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An analysis of the asymmetric effect of fiscal policy on economic growth in Pakistan: Insights from Non-Linear ARDL

Ibrar Hussain · Muhammad Rafiq · Zahoor Khan

Abstract This study investigates the dynamic asymmetric effect of fiscal deficit on growth in Pakistan using the Non-Linear ARDL technique. We employ the Mankiw et al (1992) model on annual time series data from 1976 to 2017 and find co-integration relationship between growth and cyclically adjusted primary fiscal deficit along with other variables. More generally the study seeks to empirically test the asymmetric effect that fiscal deficit has on economic growth in Pakistan. The results reveal the negative effect of expansionary fiscal policy on economic growth. From the tests of asymmetry, we find asymmetric effect of overall fiscal deficit in the short-run only, while there is no such asymmetry in the long-run. The asymmetric analysis of fiscal deficit at disaggregated levels evidences only short-run impact asymmetry in case of public spending, while both the long-run and short-run asymmetries are found in the case of public revenue. The analysis reveals that tax-based consolidation is likely to be more expansionary than spending-based adjustment in the long-run.

Keywords Cyclically adjusted primary deficit · GDP · NARDL

1 Background of the study

There is a wide array of socio-economic actions through which the government can influence the lives of its citizens. The range of such policy actions has become diverse and complex over time and across countries. Although, the objective of socio-economic policies is to promote human welfare, disagreement exists among

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policy makers over the actions to be undertaken. Human welfare is not only directly observable but is also expected to depend on both economic and social factors, as a consequence the priority of policy-makers changes with time or with the government in power (Tanzi 2006).

Economic factors normally include growth of Gross Domestic Product (GDP), reasonable levels of inflation, growth in productivity and employment, and equitable distribution of income, while life expectancy at birth, infant mortality rate, the quality of physical environment, literacy rate and the incidence of illness and of crimes are social indicators. To improve economic well-being and even social life of the masses, economists generally recommend different economic policies and among these, fiscal and monetary policies have an imperative role to this end. It was the Keynesian school of thought that strongly recommended fiscal policy for the achievement of some set of desirable goals across the world. However, disagreement exists between the Classical and Keynesian economists over the intervention by the government in the economic affairs of a country.

The Great depression (1929-1933) and the publication of Keynes's General Theory is considered as a paradigm shift in macroeconomics. This has provided a solid foundation to fiscal policy in stabilizing aggregate economic activities and achieving other desirable goals. However, with the increasing interference of governments in economic activities in the 20th century, the economies of both developed and developing world have been confronted with an enigma of fiscal deficit. Resultantly, such macroeconomic consequences of fiscal deficit have attracted the attention of policymakers, and politicians. As a consequence, fiscal deficit has become the most debated issue among the general public. The importance attached to fiscal deficit is even greater in developing countries as it is the single most important policy variable that affects the rest of the economy. Governments like other economic agents such as households and business firms consumes goods and services, invests in infrastructures, provides public goods and even borrows and lends. Similarly, it imposes taxes on goods, services, payments and incomes irrespective of whether they are produced, exchanged and consumed by households or corporations. Moreover, taxes are assumed to ensure equitable distribution of income among all segments of a society and government transfer payments in the form of unemployment compensations and other social welfare programs are expected to alleviate poverty. Besides these, public revenues are also expected to be used for the promotion of general welfare like education, health, infrastructures, and defense and even for government functionaries (Zaidi 2005). All such actions of a government are not only expected to have direct and indirect influence on the well-being of the current generation, but may determine the growth prospects of future generations too. In brief, government actions determine and influence economic performance of a country, but the debate about its macroeconomic consequences is still not settled (Van and Sudhipongpracha 2015).

Pakistan over the last decade has been experiencing stress in its fiscal position and the provision of subsidies to the power sector is one of the major factors in this regard. High inflation, low level of national saving, rising government debt, volatile exchange rate and persistent deficit in trade are often regarded as the repercussions of high fiscal deficit along with an unfavorable fi-

nancing mix. Average fiscal deficit remained 7.1 percent and 7.0 percent of GDP during 1970s and 1980s respectively. It then slightly declined to 6.8 percent in 1990s and even more to 4.8 percent in 2000s. However, the consolidated fiscal deficit remained at 4.7 percent in the fiscal year 2012-13 as compared to 8.5 percent in the previous year (SBP 2013-14). Rising fiscal deficit after the crippling energy crises is therefore considered as the major constraint to economic recovery and sustained growth in the country (Amjad and Burki 2013).

Empirical literature tends to support the phenomena of asymmetry for most developed countries; however, developing countries including Pakistan lack such empirical studies on the issue of asymmetry arising from market imperfection and incomplete information. The small size of governments to influence inflation and interest rate sharply in most developing countries on the pace of embedded uncertainty can significantly determine the extent of asymmetry in fiscal policy. In case of developing countries the studies gathered around so far have assumed the symmetric impact of fiscal policy possibly due to the misalignment of macroeconomic theory to flexible econometric framework at the turn of the twenty first century. A strand of recent empirical studies making full use of the flexible econometric models in the context of developed countries show asymmetry in fiscal policy during down-turn than during boom and in the type of fiscal adjustment.

In a nutshell, this study aims to empirically test the existence of non-linearity (asymmetry) that may be attributed with the conduct of fiscal policy in Pakistan. In particular, the study intends to discover asymmetries on two dimensions; first whether equal in magnitude expansionary or contractionary fiscal shocks equally impact economic growth and second whether cut in government spending or rise in tax have the same multiplier effect on growth.

A recent strand of empirical research points out the asymmetric response of fiscal policy to the state of the economy. The studies of Balassone et al (2010); Riera-Crichton et al (2015); Afonso et al (2018) have highlighted the asymmetric behavior of fiscal authority over the business cycle. However the studies that attempted to estimate the non-linear impact of fiscal policy on growth either used poor proxy or employed irrelevant estimation methodologies. Besides this, such studies have been mainly conducted for developed nations (Auerbach and Gorodnichenko 2012; Mencinger et al 2017; Afonso et al 2018).

In a study Arora (2018) points out the possibility of asymmetric effect of both spending and taxes on macroeconomic variables and argues that the results of spending increase may not hold true for spending cut and the same argument holds in case of tax increase. In case of Egypt, the study of Abdel-Latif and Mishra (2016) provides evidence on non-linear effect of public expenditure on economic growth at both aggregated and disaggregated levels. The study applied Shin et al (2014) model of NARDL over a data range from 1980 to 2013. In the case of Pakistan, a recent study by Hussain et al (2019) investigated the asymmetric impact of exchange rate on GDP growth by applying Shin et al (2014) methodology. The study evidences both the short-run and long-run asymmetric effect of exchange rate on GDP. In case of OECD countries the studies of Mencinger et al (2017); Riera-Crichton et al (2015) and even the influential study by Auerbach and Gorodnichenko (2012) employed STVAR model in

their analyses. Similarly, Afonso et al (2018) in case of United States, United Kingdom, Germany and Italy applied threshold VAR to estimate the non-linear impulse responses of output towards fiscal policy over different regime shifts. The study reveals that the size of the fiscal multiplier remained larger than average size during the financial crises of 2008-9. However, as per our knowledge, no single study exists in the context of Pakistan that has investigated the asymmetric effect of fiscal policy at both aggregated and disaggregated levels on growth by employing robust econometric methodology of NARDL. The current study endeavors to cover the deficiencies of the previous studies in terms of their poor proxy and irrelevant econometric methods. The use of accurate proxy and specifically disaggregated analysis of the components of fiscal deficit by applying NARDL of Shin et al (2014) contributes interesting insights to the empirical literature of fiscal policy in the case of Pakistan.

There is rich empirical research in the context of developed economies on different aspects of fiscal policy; however developing countries are still lacking such studies. Moreover it is an obvious fact that developed economies are both economically and politically more stable than developing ones and are more technologically advanced, hence the conclusions derived from the studies conducted in these nations cannot be extended to developing countries. Besides these, structural differences exist between advanced and poor nations, it is therefore necessary to carry out somewhat extensive research on the issue of fiscal deficit in the context of Pakistan. Similarly, disintegrated analyses of both spending and revenue sides of fiscal policy are required, rather than analyzing the impact of the size of the overall fiscal deficit as carried out in the previous research in the context of Pakistan.

2 A brief account of Pakistan's fiscal profile

Pakistan's economy has been through an eventful transition with occasional spurts in growth followed by slowdown since 1990s. The frequent cycles of boom and bust each one comprising 3-4 years of relatively high growth followed by macroeconomic imbalances therefore necessitate both fiscal and monetary measures. Currently, the economy is confronted with unprecedented pressure on both the fiscal side and the external front in the form of high budget and current account deficits. Public debt liabilities have reached the level where a sizeable portion of the federal budget is eaten by debt servicing and the depleted foreign exchange reserves are even insufficient to meet two months import bill. Structural bottlenecks in the economy which remained unaddressed for decades and insufficient policy responses are being held responsible for recent macro imbalance (ESP 2018-19). Average annual growth which remained 4.7 percent against a target of 5.4 percent over the past five-year plan was mainly driven by consumption led growth. Unplanned and unproductive expenditure on the pace of low revenue growth with stagnant exports and sky-rocketed imports have led to twin-deficits problem in the country. The fiscal year 2018-19 witnessed a muted growth of 3.29 percent against a target of 6.2 percent; saving-investment gap was recorded at 4.7 percent of GDP with total investment 15.4 percent

and saving 10.7 percent of GDP. Average fiscal deficit over the past five years remained 5.6 percent and average total revenue reached to 14.9 percent against average total expenditure recorded at 20.5 percent of GDP. The revenue expenditure gap over the past decade is presented in figure 1.

