This VAR model can be interpreted into three ways: Variance decomposition analysis, Impulse response function, and Granger causality. The variance decomposition procedure measures the percentage share of each particular shock in variables. The response functions show the responses of the system to the period standard deviation shock in a single variable. The Granger causality test explains the causality of variables. All results were estimated by using EViews software. All data enter into the model as an annual frequency. Hence, the growth rates of these variables are following stationary. It is proved by graphically and statistically (see the Figure.1 and Table.1). In the statistical methods, the study applied augmented Dickey- Fuller unit root test
to test the stationarity of the variables.

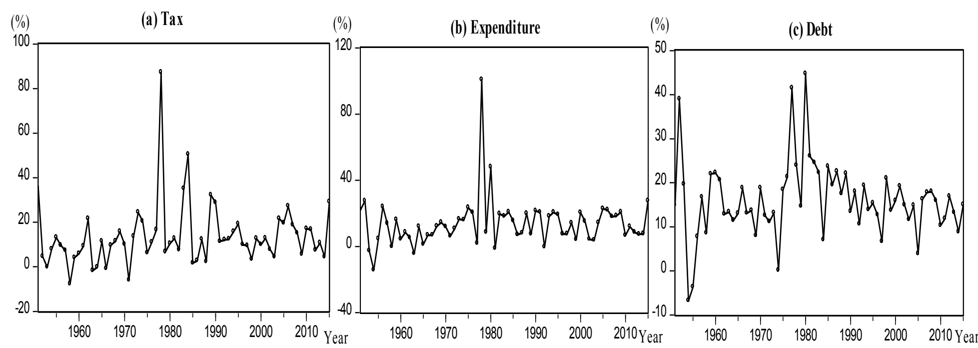

Figure 1 : Trends of growth rate of government tax revenue, expenditure, and debt
Source: Author's Calculation based on ARCBSL, 2015.

Table 1 : Results of augmented Dickey-Fuller (ADF) unit root test

Variables	Calculated t-value	Critical t-values	Stationarity
Growth rate of tax revenue	-7.2958	-2.9076	yes
Growth rate of Government expenditure	-4.5663	-2.9084	yes
Growth rate of Government debt	-5.9177	-2.9076	yes

Source: Author's Calculation based on ARCBSL, 2015.

Figure 1 shows trends of government tax revenue, expenditure and debt of Sri Lanka. In Figure 1, the plots of these variables against time demonstrate that series of variables follows stationary and there is no deterministic trend in series. It is proved statistically by using the constant specification of Augmented Dickey-Fuller (ADF) unit root test.

The results of augmented Dickey-Fuller (ADF) unit root test are given in Table.1. to test the stationarity of variables. These ADF unit root test results are given in table.1. In the Table.1, critical values which were provided by Mackinnon (1991) are given at 5% significant level. If the absolute value of calculated t-value is greater than the critical value at the particular significant level, then null hypothesis that series follows non-stationary can not be accepted. This means series is a stationary. Table.1 shows that series of all variables are stationary at 5% significant level because the absolute value of calculated t-value is greater than the critical value of that t-value at 5% significant level.

Results and Discussions

Table.2 Akaike Information Criteria and Optimal **l**ag length selection

Lag	LogL	LR	AIC
0	-668.5170	NA	22.38390
1	-653.5249	27.98536	22.18416
2	-635.6960	31.49777*	21.88987*
3	-629.5837	10.18708	21.98612
4	-619.6128	15.62105	21.95376
5	-613.7110	8.656030	22.05703

Source: Author Calculation

Table 2 shows the Akaike information criteria of selection of the optimal lag length of VAR model. The optimal lag length is determined by the minimum value of Akaike information criteria (AIC). In Table.2, the value of AIC is given in the fourth column where the minimum value of AIC is 21.8898 at lag order two. Hence, the lag order two is the optimal lag length of VAR model. According to this lag selection criterion, vector autoregressive model has estimated.

Table.3 shows the results of standard VAR model that is known as VAR (2) because the optimal lag length was two. In table.3, TX, EP, and DT are dependent variables. TX (-1), TX (-2), EP (-1), EP (-2), DT (-1), and D (-2) are independent variables and lagged variables of TX, EP, and DT. Tax revenue at lag order one (TX (-1)) had a positive and significant impact on contemporary tax revenue (TX) and government expenditure (EP). But it had a negative and insignificant impact on contemporary government debt (DT).

