Macroeconomic Policy: Evidences from Growth Laffer Curve for Sri Lanka

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Abstract: Public economic policies are vital for the provision of efficient public services, in which optimal taxation system to promote economic growth in Sri Lanka. The research question intends to identify the optimal taxation policies and government size for promoting economic growth. Rationale for the research is to provide pragmatic evidences on the economy to investigate the different macroeconomic indicators with empirical models, while supporting to build up tax systems that generate optimal tax revenues through Laffer curve estimation. An empirical approach is used to estimate the Laffer curves with Instrumental Variable Generalized Method of Moments (IV-GMM) in factors affecting optimal taxation. The results expose a strong correlation of the tax revenue, and GDP with respect to tax rate for the Laffer curves, includes significant covariates such as tax rate, tax^2, tax^3, lag (tax), young dependency ratio, total factor productivity, exchange rate, foreign direct investment, and openness. The U-test shows that extreme points are at 17.36 and 17.93 of the tax rate implying U-shape for Laffer and growth Laffer curves respectively. The implications of the study are to deliberate on the macroeconomic determinants of the optimal taxation for reform the tax systems. Finally, the paper guides policymakers to reform tax systems with empirical evidences on impacts of public economic policies to improve optimal taxation for the economic growth in Sri Lanka.

Keywords: Taxation, Laffer Curve, Economic Size, Economic Growth, IV-Generalized Methods of Moments

JEL: B23, E60, E62, F43, H21, O47

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1. Introduction

The concept of optimal taxation policies has recently emerged among many countries that are concerned on the internal control of the economies. Sri Lanka as one of the developing economies has shown a relationship of tax revenue and tax rate for facilitating GDP growth in terms of macroeconomic policy perspective. However, the concern is that the existing taxation policies need to be revised to achieve the maximum tax revenue through optimal tax rate under fiscal policy analysis of the government has been devoted to explain the optimal taxation and maintaining the optimal government size. The literature shows several studies to bridge the knowledge gap to provide empirical evidences to foster the economic growth with adoption to the optimal taxation policies and reforms for developing economies. Nevertheless, further studies on economics looking into specific characteristics of macroeconomic volatility in the economy need to be understood for the proper macroeconomic policies.

Even though, Sri Lankan tax system needs to be reformed with optimal taxation for macroeconomic policies, so far the attempts made by the taxation entities were not successful for obtaining the optimal tax revenues while maintaining the government size. Imposing over-tax rates for the public without proper tax plan is not increase the government tax revenue even though it is the apparent solution for many financial institutes. Further, underline hypothesis develops a plausible solution for increasing tax revenue for the government through increase of tax rates also affect by the government size for economic growth. One of major concerns of this paper is to evaluate the tax increase with respect to identifying the increase of tax revenue and then it impact on the economic growth.

Many Asian governments, including Sri Lanka, remain severely involved in the provision of public goods and in the redistribution of income for the economic growth. But underline drivers of the economic growth in corresponding to the tax revenues are lack to study the factors governing the optimal taxation policies. Because, many literature recognizes that high levels of taxation impede economic growth and that lower taxes can raise the rate of economic growth. Finding a set of appropriate growth promoting fiscal policies is a complicated task since different countries face different constraints in terms of institutional, structural, and socio-economics. Focusing on tax revenues, the growth GDP per capita have been studied, after analyzing the Laffer curve into growth-Laffer curve. Inefficiencies in tax systems make the governments difficult spending in economic growth such as public infrastructure and investment in human capital; in contrast, very high tax burdens can also be unfavorable to economic growth. The study intended to evaluate the appropriate macroeconomic policies for the optimum taxation under the determined government size.

Serious econometric issues are raised in empirical approach for parameter estimation to obtain the robust results with the use of time series data. These issues like endogeneity center around the likely non-random nature of the distribution of the residuals obtained from time series estimation. Therefore, it needs a number of econometric approaches to test and estimate the accurate coefficients while detecting and correcting these econometric problems. This paper also used newly developed econometric methodologies such as IV-GMM while resolving all those empirical issues to obtain the robust estimations. Lastly, this paper intended to build empirical evidences for tax reform in Sri Lanka with determinants of optimal taxation and its impact on government size under the Growth Laffer curve. Further, it is essential to determine the size of the government to be more efficient and effective taxation systems.

The outline of the remainder of this paper is as follows. Section 2 provides stylized facts and analysis of GDP, and Tax rate with structural breaks. Section 3 provides an explanation of literature review. Section 4 presents the Data and Empirical Methodology, in particular, the estimation model, methodology process, and section 5 gives the estimation of results and discussion. Section 6 and 7 present conclusion and policy recommendations respectively.

2. Stylized facts of Sri Lankan Economy

The following figures provide stylized facts of Sri Lankan economy in terms of real GDP per capita, Tax rate and Tax revenue changes, and structural changes of those macroeconomic variables from 1960 to 2014.