In Pakistan, recently the focus has been on fiscal consolidation and attempts

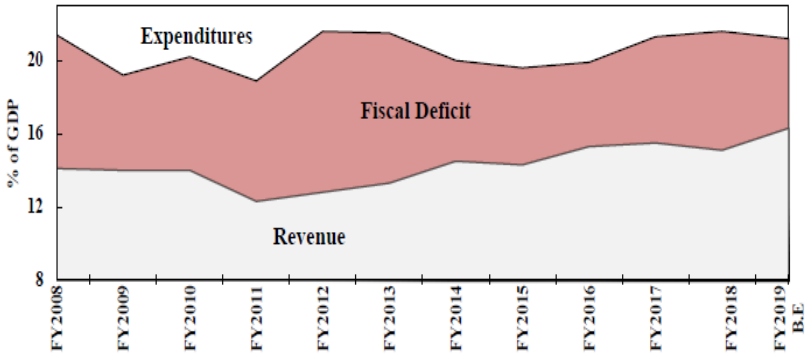

Fig. 1: Fiscal deficit as a percent of GDP

are being made to encompass both revenue and expenditure-based consolidations in order to curtail the overall fiscal deficit to a manageable level. In this regard, Fiscal Responsibility and Debt Limitation Act has been implemented since 2005 to keep public finance on a sustainable path. But, internal insurgency and world financial crises of 2007-08 and flood of 2010 put unprecedented pressure on the public exchequer in the country. However, fiscal consolidation measures including prudent expenditure management, rising revenue receipts, and rationalization of subsidies have successfully brought down overall fiscal deficit from 8.2% in FY 2013 to 4.6% of GDP in FY 2016. Total expenditures decreased from 21.5% in FY 2013 to 19.9% of GDP in FY 2016, while total revenue took the upward trajectory and rose from 13.3% in FY 2013 to 15.3% of GDP in FY 2016 (ESP 2016-17) when Pakistan Muslim League (N) took over the government in 2013 after a successful transfer of power from Pakistan People Party Parliamentarians. However, another election cycle emerged in 2018, and the opportunistic behavior of the then political party in power resulted in overall fiscal deficit of 6.5 percent of GDP. Beside this primary fiscal deficit rose from 1.6 percent of GDP in FY 2016-17 to 2.2 percent in FY 2017-18.

3 Review of literature and theoretical framework

There are numerous theoretical approaches to analyze the macroeconomic effects of fiscal policy. However, with the passage of time three broad theoretical approaches have come forth; Keynesian, Neo-classical, and Ricardian Equivalence Hypothesis (REH). Starting from a simple Keynesian framework with

price rigidity, expansionary fiscal policy in the form of increasing public spending has a multiplier effect on output and employment: the so-called "Crowding-In" effect. Neo-classical, on the other hand argues that "Crowding-Out" effect of expansionary fiscal policy on private investments stems from interest rates hike. This interest rate sensitivity of private investments therefore dampens the multiplier effect. Although, the Keynesian approach focuses on the demand-side effects, there could, however, be supply-side effects that add to the effectiveness of fiscal policy (Choi and Devereux 2006).

The demand-side tools that depend on Keynesian explanation of malfunctioning of the economy mainly focus on excessive or deficient aggregate demand as the primary culprit. Furthermore, demand-side instruments may be built-in-stabilizer or discretionary fiscal instruments. It would therefore be useful to explain the concepts of built-in-stabilizer and discretionary fiscal rules before turning to the literature that covers the impact of fiscal policy shocks on macroeconomic variables. Theoretically, fiscal policy consists of two components; built-in-stabilizers and discretionary fiscal policy. The latter is further decomposed into two components; discretionary fiscal policy that depends on the current macroeconomic conditions of the economy and reacts to the state of the economy and discretionary fiscal policy that does not depend on current economic conditions and hence is implemented for other reasons. Such other reasons may include the implementation of expansionary fiscal policy by the political party in public office to increase the chances of being re-elected and the ideology of the political party in power (Fatás and Mihov 2003).

On the other hand, since supply-side fiscal instruments are based on the connotation that supply side expansion expedites the rate of economic growth, therefore it rejects the demand-side approach. Specifically the supply-side approach is based on the Neo-classical Real Business Cycle (RBC) theory (Cuestas and Ordóñez 2018). According to this approach, output is exclusively determined by the amount of aggregate supply. Expansionary fiscal policy in the form of increase in government expenditure would be detrimental to growth as it crowds out private investments on the pace of flexible prices. This approach, therefore, attempts to change the relative prices of work versus leisure, and consumption versus savings and investment via changes in marginal tax rate. Thus a reduction in the marginal tax rate of personal income will increase the supply of labor and therefore raise the opportunity cost of leisure time, thereby increasing the supply of output and opposite will happen in case of rise in the marginal tax rate. However, in RBC model, the consumption smoothing behavior of individuals may partly reduce the crowding-out effect of expansionary fiscal policy. Since individuals start expecting future tax increase after current increase in expenditure, hence they may increase the amount of labor supplied to the labor market in order to smoothen their consumption over their entire life time. Such stimulus is expected to depend not only on the degree of intertemporal consumption, but elasticity of labor supply also plays a role. Moreover, the complementarities of government capital spending with the private sector investments will partially offset the crowding-out effect (Cuestas and Ordóñez 2018). Under sticky prices, RBC model predicts that aggregate output would be affected by the positive response by firms in increasing aggregate demand. How-

ever, accommodative monetary policy adds to such effect (Woodford 2011).

In a study, Ali et al (2010) found a significant impact of fiscal policy on growth in Pakistan by applying ARDL. They estimated the effect of the size of the overall fiscal deficit on real GDP growth along with other variables. The studies that focused on the impact of overall fiscal deficit on certain macro variables in the context of Pakistan include Ali et al (2010); Mughal et al (2011); Kakar (2011); Jalil et al (2014); Qasim et al (2015); Iqbal et al (2017). Some studies (Ali et al 2010; Jalil et al 2014) did not test for possible asymmetry between fiscal policy and economic growth. Similarly, the study used overall fiscal deficit as proxy for fiscal policy which is another weakness as the true proxy is to use primary fiscal deficit so as to isolate the effect of monetary policy. While, Qasim et al (2015) employed 2SLS and used the square of the primary fiscal deficit to test for the non-linear relationship. They adopted Gupta et al (2005) model in their analysis and pointed the non-linear relationship between fiscal deficit and growth by including squared term of fiscal deficit. This study however tests for functional non-linear relationship, but does not investigate the asymmetric relationship which is the objective of this study.

The asymmetry of many economic variables can be inferred from Keynes famous remarks. Keynes (1936) argues that the substitution of a downward for an upward tendency often takes place suddenly and violently, whereas there is no such sharp turning point when an upward is substituted for a downward tendency. The non-linearity of many economic variables has been considered in the literature around the mid nineties. Shin et al (2014) point towards the three dominated regime-switching models of Balke and Fomby (1997) threshold ECM, Psaradakis et al (2004) Markov-Switching ECM and Kapetanios, Shin and Snell (2006)'s smooth transition regression ECM. Escribano et al (2006) and Bae and De Jong (2007) were among others who devoted their efforts to non-linear co-integration.

The existing theoretical literature divides models explaining asymmetric effects of fiscal impulses into two groups (Khanfir 2019). According to the first group, government indebtedness influences private sector expectations (Blanchard and Perotti 2002), while the second group associates the non-linearity of fiscal policy to the size and persistence of fiscal impulse (Drazen 1990). The study of Giavazzi et al (2000) evidences such asymmetric relationship between fiscal adjustment and private sector consumption for a panel of OECD countries thereby supporting the proposition of size and persistence of fiscal impulse. Another strand of literature speculates that the employment of linear empirical models to the phenomena of non-linear relationship often produces spurious results and offers three explanations for the presence of such asymmetry in the adjustment process of fiscal policy (Phiri 2019). The first explanation is based on the effectiveness of multiples over the business cycles: the multiplier is more effective during downturn than during expansion (Karras 2014). The second explanation lies in the asymmetric behavior of fiscal authorities toward changes in a deficit or surplus (Baharumshah et al 2016). And finally, asymmetry in budget may stem from the response of taxpayers towards changes in tax base or effective tax rate (Ewing et al 2006).

