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Finding the Tipping Point When Sovereign and Domestic Debt Turn Bad: A Case of Pakistan

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Using a data set from 1980 to 2015 and controlling for other factors, this study explores the non-linear relationship between domestic/external debt, measured as percentage of GDP, and economic growth in Pakistan and identifies threshold level of domestic/external debt. For this purpose, ARDL Bound test and threshold model are used separately for domestic, external and public/total debt. ARDL Bound test reveals the presence of co-integration between real GDP, external debt, external debt services, gross fixed capital formation, trade openness and real effective exchange rate. Likewise, it is found that real GDP and domestic debt, domestic debt service, gross fixed capital formation, money supply and inflation are co-integrated. Further, the empirical estimation of threshold model estimates three different regions of threshold values. The estimated threshold level for external debt is 34 percent while it is 35 percent for domestic debt. The tipping point for public debt is estimated to be 68 percent which is slightly above from current debt to GDP ratio of Pakistan i.e. 69 percent (average of last 20 years). Therefore, it is suggested that policy-makers need to decrease debt and increase tax revenues to fill the fiscal deficit. This is expected to have positive impact on economic growth of the country.

1. INTRODUCTION

Public debt (domestic and external) plays an important role in fulfilling the gap between revenue and expenditure of a country, but excess accumulation of debt may stagnant economic growth, threaten fiscal and monetary sustainability by creating heavy burden of debt servicing and further smoothing path to debt trap. There is general perception that increases in public debt improve economic growth up to a certain level beyond which further increases in public debt are worse for economic growth [Reinhart and Rogoff (2010)]. Through different channels high debt could unfavorably affect long-run growth and capital accumulations such as, inflation, [Barro (1995); Kumar and Woo (2010); Cochrane 2010), higher future distortionary taxation [Barro (1979); Dotsey (1994)], higher long-term interest rates [Elmendorf and Mankiw (1999)], and greater uncertainty about prospects and policies.

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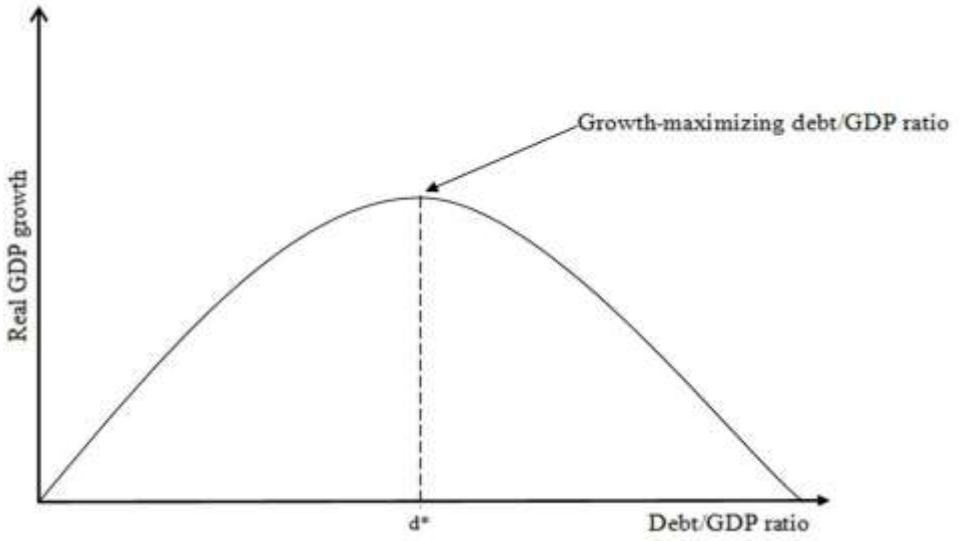
This non-linear relationship between debt and economic growth can be expressed by a so-called debt Laffer curve (Figure 1) which shows the optimal growth maximising debt to GDP ratio or tipping point for debt to GDP ratio. Point d^* is the threshold level of public debt.

Fig. 1. Debt Laffer Curve



Optimal value of debt got remarkable attention by policy-makers and media after the publication of empirical study of Reinhart and Rogoff (2010) in which they observed that excess of public debt to GDP ratio from 90 percent reduced annual economic growth from 3 to –1, which was latterly challenged by Herndon, *et al.* (2013) by finding some problems of coding error, selective exclusion of available data and inappropriate weightage given to summary statistics in the data set of Reinhart and Rogoff. Herndon, *et al.* (2013) mention in their study that after 90 percent of debt to GDP ratio actual decline in annual economic growth is 2 not –1. Caner, *et al.* (2010) estimated optimal value of 77 percent for debt to GDP ratio for the 99 developing and developed countries and 64 percent for developing countries only. Greenidge, *et al.* (2012) and Wright and Grenade (2014) used data set of Caribbean countries and found the threshold values of 55-56 percent and 61 percent respectively. Baum, *et al*. (2013) found that in 12 Euro countries debt negatively affects growth when it exceeds the limit of 95 percent. Pattillo, *et al.* (2002) concluded that the growth of developing countries turns negative if debt to GDP ratio reaches to 160-170 percent of export and 35-40 percent of GDP. Mupunga and Roux (2015) have tested the debt Laffer curve for Zimbabwe and estimated debt threshold value of 45-50 percent. Kaur and Mukherjee (2012) estimated the threshold value of 61 percent of debt to GDP ratio for India and Munir, *et al.* (2016) found 50-60 percent threshold value of external debt in Malaysia.