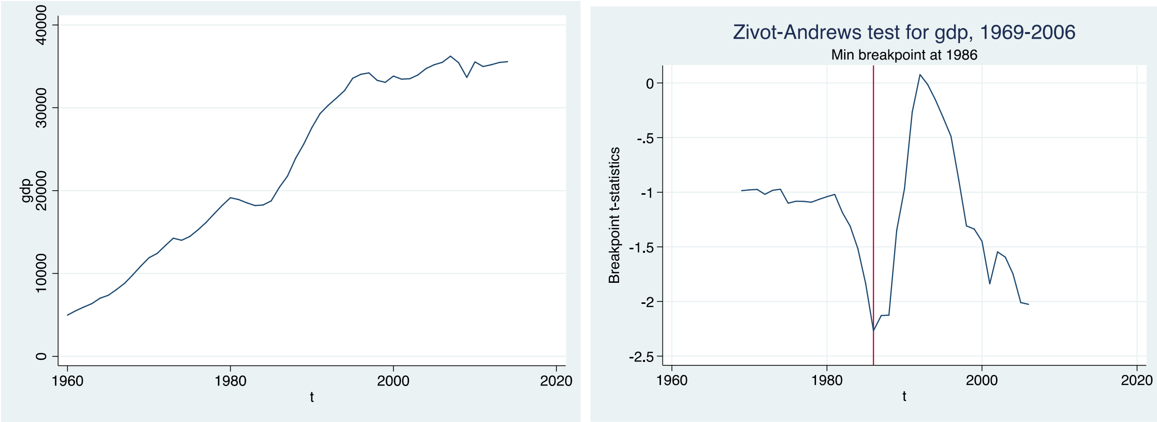

Figure 1: Change of real GDP per capita over time and structural change

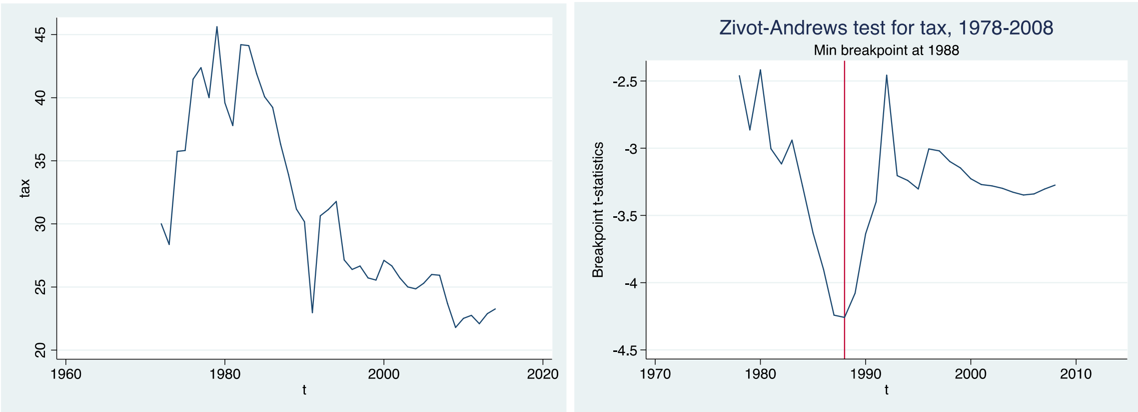

Figure 2: Change of tax rate over time and structural change

According to the above facts and analytical results of the structural change over the period, the economy has faced a major structural change of GDP in 1986. For tax rate and tax revenue, the structure has changed in 1989, and 1979 respectively.

3. Literature Review

3.1 Laffer Curve for Optimal Taxation

Optimal taxation policies is achieved with the implementation of tax rate at the optimal point, in which increase or decrease of the tax rate from the point where revenue is maximum, is low revenues based on the arguments provided in the literature. On the basis of above explanation, Laffer curve concept has been developed as in the following graph (1) showing the relationship between the revenue and tax rate.

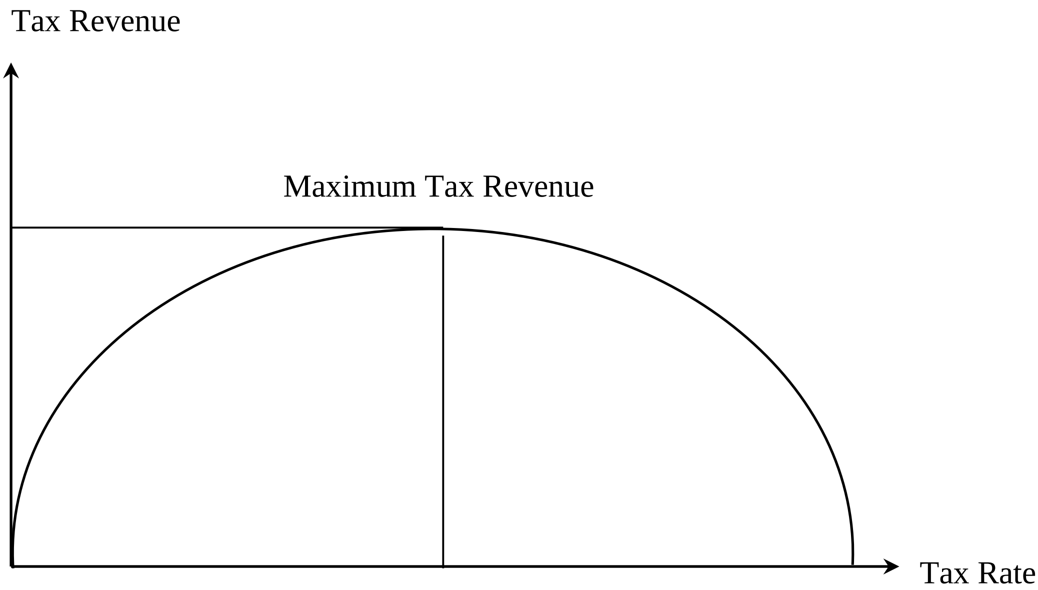

Figure 3: Laffer curve as the relationship between tax revenue and tax rate.

Malcomson (1986) explained that the relationship between tax rate and tax revenue is not continuous for all tax rates instead an inverted U-shape. It is tested for inverted U-shaped Laffer curve after employing a U-test to estimate this links. Spiegel and Templeman (2004) found that even if an individual Laffer curve has one single peak an aggregated Laffer curve can have multiple peaks due to income inequalities between individuals, and will also test for more complex shapes. However, the U-test can be used to find the more complex shapes having its start at the origin, including a lagged tax rate variable in the model also controls the dynamic effect of a change in tax rate in the model. The theory provides a ground, as tax revenue is the function of tax rate, which develop the Laffer curve potentially downward sloping.

A number of researchers have investigated the Laffer curve. Trabandt and Uhlig (2011, 2013) recently show that the Laffer curve for consumption tax is monotonically increasing, whereas the Laffer curves for labor and capital income taxes are hump-shaped. Ireland (1994) find that the hump-shaped Laffer curve for capital income tax using an AK model. Schmitt-Grohe` and Uribe (1997) derivate the hump-shaped Laffer curve for labor income tax in a neoclassical growth model. Trabandt and Uhlig (2011, 2013) estimate the Laffer curves for consumption, labor, and capital taxes for the U.S. and EU 14 using a neoclassical growth model. Nutahara (2015) applies the model of Trabandt and Uhlig (2011) to the Japanese economy. Fe`ve, Matheron, and Sahuc (2013) investigate the Laffer curves for consumption, labor, and capital taxes in an incomplete-market economy. Holter, Krueger, and Stepanchuk

(2014) focus on the effect of households' heterogeneity and progressive tax scheme on the peak tax rate of the Laffer curve for labor income tax using an overlapping generations model.