In Pakistan, research on fiscal policy is not even nave but also underdevel-

oped Hussain et al (2017); however, with the passage of time the repository is evolving. Some studies (Ali et al 2010, 2013; Madni 2013; Ahmad and Wajid 2013; Hussain and Haque 2017; Iqbal et al 2017) explored the dynamic effect of fiscal policy by applying ARDL and found a significant negative impact of fiscal deficit on growth. In the similar stratum, the studies by Kakar (2011) and Nazir et al (2013) using Johansen Co-integration, Fatima et al (2011) and Qasim et al (2015) employing 2SLS and Ahmad and Wajid (2013) applying OLS confirm the negative effect of fiscal policy on growth. However, contrarily the study of Ramazan et al (2013) applying OLS in the context of Pakistan found positive impact of budget deficit on growth by regressing GDP on budget deficit, inflation, investment and credits over a time series ranging from 1980 to 2010. But such conclusion can be very misleading, as the application of OLS to time series data results in spurious regression and requires time series analysis. The studies in their pursuit of dynamic effect of fiscal policy suffer from two problems: firstly the poor proxy of fiscal policy and secondly the failure to test the asymmetric effect of fiscal policy on growth. In brief the literature on fiscal deficit-growth nexus lacks consensus both on theoretical and analytical grounds and there are as many analytical models as the number of theories.

Therefore, there is a dire need of more comprehensive and disintegrated analyses that captures the true picture of the issue of fiscal policy rather than looking at the issue in a simple and fruitless manner. This research effort is expected to cover the deficiencies of the past studies and therefore aims to analyze the impacts of composition of fiscal deficit in Pakistan. Besides economic factors, the choice between two types of adjustments has been influenced by political ideology on the pace of volatile democracy and security challenges in the country. Such factors are expected to make the prediction of composition of fiscal adjustment difficult and therefore need to be explored. However, the conclusions derived in this study are purely contextual and therefore shall not be generalized to other countries except to the economy with similar structure and level of development. Moreover, due to data limitations the current study is based on small sample ranging from 1976 to 2017.

4 Materials and methods

To ascertain the policy-augmented growth equation, the current study borrows endogenous growth models. The study adopts the model of Mankiw et al (1992) for empirical estimation. Growth equations under the frameworks of such models tolerate the inclusion of fiscal variables besides physical and human capital, and population growth. The ECM version of this model is presented below:

$$\begin{aligned}\Delta \ln Y_t = \alpha + \sum_{i=1}^{p1} \beta_{1i} \Delta \ln Y_{t-i} + \sum_{i=0}^{p2} \beta_{2i} \Delta FP_{t-i} + \sum_{i=0}^{p3} \beta_{3i} \Delta GFCF_{t-i} \\ + \sum_{i=0}^{p4} \beta_{4i} \Delta Pop_{t-i} + \sum_{i=0}^{p5} \beta_{5i} \Delta GSSE_{t-i} + \lambda_1 \ln Y_{t-1} \\ + \lambda_2 \, FP_{t-1} + \lambda_3 \, GFCF_{tt-1} + \lambda_4 \, Pop_{t-1} + \lambda_5 \, GSSE_{t-1} + \varepsilon_t\end{aligned} \quad (1)$$

Fiscal policy is assumed to have a dynamic linear impact on growth in the above equation. Fiscal policy variable automatically responds to business cycle in the form of automatic stabilizer and is also influenced by monetary policy stance. Therefore, the study attempts to isolate discretionary fiscal stance by adjusting the overall fiscal balance with two effects. Firstly, primary fiscal balance will be used to isolate the effect of monetary policy and excludes interest payment from government expenditure. Secondly this variable is smoothed over the business cycles through Hodrick-Prescott (HP) filter[1] in order to counter balance the endogenous movements of fiscal variables over phases of the business cycle. The new variable of fiscal balance after adjustments is called cyclically adjusted primary balance (here after CAPB). Alternatively, this measure of deficit indicates the level of fiscal balance compatible with full employment level of output (Alesina et al 2019). Many influential studies (Alesina and Ardagna 2010, 2013; Alesina et al 2015, 2019) insist to use cyclically adjusted primary balance as proxy for fiscal policy.

Essentially there are three main steps involved when implementing Pesaran et al (2001) method. Cointegration technique starts with selecting the order of VAR via one of the famous criteria of lag selection (such as AIC or SIC) and testing the assumption of weak exogeneity. Since the assumption of weak exogeneity can potentially influence the dynamic properties of ECM, hence must be tested in the framework of full system (Johansen 1992). Fiscal policy proxied by CAPB can be treated as exogenous variable and therefore in the present study it is considered as a policy instrument. Johansen and Juselius (1990) and Johansen et al (1995) are of the opinion that parameters of conditional ECM could be estimated in a meaningful and independent way of the marginal distribution of the explanatory variable subject to the assumption of weak exogeneity. The study of Pesaran et al (2001) supports this view. Furthermore this exogeneity test would result in more convenience and allow efficient inferences on co-integration coefficients in the partial model (Jacobs and Wallis 2010).

Since the aim of this study is to empirically investigate the dynamic asymmetric effect of the size of fiscal deficit on economic growth therefore, Non Linear ARDL (NARDL) model of Shin et al (2014) is applied. Pesaran et al (2001) model presumes symmetric relationship between dependent and independent variables, while Shin et al (2014) technique captures the asymmetric impact of explanatory variable(s) on dependent variable along with testing for both the long-run and short-run asymmetry simultaneously. That is why some times in the literature, Shin et al (2014) technique is termed as asymmetric ARDL and that of Pesaran et al (2001) is called symmetric ARDL. The symmetric effect presumes that the impact of 1 percent increase in explanatory variable(s) like X on the dependent variable like Y is equivalent to the 1 percent decrease in X on Y, while, the phenomenon of asymmetry argues that such impact of increase and decrease are not equal. To ascertain the technique of NARDL of Shin et al (2014) and to distinguish between Linear ARDL of Pesaran et al (2001) and NARDL, the ECM version of ARDL in the context of M.R.W model is

[1] Following Leibrecht and Scharler (2013) a smoothing parameter of 6.25 is used for H.P. filter

repeated as:

$$\Delta \ln Y_t = \alpha + \sum_{i=1}^{p1} \beta_{1i} \Delta \ln Y_{t-i} + \sum_{i=0}^{p2} \beta_{2i} \Delta FP_{t-i} + \sum_{i=0}^{p3} \beta_{3i} \Delta GFCF + \sum_{i=0}^{p4} \beta_{4i} \Delta Pop_{t-i} + \sum_{i=0}^{p5} \beta_{5i} \Delta GSSE_{t-i} + \lambda_1 \ln Y_{t-1} + \lambda_2 \ FP_{t-i} + \lambda_3 \ GFCF_{t-i} + \lambda_4 \ Pop_{t-i} + \lambda_5 \ GSSE_{t-i} + \varepsilon_t \quad (2)$$

In this model all explanatory variables including fiscal policy are expected to have linear influence on economic growth. Hypothesizing that the impact of fiscal policy is non-linear (asymmetric), then Shin et al (2014) NARDL methodology is suitable to employ. To implement the technique, first changes in primary fiscal deficit (FP) have to be constructed $\Delta \ln FP_{t-i}$ which incorporates the positive changes represented by $\Delta \ln FP^+$ and negative changes represented by $\Delta \ln FP^-$. Two time series variables are to be constructed; the one reflecting contractionary fiscal policy denoted by POS_t and the other reflecting expansionary fiscal policy denoted by NEG_t as partial sum of positive and negative changes respectively as below:

$$POS_t = \sum_{i=1}^{t} \Delta \ln FP_i^+ = \sum_{i=1}^{t} max(\Delta \ln FP_i, 0)$$

$$NEG_t = \sum_{i=1}^{t} \Delta \ln FP_i^- = \sum_{i=1}^{t} min(\Delta \ln FP_i, 0) \quad (3)$$

Following, Shin et al (2014), ΔFP of equation-2 is substituted by POS_t and NEG_t as below:

$$\Delta \ln Y_t = \alpha + \sum_{i=1}^{p1} \beta_{1i} \Delta \ln Y_{t-i} + \sum_{i=0}^{p2} \beta_{2i}^+ \Delta POS_{t-i} + \sum_{i=0}^{p3} \beta_{3i}^- \Delta NEG_{t-i} + \sum_{i=0}^{p4} \beta_{4i} \Delta GFCF + \sum_{i=0}^{p5} \beta_{5i} \Delta Pop_{t-i} + \sum_{i=0}^{p6} \beta_{6i} \Delta GSSE_{t-i} + \lambda_1 \ln Y_{t-1} + \lambda_2^+ \ POS_{t-i} + \lambda_3^- \ NEG_{t-i} + \lambda_4 \ GFCF_{t-i} + \lambda_5 \ln Pop_{t-i} + \lambda_6 GSSE_{t-i} + \varepsilon_t \quad (4)$$

The above specification in equation 4 is another ECM which would be estimable by OLS. In this regard Pesaran et al (2001) bound testing procedure can be applied to this new approach (Shin et al 2014). Following, Pesaran et al (2001) the null of no long-run relationship is tested against the presence of co-integrating relationship for NARDL as:

$$H_0 : \lambda_1 = \lambda_2^+ = \lambda_3^- = \lambda_4 = \lambda_5 = \lambda_6 = 0$$
$$H_1 : \lambda_1 \neq \lambda_2^+ \neq \lambda_3^- \neq \lambda_4 \neq \lambda_5 \neq \lambda_6 \neq 0$$

