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Budget Deficits and Inflation: The Case of Sri Lanka

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Abstract

This paper explores the relationship between budget deficits and inflation in Sri Lanka using three approaches: the Granger causality test, Auto Regressive Distributed Lag (ARDL)/Bound test, and ARDL long run cointegration coefficients analysis with time series data for the time period of 1957-2016. Three statistical procedures are also exploited in the study, namely, Toda-Yamamoto (1995) Granger causality test, ARDL/Bound test procedure developed by Pesaran and Shin (1999) and Pesaran et al. (2001), and ARDL Error Correction Model. Moreover, four model specifications are formed that are distinguished by two budget deficit indicators, namely, the budget deficit scaled by narrow money (BDMI), which was developed by Catao and Terones (2003), conventional budget deficit indicator, which is the budget deficit as a per cent of Gross Domestic Product (BDGDP), and two inflation indicators, namely the Consumer Price Index (CPI) and GDP deflator. The findings of the study are statistically significant at acceptable levels (p=10%, p=5%, and p=1%). The results suggest a unidirectional causality coming from the budget deficits to inflation in Sri Lanka and the existence of a long run cointegration with high magnitudes, which interprets that a one percentage point change in natural logarithms of BDM1 and LNBDGDP, will result in a 1.5-2.5 per cent change in inflation in Sri Lanka as measured by natural logarithms of Colombo Consumer Price Index (LNCCPI) and Gross Domestic Product Deflator (LNGDPD). Further the study concludes that the importance of maintaining low budget deficits in view of reaching inflation targeting in Sri Lanka.

Key Words: *Budget deficits, Inflation, Sri Lanka*

JEL Classification:

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1. Introduction

The relationship between budget deficit and inflation has become one of the key concerns in public economics. As inflation is considered the main culprit that hinders economic development particularly in developing countries, economists are concerned about the determinants of inflation to minimise possible adverse effects in respective economies. The determinants of inflation and their effects, however, may vary among economies owing to country specific economic policies and their priorities. Some economists argue that mismatches of policies and their priorities may also lead to deteriorating economic growth and development objectives of a country. Hence, understanding the interrelationship between policies is very important in formulating and implementing overall economic policies in an economy. This study aims to examine the relationship between monetary policy and fiscal policy in terms of the relationship between the budget deficit and inflation as the main variables concerned.

The relationship between budget deficit and inflation has received extensive attention in the history of economics. As the Keynesian approach explains, public sector variables affect money demand and prices and thereby, aggregate demand. With the concept of Intertemporal Budget Constraints, the monetary-fiscal policy relationship is widely discussed. Moreover, the argument of Unpleasant Monetarist Arithmetic (Tomas J. Sargent and Neil Wallace) suggests that monetary policy may limit its control over price stability under a fiscal dominance regime. In recent decades, many economists have contributed with different ideas in favor of the role of fiscal policy in an economy. One of the milestones in this regard is the Fiscal Theory of Price Level that emphasises the importance of fiscal factors in price determination.

Traditionally, the budget deficit-inflation relationship is explained through the argument of the inflationary effect of seigniorage i.e. the printing of money by means of financing the budget deficit. Creation of money in such a way is sometimes referred to as inflation tax as it creates an inflationary effect, and is similar to imposing a tax whereas the amount of money created through inflation generates an income to the government as any other government tax. Particularly, in the case of developing countries', economists highlight adverse effects of fiscal policy on the basis of inflationary financing. Such criticism may be backed by undesirable outcomes experienced in some countries where seigniorage has become an uncontrollable problem. Therefore, it is very important to understand the effects of seigniorage and the interaction between fiscal and monetary policies in an economy.

Sri Lanka, as a developing country, has experienced large budget deficits and policy makers are making continuous efforts to curtail such deficits at an economically desirable level. Lower budget deficits, on the other hand, help to keep up with the Inflation Targeting (IT) framework of the monetary policy, which the Central Bank of Sri Lanka (CBSL) has been in the process of adopting. In line with this process, CBSL has taken various measures in terms of institutional framework and policy making processes during recent years. One of the prerequisites for adopting an IT framework is fiscal sector management that the system can improve through better monetary-fiscal policy coordination. In other words, to facilitate monetary policy in achieving its targets, fiscal sector measures need to be rule-based by managing budget deficit and debt. This study provides an important understanding of the policy links between monetary policy and fiscal policy which is based on statistical testing procedures with theory-based methodological approaches.

This paper investigates the relationship between budget deficit and inflation in Sri Lanka, using time series data for the period of 1957-2016 in terms of the nature of the causality between the budget deficit and inflation, nature of cointegration between budget deficit and inflation, and the magnitude of the long-run coefficients. Accordingly, the hypothesis of the current study is that a considerable magnitude of positive long-run relationship may exist between budget deficit and inflation in Sri Lanka. In establishing the hypothesis, this study considers the theoretical perspectives and growing concerns in public finance history on the topic, findings of previous empirical studies, and background information on Sri Lanka.

This study considers six representative variables to investigate the deficit-inflation relationship that includes fiscal balance, inflation, money supply, exchange rate, interest rate and GDP. When comparing historical data, it seems that the behavior of the selected data variables depends on the country's overall development strategies that were adopted and key policy changes that were domestically and globally introduced from time to time. Table 1 shows an overview of fiscal sector performance, by means of ten-year averages of data during the period of 1948-2016. As shown in the table, during the period after 1978, there has been a slight decrease in total revenue. The deterioration of total revenue in recent times has been very steep, recording a drop of about one-third when compared to the situation in 1970s. Total government expenditure as depicted in Table 1, from 1948 to 1987, has shown a steady increase and then, a gradual decrease.

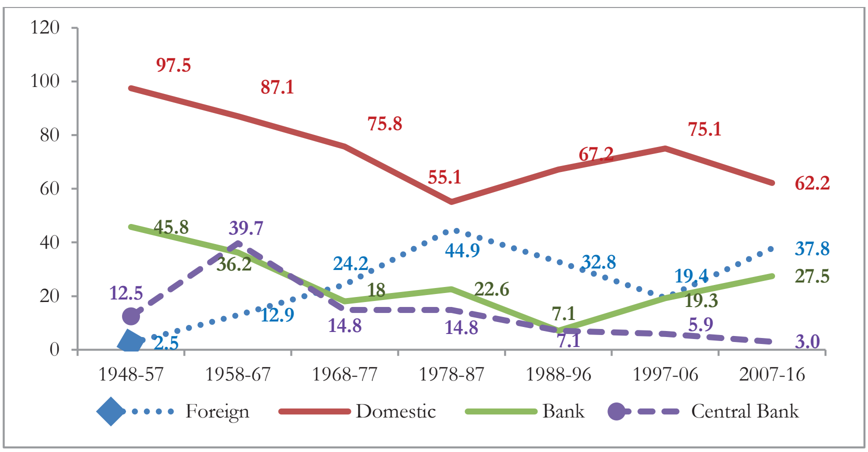
Table 1: Fiscal performance in Sri Lanka as a per cent of GDP

Category	1948-1957	1958-1967	1968-1977	1978-1987	1988-1996	1997-1906	2007-1916
Total Revenue and Grants	21.0	22.3	21.0	23.7	21.9	17.2	13.8
Total Expenditure	23.4	28.0	27.1	35.2	30.3	25.1	20.5
Current	15.7	21.0	19.9	19.4	21.9	19.6	14.9
Capital	7.7	7.0	7.2	15.8	8.4	4.9	5.3
Current AC (Surplus (+) /Deficit (-))	5.1	1.1	0.4	1.7	-1.9	-3.0	-1.6
Overall Deficit (after Grants)	-2.4	-5.8	-6.1	-11.5	-8.4	-8.5	-6.7

Source: Central Bank Annual Reports

In the wake of fiscal balances, during the period of 1978-87, overall budget deficits have shown a steady increase to a double-digit (-11.5 per cent) from around -2.5 per cent recorded in the 1950s. After 1987, the overall budget deficit has declined moderately to around -7 per cent of GDP.

Figure 1: Financing of budget deficits as a per cent of total financing



Source: Central Bank of Sri Lanka

In terms of the composition of financing sources, as given in Figure 1, during the period of 1978-87, the proportion of foreign financing has reached to around 45 per cent of total financing, from 2.5 per cent recorded in the 1950. During the period of 1987-2006, there has been a sharp drop of foreign financing to 19.3 per cent, and it has increased up to 40 per cent during the last decade. During the first three decades, domestic financing has become the major source of financing recording a proportion of over 75 per cent and it has been over 60 per cent of total financing during the last three decades. With respect to the composition of bank financing, it has initially been a high proportion of 40-46 per cent of total financing and during the period of 1968-87 it has reduced to 18-23 per cent. During the last twenty years, however, it has on average increased to about 20-30 per cent. Importantly, during the first three decades starting from 1948, central bank financing has been around 15 per cent of total financing, except the period during 1958-67 (40 per cent). In contrast, over the last three decades, central bank financing has dramatically changed, following a declining path.

With respect to inflation indicators, Consumer Price Index (CPI) and GDP Deflator (GDPD) are widely used. In Sri Lanka, there are three inflation indicators: Colombo Consumer Price Index (CCPI), Wholesale Price Index (WPI) and GDPD as far as historical data is concerned. As for updating, the base year of CCPI has been changed to 1950=100, 2002=100 and 2006/07=100. Further, as an alternative indicator to CCPI, National Consumer Price Index (NCPI) was introduced recently. Inflation rate measured by CCPI was a double-digit figure for two decades starting from 1978 and it relatively averaged to a higher value of 9.6 per cent and 7.8 per cent respectively during the next consecutive decades. Also, during earlier decades, CCPI inflation recorded a lower rate of about one per cent. Similarly, during the first three decades starting from 1968 GDPD recorded a double digits' inflation rate and during the next consecutive decades there was a slight decline to 9.0 per cent and 7.8 per cent, respectively. In contrast to historical data the budget deficit and inflation rate seem to follow a similar trend; during the period of first four decades starting from the 1950, budget deficit remained between 2.4 and 11.5 per cent while inflation rate remained between the range of 0.6-12.6 per cent. During the last three decades starting from 1988, the budget deficit changed from 8.4 to 6.7 per cent while CCPI inflation rate has changed from 12.8 to 7.8 per cent.

With respect to the patterns of other variables in this study, average historical data categorised by decades is shown in Table 2. Accordingly, in the 1950s, growth of narrow money supply (M1) stood at 2.5 per cent and then, it almost doubled decade by decade, to 12 per cent during the 1968-77 period. Over the period except the last decade, broad money supply (M2) followed a similar pattern of change. A higher volatility of annual growth rates has shown, however, in the growth rates of M1 in comparison to M2.