Since independence Pakistan is heavily depending on external and domestic debt to finance current account deficit and budget deficit. Every successive government just accumulated high debt stock rather than taking some initiative to control it. Thus, in 2001

World Bank declared Pakistan highly indebted country. Both internal and external debt are soaring and creating hurdles for our country's economic growth. This has led to unemployment, poverty [Ahmad (2011); Gul (2008)], discouraged domestic and foreign investment and put upward pressure on taxes [Khan, *et al.* (2016)] because most of our revenue is just used being as payment of debt servicing rather than for some development purposes. Currently policy-makers think that if the government of Pakistan does not take some initiative to control both domestic and external debt, it may face severe problem of debt crises in coming years as debt repayment and servicing will become unaffordable.

A Series of papers [Khan, *et al.* (2016); Arshad, *et al.* (2015); Zaman and Arsalan (2014); Shaheen and Ayub (2014); Akram (2011); Atique and Malik (2012); Ali and Mustafa (2012); Rais and Anwar (2012); Malik and Hayat (2010); Skeikh, *et al.* (2010)] have investigated the impact of debt on economic growth in Pakistan but they ignored the optimal or tipping point for both domestic and external debt. Malik, *et al.* (2010) has showed inverse relationship between external debt and economic growth in long run, contrary to results of Iqbal, *et al.* (2015), who found positive relationship between external debt and economic growth but showed negative impact of debt service on economic growth. Ali and Mustafa (2012) have shown a positive and significant link between external debt and economic growth in the short-run while negative and significant relation in the long run, which was latterly confirmed by Zaman and Arsalan (2014).

Atique and Malik (2012) have confirmed negative impact of domestic and external debt with economic growth due to depreciation of Pakistani currency against creditor countries currency. For external debt, the same finding is also confirmed by Arshad, *et al.* (2015) but they have concluded positive relation between domestic debt and economic growth. Gul (2008) and Raiz and Anwar (2012) also found a negative relation between public debt and economic growth but Khan, *et al.* (2016) reported that in the long run public debt has positive but insignificant impact on economic growth of Pakistan. However, these studies do not mention the threshold level of debt and leave a gap in literature that this study tries to fill.

The main purpose of the study is to estimate separate tipping points for domestic, external and public debt, measured as a share of GDP, in the context of Pakistan. It will act like a benchmark or correct yardstick of measurement for policy-makers to frame policy regarding debt and help them to boost economic growth.

2. LITERATURE REVIEW

A voluminous literature exists on the issue of debt and economic growth and after the recent economic crises 2008, this subject arises once again as a burning issue among academia and policy-makers [Eberhardt and Presbitero (2015)]. Time series as well as pooled studies can be found on the subject that use different methodologies and data set to unlock debt-growth nexus. Cai (2017) analyses data set from 1984-2011 through ARDL co-integration approach and found co-integration between public debt and real GDP growth per capita in China. This study also concludes that in the short-run public debt has little impact on economic growth while after a specific threshold level further accumulation of public debt disturbs economic growth. Baharumshah, *et al.* (2017) uses Markov-switching model to measure fiscal sustainability and estimate threshold value for

public debt in Malaysia. They estimate 54.71 percent of threshold level for public debt to GDP ratio and observe that beyond this limit increase in public causes decline in economic growth due to debt overhang. Munir, *et al.* (2016) use ARDL to examines the relationship between external debt and economic growth in Malaysia and estimates the optimal value for its external debt for 1970-2013 period. They found threshold value of 50 to 60 percent for external debt GDP. Khan, *et al*. (2016) estimates the relationship between public debt and economic growth in Pakistan and show positive but "insignificant" co-relation between public debt and economic growth. Using quadratic equation, Mupunga and Roux (2015) check the non-linear relationship between public debt and economics growth in Zimbabwe and conclude that the impact of public debt become negative when it exceeds 45 percent of GDP. Yuan-Hong and Chiung-ju (2015) use dynamic stochastic general equilibrium framework to assess the debt sustainability in Taiwan and report that accumulation of debt shows positive contribution to the economic growth of Taiwan till 20 percent of GDP but after this limit marginal impact of debt on economic growth starts declining and becomes negative as debt to GDP ratio crosses the limit of 40 percent.

Wright and Grenade (2014) use panel data covering time span from 1990 to 2012 for 13 Caribbean countries[1] and proves the non-linear relation between debt and economic growth. They also conclude that there exists global threshold level of 61 percent for public debt to GDP ratio. Baum, *et al.* (2013) estimate the debt threshold value for 12 Euro countries for the period 1990-2000 and point out that in the short-run accumulation of debt has positive and significant impact on economic growth but the impact of debt on economic growth becomes negative when debt to GDP ratio crosses the limit of 95 percent. Greenidge, *et al*. (2012) found that at the level of 30 percent of debt to GDP ratio the excess accumulation of debt starts a deleterious impact on economic growth in selected Caribbean countries but the problem becomes more severe when it reaches 50 percent because at this level the impact of public on economic growth become negative. Kaur and Mukherjee (2012) use Indian data from 1981 to 2013 to evaluate the debt sustainability and check the impact of public debt on the economic growth. Results of inter-temporal budget and fiscal policy response function confirm that debt is sustainable in the long-run and there exist a non-linear relationship between debt and long-run economic growth and tipping point value of debt is 61 percent. Atique and Malik (2012) analyse the impact of domestic and external debt on economic growth in Pakistan by employing OLS and conclude that both domestic and external debt are negatively and significantly affect economic growth of Pakistan through many channels such as debt overhang situation and high accumulation of debt services. Further, it also concludes that the accumulation of external debt has more severe impact on economic growth than domestic debt accumulation.

Using data from 1970 to 2010 from Pakistan, Ali and Mustafa (2012) examine the short and long-run relation between external debt and economic growth and report that, in the long run, external debt has negative impact on economic growth because of debt overhang problem. Akram (2011) analyses both short-run and long-run impacts of public debt on economic growth and investment in Pakistan by employing ARDL and

[1]Trinidad and Tobago Vincent and the Grenadines, Belize Antigua and Barbuda, Guyana, Bahamas, Jamaica, Barbados, Dominica, Grenada, St. Lucia, St. Kitts and Nevis, St. Suriname.