After establishment of co-integrating relationship based on modified F-test,

one can determine not only the short-run asymmetry, but also long-run asymmetry could also be tested. The long-run normalized coefficients associated with POS_t and NEG_t are defined as: $\tilde{\lambda^{+}} = -\hat{\lambda_2^{+}}/\hat{\lambda_1}$, and $\tilde{\lambda^{-}} = -\hat{\lambda_2^{-}}/\hat{\lambda_1}$. Four types of asymmetry can be inferred once co-integration is established based on F-statistic (Bahmani-Oskooee and Mohammadian 2017). More specifically, one could test the short-run reaction, and short-run impact asymmetries besides long-run asymmetry (Bahmani-Oskooee et al 2018). Adjustment asymmetry in the short-run can be evidenced in case when the lags with ΔPOS are not equal to the number of lags associated with variable ΔNEG. Such conclusion can be drawn by observation. The reaction asymmetry could be determined if $\hat{\beta_{2i}^{+}}$ differs from $\hat{\beta_{3i}^{-}}$ for a given value of i and the final impact on asymmetry in the short-run can be identified in case the null hypothesis $H_0 : \sum_{i=0}^{p2} \beta_{2i}^{+} = \sum_{i=0}^{p3} \beta_{3i}^{-}$ is rejected in favor of inequality. Besides this, long-run asymmetry is established if the null hypothesis $H_0 : -\lambda_2^{+}/\lambda_1 = -\lambda_3^{-}/\lambda_1$ is rejected in favor of alternative (Bahmani-Oskooee et al 2018). For all these hypotheses testing, Wald coefficient restriction test is used and compared with the critical bound values of Pesaran et al (2001) or Narayan (2005) tables for small sample studies. NARDL model as compared to Pesaran et al (2001) ARDL fit in one extra explanatory variable, therefore Shin et al (2014) are of the view to treat both the variables POS_t and NEG_t as one.

Many studies in their pursuit of asymmetry have successfully applied NARDL technique. For instance Bahmani-Oskooee and Mohammadian (2017) in case of Japan applied the technique in their investigation of asymmetric effect of exchange rate on GDP, Bahmani-Oskooee et al (2018) for testing the relationship between trade balance and exchange rate in China and its twenty one trading partners, while Long and Liang (2018) for asymmetric pass-through of global crude oil to China's inflation. Similarly, Hussain et al (2019) applied NARDL model in their investigation of the asymmetric effect of exchange rate on growth rate of GDP in the context of Pakistan. For testing the asymmetric effect of fiscal policy on macroeconomic variables, some authors have recently used the technique of NARDL. For example Abdel-Latif and Mishra (2016) for nonlinear effect of government spending on GDP in case of Egyptian economy and Tran (2019) for asymmetric effect of fiscal policy on inflation, interest rate and exchange rate in case of BRICs countries employed the technique. Other studies which applied such technique include Bahmani-Oskooee et al (2015); Bahmani-Oskooee and Fariditavana (2016); Nusair (2017); Shin et al (2018).

However, there is one common drawback in the studies which applied NARDL; none of the study took care of degenerate cases. Since Shin et al (2014) based their NARDL on Pesaran et al (2001) ARDL method, therefore one should take care to properly handle the problem of degenerate cases in NARDL as pointed by McNown et al (2018) and Sam et al (2019). Taking care of the degenerate cases in application of NARDL would be a contribution to the empirical methodology.

5 Dynamic model of fiscal deficit-growth nexus

5.1 Data, data source and variables' definitions

Annual time series data ranging from 1976 to 2017 on selected variables for M.R.W. model are gathered from two main sources: WDI published by World Bank and various issues of Economic Survey of Pakistan (ESP) published by the Ministry of Finance Government of Pakistan. Five variables are being used: Real GDP per capita, private sector gross fixed capital formation, working age population, secondary school enrollment and primary fiscal balance. Out of five variables of interest, real GDP per capita, private sector gross fixed capital formation and working age population are taken from WDI, whereas primary fiscal balance, primary public spending, total revenue and secondary school enrollment are obtained from various issues of ESP. Table A-1 presents variables' definition, their measurement and source of data, while A-2 shows construct of variables being used in M.R.W. model. To proxy economic growth per capita GDP at constant 2010 prices measured in local currency unit is utilized. Similarly, other variables which include investment, population growth, and human capital formation are being proxied by private sector gross fixed capital formation, growth of working age population and growth of secondary school enrollment respectively.

It should be noted here that the main focus of the study is to dynamically estimate the non-linear impact of fiscal deficit on growth and therefore the empirical strategy is being calibrated on M.R.W. model for robustness check and to avoid omitted variables biasness. The reason of calibrating the empirical strategy on the well known M.R.W. model is simply to render that the empirical model is well-specified. Although special attention is being paid to testing the robustness of the results with respect to the control variables of the model, nonetheless, the objective is not to give them any economic interpretation in the present endeavor.

5.2 Empirical estimation: Calibration on M.R.W. model

Before estimating the model, the variables were checked for stationarity via Dickey-Fuller Generalized Least Square (DF-GLS) and Philips-Perron (PP) tests. Summary of the tests results are reported in table 1. Although, ARDL techniques do not require pretesting of the variables for unit root, as most of the macro variables are either stationary at levels or become stationary at first difference (Bahmani-Oskooee et al 2018), however, unit root tests give surety that the underlying variables are not I(2) in which case the techniques would break down (Pesaran et al 2001). Furthermore, to test the possibility of degenerate cases arising in the application of ARDL which according to Pesaran et al (2001) do not indicate co-integration; the study therefore conducted unit root tests. Among many alternative unit root tests, DF-GLS is adopted against ADF test. It is argued that ADF test may not be reliable in studies based on small sample size (Harris 1992; Elliott et al 1992). This is what the current study focuses on this test in checking stationarity of the variables as we have small

sample data. Among many alternative unit root tests, the study therefore relies

Table 1: Evidence from Dickey-Fuller GLS (ERS) and Philips-Perron (PP) tests

Variables	DF-GLS				Philips-Perron			
	Drift		Drift & Trend		Drift		Drift & Trend	
	Level	Δ	Level	Δ	Level	Δ	Level	Δ
LPCI	0.59	-4.46*	-2.12	-4.60*	-1.23	-4.67*	-2.35	-4.80*
CAPB	-0.4	-2.52**	-1.66	-3.66**	-2.6	-3.03**	-2.19	-4.31*
GFCF	-1.07	-2.13**	-2.13	-6.38*	-2.69***	-7.73*	-2.56	-7.79*
GPOP	-0.2	-4.87*	-1.73	-5.64*	-0.22	-5.60*	-1.84	-5.65*
GSSE	-7.03*	-7.78*	-7.32*	-7.84*	-7.06*	-20.56*	-7.16*	-20.25*
LCAPS	-1.12	-7.09*	-1.71	-7.29*	-1.65	-7.25*	-1.51	-7.28*
LCAR	-1.77**	-7.59*	-2.18	-7.56*	-1.8	-7.52*	-2.51	-7.44*

Note: *, ** and *** represent significance at 1%, 5% and 10% probability level respectively.

on DF-GLS and PP tests.

Both tests reveal that five variables including log of real GDP per capita (LPCI), cyclically adjusted primary balance (CAPB), population growth (GPOP) and log of cyclically adjusted primary spending (LCAPS) carry unit roots at their levels with 'drift' and 'drift & trend'. While cyclically adjusted revenue (LCAR) and secondary school enrollment (GSSE) are found stationary at levels as indicated by DF-GLS test. When drift & trend are considered, then DF-GLS test indicated that LCAR carries unit root, while GSSE remains stationary at level. PP test indicates a slight different result with all variables carry unit roots at their levels except growth of private fixed capital formation (GFCF) and GSSE when only drift is taken into account. However, both PP and DF-GLS tests show that GSSE is stationary at level when drift and drift & trend are assumed. In a nutshell, none of the underlying variable is I(2). Since the variables are mix of I(1) and I(0), therefore ARDL techniques are applied to the estimation of dynamic relationship between dependent and independent variables. First LARDL was applied and the bound F-test reported in table 2 confirmed the co-integration relationship at 5% level of significance as the calculated F-statistic=4.560 is greater than the critical value of 4.544. However, this conclusion would be premature unless other criteria of the approach meet.

Shin et al (2018) recommend the bound t-test of Banerjee et al (1998) besides

Table 2: Bound F-test of Linear-ARDL and NARDL models

	Linear-ARDL (4, 4, 4, 3, 4) F-Statistic =4.560		NARDL (3, 4, 4, 4, 4, 4) F-Statistic = 7.471	
Level of Sig	I(0)	I(1)	I(0)	I(1)
0.1	2.66	3.838	2.66	3.838
0.05	3.202	4.544	3.202	4.544
0.01	4.428	6.25	4.428	6.25

Note: Data generating process is chosen as case-III (Unrestricted constant and no trend), lag selection criterion is based on Akaike Information Criterion (AIC).

Pesaran et al (2001) bound F-test. The error correction term which is 0.141 in case of LARDL (reported in table 3) is not only insignificant, but also takes the wrong sign. This insignificance of ECM term may be attributed to the failure of the model to correctly specify the long-run relationship and the positive sign indicates that the model would be explosively unstable (Shin et al 2018). Besides this, attempt is made to augment the conventional ARDL with Sam et al (2019) approach. Therefore, special care has been taken of the possibility of degenerate problems arising when investigating the long-run relationship via ARDL. The results indicate degenerate-dependent case under the LARDL model. The F-test therefore specifies spurious co-integration which arises from the presence of degenerate-dependent case[2]. The results of two degenerate cases for LARDL model are reported in table 4. Abd Rahman (2012) in case of Malaysia finds no long-run relationship between fiscal deficit and GDP growth while applying ARDL in his analysis while Nayab (2015) in case of Pakistan applying Johansen co-integration and Granger causality also finds no co-integration. Like the finding of this study under LARDL model, the failure of the study by Abd Rahman (2012) to find co-integration relationship could be attributed to the investigation of symmetric impact of fiscal deficit on GDP growth.