Table 2: Other macroeconomic indicators in Sri Lanka

Indicator	1951-1957	1958-1967	1968-1977	1978-1987	1988-1996	1997-2006	2007-2016
M_1	2.4	5.8	12.0	16.9	13.3	12.9	11.0
M_2	4.1	7.2	13.8	21.3	17.4	14.7	15.3
Exchange Rate US$	0.0	0.2	6.5	14.3	7.2	6.6	2.8
GDP Growth	3.4	3.8	3.8	5.2	4.8	5.2	6.0

Source: Central Bank Annual Reports

Regarding the change in the exchange rate of Sri Lankan Rupee (LKR) as against the United States dollars (USD) also amounted to 14.3 per cent during 1978-87 periods, doubling the growth rates in the previous decade. However, it has gradually decreased thereafter. Conversely, GDP growth rate stood at 3.4-3.8 per cent over three decades starting from 1951, and it increased to 4.8-6.0 per cent thereafter. The highest growth rate was recorded during the last decade. In addition, the growth of foreign reserves shows noticeable high volatility during the period concerned. In summary, the comparison of data suggests that many of the variables such as M1, M2 and exchange rate, importantly, seem to be following the similar pattern of changing; the variables have gradually increased until the period of 1978-87 and slightly fallen thereafter.

2. Theoretical overview of monetary policy and fiscal policy

There are some different views in economics on the interrelation of fiscal policy and monetary policy in an economy[2]. Establishing one of the milestones in economic history, the Keynesian

[2] In this study, fiscal policy and monetary policy are considered in the scope of only the budget deficit and inflation relationship.

approach focuses on aggregate demand as the source of output in an economy, assuming excess capacity and price rigidity. Thus, the expansionary fiscal policy influences the aggregate demand and output, thereby changing prices with a multiplier effect. Multiplier activates through the consumption related to current income, as assumed in this approach. According to the extensions of the Keynesian view, such a government intervention creates a crowding out effect: directly, through substituting economic goods and services; indirectly, through the interest rate and exchange rate.

From monetarists' point of view, quantity theory of money [3] explains that inflation is proportional to money supply. Thus, monetarists support the argument that there is no role of fiscal policy in price determination and merely, money supply determines price level. As Friedman, M. 1-21 famously mentioned, *"inflation is always and everywhere a monetary phenomenon"* and Friedman and Schwartz (1963) reiterated the same. New classical economists emphasise on the matter that inflation drives through money supply in the short run but, not in the long run. Contrary to the Keynesian approach, some economists argue on supply side influences of fiscal policy, considering concepts such as rational expectation. Even in the short-run, fiscal policy may impact long run households' decisions with rational expectation. In contrast to the Keynesian approach, consumption decisions explained in the rational expectation approach depends on the government's Intertemporal Budget Constraints (IBC) as explained below. Moreover, the Ricardian equivalence approach explains that if households are aware of IBC, a lump sum tax cut may not change their consumption, because a consumer does not consider a tax cut as a permanent increase in related revenue. The validity of Ricardian equivalence, however, is limited with households' liquidity constraints and violating with the other assumptions [4]. In addition, according to the Monetarist arithmetic argument, the fiscal-monetary policy combination is also based on IBC in explaining equilibrium in the economy. Therefore, IBC is recognised as one of the important policy tools in this study. In forming IBC, the general equilibrium model framework is used with respect to the household sector, the monetary and fiscal sector under several assumptions. Accordingly, a household's utility

[3] MV=PY where Money supply (M) determines the Price level (P) assuming the Velocity of money (V) and Output(Y) is given.

[4] Ricardian equivalence assumes imperfect foresight, imperfect capital market, short time horizons, and intergenerational fiscal burden.

maximisation that is subject to budget constraints is incorporated into consolidated government's budget constraints, that explains monitory and fiscal conditions in financing fiscal deficits. According to the idea of 'Unpleasant Monetarist Arithmetic' of Sargent and Wallace' (1981), the policy coordination would be the matter whether the monetary policy or fiscal policy which would be the dominating policy in concluding the equilibrium. Assuming the existence of the Ricardian equivalence, the unpleasant monetarist arithmetic argument explains IBC in terms of discounted value of current and future values. In other words, as shown in Eq. (1), the total sum of the present discounted value of current and future values of interest payments on outstanding debt is equal to the sum of all present and future discounted values of primary deficit, interest bearing debt and seigniorage.

$$I_{t-1}B_{t-1} = BS_t + B_t + [M_t - M_{t-1}] \qquad (1)$$

and the primary surplus is given $BS_t = P_t(\mathcal{L} - g)$.

Where $I_{t-1}B_{t-1}$ is interest payments on government debt holdings in previous period, g is government constant expenditure, B_t denotes government borrowings from the household sector in current period and $M_t - M_{t-1}$ indicates the change in money supply between two periods. Thus, primary surplus denotes the difference between lump-sum taxes and fixed expenditure.

Alternatively, IBC can be demonstrated as in Eq. (2) in real terms.[5]

$$\left(\frac{1}{\beta}\right) b_{t-1} = s_t + b_t + [m_t - m_{t-1}(1 - \pi_t)] \qquad (2)$$

Where $\frac{1}{\beta}$ is real interest rate, s_t and b_t are primary surplus and debt respectively, $\pi_t = \frac{P_t - P_{t-1}}{P_t}$ indicates inflation rate. Similarly, $[m_t - m_{t-1}(1 - \pi_t)]$ is considered as seigniorage. Further, Eq. (3) is defined: the present value of present and future government

[5] Real terms are denoted by lower cases.

debt(d_t) is to be financed by present value of present and future seigniorage revenue ($F_{cb,t}$) and present value of present and future government tax collection ($F_{gov,t}$).

$$d_t = F_{cb,t} + F_{gov,t} \tag{3}$$

In other words, the given endowed government bonds are assumed to be in real terms and financed through taxes and seigniorage. In the scope of IBC, as against the outstanding debt stock, the government needs to maintain a surplus, by changing expenditure or revenue.

Contrary to the theoretical views in the previous section, some economists argue that such an impact of seigniorage on inflation as explained in the monetarist arithmetic cannot be applicable for some counties, particularly developed countries (King 1995, Woodfold, 1996). Similarly, if fiscal policy influences price level through money supply, it is again supportive to the monetarist's argument that inflation is determined by monetary factors rather than fiscal factors (Carlstrom and Fuerst 2000). Among these arguments, the Fiscal Theory of Price Level (FTPL) explains the alternative approach of the behavior of monetary policy and fiscal policy in determining and controlling price. Introducing FTPL, Leeper (1991), Woodford (1998), Sims (1997) and Cochrane (2005) discuss that inflation would be determined by policy coordination, led by merely fiscal policy rather than monetary policy. As given in the following formula, FTPL describes that any change in real primary surpluses and discount rate is absorbed by a change in price level, owing to constant real debt stock with the assumption that IBC is satisfied. Therefore, the opponents argue price determination is directly linked with fiscal policy matters.

$$\frac{Nominal\ Debt_t}{Price\ level_l} = E_t \sum_{j=0}^{\infty} \frac{Real\ Primary\ Surpluses_{t+j}}{Discont\ Rate_{t+j}}$$

Explaining further with several theoretical aspects of FTPL, firstly, assuming that government's bond holdings and money supply in IBC are given in nominal terms, FTPL suggests that the value of the initial amount of assets and change in such assets will be determined through price changes over time. IBC, therefore, indicates the real value of government bond holdings and money supply with respect to time. Supposing that monetary policy and fiscal policy are independent and similarly, even these policies do not consider the status of IBC, and the price level should change to satisfy IBC, in response to the nominal change of the variables in IBC.

3. Empirical literature review

A large and growing body of literature exists on the topic of the relationship between budget deficit and inflation. However, owing to the differences in usage of country-wise data, techniques and methodologies, and other country-specific factors there is no consensus among researchers about such a relationship as some researchers find positive long run relation while others evidence a negative or no relationship between variables concerned.

Using cross county data from 1960-2001. Catao and Terones (2003) developed a methodology to examine the relationship between budget deficit and inflation and found a strong positive link with high magnitudes in high inflationary developing countries. They found, conversely, no such relationship in developed countries. They investigated data for 107 countries, which were categorised in several ways: firstly, on the basis of the level of financial development, which included advanced, emerging markets and other developing countries; and secondly, on the basis of the level of inflation, which included the top 25 inflators, the middle 50 inflators and the bottom 25 inflators. Sri Lanka was also included into the middle 50 inflators' group and developing country group, respectively. In terms of the scope of the study, they considered budget deficit scaled by narrow money, instead of the conventional measure of budget deficit scaled by GDP, with the theoretical approach of consolidated budget constraint. For the methodology, using the Auto Regressive Distributed Lag Model (ARDL), they aimed to capture short term dynamics explicitly from long run effects on the aforesaid relationship. Importantly, the current study follows this special modification introduced by Catao and Terones (2003).

Nguyen (2014) found budget deficit, government expenditure and interest rate as determinants of inflation in the study, which examined the data from nine Asian countries, including Sri Lanka. The findings of the study supported the argument of Fiscal Theory of Price Level (FTPL); an active fiscal policy would cause inflation. In this study, several methodological approaches for the time period of 1985 to 2012 were used: Pooled Mean Group (PMG) estimation-based Error Correction method, the panel differenced GMM Arellano-Bond estimation method, Wester Lund panel co-integration tests. Moreover, Ishaq and Mohsin (2015) conducted panel data analysis using time series data of 11 Asian countries, including Sri Lanka. They found that the relationship was stronger in an underdeveloped financial system and passive monetary policies with the lack of central bank independence. In terms of the data for the time period of 1981-2010 in this study, their methodology was the Generalised Method of Movements (GMM). Habibulah, Cheah and Bahaom (2011) analysed the data for the period from 1950 to 1999, from 13 developing countries including Sri Lanka and concluded the positive long run relationship between budget deficit, inflation and money supply. This study considered the Vector Error Correction Model (VECM) along with the two stage Engle-Granger causality test. With the data for the period of 1999-2011, Abu and Karim's (2015) research work examined a sample of 51 African countries, which were divided into two groups: low-income countries with high inflation, middle income countries with moderate inflation. They found a positive, non-linear deficit inflation nexus. In terms of the magnitude of the relationship, they concluded that a one per cent increase in budget deficit would lead to a 0.23 per cent increase in inflation. They captured the non-linearity of the relationship by adding the square of the budget deficit in their models, which were estimated using fixed effect and the GMM estimation methodology.

Turning to several country specific studies, Ndanshanu (2012) conducted a study in Tanzania with data for the period of 1967-2010, using the pair-wise Angle-Granger causality test with Error Correction (ECM) and concluded on a positive relationship between the budget deficit and inflation. In the case of Turkey, Koyuncu (2014) carried out a study with time series data from 1987 to 2013, to find the deficit-inflation nexus, considering variables: budget deficit and M2 both scaled by GDP and inflation measured by CPI. Results of the study revealed bidirectional causality between budget deficit and inflation directly and indirectly through money supply in the long run. The study used the Johansen Granger causality test and Vector Auto Regressive (VAR) approach. Bakera et al. (2014) did a study with the data for the period of 1975-2012 to find the budget deficit inflation relationship in Nigeria and revealed the budget deficit is positively related to inflation in the long run. Johansen cointegration analysis and VEC model were used in this study. For the data during the period of 1973-2003, Agha and

Khan (2006) identified a long run inflationary effect of fiscal imbalances and the government borrowings from the banking sector in Pakistan.