3. Model Specification

Malcomson (1986) explained that the relationship between tax rate and tax revenue is not continuous for all tax rates instead an inverted U-shape. It is tested for inverted U-shaped Laffer curve after employing a U-test to estimate this links. Spiegel and Templeman (2004) found that even if an individual Laffer curve has one single peak an aggregated Laffer curve can have multiple peaks due to income inequalities between individuals, and will also test for more complex shapes. However, the U-test can be used to find the more complex shapes having its start at the origin, including a lagged tax rate variable in the model also controls the dynamic effect of a change in tax rate in the model. The theory provides a ground, as tax revenue is the function of tax rate, which develop the Laffer curve potentially downward sloping.

$Tax\ revenue = f(Tax\ rate)$ ……………………………………………………………………*(1)*

$y_{it} = \alpha_i + \beta_1 Tax_{it} + \varepsilon_{it}$. ……………………………………………………………………*(2)*

Where y_{it} is tax revenue and Tax_{it} is the tax rate for given country in given year. The correct specification of the functional form will depend crucially on the specification of $f\ (Tax)$. If revenue is linearly decreasing in the tax rate it implies that the Laffer curve has the traditional inverted U-shape.

The baseline specification is:

$lny_{it} = \alpha_i + \beta_1 Tax_{it} + \beta_2 Tax_{it}^2 + \beta_3 X_{it} + \varepsilon_{it}$ ……………………………………………………*(3)*

In literature, the Laffer curve is multiplicative and specified functional form is nonlinear. However, the data does not support the whole range of possible tax revenues and tax rates, as the conventional estimation of reduced form with a specification linear in its arguments is specified as multiplicative specifications forcing to consider the origin. Therefore, the model is not reflected the accurate estimation of the rate of change in tax revenue from a change in the tax rate. To adjust for the possibility of nonlinearities, higher order polynomials of the tax rate in the specification is also included. Include a quadric term is the standard way to test if there are nonlinearities and a negative and significant coefficient on the quadric term indicates an inverted U-shape. Lind and Mehlum, (2010) also pointed out that these conditions are not sufficient to conclude that the data supports an inverted U-shape, typically a squared term could be significant for any convex relationship. Further it states that a test for the U-shape needs to prove that the function is increasing in low values of the data and decreasing in high values.

Policymakers have long been interested in how potential changes to the personal income tax system affect the economy. Tax reform is more complex, as it involves tax rate cuts as well as base-broadening changes. There is a theoretical presumption that such changes should raise the overall size of the economy in the long-term, though the effect and magnitude of the impact are subject to considerable uncertainty. Tax reform, as defined above, involves reductions in income tax rates as well as measures to broaden the tax base; namely, to reduce the use of tax expenditures or other items that narrow the base.

3.1 Growth Laffer curve: Taxation and Economic Growth

The literature regarding government expenditure (or government size) and economic growth is comprised of studies that assume a linear as well as a non-linear relationship between government expenditure and economic growth. Most of these studies are based on linear models, although Sheehey (1993), Armey (1995), Tanzi & Zee (1997), Vedder & Gallaway (1998), Giavazzi, Jappelli & Pagano (2000), among others, subscribe to forms of non-linear relationship.

A review of this literature provides inconclusive evidence as to whether government expenditure is detrimental to economic growth. On the one hand, Landau (1983), Landau (1986), Grier & Tullock (1987), Barro (1989, 1990, 1991), Alexander (1990), Engen & Skinner (1992), Hansson & Henrekson (1994), Devarajan, Swaroop & Zou (1996), Gwartney, Holcombe & Lawson (1998), Folster & Henrekson (1999), Folster & Henrekson (2001), Dar & Amirkhalkhali (2002), and Chen & Lee (2005) support a negative relationship between government expenditure and economic growth. On the other hand, Rubinson (1977), Ram (1986), Kormendi & Meguire (1986), Grossman (1988), Diamond (1989), and Carr (1989) establish arguments of a positive relationship between the two variables. The studies by Devarajan, Swaroop & Zou (1993), Sheehey (1993), Hsieh & Kon (1994), Hsieh & Lai (1994), Lin (1994), Cashin (1995), and Kneller, Bleaney & Gemmell (1998) put forward mixed results, while Kormendi & Meguire (1985) question whether there is a significant relationship between government expenditure and economic growth.

Ramayandi (2003) reviewed the relationship between economic growth and tax rates in the context of Indonesia, claims that economic growth tends to have a negative impact on growth. In a separate study, Higgins, Young & Levy (2006) reveled the relationship between US economic growth and the tax rates are explored at three levels: federal, state and local. They conclude that all federal, state and local governments are either negatively correlated with economic growth or are uncorrelated with economic growth. Grimes (2003) reassessed the work of Gwartney, Holcombe & Lawson (1998) with respect to 22 OECD countries and found that the size of government has only a minor effect on long-term growth outcomes. The study completed by Bagdigen & Hakan (2008), which examines the validity of Wagner's Law using data for Turkey, concluded that public expenditure has no effect on economic growth.

Some studies test that the evidence is consistent with the predictions of the endogenous growth model that the structure of taxation and public expenditure can affect the steady-state growth rate. Kneller, Bleaney & Gemmell (1999) use data for 22 OECD countries to demonstrate that productive government expenditure enhances growth, but non-productive expenditure. Miller & Russek (1997) examines the effects of fiscal structure on economic growth. They found evidence to support the view that debt-financed increases in government expenditure retard growth and tax-financed increases stimulate growth for developing countries. They also found evidence, on the other hand, that debt financed increases in government expenditure do not affect growth and tax-financed increases reduce growth for developed countries.