In light of the problem of degenerate-dependent case in the linear model,

Table 3: ECM t-bound test of Linear-ARDL and NARDL models

	Linear-ARDL ECM_{t-1} = 0.141 t-bound = 5.460		NARDL ECM_{t-1} = -0.733 t-bound = -8.534	
Level of Sig	I(0)	I(1)	I(0)	I(1)
0.1	-2.57	-3.66	-2.57	-3.86
0.05	-2.86	-3.99	-2.86	-4.19
0.01	-3.43	-4.6	-3.43	-4.79

Table 4: Testing degenerate Case-I and Case-II

	LARDL t-Stat=3.21		Wald-F=5.14		NARDL t-Stat=-5.45		Wald-F=6.46	
Level of Sig	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
0.1	-2.57	-3.66	2.11	3.76	-2.57	-3.86	2.03	3.63
0.05	-2.86	-3.99	2.64	4.54	-2.86	-4.19	2.49	4.36
0.01	-3.43	-4.6	3.9	6.39	-3.43	-4.79	3.71	6.02

Note: The lower and upper critical bound values for Wald-F under DGP case-III are taken from Sam et al (2019), while that of t-stat. are taken from Pesaran et al (2001) for small sample of 40.

NARDL model is therefore estimated via Shin et al (2014) technique. The calculated F-statistic (F_{PSS}= 7.471) of Pesaran et al (2001) and t-bound (t_{BDM} = -8,534) of Banerjee et al (1998) for NARDL are both highly significant at 1%

[2] Throughout the study the terms degenerate-dependent and degenerate case-II, while degenerate-independent and degenerate case-I have been used interchangeably

probability levels thereby confirming the long-run relationship. The ECM term (-0.733) of NARDL is not only significant at even 1% level of significance, but falls between -1 and zero. The significant and negative ECM term indicates that the NARDL model is stable as against the LARDL model. The size of ECM term shows that 73.3% of the deviations are corrected per unit time after a shock emerges. Due consideration is given to testing the degenerate problems which is claimed to be contribution of the current endeavor to the literature on asymmetric models[3]. The t-bound value for degenerate-dependent and Wald/F- test of degenerate-independent variables for NARDL are reported in table 4. The t-value (-5.45) is greater than the critical value of -4.79 at upper bound in absolute terms at 1% level of significance, while the Wald F-value (6.46) is found to be significantly greater than the critical value of 6.02 at upper bound for 1% level of probability. Both tests reject their null of degenerate-dependent and degenerate-independent in case of NARDL model[4].

Similarly, Johansen co-integration method is applied to investigate that how many co-integrating vectors are possible between dependent and the set of explanatory variables. Furthermore to test whether the assumption of weak exogeneity meets, the Likelihood Ratio (L.R.) test is applied. Johansen co-integration test reported in table A-3 indicates only one co-integrating vector at 5% level of significance among the dependent variable and the set of other explanatory variables while the L.R. test of weak exogeniety reported in table 5 evidences that CAPB is weakly exogenous at 10% level of significance. Other explanatory variables like GSSE and GPOP are also found to be weakly exogenous at 1% level of significance. However, GFCF was not found to be weakly exogenous.

Besides the confirmation from L.R. test, a strand of literature (Ramey and Shapiro 1999; Blanchard and Perotti 2002; Alwagdani 2014) also assumes fiscal variables to be exogenous and independent of the state of the economy. The current study uses cyclically adjusted primary balance in order to isolate the endogenous movement inherent in overall fiscal deficit in the form of 'built-in stabilizer'. Moreover, primary fiscal balance is expected to nullify the impact of monetary policy on fiscal deficit in the form of interest burden. Both LARDL and NARDL models were also tested by using real GDP instead of real GDP per capita[5], but the findings remained intake with the basic model of the study. The long-run results of both LARDL and NARDL are reported in table 6. Since CAPB is a reversed scale variable and its values range from negative to positive,

Table 5: Weak exogeniety test (Likelihood ratio)

	α_{CAPB}	α_{GFCF}	α_{GSSE}	α_{GPOP}
χ^2	2.058	27.162	5.351	1.181
Prob.	0.151	0.000	0.021	0.277

[3] Throughout this study, NARDL and asymmetric ARDL are used interchangeably.

[4] The problem of degenerate has been thoroughly discussed in a study of Sam et al (2019).

[5] To save space and not to indulge in too many models, the estimates are not reported

therefore the positive changes in CAPB represent contractionary fiscal policy and negative changes would indicate expansionary fiscal policy.

Similarly, for robustness check both models were estimated under the Schwarz

Table 6: Long-run estimates of LARDL and NARDL models

Linear-ARDL				NARDL			
Variable	Co-efficient	t-Stat	Prob	Variable	Co-efficient	t-Stat	Prob
CAPB	0.06	3.96	0.00	$CAPB_{POS}$	0.04	24.25	0.00
–	–	–	–	$CAPB_{NEG}$	-0.03	-6.44	0.00
GFCF	-3.29	-3.08	0.01	GFCF	0.21	1.59	0.15
GPOP	-38.21	-3.57	0.00	GPOP	-22.28	-11.62	0.00
GSSE	0.32	0.41	0.69	GSSE	0.02	0.2	0.85

Criterion (SC) of lag selection instead of Akaike Information Criterion (AIC) and the results were consistent across the two criteria. The estimations were done via Eviews-10 software and the optimum model of LARDL with lags (4, 4, 4, 3, 4) was selected from 2500 models based on AIC. For NARDL model, among 12500 models the optimum model which optimizes (minimizes) AIC is with lags (3, 4, 4, 4, 4, 4). The results confirm the hypothesis of 'expansionary fiscal contraction' of Giavazzi et al (1998) in case of Pakistan based on estimates of NARDL. The conclusion derived from NARDL model is reliable whereas the linear model is posed with the problem of degenerate case. The findings of the study are in conformity with the studies of Barro (1991); Barro and Sala-i Martin (1992); Easterly and Rebelo (1993); Kneller et al (1999); Bose et al (2007); Mohanty (2012); Arjomand et al (2016); Tung (2018).

In the context of Pakistan, the results also support the findings of Fatima et al (2011); Ali et al (2010); Iqbal and Zahid (1998). However, the study contradicts the finding of Ahmad (2013); Ramazan et al (2013) in case of Pakistan who found positive impact of fiscal deficit on economic growth by applying OLS in their analysis. Their results are not reliable, as the application of OLS to time series data leads to spurious relationship. Similarly, Hussain and Haque (2017) in case of Bangladesh using Johansen co-integration technique find positive impact of fiscal deficit on GDP growth. At the disintegrated level, some studies estimated the effect of current and capital expenditure on growth. For example, in case of Pakistan the study of Hussain et al (2017) reveals that development expenditures are growth enhancing, while consumption spending was reported as growth detrimental. The study also evidenced the negative effect of overall public spending on economic growth. All these studies assume symmetric effect of fiscal policy on growth. The results of NARDL are in conformity with the finding of Abdel-Latif and Mishra (2016) who analyzed the asymmetric effect of government spending on GDP per capita in Egypt at both aggregated and disaggregated levels. However, their study finds evidence of long-run asymmetric effect of government expenditure on economic growth but affirms no asymmetry in the short-run. The study further finds the impact of education expenditure to be asymmetric both in the long- and short-run in Egypt, while indicates only short-run asymmetric effect of military spending. Now turning to the dis-

tinguished feature of NARDL modeling in testing the short-run and long-run asymmetries via Wald tests, it is evident that the impact of fiscal deficit has asymmetric impact on economic growth in the short-run only. The results of Wald test are reported in table 7.

Since $\Delta CAPB\_POS$ and $\Delta CAPB\_NEG$ take the same lag length that is

Table 7: Short-run impact and long-run asymmetry

Type of asymmetry	Wald/F-Stat.	I(0)	I(1)	Conclusion
Long-run impact asymmetry	2.04	4.133	5.26	No asymmetry
Short-run impact asymmetry	10.039	2.676	4.13	asymmetry

Note: Critical bound values are taken from Narayan (2005) for DGP case-III at 5% level of significance.

lag 3 reported in table 8, therefore it indicates adjustment symmetry in the short-run. Furthermore, short-run reaction asymmetry exists at 3rd order of lag. The establishment of asymmetric co-integrating relationship stems either from short-run or long-run asymmetry (Shin et al 2014) and in the present study it comes from short-run impact asymmetry. In the short-run the impact of the size of fiscal deficit on real per capita GDP is asymmetric, while in the long-run asymmetry is not evidenced. In a nutshell, the behavior of fiscal authority towards public finances in Pakistan remained consistent over the long-run; nonetheless asymmetry exists across different types of government and other policy shifts. Looking at the short-run impact of fiscal deficit on economic growth, it is evident from the results reported in table 8 that in the first period contractionary fiscal policy (the coefficient associated with $D(CAPB\_POS)$) significantly enhances economic growth, in the second period it reduces growth although it is not significant and then enhances it in the next period and finally reduces growth in the last period.