Turning to recent country specific studies done on Sri Lanka, using time series data for the period of 1959-2008, Ekanayake (2012) found a positive significant relationship between the budget deficit and inflation, with the magnitude that a one per cent increase in narrow money supply scaled budget deficit would cause an 11 per cent increase in inflation in the long run. In terms of methodology, the pair- wise Granger causality test, ARDL/Bound test model along with the VECM form was used in this study. Using time series data from 1950 to 2010 in the case of Sri Lanka, Devapriya and Ichihashi (2012) conducted a study considering a set of variables money supply, interest rates, exchange rate and CPI inflation and revealed a positive significant relationship between budget deficit and inflation using the Johansen Granger causality test with VAR analysis in their analysis.

Analysing Indonesian data for the period from 1971to 1999, Datta and Mukhopadhyay (2011) found a positive relationship between inflation and budget deficit with the causality coming from former to latter only in the short term. The study considered the Johansen Granger causality test, Impulse Response Functions (IRF) and Variance Decomposition (VD) in VAR analysis and VECM specification as its methodology. Using data of the period of 1980-2012 in South Africa, Khumalo (2013) investigated the budget deficit inflation nexus and revealed a long run positive causality running from budget deficit to inflation. The Granger causality test and VAR analysis were employed in this study. Using data from 1980 to 2000 in Turkey, Creel and Kamber (2004) investigated the application of FTPL to explain Turkish inflation and budget deficit and concluded such relationship would exist only in the short run. A study in Pakistan was carried out with time series quarterly data from 1960 to 2007 by Mukhtar and Zakaria (2010) to examine interaction between the variables budget deficit, board money supply (M2) and CPI inflation, and they found no direct relationship between the budget deficit and inflation. The methodology of the study included the Johansen cointegration analysis, Granger causality test with VECM specification. For monthly data from January 1995 to December 2012 in Vietnam, Van (2014) revealed a no inflationary impact of the budget deficit although money supply showed a positive relation. The study used the Structural VAR model along with IRF and VD approaches as its methodology and considered inflation, real GDP, interest rate, and money growth in the set of variables. For the time period of 1980 -2010, Saysombath and Kyophilavong (2014) found no relationship between the budget deficit and inflation in the People's Democratic Republic of Laos. They applied the ARDL Bound test with the Structural VAR approach in their analysis. With the result of the Granger causality tests and impulse response in the SVAR, they further revealed inflation might cause budget deficit, although there was no causation from budget deficit to inflation.

The evidence presented in the literature review suggests mixed ideas on the interconnection between budget deficit and inflation. Many of the studies which were conducted using developing country data, however, suggest a strong positive relationship between budget deficit and inflation.

4. Research methodology

Different statistical methods were used in empirical studies to assess the relationship between budget deficit and inflation where each has its own advantages and disadvantages. In recent studies, the budget deficit-inflation relationship has been examined in different approaches namely causality analysis, linear regressions, cointegration analysis, other non-linear analysis, etc. Among them, the Granger causality test provides a statistical hypothesis in deciding whether one time series granger causes another. In other words, this approach exposes dependent-independent relationships among variables. The cointegration approach considers the predictability of two or more-time series. Thus, the time series are said to be cointegrated, if such series are non-stationary at levels, but stationary at the first differences. In other words, cointegration describes a long run relationship of time series. In the error correction approach, error correction models estimate the short-term and long-term effects of one time series to another provided that those time series are cointegrated. In other words, the speed of adjustment of a dependent variable to equilibrium is declared in response to a change in other variables. Some researchers, however, use a variety of statistical methods and tests with the mix of above alternative approaches. In terms of methods and tests, methods such as the Ordinary Least Square (OLS) model, Vector Auto Regressive (VAR) models and Vector Error Correction (VEC) models are also commonly used with the appropriate statistical tests. Researchers further consider a variety of variables that are appropriate for the model specifications that represent all four sectors in the economy: fiscal sector, monetary sector, external sector, and real sector.

In this study, three approaches are used to explore the relationship between budget deficit and inflation, in terms of adopting the best suited methods for the investigation: Granger causality test method, which has been developed by Toda- Yamamoto (1995); Bound test procedure with Auto Regressive Distributed Lag (ARDL) approach, which has been developed by Pesaran and Shin (1999) and Pesaran et al. (2001); ARDL error correction model specifications, which is used to capture long-run relation with short term dynamics.

4.1. The model specification

In the model specification, budget deficit is considered as the independent variable in two different ways which include budget deficit scaled by GDP and budget deficit scaled by narrow money (BDM1). Accordingly, BDM1 considers the impact of change in money supply even with the constant budget deficit, in measuring the inflationary effects. Other explanatory variables, along with the two indicators of inflation, are also considered in this study, with respect to four separate multivariate models.

This study follows the model specification designed by Catao and Terrones (2003). The basic formulation in modeling BDM1 is based on the general equilibrium model developed by Liungqvist and Sargent (2000), which explains the relationship among money supply, inflation, and government sector variables. The variables are incorporated by means of the government budget constraint that explains fiscal-monetary relation in explaining inflation with a theoretical approach. In this specification, several assumptions are made: the representative household maximises its utility; the economy is a small open economy; money in the economy is as explained in the shopping time model. The shopping time model also entails several assumptions: constant amount of income per period (y), that is divided into private consumption (c_t) and government consumption (g_t); one unit of time, that is divided into leisure (l_t) and shopping (s_t). The subsequent equations are demonstrated as follows:

Given $c_t + g_t \leq y$ and $l_t + s_t = 1$ Where $t \geq 0$ and $y > 0$,

$$s_t = H\left(c_t, \frac{m_{t+1}}{p_t}\right) \quad (4)$$

Where, H_c, H_{cc}, $H_{m/p,m/p} \geq 0$ and $H_{c,m/p} \leq 0$, which denote that shopping time is a function of consumption and money holdings; the shopping time is negatively linked to real money balances of the household $\left(\frac{m_{t+1}}{p_t}\right)$ owing to transaction cost and m and p denote money supply and inflation respectively. According to the money demand function of the shopping time model, the return on risk-free bonds is higher than money holding with transaction costs. With the description of the shopping time model, equations related to the household sector and government sector are presented to signify the equilibrium positions in each sector.

As assumed earlier, representative household maximises its utility that is given by:

$$\max \sum_{t=0}^{\infty} \beta^t u(c_t, l_t) \quad (5)$$

subject to,

$$c_t + \frac{b_{t+1}}{R_t} + \frac{m_{t+1}}{p_t} = y - \tau_t + b_t + \frac{m_t}{p_t} \quad (6)$$

Where $c_t \geq 0$, $l_t \geq 0$, $u_{c,\, uz} > 0$, $u_{cc}, u_{zz} < 0$ and $u_{cz} \geq 0$ assumes an increasing and concave function. Furthermore, β in the equation (5) denotes the discount factor, where $0 < \beta < 1$. In Eq. (6), the components are defined: nominal money balances with household is m_{t+1} during the period between time t and t+1; τ_t denotes lump sum tax; b_t is the real value of one-period risk-free bond; p_t is the price level and R_t denotes the real gross rate of return.

Therefore, the necessary condition of above maximisation problem is:

$$1 - \frac{p_t}{p_{t-1}} \frac{1}{R_t} = 1 - \frac{R_{mt}}{R_t} = \frac{i_t}{1+i_t} \geq 0 \quad (7)$$

Eq. (7) can be rewritten as in Eq. (8), that is equivalent to the Fisher equation:

$$\frac{R_{mt}}{R_t} - 1 = R_t \frac{p_{t+1}}{p_t} - 1 \simeq r_t + \pi_t = i_t \quad (8)$$

Where r_t and π_t imply the real interest rate and inflation rate, respectively. In addition, $R_{mt}=\frac{p_t}{p_{t-1}}$ shows the inverse relation of inflation rate on real gross return on money holdings during the time t and t+1 and $1+i_t=\frac{R_{mt}}{R_t}$ indicates the gross nominal interest rate.

Accordingly, the relevant Lagrangian equation with respect to Eq. (4), (5) and (6) is:

$$\sum_{t=0}^{\infty} \beta^t \left\{ u(c_t, l_t) + \lambda_t \left(y - \tau_t + b_t + \frac{m_t}{p_t} - c_t + \frac{b_{t+1}}{R_t} + \frac{m_{t+1}}{p_t} \right) + \mu_t \left[1 - l_t - H\left(c_t, \frac{m_{t+1}}{p_t} \right) \right] \right\} \quad (9)$$

Related first order conditions are derived with respect to $c_t, l_t, b_{t+1}, m_{t+1}$ as given in following equations:

$$u_c(t) - \lambda_t - \mu_t H_c(t) = 0 \quad (10)$$

$$u_l(t) - \mu_t = 0 \quad (11)$$

$$-\lambda_t \frac{1}{R_t} + \beta\lambda_{t+1} = 0 \quad (12)$$

$$-\lambda_t \frac{1}{p_t} - \mu_t H_{m/p}(t) \frac{1}{p_t} + \beta\lambda_{t+1} \frac{1}{p_{t+1}} = 0 \quad (13)$$

In addition, the following expression for λ is obtained using Eq. (8) and Eq. (9).

$$\lambda_t = u_c(t) - u_\ell(t) H_c(t) \quad (14)$$

Similarly, by substituting Eq. (14) to Eq. (12), the real interest rate is expressed:

$$R_t = \frac{1}{\beta} \frac{u_c(t) - u_\ell(t) H_c(t)}{u_c(t+1) - u_\ell(t+1) H_c(t+1)_t} \quad (15)$$

Furthermore, Eq. (12) and Eq. (13) are rearranged to obtain Eq. (16) which equates cost and benefits of holding a marginal unit of real money. In other words, there may be a loss, because of money holdings instead of investing in interest bearing bonds whereas the consumer may be benefited by having money in hand, owing to reduce shopping time. Accordingly, Eq. (16) is derived:

$$\frac{R_t - R_{mt}}{R_t} \lambda_t = -\mu_t \mathrm{H}_{\mathrm{m/p}}(\mathrm{t}) \tag{16}$$

To derive money demand function in this model, Eq. (17) forms as follows, using Eq. (11), Eq. (14) and Eq. (16) and equating $\mathrm{u_c(t)}$ and $\mathrm{u}_{\ell}(\mathrm{t})$ at $\ell_t = 1 - H\left(c_t, \frac{m_{t+1}}{p_t}\right)$.

$$\left(1 - \frac{R_{mt}}{R_t}\right)\left[\frac{\mathrm{u_c(t)}}{\mathrm{u}_{\ell}(\mathrm{t})} - \mathrm{H_c(t)}\right] + \mathrm{H}_{\mathrm{m/p}}(\mathrm{t}) = 0 \tag{17}$$

Finally, the money demand function is defined in the first part of Eq. (18):

$$\frac{m_{t+1}}{p_t} = F\left(c_t, \frac{R_{mt}}{R_t}\right) = \hat{F}\left(c_t, \frac{i_t}{1+i_t}\right) = M^d\left(c_t, \frac{1}{R^{\star}(1+\pi_t)}\right) \tag{18}$$

Similarly, the first part of the equation is equal to the latter parts with respect to the expressions given in Eq.(7) and Eq.(8); the third part of the Eq. (18) demonstrates that c_t is positively related to money demand while negatively related to the interest rate $\frac{i_t}{1+i_t}$ as derived in Eq. (8). Furthermore, according to the explanation of Catao and Terrones (2003), since the model assumes interest rate parity of ($R^{\star} = R$), the last part of the Eq. (18) shows that c_t is positively related to money demand and is negatively related to international interest rate $R^{\star}$ and domestic inflation rate $\pi_t = \frac{p_{t+1}}{p_t}$. With the completion of household sector equilibrium, the government sector is to be explained.