If governments could interfere in the economic growth process by becoming actively involved in the economy as some of the literature suggests, how much government involvement is needed? One can use the notion of optimal size of tax rates to answer this question. The idea of optimal size of government in taxation was refined and popularized by Armey (1995), which explains the optimal government size that ensures positive incremental economic growth for a particular country.

3.2 Macroeconomic Policy

The evidences show that the macroeconomic volatility leads to lower economic growth: a very general fact is that volatility tends to be associated with uncertainty. Economic uncertainty may reduce growth through several channels: induce agents to postpone decisions when decisions are riskier, investment irreversibility make firms invest sub-optimally in the uncertainty. Servén (1998) confirms empirically the negative link between volatility and investment. A more specific argument is related to the existence of financial constraints that are bound to increase with macroeconomic volatility, particularly during sharp recessions (Martin and Rogers, 1997; Talvi and Végh 2000). Exploring the underlying reasons for a Laffer curve depicting the relation between volatility and growth, the study focus on the role of economic crises. This is because of their importance in explaining large swings in economic growth. While the consensus view is that crises - being associated with high volatility - are very detrimental for growth (Hnatkovska and Loayza, 2005), they could also serve as a catalyst for change and, thereby, enhance long term growth. In this manner, Rancière et al. (2003) show theoretically and empirically that countries having experienced occasional crises and with a negative tendency of growth experience faster income growth. While Hnatkovska and Loayza (2005) study cases of extremely negative volatility independently of their source, Rancière et al. (2003) focus on experiences of sharp reductions in credit growth, generally identified as banking crises. Hence, the evidences of the Laffer curve and Growth Laffer curve provides prudent macroeconomic policies for the economies to adjust the tax rates based on the tax revenue and economic growth.

4. Data and Empirical Methodology

4.1 Data Description

The dataset includes Sri Lankan data from WDI of the World Bank and PWT 9 over the period of 1980-2014. Annual data on tax revenues, tax-rates, government expenditure, real GDP per capita, inflation, total population growth, old dependency ratio, young dependency ratio, foreign direct investment, unemployment rate, debt, trade openness, workforce and education expenditure, population density are generated; all nominal values are converted to constant 2015 U.S. dollars using the CPI. Further, financial data are obtained from the IMF Government Financial Statistics database. All nominal variables are expressed in real terms.

Econometric approach follows previous empirical studies in Laffer curve that is based upon the estimation of a function in which tax revenue depends upon tax rate, and additional exogenous variables. Starting from a basic model with macroeconomic data that cover different time periods, different explanatory variables, several different estimation methods are employed, but focusing on estimators that attempt to control for endogeneity, omitted variable bias, simultaneity, and measurement error.

4.2 Empirical Approaches

Unit root test with structural break has been employed to identify the stationarity of the times series data. The results of the tests are included in the stylized facts section.

4.2.1 Estimation of Laffer Curve for Sri Lanka

The basic model for estimating the Laffer curve can be expressed in terms of:

$$y_t = \alpha_1 + \beta_1 Tax_t + \beta_2 Tax_t^2 + \beta_3 X_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where y_{it}= the log of tax revenue; X_{it}= the vector of exogenous variables, that is X and α_i = the period specific intercept terms to capture changes common to all sectors; ε_{it} = the time variant idiosyncratic error term. The baseline model can be expanded with the use of integration of Z variables as follows:

$$y_{it} = \alpha_i + \beta_1 Tax_{it} + \beta_2 Tax_{it}^2 + \beta_1^*(Tax_{it} * Z_{it}) + \beta_2^*(Tax_{it}^2 * Z_{it}) + \beta_3 X_{it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (5)$$

However, in order to incorporate the dynamic nature of tax revenue into the model, it can rewrite econometric equation as an AR (1) model in the following form if *ln. (rev)* is considered as y and in the equation (4):

$$y_{it} - y_{it-1} = \alpha_i + \vartheta y_{it-1} + \beta_1 Tax_{it} + \beta_2 Tax_{it}^2 + \beta X_{it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(6)$$

Equivalently, above equation can be written as:

$$y_{it} = \alpha_i + (\vartheta + 1) y_{it-1} + \beta_1 Tax_{it} + \beta_2 Tax_{it}^2 + \beta X_{it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(7)$$

Instrumental Variable (Anderson and Hsiao, 1982) GMM[2] estimators are used to overcome endogeneity issue of the dependent variable while it is described as follows:

[2] The generalized method of moments (GMM) estimator is a workhorse of modern econometrics and is discussed in all the leading textbooks, including Cameron and Trivedi (2005, 2010), Davidson and MacKinnon (1993, 2004), Greene (2012, 468–506), Ruud (2000), Hayashi (2000), Wooldridge (2010), Hamilton (1994), and Baum (2006).

Instrumental Variable –Generalized Method of Moment Estimator (IV-GMM)

Considering the model:

$y = X\beta + u, \qquad u \sim (0, \Omega)$ ……………………………………………………………………….……(8)

With X ($N \times k$) and define a matrix Z ($N \times l$) where $l \geq k$. This is the Generalized Method of Moments IV (IV-GMM) estimator. The l instruments give rise to a set of l moments:

$g_i(\beta) = Z_i' u_i = Z(y_i - x_i\beta)$ *i=1, N*………………………………………………………….…………(9)

where each g_i is an l-vector. The method of moments approach considers each of the l moment equations as a sample moment, which we may estimate by averaging over *N*:

$\bar{g}_i(\beta) = 1/N \sum_{i=1}^{N} = Z_i(y_i - x_i\beta) = 1/N\ Z_i' u_i$ ……………………………………………….………..(10)

The GMM approach chooses an estimate that solves $\bar{g}(\hat{\beta}_{GMM}) = 0$ If l = *k*, the equation to be estimated, is said to be *exactly identified* by the *order condition* for identification: that is, there are as many excluded instruments as included right-hand endogenous variables. The method of moments problem is then *k* equations in *k* unknowns, and a unique solution exists, equivalent to the standard IV estimator:

$\hat{\beta}_{IV} = (Z'X)^{-1} Z'y$ ……………………………………………………………………………….…………(11)

In the case of *over-identification* (l >*k*) we may define a set of *k* instruments:

$\hat{X} = Z'(Z'Z)^{-1} Z'X = P_Z X$, which gives rise to the two-stage least squares (2SLS) estimator

$\hat{\beta}_{2SLS} = (\hat{X}'X)^{-1} \hat{X}'y = (X'P_Z X)^{-1} X'P_Z y]$ which despite its name is computed by this single matrix equation.