Diagnostic checking[6] in the form of conventional tests of normality, serial correlation, heteroskedasticity and specification are conducted for both LARDL and NARDL models and reported in table 9. Both models pass the conventional tests and no evidence of the problem of non-normality, serial correlation, heteroskedasticity, and specification error is found. Similarly, parameters stability test for NARDL model is done via CUSUM and square of CUSUM (table A-4). Both tests show that parameters of the models are dynamically stable.

To ascertain the asymmetric effect of fiscal policy on GDP growth at disintegrated level, fiscal deficit proxied by CAPB was split into public spending and public revenue. Two separate models were estimated; the one with public spending and the other with public revenue. Primary public spending instead of total spending was used in order to nullify the effect of monetary policy. Both public spending and total revenue as percent of GDP were cyclically adjusted via H.P. filter. Each model was then estimated through LARDL and NARDL techniques; however, LARDL model of cyclically adjusted revenue (CAR) could

[6] Normality is checked via Jarque-Bera Statistic; Serial Correlation via Breusch-Godfrey Lagrangian Multiplier test; Heteroskedasticity via Breusch-Pagan-Godfrey test; Specification via Ramsey RESET tests.

Table 8: Estimates of ECM of NARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.055	0.942	8.549	0.000
D(LPCI(-1))	0.259	0.071	3.629	0.007
D(LPCI(-2))	0.481	0.074	6.519	0.000
D(CAPB_POS)	0.098	0.017	5.735	0.000
D(CAPB_POS(-1))	-0.180	0.034	-5.328	0.001
D(CAPB_POS(-2))	0.025	0.038	0.654	0.531
D(CAPB_POS(-3))	-0.036	0.019	-1.915	0.092
D(CAPB_NEG)	-0.051	0.018	-2.902	0.020
D(CAPB_NEG(-1))	-0.094	0.033	-2.853	0.021
D(CAPB_NEG(-2))	0.067	0.035	1.907	0.093
D(CAPB_NEG(-3))	0.096	0.031	3.058	0.016
D(GFCF)	0.023	0.012	2.014	0.079
D(GFCF(-1))	-0.125	0.020	-6.217	0.000
D(GFCF(-2))	-0.067	0.016	-4.260	0.003
D(GFCF(-3))	-0.040	0.009	-4.462	0.002
D(GPOP)	-2.586	0.791	-3.268	0.011
D(GPOP(-1))	10.101	1.830	5.521	0.001
D(GPOP(-2))	-0.348	1.048	-0.332	0.748
D(GPOP(-3))	2.883	1.051	2.743	0.025
D(GSSE)	0.098	0.012	8.375	0.000
D(GSSE(-1))	0.097	0.020	4.850	0.001
D(GSSE(-2))	0.027	0.017	1.560	0.157
D(GSSE(-3))	-0.018	0.009	-1.932	0.089
ECM(-1)*	-0.734	0.086	-8.535	0.000

Note: * the p-value is not applicable. The t-bound values for the ECM term are reported in table 3.

Table 9: Diagnostic checking for LARDL and NARDL models

	LARDL		NARDL	
Problem	test-Stat.	Prob.	test-Stat.	Prob.
Normality	J.B. = 0.573	0.751	J.B. = 1.613	0.446
Serial Correlation	FLM =1.590	0.247	FLM = 3.200	0.113
Heteroskedasticity	$\chi^2_{B.P.G}$=25.941	0.304	$\chi^2_{B.P.G}$=26.431	0.549
Specification	F_{RESET} = 0.062	0.807	F_{RESET} = 0.143	0.716

Note: Data generating process is chosen as Case-III (Unrestricted constant and no trend), lag selection criterion is Akaike Information Criterion (AIC).

not reject the null hypothesis at even 10 percent level of probability. The bound F-value (3.334) falls between lower and upper bounds for sample of size 40. Similarly, LARDL model of cyclically adjusted primary spending (CAPS) was posed with the problem of degenerate dependent case with t-bound = -3.323 which lies between I(0)=-3.13 and I(1)=-4.04 at 10 percent probability. Both models were then estimated via NARDL and the bound F-values reported in table 10 reject their null hypotheses of no co-integration at 1% levels of probability.

The test of weak exogeneity conducted via L.R. test (see table 11) for both models indicates that CAPS and CAR are weakly exogenous and therefore justifies the application of LARDL and NARDL techniques. Unlike other studies which assumed fiscal variables to be strictly exogenous, this study relies

Table 10: NARDL bound tests for CAPS and CAR models

	CAPS-Model (1, 3, 0, 0, 1, 2) F-Statistic = 23.179		CAR-Model (1, 4, 3, 1, 3, 1) F-Statistic = 6.670	
Level of sig	I(0)	I(1)	I(0)	I(1)
0.1	3.032	4.213	2.483	3.708
0.05	3.577	4.923	2.962	4.338
0.01	4.885	6.55	4.045	5.898

Note: Data generating process is chosen as case-V (unrestricted constant and unrestricted trend) for CAPS model and case-III for CAR model, lag selection is based on SIC.

on fulfillment of the assumption of weak exogeneity and allows feedback from the dependent variable (to follow De Cos & Morel-Benito, 2013) unless proven by the Granger causality test[7] to be strongly exogenous. The ECM terms of both models reported in table 12 are significant at 1 percent level of probability, but fall between -1 and 0. The ECM term for model of CAPS shows that 71.9 percent of the deviation is corrected each year, while for CAR model only 58.9% is corrected after a shock occurs. Similarly, both models pass the tests of degenerate-dependent and degenerate-independent case reported in table 13.

Table 11: Weak exogeneity test (Likelihood ratio)

CAPS-Model		CAR-Model	
χ^2	Prob.	χ^2	Prob.
α_{CAPS}=3.514	0.172	α_{CAR}=0.962	0.326
α_{GFCF}=21.900	0.000	α_{GFCF}=9.861	0.002
α_{GSSE}=0.216	0.898	α_{GSSE}=0.057	0.811
α_{POP}=10.780	0.004	α_{POP}=0.979	0.322

Table 12: NARDL ECM t-bound tests for CAPS and CAR models

	CAPS-Model ECMt-1 = -0.719 t-bound = -12.963		CAR-Model ECMt-1 = -0.589 t-bound = -7.151	
Level of Sig	I(0)	I(1)	I(0)	I(1)
0.1	-3.13	-4.21	-2.57	-3.86
0.05	-3.41	-4.52	-2.86	-4.19
0.01	-3.96	-5.13	-3.43	-4.79

Turning to long-run results of CAPS-model, it is evident that positive changes in public expenditures represented by $LCAPS\_POS$ negatively affect economic growth in Pakistan, while negative changes denoted by $LCAPS\_NEG$ impact growth positively. Both coefficients are significant at 1 percent levels of probability (see table 14). Since both dependent variable (economic growth) and

[7] A variable is considered to be strictly exogenous if it was weak exogenous and based on Granger causality test such causation is found to be unidirectional running from this variable to the dependent variable.

Table 13: NARDL testing degenerate Case-I and Case-II in CAPS and CAR models

	CAPS-Model				CAR-Model			
	t-Stat=-9.324		Wald-F=13.379		t-Stat=-5.457		Wald-F=5.206	
Level of Sig	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
0.1	-3.13	-4.21	2.03	3.54	-2.57	-3.86	2.03	3.63
0.05	-3.41	-4.52	2.51	4.24	-2.86	-4.19	2.49	4.36
0.01	-3.96	-5.13	3.69	5.96	-3.43	-4.79	3.71	6.02

Note: The lower and upper critical bound values for Wald/F-test under D.G.P of case-V and case-III are taken from Sam et al. (2019) for small sample of 40, while that of t-stat. are taken from Pesaran et al. (2001).

independent variable (public spending) are in log form, therefore the associated coefficients represent elasticities. One percent increase in public spending reduces economic growth by 0.68 percent on average, while one percent decrease in public spending enhances growth by 0.37 percent on average. This implies that the extent of negative effect of expansionary fiscal policy is greater than that of the positive impact of fiscal austerity. This asymmetric finding supports the findings of Abdel-Latif and Mishra (2016) in case of Egypt. In model of CAR, positive changes denoted by $LCAR\_POS$ positively affect growth and the associated coefficient (1.57) is highly statistically significant at 1 percent probability, while negative changes represented by $LCAR\_NEG$ negatively impact growth with the estimated coefficient of -1.07. This finding is in line with the argument made by Baldacci et al (2004) regarding the positive effect of tax-based consolidation on growth in less developed countries. The study of IMF (2015) also indicates that in some cases tax-based adjustment may be more appropriate and equity-friendly in low income countries.