The government budget constraint as explained in the chapter on theoretical literature is:

$$\frac{B_{t+1}}{R_t} = \tau_t - g_t + B_t + \frac{M_{t+1} - M_t}{p_t} \tag{19}$$

Where B_t denotes the government borrowing from the private sector in terms of units of goods in time t and M_t denotes money stock. Further, M_0 and B_0 are assumed to be given in the model. Finally, the long run equilibrium is formed to obtain an estimated form of this study, incorporating equations related to the household sector and government sector.

In forming the long run equilibrium, the additional assumptions with respect to prices and taxes are given; demand for money equals the supply of money ($m_t = M_t$); bond holding is $(b_t = B_t)$ at the point that household maximises its utility and entity holds that $y = c_t + g_t$.

Therefore, economy-wide budget constraint is,

$$\frac{b_{t-1}}{R_t} = y_t - c_t - g_t + b_t \tag{20}$$

Furthermore, in the long run stationary equilibrium, the following conditions are assumed:

$\frac{p_t}{p_{t+1}} = R_m$, $R_t = R$, $c_t = c$, $s_t = s$ where $t \geq 0$

As shown in Eq.21, the stationary equilibrium is obtained using Eq. (15) and Eq. (18).

$$R = \beta^{-1} \text{ and } \pi = \frac{M}{p} = M^d\left(c_t, \frac{1}{R^*(1+\pi_t)}\right) = \varphi(\pi) \tag{21}$$

In order to form the estimated formula, Eq. (21) is substituted to Eq. (19) resulting in the following equation.

$$\frac{\pi}{1+\pi} = \frac{p[g-\tau+B\frac{(R-1)}{R}]}{M} \tag{22}$$

Hence, the estimated form, $\pi = \varphi\ \frac{G-T}{M}$ is derived considering the approximation:

$$\pi \approx \frac{\pi}{(1-\pi)} \text{ and } G - T \approx p[g - \tau + B\frac{(R-1)}{R}, \text{ where BDM1 is } \frac{G-T}{M}.$$

Having defined BDM1, the ARDL model specification is formed along with the other variables.

4.2. ARDL model

The synthesis of budget deficit and inflation is formed according to the procedure proposed by Pesaran and Shin (1999) and Pesaran et al. (2001), in terms of cointegration and error correction models in this study, which provides an appropriate framework to find the long run relationship with short-run dynamics. One advantage of the ARDL methodology is that it avoids the prerequisite of the existence of the same order of integration in time series data as other methodologies. In addition, the ARDL model/Bound testing methodology estimates and interprets a simple model with a single equation form. Furthermore, the different lag levels may be included into the model, with respect to dependent and independent variables.

Before proceeding to the cointegration process with the ARDL model equations, it will be necessary to describe properties of ARDL. The ARDL model is autoregressive since the lag values of the dependent variable are included in the model as regressors. Similarly, the model has explanatory variables with lag values as regressors that are called distributed lag. Therefore, the model illustrated in Eq. (23) is explained as ARDL ($p,q_1.....q_k$) model, where 'p' symbolizes the number of lag for regressors of dependent variables and '$q_1...q_k$' refer to the number of lags of explanatory variables from the first variable to k^{th} number of variables. Thus, the system entails (k+1) variables including k^{th} number of other variables and the dependent variable in the single equation system. In addition, in a certain model, some of the explanatory variables may be incorporated without lags and some of the other variables may have several lags.

Setting the equation form, there are three versions of ARDL model specifications: simple ARDL model, long- run version of ARDL model and the Bound tests formulation of ARDL model. The first form of equation estimates ARDL ($p, q_1....q_k$), that denotes dependent variable with its own lags and lags of other explanatory variables:

$$y_t = a_0 + a_1 t + \sum_{i=1}^{\mathcal{P}} \Psi_i \ y_{t-i} + \sum_{j=1}^{k} \sum_{l_j=0}^{q_j} \beta_{j,l_j} x_{j,t-l_j} + \varepsilon_t \qquad (23)$$

Where y is the dependent variable; α_0 is the constant term and a_1 is the coefficient of linear trend, Ψ is the coefficient of lag variables of dependent variables used as repressors; β is the coefficient of other explanatory variables; ε_t is the random disturbance term.

Secondly, in the long run ARDL model, the long run coefficients are presented in Eq.24.

$$\hat{\alpha}_1 = \frac{\hat{a}_1}{1-\sum_{i=1}^{\mathcal{P}} \hat{b}_0} \text{ and } \hat{\theta}_j(1) = \frac{\hat{b}_j}{1-\sum_{i=1}^{\mathcal{P}} \hat{b}_{0,i}} \qquad (24)$$

Accordingly, ARDL cointegrating regression relationship EC_t and the bound test null hypothesis form is derived considering the differences of Eq.23 and substituting Eq.24:

$$\triangle y_t = b_0 y_{t-1} + \sum_{j=1}^{k} b_j x_{j,t-1} + \sum_{i=1}^{p-1} c_{0,j} \Delta y_{t-1} + \sum_{j=1}^{k} \sum_{l_j=1}^{q_j-1} c_{j,l_j} \Delta x_{j,t-l_j} + \varepsilon_t \qquad (25)$$

Where, $EC_t = y_t - \sum_{j=1}^{k} \frac{b_j}{b_0} x_{j,t}$ and $H_0: b_0 = b_j = 0, \forall j$

Bound test procedure provides bounds on the critical values of F statistics, where the critical values of lower bound and upper bound are given for the different number of variables, depending on the order of cointegration. The assumptions for bounds are: all the variables are I(0) for lower bound; all the variables are I(1) for upper bound. Moreover, F statistics generated by a certain model are tested against the given bound values. In terms of decision rule, if the calculated value falls below the lower bound, the assumption for lower bound must be accepted, concluding that there is no long run relationship between two variables. Conversely, if the calculated F-statistics fall above the upper bound, the upper bound assumption is accepted, with the meaning that there is a long run relationship between dependent and independent variables. If the computed value falls between the lower and upper bounds, however, the result tends to be inconclusive.

It is also worth to note that the ARDL model assumes no serial correlation issue in the system owing to the fact that the formation includes lag variables of dependent variables as regressors. Serial autocorrelation is known as the situation where the residuals of a series that is known as the unexplained part of a regression, are correlated with its own lag values. Simply, ε_t of the above model is said to be serially correlated, if ε_t is correlated with $\varepsilon_{t-1}, \varepsilon_{t-2}$ and so on. If the model is suffered from a serial correlation issue, however, the coefficient of the regression is considered to be biased and respective standard errors may be incorrect. Thus, it is important to identify the serial correlation issue of a certain model before proceeding with the model.

4.3. Toda-Yamamoto granger causality procedure

The Granger causality between the dependent variable and independent variables is very important in modeling ARDL single equation formation that finds the causality between two or more series of stationary data that are cointegrated. As an example, with two time series data 'x' and 'y', x is said to Granger-cause y if y can be explained/forecasted more strongly after taking x and y together, rather than taking only y. In testing Granger causality, a null hypothesis is tested against an alternative hypothesis at the appropriate significance level, based on the model specification as demonstrated below, assuming the VAR model.

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \cdots + \alpha_p y_{t-p} + \beta_1 x_{1-1} + \cdots + \beta_p x_{t-p} + u_t \qquad (26)$$

$$x_t = \gamma_0 + \gamma_1 x_{t-1} + \cdots + \gamma_p x_{t-p} + \delta_1 y_{1-t} + \cdots + \delta_p y_{t-p} + v_t \qquad (27)$$

Where α and β symbolise coefficients for the variables x and y. Regarding Eq.26, the relevant null hypothesis is set to be: H_0: $\beta_1 = \beta_2 = \cdots = \beta_p = 0$ that implies that x does not Granger cause y, as against H_1 that assumes, H_0 is not true. Similarly, the set of hypotheses is also formed with respect to Eq. 27, $H_o: \delta_1 = \delta_2 = \cdots \dots \dots \dots = \delta_p = 0$, that assumes y does not Granger cause x. Accordingly, the existence of Granger causality is concluded by rejecting H_0 with a suitable confidence level.

Engle and Granger (1987), however, point out that if the data is stationary at the different orders, even though they are cointegrated, the testing procedure explained above may be erroneous. The Engle-Granger causality test, therefore, may not provide a strong decision rule for the data in the current study. Therefore, the Granger causality procedure developed by Toda and Yamamoto (1995) is used in this study, as that is the most appropriate testing procedure for the data in the study that are integrated in different order. Toda and Yamamoto (1995) provide very comprehensive information about the procedure with the abstract of their paper as given in the following quotation:

> ……..*We can apply a usual lag selection procedure to a possibly integrated or cointegrated VAR since the standard asymptotic theory is valid (as far as the order of integration of the process does not exceed the true lag length of the model). Having determined a lag length k, we then*

> *estimate a ($k + d_{max}$)th-order VAR where d_{max} is the maximal order of integration that we suspect might occur in the process.* (Hiro Y.Toda, , Taka, Yamamoto. (1995) Statistical Inference in Vector Auto regressions with possibly integrated processes. Journal of Econometrics, 66 (1995): pp.225-250.)

The Toda and Yamamoto procedure, thus, provide the testing method, which is free from the problems of the order of integration or cointegration.

The testing process has several steps. The first step includes determining the maximum order of integration (d_{max}) using the unit root tests: the Augmented Dickey-Fuller (ADF) test, Kwiatkowski-Phillips-Schmidt-Shin test etc. Secondly, the VAR model specification, like a model as illustrated in Eq.26/Eq.27, is to be used in deciding the maximum lag length (k^{th} lag), considering the selections of lag length criteria: Akaike Criteria (AIC), Bayesian Information Criteria (BIC), Schwarz Information Criteria (SIC) etc. The third step is to check the VAR model for serial independence, stability etc. applying the standard tests: Auto Regressive unit root graph, VAR residual serial correlation Lagrange Multiplier (LM) test, VAR residual normality test etc. The fourth step is to include $k+d_{max}$ lags as exogenous variables and re-estimate the VAR model. Finally, depending on relevant results of the Wald test, the null hypothesis is rejected at an appropriate significance level to decide Granger causality. As explained above, this decision provides statistical evidence of the existence of a causal relationship between variables concerned. Relevant to the current study, the Wald test results are used to examine the causality coming from budget deficit to inflation while rejecting the opposite direction.