Error Correction Model and confirms that both in the long-run and short-run external debt have negative and significant impact on the economic growth while domestic debt has insignificant impact on per capita. Cecchetti, *et al.* (2011) employ panel data of 18 OECD countries and examine the impact of three different types of debt i.e. government debt, corporate debt and household debt on economic growth and estimate optimal values of 85 percent, 90 percent, and 85 percent of GDP for government, corporate and household debt respectively. Caner, *et al.* (2010) prove the existence of optimal debt to GDP ratio in 99 developing and developed countries for the period 1980-2008. It estimates an optimal value of 77 percent of public debt-to-GDP ratio for developed and 64 percent for developing countries. Reinhart and Rogoff (2010) evaluate the correlation between public debt and economic growth for a large panel of 44 economies for 200 years by using histograms. The study finds the threshold value of 90 percent for debt to GDP ratio for these countries. As mentioned earlier huge literature is available on the relationship between debt and GDP. For parsimonious purpose, further literature is presented in Table 1.

Table 1

Summary of Literatures Review

Author	Time Period	Country	Methodology	Findings
Klomp (2017)	1985-2010	115 countries	Binary choice model, Logit model, Discrete choice model	Large-scale natural disasters increase significantly the onset probability of a sovereign debt default by about three percentage points, limiting the debt servicing opportunities of a country in the future.
Eberhardt and Presbitero (2015)	1960-2012	118 developing, emerging and advanced economies	OLS, Common factor model, Dynamic CMG Model	Negative relationship between public debt and long-run growth across countries but no evidence for a similar debt threshold within countries.
Gómez -Puig and Sosvilla-Rivero (2015)	1980-2013	EMU countries	Granger-causality test, ADF test, OLS	Evidence of a "diabolic loop" between low economic growth and high public debt levels in Spain after 2009.
Égert (2015)	1946 to 2009	20 OECD	Nonlinear threshold models, Hansen's threshold modelling framework	Limited evidence in favour of a negative nonlinear relationship between debt and growth.
Puente-Ajovín and Sanso-Navarro (2015)	1980-2009	16 OECD countries	Panel bootstrap Granger causality test, OLS	Evidence of the presence of a higher number of causal relationships running from growth to debt.
Lof and Malinen (2014)	1954-2008	20 developing countries	PVAR model	The negative correlation between sovereign debt and growth is due to a negative reverse effect of growth on debt.

Continued—

Table 1—(*Continued*)

Doğan and Bilgili (2014)	1974-2009	Turkey	Markov Regime-switching model	Public private external borrowing has negative impact on growth both in regime at zero and regime at one.
Teles and Mussolini (2014)		74 countries	overlapping-generations model (OLG)	The level of public debt-to-GDP ratio negatively impacts the effect of fiscal policy on growth.
Zouhaier and Fatma (2014)	1990-2011	19 developing Countries	dynamic panel data model	Negative effect of the total external debt to GDP and external debt as a percentage of GNI ratio on economic Growth.
Eberhardt and Presbitero (2013)	1972-2009	105 developing, emerging and developed economies countries	Asymmetric ARDL, Common factor model, Spline regression, Endogenous threshold regression	A nonlinear relationship between debt and long-run growth across countries but no evidence for common debt thresholds within countries over time.
Afonso and Jalles (2013)	1970–2008	155 OECD countries	Neoclassical growth model, OLS, Fixed effect	The higher the debt maturity the higher economic growth, financial crisis is detrimental for growth and higher debt ratios are beneficial to TFP growth.
Checherita-Westphal and Rother (2012)	1970-2009	12 euro Area countries	Fixed effect (FE) models, Instrumental variable (IVREG) models, dynamic panel model	Government debt is found to have a non-linear impact on the economic growth rate through the channel of private saving, public investment and total factor productivity.
Checherita-Westphal, *et al*. (2012)	1960-2010	22 largest OECD economies, 14 EU, 11 euro area countries	fixed effects, system GMM, and two stages least squares	The marginal effect of debt becomes negative when the debt-to-GDP ratio is between 90 and 105 percent.
Kumar and Woo (2010)	1970-2007	38 advanced and emerging economies	Baseline Panel Regression, pooled OLS, between estimator (BE), robust regression, fixed effects (FE), panel regression system GMM (SGMM) dynamic panel regression	The empirical results suggest an inverse relationship between initial debt and subsequent growth.
Minea and Parent	1946-2010	20 advanced economies	Panel Smooth Threshold Regression (PSTR) method	Public debt is negatively associated with growth when the debt-to-GDP ratio is above 90 percent and below 115 percent.

3. DATA AND MODEL

This section describes the data, sources, variables and model development. It also describes the detail of various econometric approaches and methodology used for estimation of three different models such as external, domestic and total debt model. A Series of variables are used in the model as mentioned in Table 2. All the independent variables are expressed as percent of GDP except inflation, real effective exchange rate, population growth. Our study covers time period from 1980 to 2015.