From the results, an important conclusion can be deduced at this stage re-

Table 14: NARDL long-run estimates of CAPS and CAR models

	CAPS-Model				CAR-Model		
Variable	Co-eff.	t-Stat.	Prob.	Variable	Co-eff.	t-Stat.	Prob.
LCAPS_POS	-0.68	-9.42	0.00	LCAR_POS	1.57	9.40	0.00
LCAPS_NEG	0.37	7.54	0.00	LCAR_NEG	-1.07	-30.12	0.00
GFCF	0.08	2.29	0.03	GFCF	0.23	2.57	0.02
GSSE	0.18	4.87	0.00	GSSE	-0.06	-0.62	0.54
POP	-7.64	-3.88	0.00	POP	-9.00	-3.89	0.00

garding the composition of fiscal deficit: tax-based consolidation is found to be more expansionary than spending-based adjustment in the long-run. The plausible reason seems to lie in the small size of public spending and taxes. Since the country is deficient in infrastructure and investment in social and human capital, therefore mobilization of domestic resources in the form of more tax collections to be channelized to such areas are expected to add to economic growth. Besides this, financing fiscal deficit largely through domestic debt rather than tax increase would reduce growth as domestic debt is costly thereby limiting future fiscal maneuvering. Likewise, uncertainty in public policies, high public debt

and inflation deters private investments thereby undermining growth prospects. Furthermore, from the tests of asymmetry reported in table 15, Wald test does not reject the null hypothesis in case of public spending in the long-run, while the short-run impact asymmetry is confirmed at 5 percent level of probability. However, there is enough statistical evidence for both short and long-run asymmetry at 5 percent probability level. Both models do not suffer from the problem of non-normality, serial correlation, Heteroskedasticity, and specification error. Diagnostic tests have been presented in table 16. Similarly, parameters stability test conducted via CUSUM and square of CUSUM for CAR-model are reported in figure A-5, while that of CAPS-model are reported in figure A-6.

Both tests show that parameters of the models are dynamically stable. Table 17 reports short-run coefficients estimates of both models. Tax hike in the first and third periods are found to enhance growth, however the impacts in both periods are statistically insignificant, while in the second and fourth periods growth has been significantly reduced. On the contrary, negative changes in taxes in the first two periods reduce growth, but such negative impact is statistically insignificant. It is the third period in which tax reduction significantly adds to growth in the short-run.

Table 15: Testing short-run and long-run asymmetry of CAPS and CAR models

Type of asymmetry	CAPS-Model		CAR-Model	
	Wald-Stat.	Conclusion	Wald-Stat.	Conclusion
Long-run impact asymmetry	0.665	No asymmetry	6.985	asymmetry
Short-run impact asymmetry	5.239	asymmetry	10.436	asymmetry

Table 16: Diagnostic checking of CAPS and CAR models

	CAPS-Model		CAR-Model	
Problem	test-Stat.	Prob.	test-Stat.	Prob.
Normality	J.B. =1.139	0.566	J.B. = 0.328	0.849
Serial correlation	F_{LM} =1.280	0.298	F_{LM}= 0.829	0.454
Heteroskedasticity	$\chi^2_{B.P.G}$=7.402	0.88	$\chi^2_{B.P.G}$=7.722	0.982
Specification	F_{RESET} =0.072	0.791	F_{RESET} =0.175	0.681

6 Conclusions and policy recommendations

The present study is an endeavor to estimate the dynamic impact of fiscal policy on economic growth in Pakistan. For this purpose, the famous empirical model of Mankiw et al (1992) was adopted and estimation done through Pesaran et al (2001) ARDL technique. Real GDP was regressed on cyclically adjusted primary fiscal deficit along with gross fixed capital formation, employed labor force and human capital formation proxy by secondary school enrollment on annual time series data ranging from 1976 to 2017. Unlike the previous studies done in the

Table 17: ECM estimates of CAR and CAPS models

CAR-Model			CAPS-Model		
Variable	Co-eff.	Prob.	Variable	Co-eff.	Prob.
C	6.22	0.00	C	7.51	0.00
D(LCAR_POS)	0.98	0.12	Trend	0.02	0.00
D(LCAR_POS(-1))	-2.22	0.08	D(LCAPS_POS)	0.04	0.87
D(LCAR_POS(-2))	0.92	0.39	D(LCAPS_POS(-1))	1.62	0.00
D(LCAR_POS(-3))	-1.83	0.01	D(LCAPS_POS(-2))	0.49	0.09
D(LCAR_NEG)	-0.64	0.10	D(GSSE)	0.08	0.00
D(LCAR_NEG(-1))	-0.11	0.86	D(POP)	1.86	0.05
D(LCAR_NEG(-2))	2.34	0.00	D(POP(-1))	5.20	0.00
D(GFCF)	0.04	0.03	ECM(-1)*	-0.72	0.00
D(GSSE)	0.03	0.07	-	-	-
D(GSSE(-1))	0.08	0.00	-	-	-
D(GSSE(-2))	0.04	0.01	-	-	-
D(POP)	0.88	0.46	-	-	-
ECM(-1)*	-0.59	0.00	-	-	-

Note:* indicates that p-values are not compatible. The bound t-values have been reported in table 12.

context of Pakistan, firstly we took the primary fiscal deficit as a percent of GDP against overall fiscal deficit so as to isolate the effect of monetary policy in the form of interest burden. Secondly, we adjusted the primary fiscal deficit with the business cycle via Hodrick-Prescott filter in order to isolate discretionary fiscal stance of the country.

The result of Linear-ARDL was found poor, and we did not find evidence of co integration relationship. We then estimated the model via Shin et al (2018) NARDL technique and found co integration relationship between the dependent and set of independent variables. The results show that expansionary fiscal policy reduces growth in Pakistan, while fiscal consolidation adds to growth. In the similar vein, the disaggregated analysis of fiscal deficit was also conducted and again the study finds the asymmetric effect of public spending and revenue over growth. From the tests of asymmetry within NARDL framework, the study confirms short-run impact and short-run adjustment asymmetries in case of the size of fiscal deficit. The study however, finds no asymmetry in long-run. The disaggregated analysis shows that there exists only short-run impact asymmetry in public spending, while evidences both long-run and short-run asymmetry in case of public revenue. From the results, an important conclusion has been deduced regarding the composition of fiscal deficit. The analysis reveals that tax-based consolidation is likely to be more expansionary than spending-based adjustment in the long-run. In order to achieve growth targets and the objective of sustainable development, fiscal management should focus on fiscal consolidation.

Since it is found that the size of overall fiscal deficit reduces economic growth, therefore immediate measures of fiscal consolidation are needed by the fiscal authorities to curtail fiscal deficit to a manageable level. There are two ways to reduce the size of overall fiscal deficit: decrease spending and/or increase taxes. However, decreasing public spending or increasing taxes may result in lower output growth, therefore smart consolidation would be required to switch fiscal

restraints into opportunity of growth and development. In this regards, prudent expenditure management aiming to twist the composition of public spending towards capital spending as against the current expenditures may help achieve the objective of economic growth. Since the country is deficient in infrastructure and lagging behind in the race of human development, therefore allocation to such areas will enhance growth. This is likely to boost private sector investments either directly by creating crowd-in effect or indirectly by ensuring macroeconomic stability conducive to such capital accumulation. Moreover, loss making public sector enterprises need to be restructured or privatized so as to minimize pressure on public exchequer for bail-out packages. Besides this, stagnant revenue-to-GDP is another cause of large fiscal deficit. In this regards, some direct and indirect tax rates need to be rationalized in order to exploit the revenue potentials. Similarly, promotion of tax culture through print and electronic media and academia is required to make the citizens aware about their responsibility of paying taxes. This will create civic consciousness and is expected to promote tax culture in Pakistan. Since the analysis indicates that the short-run effect of fiscal deficit is asymmetric, therefore any opportunistic approach towards running large fiscal deficit may reduce growth which is not possible to recover losses in growth if the deficit would have curtailed to its previous level. Establishment of fiscal council to device strategies to gradually reduce current spending in favor of capital spending in both the short-run and long-run may be considered an option in this regard. Such growth oriented shift is likely to cover the deficiency in infrastructure and would add to growth.

The analysis of composition of fiscal deficit reveals that public spending has short-run asymmetric effect on GDP growth, while such asymmetric impact is not witnessed in the long-run. The results reveal that negative growth effect of a unit increase in public spending exceeds that of the positive effect of a unit decrease in the short-run. Again, the study evidences asymmetric effect of revenue-based consolidation on growth in both the short and long-run. Since growth-friendly reforms would require enough fiscal space, therefore broadening tax base is expected to minimize distortion, while prudent expenditure policy is likely to improve efficiency. The negative effect of expansionary public spending can plausibly be associated with imprudent composition of public spending which is skewed towards current spending. Besides this tax structure is skewed towards indirect taxes. Since the country is deficient in infrastructure and investment in social and human capital, therefore mobilization of domestic resources in the form of more tax collections to be channelized to such areas will enhance productive capacity and contribute to human capital formation, the key ingredients to increase economic growth. Besides this, financing fiscal deficit largely through domestic borrowing rather than tax increase would reduce growth as domestic debt has been switched from long-term to short-term and from foreign to domestic debt. Such unfavorable switch in public debt is costly thereby limiting future fiscal maneuvering. Since, the current tax structure carries variety of tax exemptions and is skewed towards indirect taxes, therefore fiscal reforms that may make the tax system fairer and efficient with a switch from indirect to direct tax would be helpful in generating sufficient revenue. This would minimize the negative impacts of unsustainable public finance on the macro economy.