5. Empirical analysis

This study examines the relationship between budget deficit and inflation in Sri Lanka in terms of causality, long run cointegration and magnitude of long run coefficients using time series data from the period 1957-2016. As explained previously, the variables and models are appropriately applied with statistical tests,[6] to assess this relationship. In summarising the variables in the study, firstly, two measures of budget deficit are used: budget deficit scaled

[6] This study uses e-views 9.5 version to carry out aforementioned tests.

narrow money supply (BD/M1), budget deficit scaled by Gross Domestic Product (BDGDP). Secondly, two alternative indicators of inflation are also considered in this study: Colombo Consumer Price Index (CCPI) and GDP deflator. Additionally, the study considers several explanatory variables in the selected models: the exchange rate of Sri Lankan Rupees vs. US$ (US$), Broad money supply (M2), GDP growth, three months Treasury Bill Yield (TBR). The data in this study are taken from the latest Annual Reports of the Central Bank of Sri Lanka.

Graphical representation reveals the hypothesis of this study demonstrating a long run trend with random cycles. LNBDM1 shows an upward trend with a curvature. In addition, the variables namely, LNFR, LNUSD and LNM2 and LNTBR demonstrate an upward trend. In common, the variables appear to be a mix of stationary and non-stationary.

5.1. The analysis of unit root

Although testing for the unit root is not a necessary condition or pre-test requirement in the ARDL system, owing to the ability to deal with variables in the different order of integration, it is advisable to test for the presence of unit root to clarify that the data series are not I (2). This is because the system of ARDL tends to be erroneous, when dealing with integrated stochastic trends of I (2) variables. Thus, with understanding of the nature and the behavior, the variables are tested for prevalence of unit root. To test for the unit root, Augmented Dikey-Fuller (ADF) test has been applied in this study with Akaike Information Criteria (AIC). Accordingly, t-statistics of the ADF test statistics are compared with the test critical values at different significance levels. Consequently, the null hypothesis of non-stationarity is rejected considering related probabilities to determine order of integration. The t-statistics and related probabilities demonstrate the variables are integrated at different levels: integrated at levels I (0) or integrated at the first difference I (1).

The results show that the stationarity of variables is varied owing to the presence of different probabilities with different options. The statistical tests, however, reveal that none of the variables are I (2). This data series, thus, are well fitted for the ARDL model specification, which are designed particularly for the data in this nature.

5.2. Estimated models

There are four functional forms modeled in this study: VAR models in the Toda-Yamamoto Ganger causality analysis and the ARDL model specifications in cointegration analysis. Thus, the functional forms are designed based on the nature of the variables and the order of integration. Accordingly, this study considers four separate models, which are divided into two, depending on separate alternative indicators for inflation: CCPI and GDPD. Furthermore, the two categories are again classified into two forms, considering different budget deficit indicators: BDM1 and BDGDP. In other words, this study investigates the two budget deficit indicators scaled by different denominators (M1 and GDP), in terms of two alternative inflation indicators (CCPI and GDPD). The denominator of the conventional budget deficit indicator (BDGDP) is considered as an indicator, which may capture all the changes in budgetary components: revenue, expenditure, deficit financing etc. On the other hand, BDM1 has been derived, concerning the government budget constraints and BDM1 is believed to capture the effects of inflationary financing of the budget deficit, considering narrow money supply as its base. Applying these two measures, thus, provides sufficient theoretical and practical background for a better comparison, while ensuring strong evidence in revealing the interaction between budget deficit and inflation. Regarding indicators of inflation, CCPI calculates with selected samples of consumer items, including imported items and selected population groups. GDPD covers all the items domestically produced with respect to all the population. CCPI is, however, widely utilised in measuring inflation. Both the indicators, thus, are very important in explaining inflationary impacts, particularly, in the long run. Considering these differences, both measures are alternatively used in this study, to ascertain a comprehensive analysis with a better comparison and statistical evidence. With regard to the other variables, this study includes several explanatory variables, namely, US$, FR, M2, GDP, TBR, considering their impact on the main variables.

5.3. Causality analysis

In performing the causality test, this study examines the nature of the causal relationship between budget deficit and inflation. In other words, the causality test is carried out to determine the relationship, which was established in the hypothesis of this study; the causality may come from budget deficit to inflation. As mentioned in the methodology, this study applies the Toda-Yamamoto procedure to test Granger causality followed by the pre-tests for serial independence and stability. In line with pre-testing steps, maximum lag length (d_{max}) is determined based on the Akaike Information Criteria (AIC) and maximum order of integration (k) is concluded in line with the unit root analysis. Subsequently, this study has applied the VAR residual serial correlation LM test with the null hypothesis of no serial correlation at the lag order, of which acceptance is based on higher chi-square probabilities. In addition, the pre-testing procedure has observed the AR root graph to ensure the stability of the VAR model, which must proceed with the Wald test at the next step.

Regarding all the models, the maximum order of integration (k) equals one that indicates all the variables are I (0) or I (1). Also, the maximum lag length (d_{max}) selected on the basis of AIC is higher than the value of k. With the acceptance of the null hypothesis at 5 per cent significance levels, the result of the serial correlation LM test concludes the serial independence of all four models. Further the result of the stability test also conclude that the selected VAR models are dynamically stable.

With the success of pre-tests as described above, the selected VAR models have been rematerialised imposing $(k+d_{max})th$ lags as exogenous variables. Subsequently, with the result of the Granger causality/Block Exogeneity test, Granger causality has been determined by rejecting the null hypothesis of no dependent- independent relation between the selected two variables with lower probabilities. Using the same logic, higher probabilities conclude acceptance of null hypothesis.

The results, as shown in Table 3, indicate that all four models reject the null hypothesis at the one per cent significance level, confirming causality coming from budget deficit to inflation. Similarly, all four models reject the opposite causality by accepting relevant null hypotheses. This concludes that a unidirectional relationship exists between representative variables namely BDM1 and BDGDP (indicative variables of the budget deficit) and CCPI and GDPD (two indicators of inflation) at acceptable significance levels: model 1 at 10 per cent, model 2 at 5 per cent, model 3 and model 4 at one per cent. On the other hand, all null hypotheses of no opposite direction cannot be rejected with a very high significance level. In other words, the unidirectional relationship of the deficit–inflation relationship has been revealed with the evidence given in Table 3 below. Importantly, irrespective of the difference in the indicators of both budget deficit and inflation, the results are confirmed with strong statistical evidence. This study, thus, concludes strong statistical evidence for the existence of unidirectional causality, coming from budget deficit to inflation in Sri Lanka.

In completion of testing procedure for Granger causality, cointegration testing process can be proceeded to explore budget deficit-inflation interaction. Regarding the cointegration analysis, the ARDL model specification designs a single equation system where the dependent-independent causality is considered to be very important.

Table 3: Result of Block Exogeneity Wald test

Model	Null hypothesis	Result	Probability
1	1.no causality from LNBDM1 to LNCCPI	H_0 rejected	0.0570
	2.no causality from LNCCPI to LNBDM1	H_0 accepted	0.3431
2	1.no causality from LNBDGDP to LNCCPI	H_0 rejected	0.0425
	2.no causality from LNCCPI to LNBDGDP	H_0 accepted	0.9582
3	1.no causality from LNBDM1 to LNGDPD	H_0 rejected	0.0000
	2.no causality from LNGDPD to LNBDM1	H_0 accepted	0.6402
4	1.no causality from LNBDGDP to LNGDPD	H_0 rejected	0.0039
	2.no causality from LNGDPD to LNBDGDP	H_0 accepted	0.2463

In addition, the results provide strong evidence to proceed with the estimated models for further investigation of possible long-run cointegration.

5.4. ARDL regression and bound test procedure

To assess the cointegration between budget deficit and inflation, the ARDL model specifications associated with ARDL/Bound test procedure need to be formed. To form the relevant ARDL model specifications, this study follows the similar model formulation that tested for Granger causality in the previous section. The illustrative long run ARDL model formulation is as follows:-

Model-1

$$\triangle \mathrm{CCPI}_t = \alpha_0 + \sum^{q1}{}_{\ell=1} \delta_m \triangle \mathrm{CCPI}_{t-\ell} + \sum^{q2}{}_{m=0} \delta_m \triangle \mathrm{BDM1}_{t-m} + \sum^{q3}{}_{m=0} \theta_m \triangle \mathrm{M2}_{t-m} + \sum^{q4}{}_{m=0} \sigma_m \triangle \mathrm{US\$}_{t-m} + \sum^{q5}{}_{m=0} \gamma_m \triangle \mathrm{TBR}_{t-m} + \sum^{q6}{}_{m=0} \zeta_m \triangle \mathrm{RGDP}_{t-m} + \omega_0 \mathrm{CCPI}_{t-1} + \omega_1 \mathrm{BDM1}_{t-1} + \omega_2 \mathrm{M2}_{t-1} + \omega_3 \mathrm{US\$}_{t-1} + \omega_4 \mathrm{TBR}_{t-1} + \omega_5 \mathrm{RGDP}_{t-1} + \varepsilon_t$$

The graphical representation suggests a mix of possible stationarity and non-stationarity time series data. Moreover, the test result of the order of integration of the variables reveals that all the variables are a mix of I(0) and I(1) variables. In determining the lag length as to select information criteria for model specifications presented above, this study applies automatic model selection feature incorporated with E-views, where the model selection process is based on the lowest value of selection criteria that is AIC. Model selection is based on the process where the best fitted model specifications are selected pooling a considerable number of models, by means of respective maximum lag lengths provided with the VAR specifications.

The tests performed for the serial autocorrelation using the Breush-Godfrey Serial Correlation LM test concludes that no serial correlation exist in selected models, by rejecting the null hypothesis that the residuals of the series are serially correlated. The null hypothesis has been rejected at higher probabilities of F statistics and Chi-Squares in model 1 and model 2. However, model 3 and model 4 probabilities of F statistics have exceeded only a 5 per cent significance level. Furthermore, the graphical representations of autocorrelation, partial autocorrelation and Q-stat with related probabilities confirm the statistical evidence of non-presence of serial autocorrelation. The results, therefore, verify the selection of the best models at a strong significance level, thereby providing sufficient statistical evidence for applying the single equation ARDL model which incorporated lag values of dependent variables as repressors.

In investigating cointegration, the selected ARDL models are to be appropriately arranged to perform the bound test, where F values and related bounded critical values are obtained for lower bound I(0) and upper bound I(1). Accordingly, the decision rule is made by comparing calculated F-statistics with related bounds critical values with respect to different significance levels. Decision rule measures the existence of cointegration of series, depending on the region, where the calculated F values fall. Accordingly, if F-statistics exceeds upper bound critical values, a decision is to be taken in favor of the presence of cointegration. Conversely, if F-statistics falls below the lower bound, non-existence of cointegration is determined. Nevertheless, the results are inconclusive if F-statistics falls in between the bounds.