In 2SLS method with over-identification, the l available instruments are "boiled down" to the *k* needed by defining the P_Z matrix. In the IV-GMM approach, that reduction is not necessary. All l instruments are used in the estimator. Furthermore, a *weighting matrix* is employed so that we may choose $\hat{\beta}_{GMM}$ so that the elements of $\bar{g}(\hat{\beta}_{GMM})$ are as close to zero as possible. With l >*k*, not all l moment conditions can be exactly satisfied, so a criterion function that weights them appropriately is used to improve the efficiency of the estimator. The GMM estimator minimizes the criterion,

$J(\hat{\beta}_{GMM}) = N\ \bar{g}(\hat{\beta}_{GMM})'W\bar{g}\ (\hat{\beta}_{GMM})$ …………………………………………………………………..(12)

where W is a l × l symmetric weighting matrix.

Solving the set of FOCs, IV-GMM estimator can be derived of an overidentified equation:

$\hat{\beta}_{GMM} = (X'ZWZ'X)^{-1}X'ZWZ'y$ ……………………………………………………………………….(13)

which will be identical for all W matrices which differ by a factor of proportionality. The *optimal* weighting matrix, as shown by Hansen (1982), chooses $W = S^{-1}$ where S is the covariance matrix of the moment conditions to produce the most *efficient* estimator:

$S = E[Z'uu'Z] = \lim N_{\rightarrow\infty} Z^{-1}[Z'\hat{\Omega}Z]$ With a consistent estimator of S derived from 2SLS residuals, defining the feasible IV-GMM estimator as

$\hat{\beta}_{FEGMM} = (X'Z\hat{S}^{-1}Z'X)^{-1}X'Z\hat{S}^{-1}Z'y$, Where *FEGMM* refers to the *feasible efficient* GMM estimator.

The derivation makes no mention of the form of Ω, the variance-covariance matrix (*vce*) of the error process *u*. If the errors satisfy all classical assumptions are *i.i.d.*,$S = \sigma_u^2 I_N$ and the optimal weighting matrix is proportional to the identity matrix. The IV-GMM estimator is merely the standard IV (or 2SLS) estimator. If there is heteroskedasticity of unknown form, we usually compute *robust* standard errors. In this context, $\hat{S} = 1/N\sum_{i=1}^{N}\hat{u}_i^2 Z_i\, Z_i$ Where $u\hat{}$ is the vector of residuals from any consistent estimator of β. For an overidentified equation, the IV-GMM estimates computed from this estimate of S will be more efficient than 2SLS estimates.

It is widely stated that growth regressions are apprehended with many concerns (Islam, 1995, Caselli, Esquivel & Lefort, 1996, or Temple, 1999). Caselli et al. (1996) discussed that there exist mainly two sources of inconsistency in the empirical work on economic growth, both in cross-section analysis. First, the incorrect treatment of country-specific effects, representing differences in technology or tastes, gives rise to the omitted variables bias. Second, most regressors might be endogenous to economic growth, and the presence of simultaneous or reversed causality can generate a bias in the estimation. To handle this issues like the unobserved country-specific effects and the endogeneity of explanatory variables and of the lagged dependent variable, is to use the Instrumental Variable Generalized Method of

Moments (GMM) technique combining system of the previous regressions in differences instrumented by lagged values, with an additional set of equations in levels, by using lagged first differences as instruments.

5. Results and Discussion

Before presenting the relationships between the variables, the following table (1) provides the summary statistics of the explanatory variables in the study. Then, the Laffer curve is estimated using IV-GMM estimators in the proceeding results.

5.1 Summary of Variables

Table 1: Summary statistics of the variables

Variables	Mean	Standard Deviation	Min	Max	Observations
Revenue	3.68e+11	8.32e+10	6.12e+10	1.05e+12	43
Tax rate	14.96	4.30	10.05	19.02	43
Young	51.85	5.85	43.70	61.92	55
Old	14.00	2.76	7.91	18.02	55
Hc	3.10	0.28	2.58	3.53	55
FDI	1.72	1.92	0.06	9.90	45
Inflation	13.01	19.26	-0.41	33.82	55
TFP	0.71	0.13	0.39	0.85	55
Exchange rate	103.95	63.60	79.79	160	55
GDP per capita	6332.21	2742.11	3665.09	10642.44	55
Population	17.02	5.44	12.51	20.77	55
Unemployment	0.48	0.01	0.46	0.49	55
Population density	271.40	72.94	199.51	331.34	55
Openness	75.88	21.76	22.74	125.57	55

Note: variables are Young = young dependency ratio; old=old dependency ratio; Hc=human capital; TFP=total factor productivity.

4.1 Estimation of Laffer curve in determining the optimal taxation

Given the availability of the data, proposed empirical equation for the Laffer curve is estimated and the results are shown in the table (1). The IV-GMM estimation increases efficiency and robustness of the estimation. In this setting, IV-GMM uses lag variables and then includes more instruments in the second equation for estimating the Laffer curves. Overall, the results of the IV-GMM estimation provide a strong correlation of the tax revenue and tax rate, and GDP and tax rate.