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Appendix

Table A1: Definitions of variables, their measurement and data sources

Variables definition	Notation	Measurement	Data source
Real GDP Per Capita	LPCI	Constant at 2010 Local Currency Unit (LCU)	WDI-2017
Private Gross Fixed Capital Formation	GFCF	Gross fixed capital formation, private sector (% of GDP)	WDI-2017
Population	POP	Working age population in million	WDI-2017
Primary Fiscal Balance	PFB	Total revenue less total government spending excluding interest payment as a percent of GDP	ESP (Various Issues)
Secondary School Enrollments	SSE	Number of enrollments	ESP (Various Issues)
Total Revenue	R	Total revenue consists of tax and non-tax revenue as percent of GDP	ESP (Various Issues)
Primary Spending	PS	Total government spending excluding interest payment as percent of GDP	ESP (Various Issues)

Note: WDI is World Development Indicator published by World Bank, while ESP is Economic Survey of Pakistan published by ministry of finance government of Pakistan.

Table A2: Construction of variables

Variable	Construction of variables
LPCI	Log of real GDP per capita in LCU (LCU refers to Pakistani currency)
CAPB	Cyclically adjusted primary fiscal balance
GFCF	Growth of Private Gross Fixed Capital Formation (GFCF) = Log(FCF) Log(FCFt-1)
GPOP	Growth of working age population (POP) = Log(POP) Log(POPt-1)
GSSE	Growth of Secondary School Enrollments (GSSE) = Log(SSE) Log(SSEt-1)
LCAPS	Log of cyclically adjusted primary spending
LCAR	Log of cyclically adjusted revenue

Note: For cyclical adjustment of the variables Hodrick-Prescott (HP) Filter with Lambda equal to 6.25 is used. Hodrick and Prescott suggest to use lambda=100, whereas Ravn and Uhlig (2002) recommend to set Lambda equal to 6.25.

Table A3: Johansen co-integration test

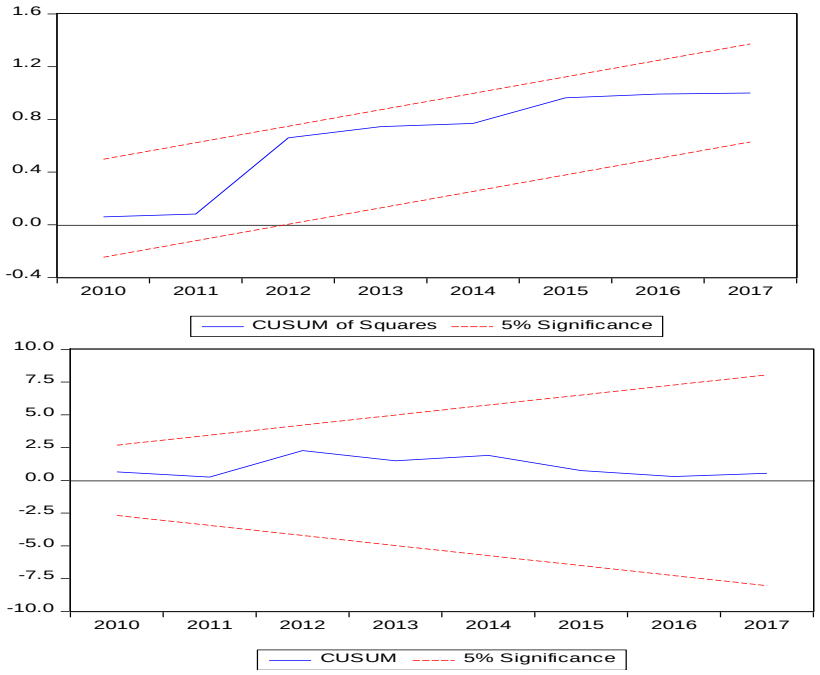
Unrestricted cointegration rank test (Trace)				
Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.769215	92.52333	69.81889	0.0003
At most 1	0.380663	36.80511	47.85613	0.3568
At most 2	0.255271	18.59907	29.79707	0.5220
At most 3	0.151967	7.399140	15.49471	0.5317
At most 4	0.029436	1.135364	3.841466	0.2866

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values

Table A3 continued: Johansen co-integration test

Unrestricted Cointegration Rank Test (Maximum Eigen value)				
Hypothesized No. of CE(s)	Eigen value	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.769215	55.71822	33.87687	0.0000
At most 1	0.380663	18.20604	27.58434	0.4781
At most 2	0.255271	11.19993	21.13162	0.6274
At most 3	0.151967	6.263776	14.26460	0.5796
At most 4	0.029436	1.135364	3.841466	0.2866

Max-eigen value test indicates 1 cointegrating eqn(s) at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values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5% Significance
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7.5
5.0
2.5
0.0
-2.5
-5.0
-7.5
-10.0
2010
2011
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2015
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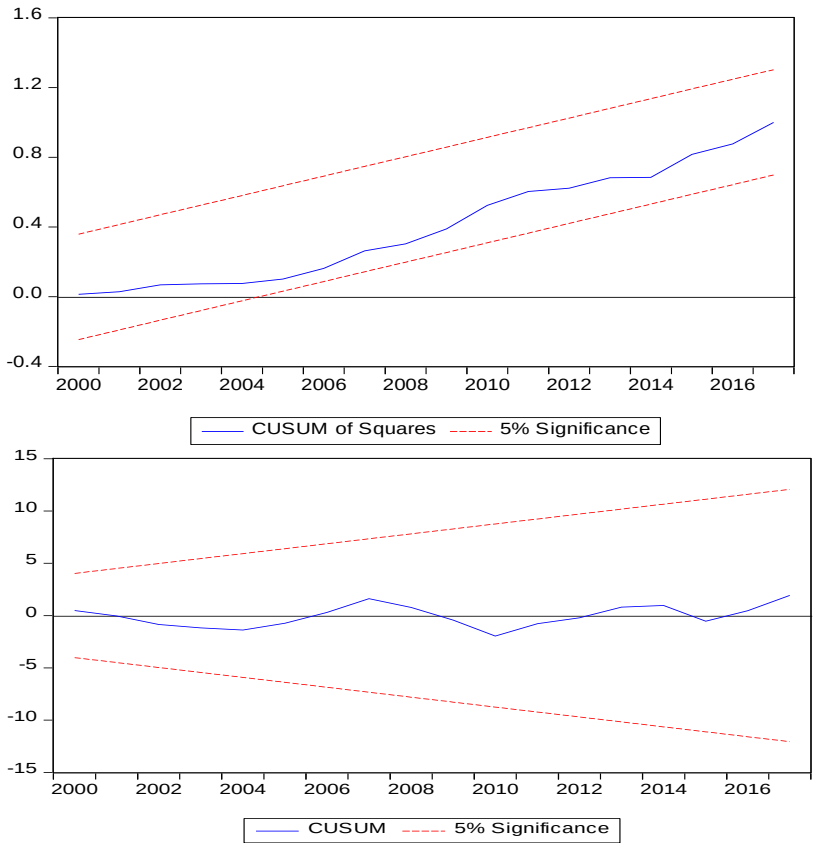
2017
CUSUM
5% Significance

Figure A-4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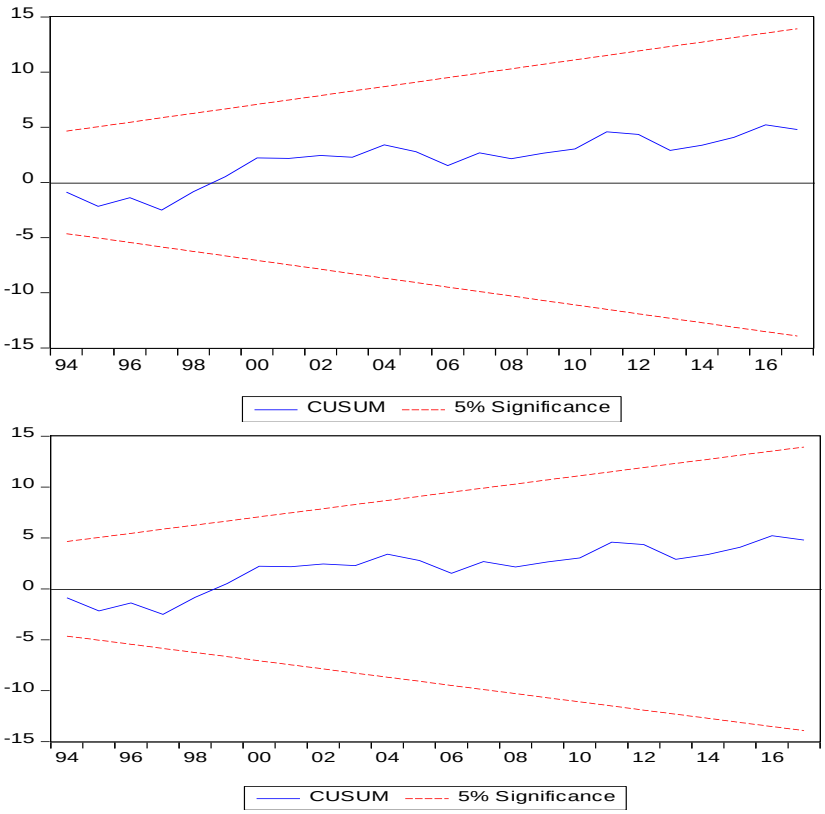
CUSUM
5% Significance

Figure A-5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CUSUM
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CUSUM
5% Significance

Figure A-6