The government expenditure at lag order one (EP (-1)) had a negative and significant impact on current tax revenue (TX) and government expenditure (EP) while it had a positive and insignificant impact on government debt (DT). The government debt at lag order one (DT (-1)) had a positive impact on the government tax revenue and expenditure but no significant impact on current government debt (see the Table.3)

When considering the impact of variable lag order two, only one case, government expenditure at lag order two (EP (-2)) had a significant impact on current government debt (DT). There were no other cases of the significant impact of study variable at lag order two (see Table.3).

Table 3: Results of Vector Autoregressive Model

Variables	TX	EP	DT
TX(-1)	0.373103 [2.00155]	0.622268 [3.28450]	-0.115802 [-1.16407]
TX(-2)	-0.047462 [-0.25538]	0.231921 [1.22782]	0.048561 [0.48961]
EP(-1)	-0.381844 [-2.03067]	-0.607890 [-3.18077]	0.160801 [1.60237]
EP(-2)	-0.088927 [-0.47413]	0.061762 [0.32400]	0.236229 [2.36003]
DT(-1)	0.673519 [2.82376]	0.568652 [2.34573]	0.138683 [1.08949]
DT(-2)	0.005233 [0.02174]	-0.346628 [-1.41701]	-0.081273 [-0.63274]
C	4.589626 [0.97873]	6.138348 [1.28792]	10.17562 [4.06601]

Source: Author Calculation

Table.4. Breusch- Godfrey serial correlation

Null Hypothesis: no serial correlation
Sample: 1951 2015
Included observations: 63

Lags	LM-Stat	Prob
1	12.72538	0.1754
2	14.65470	0.1009

Probs from chi-square with 9 df.

Table 4 shows the results of Breusch-Godfrey serial correlation LM statistics of the vector autoregressive model (VAR) model. If there is a serial correlation in the model then the estimated results might be biased. For the serial correlation test, the study included 63 observations. The last column of Table.4 shows the p-value of LM statistics. These p-values show that null hypothesis that there is no serial correlation in the VAR model can not be rejected at 5 % significant level. Hence, the estimated results of VAR model given in Table.3 are robustness at 5 % significant level. The next sections are an interpretation of the vector autoregressive model. This interpretation has three parts as explained in the methodology section.

Variance Decomposition Analysis

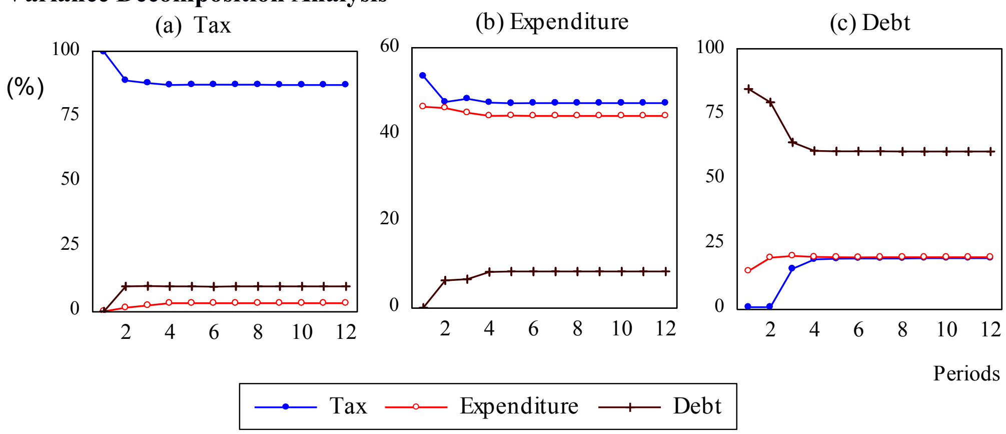

Figure 2 : Variance decomposition analysis for Tax, Expenditure, and Debt in Sri Lanka
Source: Author's Calculation

Figure 2 shows the decomposition of variance for the three cases, tax, expenditure, and debt. The variance-decomposition procedure measures the percentage share of each particular shock. The variance decompositions were calculated over 12 periods ahead for each variable and are reported in Table.5. After one period, there were stable forecast errors in TX explained by own shock and other shocks. The impact of shock (innovations) in EP on forecast error of TX remains same and negligible (nearly 3%). And also the impact of innovations in DT on forecast error of TX was very low (less than 10%). Whereas, the substantial or major portion forecast error (nearly 87%) is explained by its own innovations. Those results indicate that tax policy remained endogenous rather exogenous to the developments in the Sri Lankan economy in both short-run and long-run.