Table 2: IV-GMM estimation results of Laffer curve

Dependent	IV GMM			
Variable:	ln (Revenue)	ln (Revenue)	ln (GDP)	ln (GDP)
	(1)	(2)	(3)	(4)
Tax	-1.092***	-1.143***	-0.521***	-1.186***
	(0.64)	(0.02)	(0.14)	(0.90)
Tax^2	1.020**	0.175**	0.131**	0.146**
	(0.00)	(0.02)	(0.12)	(0.42)
Tax^3		-0.415**		-0.372**
		(0.00)		(0.00)
Tax^4		0.218		0.117
		(0.00)		(0.02)
Lag (Tax)	0.024***	-1.025***	-0.024***	-0.066***
	(0.36)	(0.07)	(0.01)	(0.30)
ln (lag (Rev))	1.141	0.638***	0. 797***	0.805
	(0.27)	(0.02)	(0.01)	(0.04)
Young		0.055**		0.058***
		(0.01)		(0.02)
Old		-1.002		-1.029
		(0.04)		(0.04)
Hc	-2.954	0.115***	-1.255	-2.782*
	(0.31)	(1.25)	(1.49)	(0.51)
Unemployment		-3.268**		-1.082
		(2.71)		(3.81)

TFP	-2. 743**	0.463***	1.430**	-1.390***
	(2.40)	(0.05)	(1.34)	(1.62)
ExRate		-1.402***		-1.094***
		(0.00)		(0.05)
FDI	-1. 144**	0.909**	1.014***	0.711**
	(0.62)	(0.00)	(0.00)	(0.00)
Inflation		0.047		0.023***
		(0.00)		(0.00)
Pop. Density		0.000		0.043
		(0.00)		(0.00)
Population		0.045		0.153
		(0.17)		(0.04)
Openness	-2.004***	-1.405***	-2.623**	-1.725***
	(0.12)	(0.03)	(0.50)	(0.60)
Constant	3.129	1.421**	2.041**	-8.114***
	(5.66)	(0.09)	(0.02)	(2.91)
N	24	24	24	24
Adj. R^2	93.70	91.49	90.29	93.87
Wald Chi2	3861.51	2817.94	7235.20	4633.27
statistic	(0.000)	(0.000)	(0.000)	(0.000)

Note: Cluster robust standard errors in parenthesis. a * denotes statistical significance at the 10 percent level and a ** denotes statistical significance at the 5 percent level and a *** denotes statistical significance at the 1 percent level. Both time and year fixed effects are used. Instrumental variables: Lag variable of the explanatory variables are used as instrumental variables in the model in addition to the government consumption expenditure, labour force and population density. Adjusted sample 1981-2014.

In particular, as in the above table (1), approximation of IV-GMM is estimated for the Laffer curve for Sri Lanka. The explanatory variables in the estimation (1) revealed that tax rate, openness, foreign direct investment, total factor productivity are negatively, and tax^2, and lag (tax) are positively significant. Equation (2) included more variables to predict the relationships and it shows that tax^2, young dependency ratio, human capital, total factor productivity, and foreign direct investment are positively significant while tax, tax^3, lag (tax), unemployment, exchange rate, trade openness are negatively significant.

Further, approximation of IV-GMM is also estimated for the growth Laffer curve for Sri Lanka. Correspondingly, equation (3) estimates expose that tax^2, lag (tax), total factor productivity, and foreign direct investment are positively significant, whereas tax, lag (tax) and trade openness are negatively significant. Moreover, equation (4) results tax^2, young dependency ratio, foreign direct investment, and inflation are significant positive determinants in the growth Laffer curve, while tax, tax^3, lag (tax), total factor productivity, exchange rate and trade openness are negative factors of predicting the GDP. Overall, tax, tax^2, tax^3, lag (tax), young dependency ratio, total factor productivity, exchange rate, foreign direct investment, and Openness are significant predictors in both curves.

4.2 Laffer curve: nonlinear relationship between tax revenue and tax rate

Nevertheless, it is essential to identify the relationship between the tax revenues and tax rates under the Laffer curve. Hence, the nonlinear relationship of the Laffer curve is predicted based on the U-test, and results revealed that a strong relationship in the quadratic form of the equation and U-shape Laffer curve (Figure 1) for Sri Lanka.

Table 3: Nonlinear relationship of tax revenue and tax rate

Dependent Variable: Revenue	Coefficient	Std. Err.	t-value	p-value
Tax	-5.55e+11***	9.32e+10	-5.95	0.000
Tax^2	1.55e+10***	3.21e+09	4.82	0.000
Constant	5.05e+12***	6.62e+11	7.63	0.000
N	25			
R-square	0.8843			
F-value	93.73			
p-value	0.000			

Cluster robust standard errors in parenthesis. a * denotes statistical significance at the 10 percent level and a ** denotes statistical significance at the 5 percent level and a *** denotes statistical significance at the 1 percent level. Both time and year fixed effects are used.

Table 4: U-test results for nonlinear relationship

	Value	Lower bound	Upper bound

Interval	-	10.05	19.02
Slope	-	-2.44e+11	3.37e+10
t-value	-	-8.24	1.10
p-value	-	0.000	0.14
Extreme point	17.93***	-	-
Overall test	1.11	H1: Presence of a Inverse U shape	
p-value	0.014	-	-