Table 4: ARDL/Bound test results

Significance Level	Bounds	Model 1	Model 2	Model 3	Model 4
		F Statistics			
		2.991	3.218	5.745	4.49
		Bounds Critical Values			
10.0%	I(0)	1.99	1.99	1.99	2.08
	I(1)	2.94	2.94	2.94	3.00
5.0%	I(0)	2.27	2.27	2.27	2.39
	I(1)	3.28	3.28	3.28	3.38
2.5%	I(0)	2.88	2.88	2.55	2.70
	I(1)	3.61	3.61	3.61	3.73
1.0%	I(0)	2.88	2.88	2.88	3.06
	I(1)	3.99	3.99	3.99	4.15

The results obtained from the bound test presented in Table 4 that shows the related F-statistics of all four models exceed upper bounds, at acceptable significance level, revealing statistical evidence to accept the cointegration relationship as formed in the models. Accordingly, F stat of Model 1 exceeds bound at a 10% significance level and Model 2 passes the test with a 2.5% significance level. Model 3 and 4, however, exceed the upper bound at 1% significance level.

The results reveal the long-run relationship between the budget deficit and inflation in Sri Lanka. In other words, the overall findings of cointegration confirm further that the existence of cointegration in both the deficit indicators (BDM1 and BDGDP) irrespective of the scales and the results are commonly applied to the two different inflation measures (CCPI and GDPD) as well. Thus, these results are in line with the results obtained in causality tests. Furthermore, it is provided with the statistical evidence to proceed with investigating long run coefficients using the ARDL error correction version to ascertain the magnitudes of the existing relationship.

Table 5: Results of the long-run form of ARDL model

Independent Variables	Dependent Variable			
	LNCCPI		LNGDPD	
	Model 1	**Model 2**	**Model 3**	**Model 4**
LNBDM1	1.62**	-	1.46*	-
LNBDGDP	-	1.69*	-	2.34*
LNGDPD	-	-	-	-
LNM2	-0.60	-0.06	0.71	2.25
LNRGDP	-0.44	-0.46	-0.57	0.70
LNUS$	1.91	1.67	-0.70	-0.56
LNTBR	0.29	-0.19	0.94*	0.06
LNF	-0.61	-0.86**	-0.80	-2.88**
C	-0.52	-0.13	-6.43*	-10.31
Cointeg. Term	-0.69***	-0.67***	-0.80***	-0.64***

*,** and *** denote significant levels of 10%, 5% and 1% respectively

5.5. ARDL regression and long run analysis

In obtaining long-run coefficients of the ARDL model, which was suggested by the bound test procedure, this study applies error correction versions of the ARDL model. Accordingly, similar model specifications of ARDL/Bound test procedure are rearranged to the ARDL cointegration and long run form in E-views to obtain relevant coefficients. With the successive application of the tests, the results are demonstrated in Table 5: the respective cointegration terms indicate a desired minus sign and value of each is less than one; the coefficients of budget deficit indicators are positive and significant; other variables show mixed results and many of them are insignificant. Regarding model 1: the cointegration term is -0.59, which means more than half of the disequilibrium will correct within one year; the coefficient of BDM1 is positive and significant at 10 per cent. Moreover, the coefficient predicts that a one per cent increase in LNBDM1 will lead to a 1.26 per cent increase in inflation rate measured by LNCCPI. Other variables in model 1, however, are insignificant (except RGDP), although some of the variables entail a correct sign. Regarding model 2, the cointegration term (-0.67) and coefficient of LNBDGDP (2.13) are both highly significant, p=0.01. Similarly, model 3 records that 80 per cent of deviations will be corrected within one year while coefficient of LNBDM1 is significant at 10 per cent level. Model 4 results confirm that the cointegration term is highly significant and the coefficient of LNBDGDP is significant at 10 per cent level.

The results shown in the above table reveal, in common, about half of the equilibrium adjustment will be corrected within one period as evidenced with one per cent significance level. Alternative indicators of the budget deficit (BDM1 and BDGDP), are both significant with respect to both indicators of inflation, concluding a strong positive relationship between budget deficit and inflation. With respect to the magnitudes, the relationship establishes that a one per cent increase in LNBDM1 and LNBDGDP may cause a 1-2 per cent increase in inflation irrespective of measurement of inflation. In summary, the overall results, therefore, reveal a long run positive relationship with the causality coming from the budget deficit to inflation with the magnitudes of 1-2 per cent, as proved by the different statistical tests under acceptable significance levels. The result further confirms the budget deficit inflation relationship in terms of both the budget deficit indicators and inflation indicators irrespective of their differences.

6. Conclusion and recommendations

6.1. Conclusion

The purpose of this study is to examine the relationship between the budget deficit and inflation in Sri Lanka. Accordingly, the relationship is assessed using three alternative statistical approaches: the Toda-Yamamoto Granger causality procedure, which examines the causal relationship between the variables; the ARDL/Bound test cointegration approach, which investigates the long-run relationship with short-term dynamics; the ARDL error correction form, which examines the cointegration term and long-term coefficients. Using these statistical approaches, this study models budget deficit in two different scaling. Firstly, budget deficit is scaled by narrow money (BDM1), based on the theoretical approach of Intertemporal Budget Constraint (IBC) and secondly, budget deficit is scaled by GDP used as a conventional indicator. Moreover, separate inflation indicators (CCPI and GDPD) are also used in this study, in order to capture different aspects of inflation within the scope of the two inflation measures.

With respect to the estimated models, four separate model specifications are designed to estimate the aforementioned relations, which are categorised according to the separate indicators for budget deficits and inflation. Additionally, several explanatory variables are also included in all the models, representing macroeconomic sectors directly associated with budget deficit and inflation. As discussed previously in this study, background information and empirical research designs are considered in forming the above models. Furthermore, empirical analysis of the current study works out with time series annual data during the period of 1957-2016.

Turning to the findings, this study concludes firstly, unidirectional Granger causality with respect to all the estimated models. In other words, the results reveal that the budget deficits Granger caused inflation, but not vice versa in Sri Lanka. This causal relationship was commonly evidence in all four models irrespective of the difference in the indicators used in the models. Furthermore, the conclusion of the Granger causality tests proves a strong statistical significance of acceptable level.

Secondly, in line with the result of Granger causality tests, this study reveals a long run cointegration relationship between budget deficit and inflation in Sri Lanka. Moreover, the results of the cointegration tests also prove that the cointegration results are seemingly common to all the estimated models. In addition, the cointegration test results are proved with acceptable statistical evidence of significance levels (p=0.10, p=0.5, and p=0.01).

Thirdly, this study concludes the positive long-run correlation with considerable magnitudes between budget deficit and inflation in Sri Lanka. The long-run cointegration coefficients of estimated models are less than one with negative sign and are significant at one per cent level. The magnitudes of long-run cointegration terms in all the four models are between -0.6 and -0.8 per cent, commonly indicating 60 per cent to 80 per cent of disequilibrium between principal variables would be corrected within a one-year period; the speed of adjustments was comparably high. Regarding the magnitudes of long run cointegration coefficients, the long run coefficients of the ARDL error correction models reveal that one per cent change in budget deficits as measured by LNBDM1 and LNBDGDP will result in a 1.5-2.5 per cent change in inflation as measured by LNCCPI and LNGDPD in Sri Lanka at acceptable significance levels (10%, 5%, and 1%). Moreover, four separate models formed in this study conclude nearly similar results suggesting strong evidence of the positive relationship between variables interested in this study. The results of all three approaches: Granger causality test results, ARDL/Bound test results and the ARDL long run coefficients collectively confirm the hypothesis in this study that the existence of considerable magnitude of the positive relationship between the budget deficit and inflation in Sri Lanka are proved with strong statistical evidence.

Referring to the theoretical literature, Unpleasant Monetarist Arithmetic (Sargent and Wallace, 1981) that is considered as one of the milestones in uncovering the budget deficit-inflation nexus, emphasises the importance of fiscal policy in price determination, particularly under fiscal dominance. In recent economic history, theoretical arguments have emerged in favor of a considerable role of fiscal policy in determining price level, with approaches such as fiscal theory of price level. The findings of the current study are supported by these theoretical explanations.

According to the findings of the empirical studies, some researchers conclude the strong positive relationship between budget deficit and inflation, particularly, in developing countries. Thus, the findings of this study contribute to filling the gap in the literature, enhancing the understanding of the budget deficit-inflation relationship. In line with that, this study broadly confirms similar type of findings: findings of Catao and Terrones (2003), Ishaq and Mohsin (2015), Habibulah, Cheah and Bahaom (2011), which consider a developing country group including Sri Lanka; findings of Abu and Karim (2015) which did not include Sri Lanka in the sample of the study; findings of country-specific studies, such as the studies of Solomon and Wet (2004), Helmy (2008), Ndanshanu (2012), and Ekanayake (2012), which was conducted using similar country data. Similarly, Devapriya and Ichihashi (2012) also found a similar positive long-run relationship with bi-directional causality using country data for Sri Lanka.

6.2. Policy recommendations

The findings of this study entail several important implications for policy makers and future researchers. Firstly, the findings explore fiscal policy influence into the inflation in Sri Lanka. According to the concept of intertemporal budget constraints in Economics, the impact of budget deficit on inflation may emerge sooner or later with a higher cost. Similarly, Sargent and Wollece (1981) explain the unpleasant monetarist arithmetic, where the fiscal dominance situation may limit a central bank's ability to control inflation in an economy. The findings of this study suggest that a similar theoretical approach is applicable to Sri Lanka to some extent. Thus, policy makers may consider the policy interaction revealed in this study in formulating and implementing the fiscal policy and monetary policy in Sri Lanka. In this regard, the fiscal policy may be rule-based, to keep budget deficits at a lower level to minimise the adverse impact on inflation. This may be realized through rationalising expenditure, improving revenue performance, and assuring maximum efficiency of government resource utilisation. These measures, in addition, may be helpful to reduce the pressure on monetary policy which is responsible for price stability. However, fiscal policy management is always a challenge for policy-makers in terms of several key factors: higher expenditure in expediting economic growth in the country, unavoidable expenditures such as interest payments and amortisation, lower revenue performance and limited accessibility of non-inflationary financing, underdeveloped market structures etc. Monetary policy, on the other hand, is also challenging with poor fiscal management including inflationary deficit financing.

Secondly, the findings of this study are important, in the wake of the improvements of the monetary policy framework in Sri Lanka as the Central Bank of Sri Lanka is in the process of adopting IT framework as its monetary policy framework. Well managed fiscal-monetary coordination is a prerequisite of an IT framework, and the findings of this study provide insightful understanding about the fiscal-monetary policy relationship and some other key areas to be considered. Therefore, as a policy recommendation, fiscal sector pressure on monetary policy needs to be minimised with strong fiscal management strategies.