Now, we consider the forecast error of Expenditure (EP) in Sri Lanka. After one period, less than 50% of the forecast error in EP explained by own innovations and more than 50% of the forecast error in EP explained by external shocks. The impact of a shock in DT on forecast error of EP is very low, and it was less than 9% in all period of time. The own shock of EP and shock from TX are nearly same, and it is more than 44% of the forecast error in EP in all period of time. Therefore, the variance of EP depends on both own shock and external shocks which are more or less same weight.

The final case is decomposition of DT. Whereas over 79% of the forecast error in DT explained by its own innovations in the short term (two periods), this share drops below 65% over longer terms (3to 10 periods). The impact of a shock in TX on forecast error in DT was negligible (0.62%) in short-term (1 and 2 periods) but this share increased to 20% over longer terms periods (from period 3). These results say that impact of the external shock on forecast error in tax can be negligible but in the case of expenditure and debt that can not be negligible, however, the impact of the own shock on forecast error in all cases can not be negligible.

Impulse Response Function

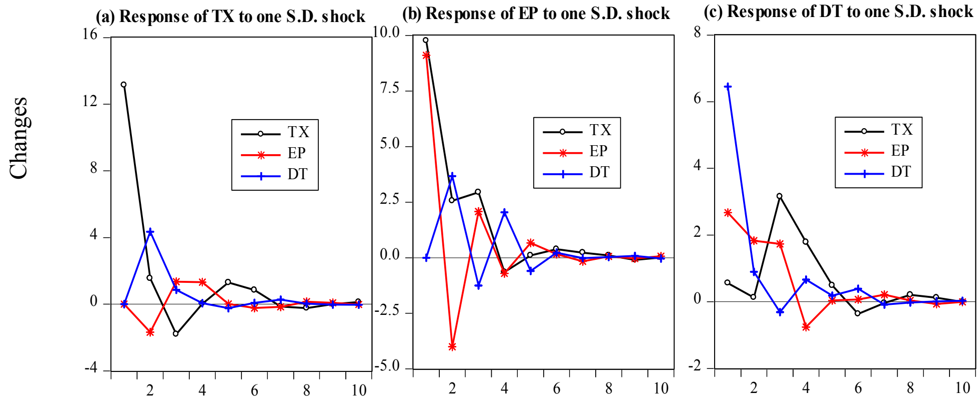

Figure 3 : Impulse Response Functions of Government Tax Revenue, Expenditure, and Debt
Source: Author's Calculation

The response functions show the responses of the system to the period standard deviation shock in a single variable. The results are reported in Figure 3. In Figure.3, the first figure shows the responses of government tax revenue to one standard deviation shock in all three variables. In Figure.3, the second figure shows the response of government expenditure to one standard deviation shock in government tax revenue, expenditure, and debt. Similarly, the last figure of Figure.3 shows the responses of government debt (DT) to one standard deviation shock in all three variables. These figures show that responses of the system to standard deviation shock in a single variable were meaning full in the short-run (up to five periods) and that are negligible in the long-run. In many periods, responses to one standard deviation shock are positive in all three cases. And negative responses are negligible compared to positive shock in case (a) and (c).

Granger Causality Test

Table.5 : Results of Granger Causality Test

No.	Null Hypothesis	p-value
01	Tax revenue does not Granger Cause Expenditure	0.049
02	Expenditure does not Granger Cause Tax Revenue	0.608
03	Expenditure does not Granger Cause Debt	0.000
04	Debt does not Granger Cause Expenditure	0.598
05	Tax revenue does not Granger Cause Debt	0.004
06	Debt does not Granger Cause Tax revenue	0.083

Source: Author Calculation

Table.5 shows the results of Granger Causality test. In Table.5, p-values of first two null hypotheses explain that there is uni-directional causality from government tax revenue to expenditure in Sri Lanka. The p-values of third and fourth null hypotheses explain that there is uni-directional causality from government expenditure to government debt at 5% significant level. The p-values of last two null hypotheses explain that there is also uni-directional causality from tax revenue to government debt at 5% significant level but there is a bidirectional causality relation between these government tax revenue and debt at 10% significant level in Sri Lanka.

Conclusion

Results of variance decomposition analysis concluded that impact of the external shock on forecast error in tax can be negligible but it can be negligible in the case of government expenditure and debt. Further, the impact of the own shock on forecast error in all cases can not be negligible. The results of impulse response function concluded that responses of the system to standard deviation shock in a single variable were meaning full only in the short-run (up to five periods). The results of Granger Causality test concluded that government tax revenue did Grange cause government expenditure and debt in Sri Lanka not vice versa at 5% significant level. And there was a uni-directional causal relation from government expenditure to debt at 5% significant level. Further, at 10% significant level, there was a bi-directional Granger Causality between government tax revenue and debt in Sri Lanka.

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