Table 2

Variables Description and their Source

Sr. No.	Name of Variable	Data Source	Description
1	GDP Growth (LGDP)	PBS2	GDP at factor cost is used as proxy for economic growth. Gross Domestic Product at factor cost is measured when indirect taxes are deducted and subsidies are added to Gross domestic product
2	Public Debt (PDG)	PES	"The part of total debt is described as public debt when it has a direct charge on government revenues as well as the debt receive from IMF. It is combination of external debt and domestic debt."
3	Public Debt Service (PDSG)	PES	Public debt service is required to cover the repayment of interest and principal on Public debt for a particular period
4	Domestic Debt (DDG)	PES[3]	Pakistan domestic debt is composed of both "medium and long-term permanent debt, short-term floating debt and unfunded debt which is made up of the various instruments available under the National Savings Schemes.
5	External Debt (EDG)	PES	External debts consist of all foreign currency debt contracted by private and public sector and foreign exchange liabilities of State Bank of Pakistan
6	External Debt Service (EDSG)	PES	External service is the cash that is required to cover the repayment of interest and principal on external debt for a particular period
7	Domestic Debt Service (DDSG)	PES	Domestic debt service is the cash that is required to cover the repayment of interest and principal on domestic debt for a particular period
8	Gross Fixed Capital Formation (GFCFG)	WDI[4]	Gross capital formation (formerly gross domestic investment) comprises of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets embrace land enhancements (fences, drains and ditches so on); plant, equipment purchases and machinery; and the construction of railways and roads, the like, including schools, offices, hospitals, private residential dwellings, and industrial and commercial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress." According to the 1993 SNA, net acquisitions of valuables are also considered capital formation
9	Openness (TOP)	WDI	It measures the degree of trade openness, which is equal to the sum of imports and export of goods and services divided by GDP
10	Real Effective Exchange Rate (LREER)	WDI	Real effective exchange rate is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs
11	Inflation (INF)	WDI	have used GDP deflator as proxy for inflation because it is consider a best estimator, it covers the entire range of goods and service as compare to others inflation indicators

[2]Pakistan Bureau of Statistic.
[3]Pakistan Economic Survey.
[4]World Development Indicator.

Model Development

The following three models are used for domestic, external, and public debt.

$$LGDP = f(EDG, EDSG, GFCFG, TOP, REER) \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

$$LGDP = f(DDG, DDSG, GFCFG, MG, INF) \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

$$LGDP = f(PDG, PDSG, GFCFG, MG, INF, TOP, LREER) \quad \ldots \quad \ldots \quad (3)$$

LRGDP is log of GDP at factor cost which is a dependent variable in all three equations. EDG is external debt as percent of GDP, EDSG is external debt servicing as percentage of GDP, GFCFG is gross fixed capital formation, TOP is trade openness, REER is real exchange rate, DDG is domestic debt as percent of GDP, DDSG is domestic debt service as percent GDP, MG is money supply measured as percent of GDP, and INF is inflation. Variables selection is supported by economic theory and empirical literature. For example, in the short-run external debt my enhance capital accumulation and productivity and hence lead to economic growth [Chaudary (2001)] while, high debt accumulation may worsen economic growth and investment as in future debt may be higher than country repayment debt ability, thus anticipated debt cost will decease domestic as well as foreign investment [Karagol (2002); Krugman (1988)]. One of the important channels through debt affects economic growth negatively is known as "crowding out" effect. A major part of the foreign capital will be used for the payment of debt services rather than investment and development projects. It is also known that total debt reduces human and capital productivity and hence economic growth [Cunningham (1993)]. It is also observed by Were (2001) that external debt obligation has a deleterious impact on private investment and economic growth. Debt service has significant impact on the gross fixed capital formation and hence economic growth [Adesola (2009)]. The increase of external debt servicing left little room to finance the development projects, thus saving and investment decrease and lead to depress the economic growth [Malik, *et al.* (2010)].

A series of paper observe positive impact of trade openness on economic growth [Dollar (1992); Sachs, *et al.* (1995); Edwards (1998); Willard (2000)]. Edward (1998) points out that trade openness increase productivity of the respective country and hence economic growth. The positive relation between trade openness and may exist if the trade openness is upheld by investment in human capital [Chang, *et al.* (2005)]. Trade openness may be worse for economic growth of a country when it is specialised in the production of low quality goods, but it is observed that trade openness will improve the economic growth of a country when it has specialisation in the production of high quality good [Huchet-Bourdon, *et al.* (2011)].

Many studies conclude significant impact of real effective exchange rate on the economic growth as Yan, *et al.* (2016) have confirmed in their study that depreciation of real effective exchange rate has a significant positive impact on net export that lead to economic growth. But new structuralist school of thought oppose the depreciation of currency and they give an arguments that "on demand the depreciation of currency will switch of income from worker , who have fixed nominal wages, to capitalists with higher propensity to save, which will reduce demand and, thus output and on supply side the devaluation of currency will adversely affect production because of rise in the price of

intermediate input imported from other countries" [Krugman and Taylor (1978); Wijinbergen (1986)].

There is negative relation between price and economic growth [Kasidi and Mwakanemela (2013); Barro (1995)]. In the short-run inflation may increase economic growth but its impact become negative beyond a specific threshold value, that shows a non-linear relationship between inflation and economic growth [Ayyoub, *et al.* (2011); Khan and Senhadji (2001)]. Mundell (1965) and Tobin (1965) concludes that the rate of inflation increases the rate of capital and hence, lead to economic growth.

As well as money supply is concerned, various studies have shown ambiguous result for the impact of money supply on economic growth. Hsing (2005) has shown in his study that increase in money supply will decline nominal interest rate, which will lead to increase in investment and hence, rise in economic growth. Increase in money supply increase growth but lead to inflation [Tabi and Ondoa (2011)].

Econometrics Procedure

This section provides the specification of different econometric procedure used in the study.