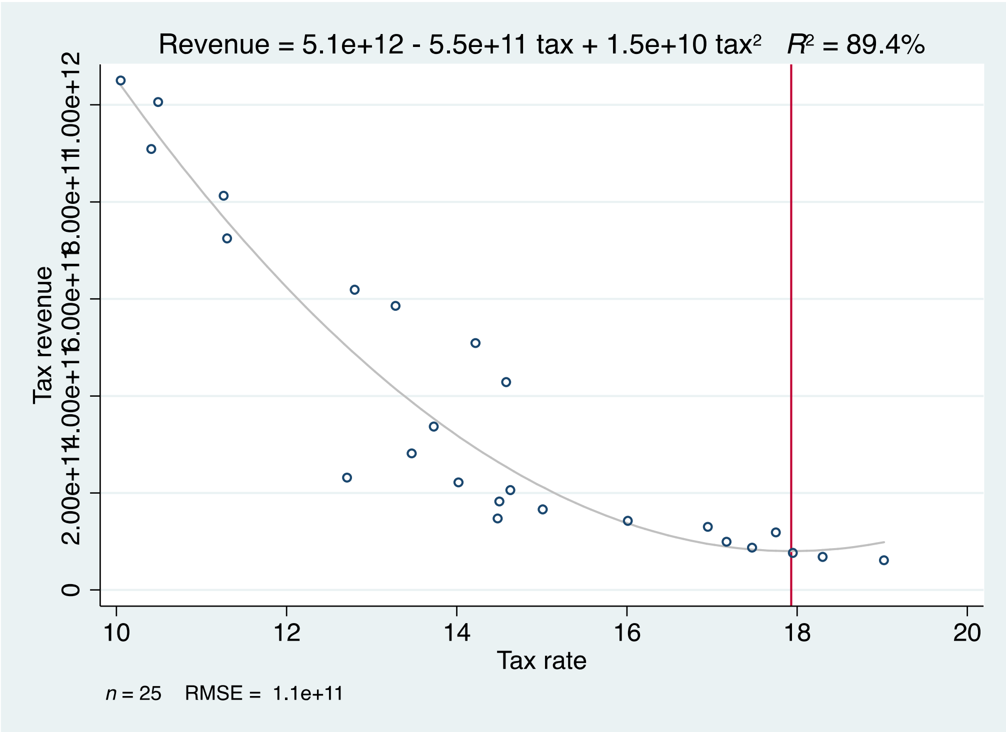

Figure 4: Laffer curve: nonlinear relationship between tax revenue and tax rate

4.3 Growth Laffer curve: nonlinear relationship between GDP and tax rate

Further it predicts the growth Laffer curve (Table 4 & 5) estimation is to obtain the elasticities with respect to the tax rate. Moreover, the nonlinear relationship of the growth Laffer curve is predicted based on the U-test, and results revealed that a strong relationship in the quadratic equation and U-shape growth Laffer curve (Figure 2) for Sri Lanka.

Table 4: Nonlinear relationship of GDP and Tax rate

Dependent Variable: GDP	Coefficient	Std. Err.	t-value	p-value
Tax	-2133.70***	279.69	-7.63	0.000

Tax^2	61.42***	9.62	6.38	0.000
Constant	19078.73***	1986.85	9.60	0.000
N	25			
R-square	0.9080			
F-value	120.00			
p-value	0.000			

Note: Cluster robust standard errors in parenthesis. a * denotes statistical significance at the 10 percent level and a ** denotes statistical significance at the 5 percent level and a *** denotes statistical significance at the 1 percent level. Both time and year fixed effects are used.

Table 5: U-test results for nonlinear relationship

	Value	Lower bound	Upper bound
Interval	-	10.05	19.02
Slope	-	-899.07	202.87
t-value	-	-10.12	2.22
p-value	-	4.77e-10	.018
Extreme point	17.36***	-	-
Overall test	2.23	H1: Presence of a Inverse U shape	
p-value	0.0183	-	-

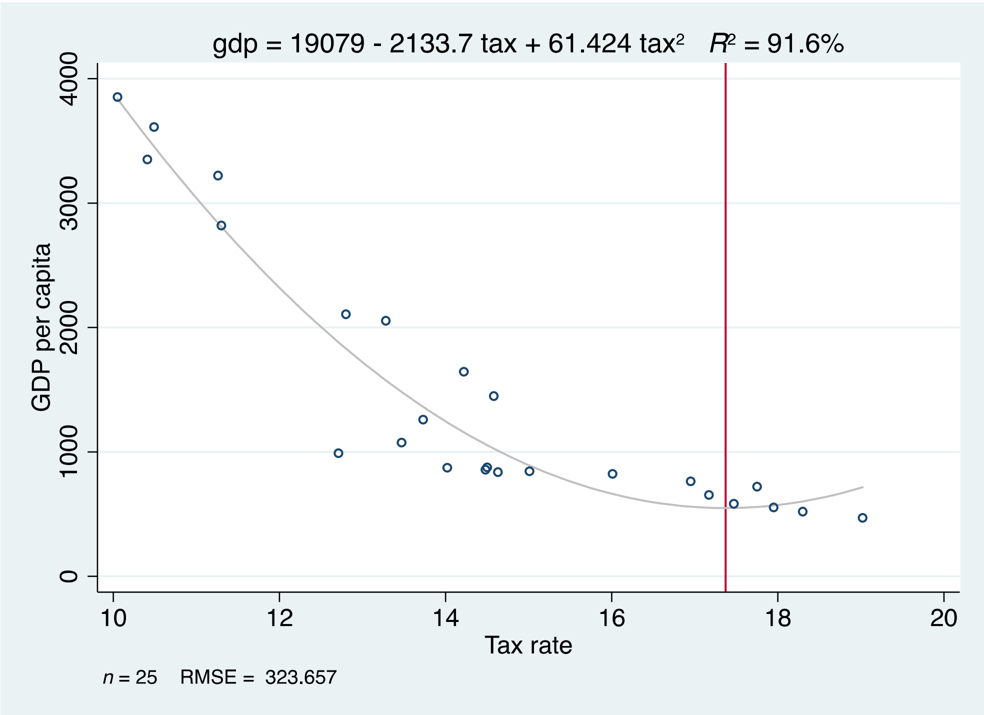

Figure 5: Growth Laffer curve: nonlinear relationship between GDP and tax rate

In identification of elasticities of the tax rate and related macroeconomic determinants in terms of GDP can be used to policymaker to adjust the economic determinants accurately. Therefore, the following analysis in consistent with the Laffer curve estimation is conducted to predict the Laffer curve (Table 2 & 3) estimating the elasticities with respect to the tax rate.

Table 6: IV-GMM Estimation of elasticities

Dependent Variable:	IV GMM (1) Ln (Tax Revenue)	(2) Ln (GDP)
lnTax	0.045**	0.035**
	(0.05)	(0.04)
lnLag (Tax)	-0.076***	-0.081***
	(0.03)	(0.02)
ln(lag (Rev))	0.011***	-0.001
	(0.02)	(0.00)
ln (D.Rev)	0.063***	-0.062***
	(0.03)	(0.01)
lnYoung	-0.427***	-0.498***
	(0.42)	(0.09)
lnOld	0.614*	0.212*
	(0.72)	(0.11)
lnHc	4.774***	3.515***
	(0.23)	(0.39)
lnUnemployment	-1.915***	-1.746***
	(0.164)	(0.10)
lnTFP	1.289***	1.138***
	(0.06)	(0.06)
lnExRate	-0.711***	0.010
	(0.05)	(0.01)
lnFDI	0.013***	0.004
	(0.00)	(0.00)
lnInflation	-0.502***	0.001

	(0.06)	(0.00)
lnOpenness	0.310*	0.040
	(0.52)	(0.02)
Constant	3.929***	6.433***
	(0.45)	(0.57)
N	41	41
Centered R^2	99.82	99.88
F statistic	2859.26 (0.000)	3522.33 (0.000)
Under. Test:	7.932 (0.160)	9.046 (0.107)
Weak identification test	2.117	1.703
Hansen J statistics	5.734 (0.220)	3.433 (0.488)

Note: Cluster robust standard errors in parenthesis. a * denotes statistical significance at the 10 percent level and a ** denotes statistical significance at the 5 percent level and a *** denotes statistical significance at the 1 percent level. Both time and year fixed effects are used. Instrumental variables: Lag variable of the explanatory variables are used as instrumental variables in the model in addition to the GDP per capita, government consumption expenditure, labour force and population density. Adjusted sample 1991-2014.