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Appendices

Figure A1: Graphical representations of data

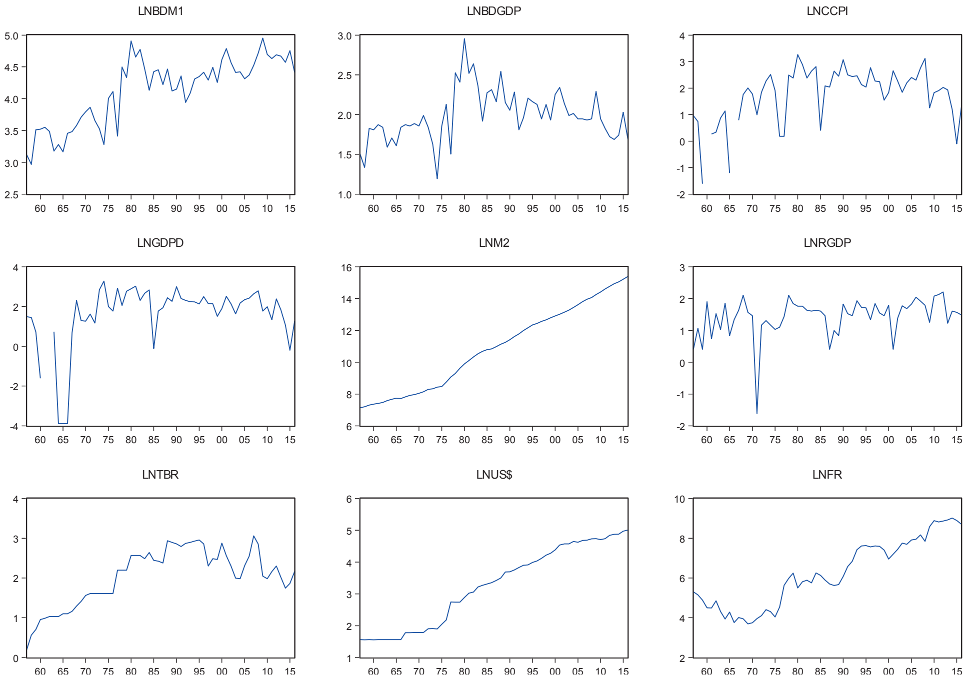


Table A1: Test results of unit root

Variables	Include in Test Equation	Augmented Dicky-Fuller							
		Akaike Info. Criterion				Schwarz Inf. Criterion			
		Levels		1st difference		Levels		1st difference	
		t-Stat.	Prob.	t-Stat.	Prob.	t-Stat.	Prob.	t-Stat.	Prob.
LNCCPI	**Tre.and Int.**	-2.96	0.15	-4.53	0.00	-2.96	0.15	-7.40	0.00
	None	-0.52	0.48	-4.31	0.00	-1.27	0.19	-7.68	0.00
LNGDPD	**Tre.and Int.**	-3.10	0.12	-7.81	0.00	-3.10	0.12	-5.94	0.00
	None	-0.52	0.48	-6.76	0.00	-1.86	0.06	-5.92	0.00
LNBDM1	**Tre.and Int.**	-2.94	0.16	-11.42	0.00	-4.04	0.01	-11.42	0.00
	None	0.76	0.87	-11.36	0.00	0.76	0.87	-11.36	0.00
LNBDGDP	**Tre.and Int.**	-2.92	0.16	-11.68	0.00	-3.99	0.01	-11.68	0.00
	None	-0.13	0.64	-11.74	0.00	-0.13	0.64	-11.74	0.00
LNRGDP	**Tre.and Int.**	-5.13	0.00	-4.52	0.00	-7.16	0.00	-13.14	0.00
	None	-0.30	0.57	-4.59	0.00	-0.94	0.31	-13.36	0.00
LNM2	**Tre.and Int.**	-3.23	0.09	-3.68	0.03	-2.73	0.23	-3.68	0.03
	None	3.21	1.00	-0.81	0.36	3.21	1.00	-1.20	0.21
LNTBR	**Tre.and Int.**	-0.82	0.96	-7.18	0.00	-2.11	0.53	-7.18	0.00
	None	0.46	0.81	-6.43	0.00	0.16	0.73	-6.43	0.00
LNUS$	**Tre.and Int.**	-1.72	0.73	-7.05	0.00	-1.72	0.73	-7.05	0.00
	None	4.55	1.00	-1.33	0.17	4.55	1.00	-5.25	0.00

Tre. and Int.=Trend and Intercept, t-stat=t-statistics, prob.=probabilities

Table A2: Functional forms of the estimated models

Model	Functional Form
Model-1	LNCCPI=f(LNBDM1, LNM2, LNRGDP, LNTBR, LNUS$, LNFR)
Model-2	LNCCPI=f(LNBDGDP, LNFR, LNUS$, LNTBR, LNM2, LNRGDP)
Model-3	LNGDPD=f(LNBDM1, LNM2, LNTBR, LNUS$, LNRGDP, LNFR)
Model-4	LNGDPD=f(LNBDGDP LNM2, LNRGDP, LNFR, LNUS$)

Table A3: Tests results of serial independence

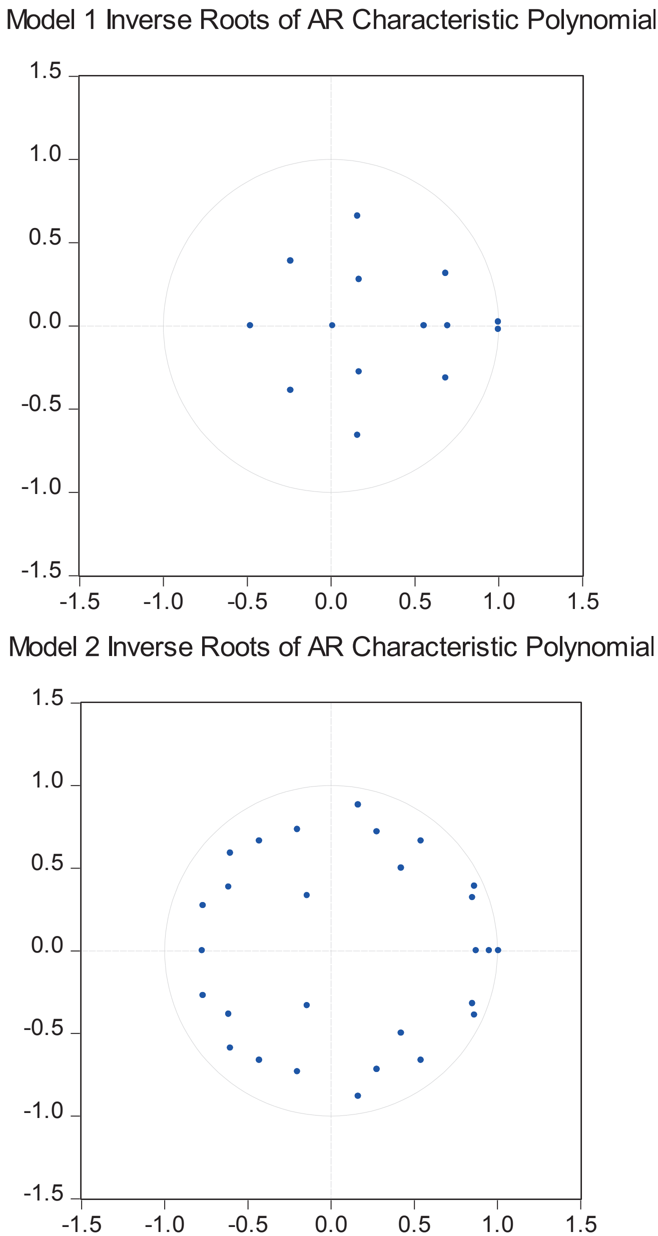
Model	Lag Order (k)	Information Criteria	d_{max}	Serial Correlation LM test	Inverse Root of AR Characteristic Pyramid[7]
1	1	AIC	2	H_0 accepted	Dynamically stable
2	1	AIC	3	H_0 accepted	Dynamically stable
3	1	AIC	5	H_0 accepted	Dynamically stable
4	1	AIC	5	H_0 accepted	Dynamically stable

Table A4: Test result of Breush-Godfrey serial correlation LM test

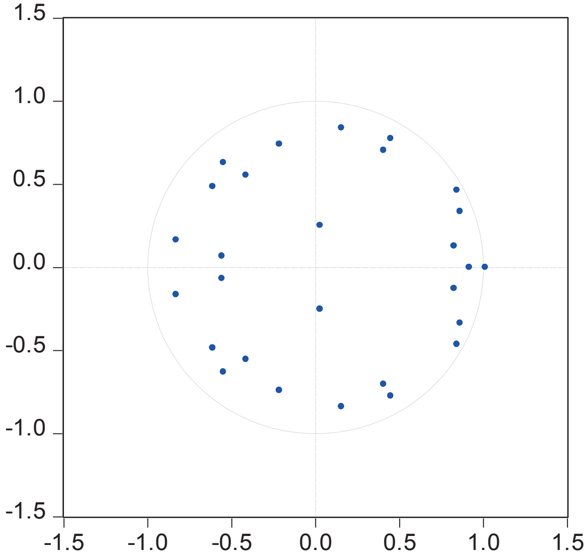
Model	Prob. F Statistic	Prob. Chi-Square
1	F(4,24), 0.9949	C(4), 0.9787
2	F(2,24), 0.6512	C(2) 0.3943
3	F(3,26), 0.1345	C(2), 0.0198
4	F(4,23), 0.0935	C(4), 0.0370

[7] The results are based on Inverse Root of AR Characteristic Pyramids as given in Figure A2.

Figure A2: Inverse roots AR characteristic polynomial (for causality tests)