(a) *Significance of Structural Break*

We use Chow test developed in 1960 to check the significant impact of structural beak or shock on the economic growth of Pakistan. The general equation of the test is as under;

$$Y_t = \alpha + \beta X_{1t} + \gamma X_{2t} + \varepsilon \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

This equation can be written in two sub groups. Such as:

$$Y_t = \alpha_1 + \beta_1 X_{1t} + \gamma_1 X_{2t} + \varepsilon \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4.1)$$

$$Y_t = \alpha_2 + \beta_2 X_{1t} + \gamma_2 X_{2t} + \varepsilon \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4.2)$$

While it is assumed that the error term "ε" of the model are identically normally distributed, which can be written as;

$\varepsilon \sim iid\ (0,\sigma^2)$

The null and alternate hypothesis for chow test can be expressed as;

H_0: $\alpha_1 = \alpha_2$, $\beta_1 = \beta_2$, $\gamma_1 = \gamma_2$
H_1: $\alpha_1 \neq \alpha_2$, $\beta_1 \neq \beta_2$, $\gamma_1 \neq \gamma_2$

The F statistic of the chow test is expressed as

$$F = \frac{(SSQ_c - (SSQ_1 + SSQ_2))/k}{(SSQ_1 + SSQ_2)/(N_1 + N_2 - 2K)} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

SSQ_c represents sum Of square of combine Equation (4), which is also called restricted sum of square (RSS), SSQ_1 shows sum of square of first sub Equation (4.1) and "SSQ_2" is sum of square of second sub equation (4.2). While "k" and "$N_1 + N_2 - 2K$" are degrees of freedom. Null hypothesis will be rejected, if the value of F calculated is greater than F tabulated.

(b) *Stationarity Tests*

To check stationarity of the variables, we use modified version of Augmented Ducky and Fuller test introduced by Perron (1989) that includes dummy variables to account for one known /exogenous structural change in the economy. Model (6) allows for a break in intercept or level of series, model (7) allows for a break in in the slope and model (8) allows for both intercept and slop.

$$\Delta Y_t = \delta_0 + \delta_1 DU_t + d(DTB)_t + \delta_t + \eta Y_{t-1} + \sum_{i=1}^{k} \emptyset \Delta Y_{t-i} + e_i \quad \ldots \quad (6)$$

$$\Delta Y_t = \delta_0 + \gamma DT_t^* + \delta_t + \eta Y_{t-1} + \sum_{i=1}^{k} \emptyset \Delta Y_{t-i} + e_i \quad \ldots \quad \ldots \quad (7)$$

$$\Delta Y_t = \delta_0 + \delta_1 DU_t + d(DTB)_t + \gamma DT + \delta_t + \eta Y_{t-1} + \sum_{i=1}^{k} \emptyset \Delta Y_{t-i} + e_i \quad \ldots \quad (8)$$

Where the "*i*" represent interval of time period, η represent Parameter, *t*-1 indicate first lag, Δ represent first difference operator, e=error term , DU_t is intercept dummy (shows change in level), DU_t will be equal to 1 if $t >$ TB(break date) and zero otherwise, DT_t (also DT_t^*)is slope dummy (indicates change in the slope of the trend function) DT_t^* will be equal to *t*-TB (or DT_t *= *t* if *t* > TB) and zero otherwise and DTB represent crash dummy that will be equal to 1 if *t* = TB +1, and zero otherwise and TB indicate break date.

(c) ARDL Bound Test for Co-integration

ARDL bound test is used to determine the short-run and long-run relationship of external and domestic debt with economic growth. One of the main advantages of ARDL approach is that it also encounters short-run analysis along long-run. Other advantages of ARDL is that it can be used for time series data analysis integrated with I (0) and 1(1) or the mixture of both, but not applicable in case of I(2). ARDL model can be written as;

Model 1 for External Debt

$$\begin{aligned}\mathrm{LGDP}_t = {} & \gamma_0 + \sum_{i=1}^{n} \gamma_{1i} \Delta \mathrm{LGDP}_{t-i} + \sum_{i=1}^{n} \gamma_{2i} \Delta \mathrm{EDG}_{t-i} + \sum_{i=1}^{n} \gamma_{3i} \Delta \mathrm{EDSG}_{t-i} + \\ & \sum_{i=1}^{n} \gamma_{4i} \Delta \mathrm{GFCFG}_{t-i} + \sum_{i=1}^{n} \gamma_{5i} \Delta \mathrm{TOPEN}_{t-i} + \sum_{i=1}^{n} \gamma_{6i} \Delta \mathrm{REER}_{t-i} + \delta_1 \mathrm{LGDP}_{t-1} \\ & + \delta_2 \mathrm{EDG}_{t-1} + \delta_3 EDSG + \delta_4 \mathrm{GFCFD}_{t-1} + \delta_5 TOPEN_{t-1} + \delta_6 \mathrm{REER}_{t-1} + \varepsilon t \quad \ldots \quad (9)\end{aligned}$$

Model 2 for Domestic Debt

$$\begin{aligned}\mathrm{LGDP}_t = {} & \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta \mathrm{LGDP}_{t-i} + \sum_{i=1}^{n} \alpha_{2i} \Delta \mathrm{DDG}_{t-i} + \sum_{i=1}^{n} \alpha_{3i} \Delta \mathrm{DDSG}_{t-i} + \\ & \sum_{i=1}^{n} \alpha_{4i} \Delta \mathrm{GFCFG}_{t-i} + \sum_{i=1}^{n} \alpha_{5i} \Delta \mathrm{MG}_{t-i} + \sum_{i=1}^{n} \alpha_{6i} \Delta \mathrm{INF}_{t-i} + \beta_1 \mathrm{LGDP}_{t-1} \\ & + \beta_2 DDG_{t-1} + \beta_3 DDSG_{t-1} + \beta_4 GFCG_{t-1} + \beta_5 MG_{t-1} + \beta_6 INF_{t-1} + \varepsilon t \quad \ldots \quad (10)\end{aligned}$$