The most important prediction for the Laffer curve estimation is to obtain the elasticities with respect to the GDP per capita. Table (4) shows that the results of the estimated elasticities for the Laffer curve for the economy. Based on the above equation (1) results, tax, lag (tax), human capital, total factor productivity and foreign direct investment are significant positive elasticities while lag (revenue) and unemployment show a negative significance. These results implied that how much GDP could be increased with respect to increase of 1% of those variables. According to the equation (2), the results further confirm the previous results of equation (1). It shows that tax, lag (tax), human capital, and total factor productivity are positively significant elasticities whereas young dependency, and unemployment are negative and significant elasticities.

The macroeconomic policy perspective of this study is the properties of the estimated parameters provide extra information about the potential policy directions: these coefficients of the estimated non linear equation provide evidence to prove or not to prove the existence of the Laffer curve. The geometric presentation of the quadratic function and its properties are established in the U-shaped curve, the coefficient of the square term of squared tax rate needs to be negative. The quadratic function specified above plots as a parabola, a curve with a single built in bump or wiggle. The positive sign of the linear term is designed to show the positive beneficial effects of government taxation on output, while the negative sign of the squared term means that the variable measures any adverse effects associated with increased governmental tax rates. Since the squared term increases in value faster than the linear term, the presence of negative effects from tax rates eventually will outweigh the positive effect, producing a downward-sloping portion. The values that were obtained in the case of Sri Lanka are consistent with this principle. The graphical solution of the optimum value is the peak of the quadratic curve. The mechanism can be used to calculate the elasticities of optimal level of tax rate using first partial differentiation. This study calculates the partial derivative of GDP with respect to tax rate, to indicate that all the other independent variables in the function are held constant when taking this particular derivative through partial differentiation.

5. Conclusion

The empirical analysis of relationship between tax revenue and tax rate is imperative to provide the pragmatic evidences for optimal taxation policy. Hence, in this paper, Laffer curve is estimated to identify the factors determining the optimal taxation and the long run relationships between economic growth and tax revenue from 1960 to 2014. The advantage of IV-GMM estimation of Laffer curve is that it counts for the many econometric issues like endogeneity. The results of the approximation revealed a strong correlation in Laffer curve equations for supporting with other covariates. It is found that many macroeconomic variables in the IV-GMM models have significant effect on the tax revenue with consistent coefficient signs as in economic literature. The empirical results of the IV GMM provide support for a robust long-run relationship between the variables, indicating that tax-rate is positively related to tax revenue.

Overall, the results of the IV-GMM estimation provide a strong correlation of the tax revenue and tax rate. In summary of all different approximations of IV-GMM for the Laffer curve revealed that tax^2, young dependency ratio, human capital, total factor productivity, and foreign direct investment are positively significant while tax, tax^3, lag (tax), unemployment, exchange rate, trade openness are negatively significant in Sri Lanka. The test for U-shape in the Laffer curve shows that extreme point is at 17.36 of the tax rate, and the significant of test implies that the structure is U-shape. The model has supplemented with the elasticities with respect to the tax revenue for the Sri Lankan economy. Whereas, the Growth Laffer curve provides the possibility of estimating the optimal tax rate for economic growth, and, therefore, may be used as a policy tool in determining the efficient levels of government expenditure. The results expose a strong correlation of the tax revenue, and GDP with respect to tax rate for the growth Laffer curve, includes significant covariates such as tax rate, tax^2, tax^3, lag (tax), young dependency ratio, total factor productivity, exchange rate, foreign direct investment, and openness. The U-test shows that extreme point is 17.93 of the tax rate implying U-shape for the growth Laffer curve.

One of the significant evidences of this study is that the Laffer curve estimation is that the maximum revenue depends on tax rate, and explanatory macroeconomic variables in Sri Lanka. Therefore, the optimal taxation policies can be implemented with the fiscal policy adjustments of Sri Lankan economy focusing on individual estimated-coefficients and elasticities. Therefore, the research evidences suggest the policymakers to design the appropriate public economic policies with the use of pragmatic findings of the economy.

6. Policy Recommendations

The findings from the study can be inferred to provide recommendations to the macroeconomic policies for policymakers in Sri Lanka. The implications of the study are cautious on the macroeconomic determinants of the optimal taxation to reform the tax systems. Provided that, the determinants, especially tax-rate, have negative impacts on the tax revenue in the Laffer curve and also for the GDP in growth Laffer curve. Therefore, it implies that increase of tax-rate effects in decrease of maximum tax revenue in Sri Lanka. Robust estimated determinants are vital for preparing the taxation policies for the economic growth in long run. However, the macroeconomic policy concentration is that the policymakers should be aware that a persistent increase of tax rates exerts a reduction in economic growth in long run. In identification of elasticities of the tax rate and related macroeconomic determinants in terms of GDP can be used to policymaker to adjust the economic determinants accurately.

Approximation of Laffer curve can be used as a policy instrument in order to address the optimal taxation for the generation of required revenue. It can be generated two major recommendations based on the empirical evidences of the study.

(i) It is recommended to develop a tax system that generates optimal tax revenue with adjustment of the tax rates based on this study. Strong evidences show that key factors need to be considered for designing such optimal tax reforms for Sri Lanka.

(ii) Increase of tax rate will decrease the maximum revenue that can be achieved while considering other controlling macroeconomic determinants.

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