Model 3 Inverse Roots of AR Characteristic Polynomial



Model 4 Inverse Roots of AR Characteristic Polynomial

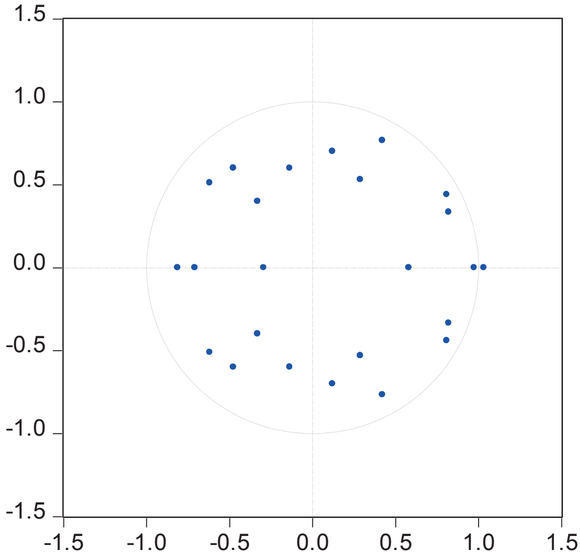
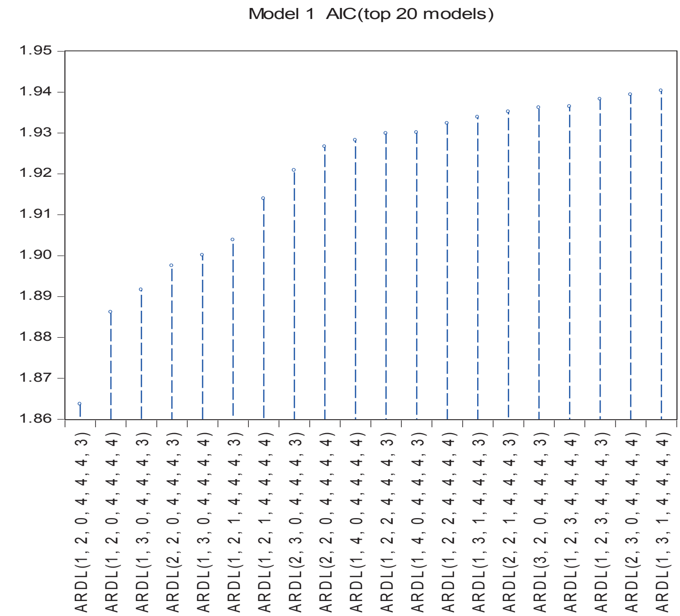
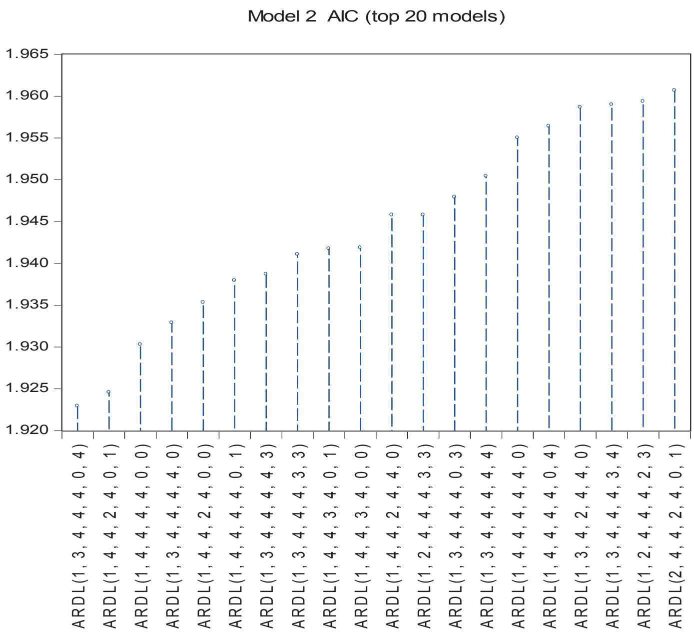
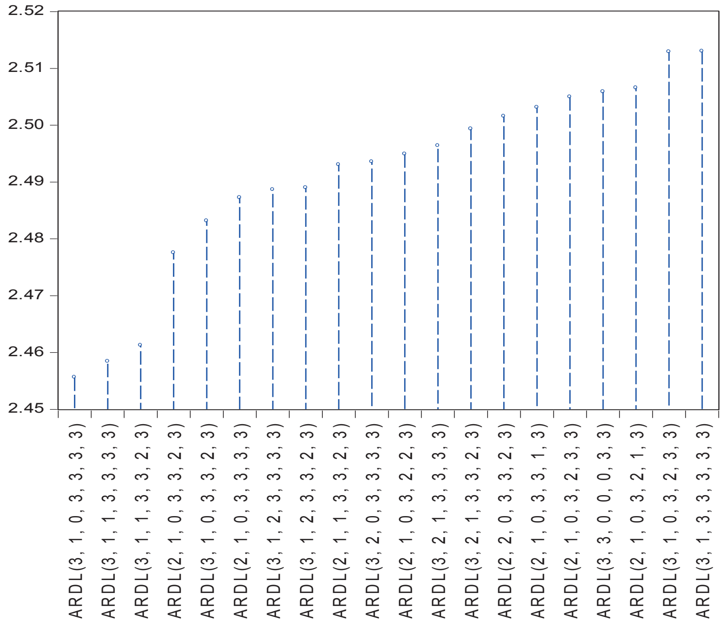


Figure A3: Top 20 ARDL models selected through AIC





Model 3 AIC (top 20 models)



Model 4 AIC (top 20 models)

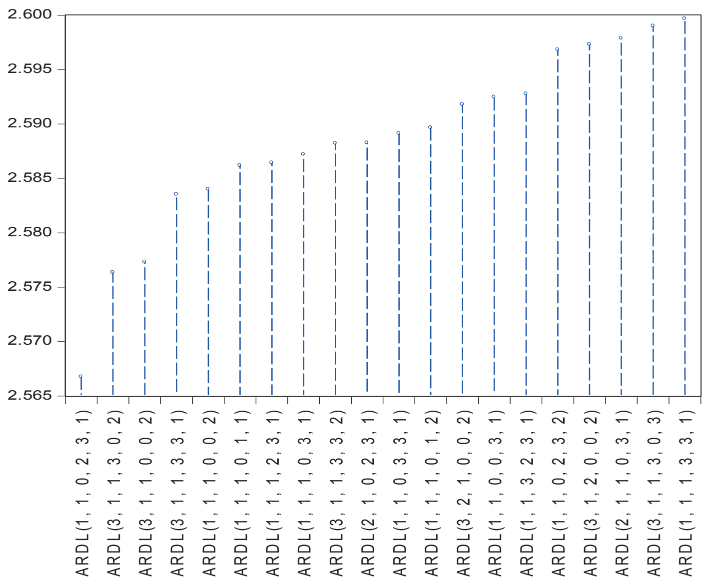


Table A5: Auto correlation and partial auto correlation (for ARDL)

Model 1

Date: 05/24/17 Time: 09:30
Sample: 1957 2016
Included observations: 53
Q-statistic probabilities adjusted for 1 dynamic regressor

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.008	0.008	0.0039	0.950
		2	0.076	0.076	0.3334	0.846
		3	-0.106	-0.108	0.9943	0.803
		4	0.019	0.016	1.0167	0.907
		5	0.062	0.079	1.2513	0.940
		6	-0.204	-0.226	3.8230	0.701
		7	0.026	0.032	3.8662	0.795
		8	-0.133	-0.090	5.0081	0.757
		9	0.138	0.093	6.2642	0.713
		10	0.009	0.032	6.2694	0.792
		11	-0.174	-0.212	8.3786	0.679
		12	-0.116	-0.130	9.3411	0.674
		13	-0.088	-0.031	9.9006	0.702
		14	0.012	-0.084	9.9107	0.769
		15	-0.037	0.011	10.017	0.819
		16	-0.119	-0.137	11.142	0.801
		17	-0.054	-0.113	11.382	0.836
		18	-0.073	-0.118	11.828	0.856
		19	-0.042	-0.168	11.977	0.887
		20	0.017	0.013	12.002	0.916
		21	-0.069	-0.087	12.436	0.927
		22	0.059	-0.068	12.763	0.940
		23	0.074	0.018	13.290	0.945
		24	0.138	-0.010	15.214	0.914

*Probabilities may not be valid for this equation specification.

Model 2

Date: 05/24/17 Time: 09:43
Sample: 1957 2016
Included observations: 53
Q-statistic probabilities adjusted for 1 dynamic regressor

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.064	0.064	0.2327	0.630
		2	0.067	0.063	0.4913	0.782
		3	-0.069	-0.077	0.7659	0.858
		4	-0.051	-0.047	0.9196	0.922
		5	0.054	0.071	1.0944	0.955
		6	-0.165	-0.175	2.7872	0.835
		7	-0.027	-0.020	2.8333	0.900
		8	-0.085	-0.052	3.3008	0.914
		9	0.005	-0.003	3.3023	0.951
		10	0.061	0.049	3.5549	0.965
		11	-0.150	-0.158	5.1166	0.925
		12	-0.100	-0.125	5.8224	0.925
		13	0.040	0.095	5.9367	0.948
		14	-0.080	-0.133	6.4174	0.955
		15	-0.016	-0.059	6.4367	0.971
		16	-0.153	-0.113	8.2750	0.940
		17	-0.122	-0.176	9.4891	0.924
		18	-0.042	-0.077	9.6377	0.943
		19	-0.053	-0.078	9.8756	0.956
		20	0.072	-0.029	10.336	0.962
		21	-0.063	-0.081	10.693	0.968
		22	0.107	0.012	11.766	0.962
		23	-0.004	-0.139	11.768	0.974
		24	0.059	0.007	12.120	0.979

*Probabilities may not be valid for this equation specification.

Model 3

Date: 05/24/17 Time: 09:50
Sample: 1957 2016
Included observations: 52
Q-statistic probabilities adjusted for 3 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.167	-0.167	1.5357	0.215
		2	0.220	0.197	4.2471	0.120
		3	0.010	0.077	4.2525	0.235
		4	0.236	0.221	7.5222	0.111
		5	-0.167	-0.132	9.1824	0.102
		6	0.127	-0.006	10.160	0.118
		7	0.010	0.060	10.166	0.179
		8	-0.051	-0.101	10.333	0.242
		9	-0.028	-0.013	10.383	0.320
		10	-0.132	-0.187	11.548	0.316
		11	-0.083	-0.123	12.024	0.362
		12	-0.165	-0.115	13.927	0.305
		13	-0.112	-0.145	14.838	0.318
		14	-0.224	-0.171	18.545	0.183
		15	-0.063	-0.093	18.843	0.221
		16	-0.162	-0.093	20.884	0.183
		17	-0.062	-0.044	21.197	0.218
		18	-0.188	-0.168	24.130	0.151
		19	-0.028	-0.119	24.198	0.189
		20	-0.015	0.017	24.219	0.233
		21	-0.112	-0.173	25.358	0.232
		22	0.027	-0.070	25.426	0.277
		23	0.116	0.041	26.720	0.268
		24	0.132	0.080	28.468	0.241

*Probabilities may not be valid for this equation specification.

Model 4

Date: 05/24/17 Time: 10:09
Sample: 1957 2016
Included observations: 54
Q-statistic probabilities adjusted for 1 dynamic regressor

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.120	0.120	0.8255	0.364
		2	0.086	0.073	1.2565	0.534
		3	-0.283	-0.307	6.0015	0.112
		4	-0.063	0.003	6.2444	0.182
		5	-0.074	-0.011	6.5862	0.253
		6	0.122	0.060	7.5245	0.275
		7	0.056	0.025	7.7249	0.357
		8	0.010	-0.051	7.7319	0.460
		9	-0.268	-0.250	12.544	0.184
		10	-0.185	-0.112	14.892	0.136
		11	-0.162	-0.090	16.739	0.116
		12	0.091	0.012	17.337	0.137
		13	0.025	-0.073	17.381	0.182
		14	0.097	-0.013	18.087	0.203
		15	-0.151	-0.155	19.861	0.177
		16	-0.066	-0.052	20.205	0.211
		17	-0.105	-0.044	21.106	0.222
		18	-0.101	-0.274	21.958	0.234
		19	0.040	-0.056	22.094	0.280
		20	0.112	-0.016	23.204	0.279
		21	0.073	-0.082	23.698	0.308
		22	-0.037	-0.127	23.830	0.356
		23	0.021	0.030	23.871	0.411
		24	0.005	-0.095	23.873	0.469

*Probabilities may not be valid for this equation specification.

Table A6: ARDL Model Selection

Model	Selected model	Max. lags	Lowest value of the criteria
1	ARDL(1,2,0,4,4,4,3)	4	1.864
2	ARDL(1,3,4,4,4,0,4)	4	1.923
3	ARDL(3,1,0,3,3,3,3)	3	2.456
4	ARDL(1,1,0,2,3,1)	3	2.567