Model 3 for Public Debt

$$\begin{aligned}\mathrm{LGDP}_t = {} & \delta_0 + \sum_{i=1}^{n} \theta_{1i} \Delta \mathrm{LGDP}_{t-i} + \sum_{i=1}^{n} \theta_{2i} \Delta \mathrm{PDG}_{t-i} + \sum_{i=1}^{n} \theta_{3i} \Delta \mathrm{PDSG}_{t-i} + \\ & \sum_{i=1}^{n} \theta_{4i} \Delta \mathrm{GFCFG}_{t-i} + \sum_{i=1}^{n} \theta_{5i} \Delta \mathrm{HC}_{t-i} + \sum_{i=1}^{n} \theta_{6i} \Delta \mathrm{PG}_{t-i} + \eta_1 \mathrm{LGDP}_{t-1} + \\ & \eta_2 PDG_{t-1} + \eta_3 PDSG_{t-1} + \eta_4 GFCG_{t-1} + \eta_5 HC_{t-1} + \eta_6 PG_{t-1} + \varepsilon t \quad \ldots \quad (11)\end{aligned}$$

ε_t is error term at time t, n is optimal lag length, Δ is difference operator, whereas δ , β and η are long-run parameters, γ, α and η are short term parameters. The null and alternate hypothesis for long run relationship for Equation (9) can be written as;

$H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$ (No long run co-integration)
$H_1: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq 0$ (Long run co-integration)

Thus, for Equation (10) can be written as;

$H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$ (No long run co-integration)
$H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$ (Long run co-integration)

Hypothesis of Equation (11) is as follows;

$H_0 = \eta_1 = \eta_2 = \eta_3 = \eta_4 = \eta_5 = \eta_6 = 0$ (No long-run co-integration)
$H_0 = \eta_1 \neq \eta_2 \neq \eta_3 \neq \eta_4 \neq \eta_5 \neq \eta_6 \neq 0$ ((Long run co-integration))

The null hypothesis of co-integration is tested on the basis of ARDL bound test, for this purpose F-static is employed in bound test. If the value of F-statistic is greater than upper bound value then null hypothesis of no co-integration is rejected. If the F-statistic value is lies between upper and lower bound the results are inconclusive while if F-statistic value is less than lower bound value, we cannot reject null hypothesis.

(d) Threshold Model

Threshold model divides nonlinear region into two or more regions of linear specification and determines a threshold or range of threshold values beyond which the effect of the observed variable becomes negative on given variable. Our purpose is to estimate separate threshold models for domestic, external and public debt beyond which economic growth become negative. For this purpose we use threshold model which combines specification of "Threshold Autoregression (TAR) and self-exciting Threshold Autoregression (SETAR)" of Hansen (1999, 2011) and Potter 1999).

Optimal Model for External Debt

$$Y_t = \beta_0 EDG_t + \beta_1 EDSG_t + \beta_3 GFCFG_t + \beta_4 TOP_t + \beta_5 REER + D_t \quad D_t \leq \gamma \quad (12.1)$$

$$Y_t = \beta_0 EDG_t + \beta_1 EDSG_t + \beta_3 GFCFG_t + \beta_4 TOP_t + \beta_5 REER + D_t \quad D_t > \gamma \quad (12.2)$$

Optimal Model for Domestic Debt

$$Y_t = \beta_0 DDG_t + \beta_1 DDSG_t + \beta_3 GFCFG_t + \beta_4 MG_t + \beta_5 INF_t + D$$
$$D_t \leq \gamma \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots (13.1)$$

$$Y_t = \beta_0 DDG_t + \beta_1 DDSG_t + \beta_3 GFCFG_t + \beta_4 MG_t + \beta_5 INF_t + D_t$$
$$D_t > \gamma \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots (13.2)$$

Optimal Model for Public Debt

$$Y_t = \beta_0 PDG_t + \beta_1 PDSG_t + \beta_2 GFCFG_t + \beta_3 MG_t + \beta_4 INF_t$$
$$+ \beta_5 TOP_t + \beta_6 REER_t + D_t$$
$$D_t \leq \gamma \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots (14.1)$$

$$Y_t = \beta_0 PDG_t + \beta_1 PDSG_t + \beta_2 GFCFG_t + \beta_3 MG_t + \beta_4 INF_t$$
$$+ \beta_5 TOP_t + \beta_6 REER_t + D_t$$
$$D_t > \gamma \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots (14.2)$$

D_t is the threshold variable that is used to split the sample into two regions, called classes or regimes, it will be 1 if domestic, external or public debt to GDP ratio exceeds from growth maximising threshold value, otherwise 0. Where, γ is unknown threshold β_i are coefficients. Methodology of Bai and Perron (1998) is used to estimate values of thresholds that is preferred to fixed regression bootstrap procedure as suggested by Hansen (1999).

4. RESULTS AND DISCUSSION

This section comprises unit root test, chow test, ARDL bound to Co-integration test, Diagnostic test for ARDL bound test, Granger Causality test for each model.

(a) Lag Selection Criterion

Before estimation through ARDL bound to co-integration approach, the optimal lag length for unrestricted error correction model (UECM) should be selected. For this purpose we use vector autoregression (VAR) lag order selection criteria and select optimal lag length on the basis of Akaike information criterion (AIC), Schwarz information criterion (SC), Hannan-Quinn information criterion (HQ). Table 3 shows that optimal lag length for external debt is 1, while for domestic and public debt optimal lag length is 1.

Table 3

VAR Lag Order Selection Criteria

S.	External Debt Model			Domestic Debt Model			Public Debt Model		
No.	AIC	SC	HQ	AIC	SC	HQ	AIC	SC	HQ
0	13.58	13.80	13.6	22.57	22.84	22.66	24.80	25.20	24.90
1	5.23	6.58*	5.69	11.87	13.76*	12.52*	12.34*	15.58*	13.45*
2	4.85*	7.32	5.63*	11.43*	14.94	12.62	12.60	18.70	14.70

*Specifies maximum lag length order. Test are performed at 5 percent level.

(b) Chow Break Test

To check the significance impact of 1998 restriction imposed by USA on the economy we apply chow break point test.

Table 4 shows that F-statistic is significant at 10 percent, log likelihood and Wald statistic are significant at 1 and 5 percent respectively, thus we can reject null hypothesis of no structural break in the model which shows 1998 US sanctions have significant impact. The results also confirmed by Morrow and Carrier (1999) and Abbasa (2007).

Table 4

Chow Break Test

	F-statistic	Pro(F)	Log Likelihood Ratio	Prob. Chi-Square(6)	Wald Statistic	Prob. Chi-Square (6)
External Debt Model	2.41	0.06	16.98	0.01	14.46	0.02
Domestic Debt Model	2.21	0.08	15.83	0.01	13.26	0.04
Public Debt Model	2.37	0.06	24.00	0.00	18.95	0.02

(c) Modified ADF Unit Root Test

Results of modified version of augmented dickey fuller unit root test are reported in Table 5.

Table 5

Unit Root Test of All Variables Used in all Models

Variables	Mod ADF-level	Mod ADF-1st diff	Decision
RGDP	–3.56	–7.16*	I(1) with trend and intercept
EDG	–3.05	–5.49*	I(1) with trend and intercept
ESG	–3.72	–5.92*	I(1) with trend and intercept
GFCFG	–3.84	–5.54*	I(1) with trend and intercept
TOPEN	–3.59	–8.71*	I(1) with trend and intercept
REER	–3.12	–7.37*	I(1) with trend and intercept
DDG	–5.27**	–6.73*	I(0) with trend and intercept
DSG	–3.85	–6.13*	I(1) with trend and intercept
MG	–4.69***	–6.10*	I(0) with trend and intercept
INF	–4.89**	–7.63*	I(1) with trend and intercept
PDG	–4.39	–5.63*	I(1) with trend and intercept
PDSG	–4.83**	–7.48*	I(0) with trend and intercept

Level of significance:* 1 percent, * * 5 percent, *** 10 percent.

(d) ARDL Bound Test

In this section, we estimate ARDL bound test to check short-run and long-run cointegration between real GDP and among all other explanatory variables, mentioned in Equations 9, 10 and 11. The results are reported in Table 6.

Table 6

Critical Values of Bound Approach

F-statistics				External and Domestic Debt				Public Debt Model			
External Dent	Domestic Debt	Public Debt	Sig.	I(0) Bound	I(1) Bound	I(0) Bound	I(1) Bound	I(0) Bound	I(1) Bound	I(0) Bound	I(1) Bound
9.08	7.21	7.42	10%	2.12	3.23	2.51	3.76	2.03	3.13	2.30	3.60
			5%	2.45	3.61	3.04	4.44	2.32	3.50	2.75	4.21
			1%	3.15	4.42	4.26	6.04	2.96	4.68	2.75	5.69
				Pesaran and Shin (1997)		Naryan (2005) Critcal Values		Pesaran and Shin (1997)		Naryan (2005) Critcal Values	

The critical value of Pesaran and Shin (1998) and Pesaran, *et al.* (2001) are generated for large sample size 500 and 1000 respectively observations [Naryan and Smyth (2005)], thus for small sample size these critical values are inappropriate. Therefore, we check with the critical values generated by Narayan (2005). The F-statistic values of external debt model (9.08), domestic debt model (7.21) and Public debt model (7.42) are greater than the upper bound value of Narayan (2005) critical values. Therefore, long-run relationship is confirmed between growth in Real GDP and all other exogenous variables. The next step is to estimate the Error Correction for all of three models.

In Table 7 differential variables indicate short-run relationship and non-differential variables are showing long-run relationship and error correction of all of three models are statistically significant. External debt model indicates annually 10 percent convergence of economic growth towards long run equilibrium. The results point out that External debt as percent of GDP has negative and significant impact on economic growth. Similar findings are reached by many previous studies. For example, Munir, *et al*. (2016) found negative and, Ali and Mustafa (2012) found negative association between external debt and economic growth and confirmed the debt overhang problem. The estimated coefficient of external debt service shows a positive but insignificant impact on real GDP in the short-run but in the long run it becomes negative. This negative relationship is also confirmed by Malik, *et al.* (2010) and Karagöl (2002). Our finding of positive and significant relationship between gross capital formation and economic growth are also supported by Aurangzeb and Haq (2012) and Ali, *et al.* (2012).

The depreciation of local currency is found to have negative and significant impact on economic growth. Agénor (1991) and Gala (2008) have proved in their studies that mild depreciation of exchange rate improves economic growth. Trade openness has negative but insignificant relation with real GDP in the short-run but in long run this relation becomes positive and significant. Siddiqui and Iqbal (2005) report similar findings for Pakistan while Yucel-Hong (2009) reach the same conclusion for Turkey. The negative relation between trade openness and economic growth may be because of heavy dependence on exports of raw material instead of finished goods [Ali and Abdullah (2015)].

The results of domestic debt model point out annul convergence of 5 percent for economic growth. The results also highlight the positive effect of domestic debt in short-run but negative and significant impact in the long-run on economic growth. This result is fully supported by Sheikh, *et al.* (2010) and Babu, *et al.* (2015). The negative impact of domestic debt on economic growth can be attributed to decline in the financing of health, education, basic infrastructure and other essential service [Kiringai (2002)]. The results illustrate that gross fixed capital formation improves economic growth in short-run yet in long-run its impact impact becomes insignificant. This phenomenon is well explained by Ali, *et al.* (2012) and Lipsay (1999). Both in short and long run money supply has a significant positive impact on real GDP. This finding is in line with the conclusions of Hsing (2005) and Boweni (2000). Results indicate that inflation is positively linked with economic growth both in short and long-run. Akram (2011) also report positive relation between prices and economic growth in case of Pakistan. Malik and Chowdhury (2001) advocate the positive relation between inflation and economic growth for the case of South Asian countries. Results also reveal that US 1998 sanctions have negative impact both in short and long-run.

Our third model of public debt demonstrates that economic growth converges to equilibrium with the speed of 7.7 percent annually. Other results show that public debt has negative and significant impact on economic growth in short as well as in long-run. Dinca (2013) report that public debt significant negative impact on economic growth. Gross fixed capital formation once again shows positive impact on economic growth in short and long-run. Similar results are reached by Atique and Malik (2012), Pattillo, *et al.*

Table 7

Table 7

Short and Long-Run Coefficient Estimates

External Debt Model				Domestic Debt Model				Public Debt Model			
S.run Coefficient		L.Run Coefficient.		S.run Coefficient		L.Run Coefficient.		S.run Coefficient		L.Run Coefficient	
dLGDP(-1)	–0.546**	EDG	–0.023**	dLGDP(-1)	–0.559*	DDG	0.054**	dPDGD	–0.002**	PDG	–0.031**
dEDG	–0.006*	EDSG	–0.532*	dDDG	0.001	DDSG	–0.435**	dPDSG	0.002	PDSG	0.027
dEDG(-1)	–0.002**	GFCFG	0.097**	dDDG(-1)	–0.001	GFCFG	–0.056	dGFCF	0.004	GFCFG	–0.099*
dEDSG	0.005	REER	–0.005*	dDDSG	–0.009*	MG	0.098*	dINF	–0.001	INF	–0.009
dGFCFG	0.013*	TOPEN	–0.044**	dGFCFG	0.008*	INF	0.053*	dM2	0.002	MG	0.021
dGFCFG(-1)	–0.003	DUM98	–0.179**	dMG	0.005*	DUM98	0.613*	dTOP	–0.001	TOP	–0.011
dREER	–0.001*	C	17.93*	dINF	0.002*	C	13.378*	dLREER	–0.109**	LREER	–1.415**
dTOPEN	–0.001			dDUM	–0.078*			DUM98	–0.030**	DUM98	–0.149
dDUM98	–0.038*			ecm(-1)	–0.051*			ecm(-1)	–0.077*	C	25.98*
ecm (-1)	–0.102*										
R-squared	0.917			R-squared	0.821			R-squared	0.840		
F-statistic	10.415			F-statistic	5.499			F-statistic	9.338		
Prob(F)	0.0001			Prob(F-statistic)	0.000			Prob(F-statistic)	0.001		

Level of significance:* 1 percent, * * 5 percent, *** 10 percent.

(2002) and Abbas (2007). Inflation, money supply and trade openness has insignificant impact on economic growth. Real effective exchange rate and economic growth has negative relation which reveals that depreciation of Pakistan currency relative to other currencies will deter economic growth.

(e) Diagnostic Test for ARDL Bound Test

Table 8

Results of Diagnostic Tests for ARDL Bound Test

	External Debt Model		Domestic Debt Model		Public Debt Model	
Diagnostic Test	F- Statistic	P-value	F- Statistic	P-value	F- Statistic	P-value
Serial Correlation (LM Test)	1.91	0.18	2.17	0.13	2.43	0.12
Hetroskedasticity (ARCH Test)	0.51	0.68	0.23	0.79	0.07	0.93
Normality Test (Jarque-Bera)	0.60	0.74	2.94	0.23	1.11	0.57
Model specification (Ramsey Reset)	3.95	0.07	0.37	0.69	0.89	0.43

The reliability of ARDL test for all three models is tested through different diagnostic tests i.e. LM, ARCH, Jarque-Bera and Ramsey Reset test which show that model does not face have any major drawback.

(f) Threshold Regression Model

Table 9 presents the threshold values for domestic, external and public debt of Pakistan.

Table 9

Threshold Value for External, Domestic and Public Debt

	External Debt as Threshold Variable				Domestic Debt as Threshold Variable				Public Debt as Threshold Variable	
	EDG < 29.33	29.33 <= EDG < 34.25	34.25 <= EDG		DDG < 28.26	28.26 <= DDG < 35.33	35.33<= DDGDP		PDGD < 68.18	68.18<= PDGD
Variable	Coeff.	Coeff.	Coeff.	Variable	Coeff.	Coeff.	Coeff.	Variable	Coeff.	Coeff.
C	-0.011	-0.168	0.369*	C	-0.147**	-0.047	-0.011	C	0.039	0.336*
	(0.092)	(0.131)	(0.115)		(0.052)	(0.089)	(0.072)		(0.074)	(0.091)
EDG	0.001	-2.77E-05	-0.006*	DDG	0.025*	0.003	-0.005*	PDGD	-0.001	-0.003***
	(0.002)	(0.001)	(0.001)		(0.004)	(0.003)	(0.002)		(0.002)	(0.001)
EDG(-1)	0.005*	0.003	-0.003**	DDG(-1)	0.002*	-0.003	-0.006**	PDGD(-1)	0.002	-0.004
	(0.002)	(0.005)	(0.001)		(0.001)	(0.003)	(0.002)		(0.001)	(0.001)*

Level of significance:* 1 percent, * * 5 percent, *** 10 percent.

Results reported in table 10 show that the threshold value of external debt as percentage of GDP ranges from 29.326 to 34.25. If level of external debt is less than 29.32 percent of GDP, then current level of external debt has no statistically significant impact on real GDP and previous year's level of external debt cause real GDP to increase by 0.005 percent. External debt shows no impact on real GDP when it is in the range of 29.32 to 34.25 percent of GDP. But when External debt approaches or exceeds 34.3percent of GDP then real GDP tends to decrease and if external debt increases further then decline in real GDP in current year 0.006 percent. The negative effect of external debt on growth after the threshold level is due to overhang problem [Ali and Mustafa (2012); Ali and Sadraoui (2013); Pattillo, *et al.* (2002); Pattillo, *et al.* (2004) and Celemet, *et al.* (2003)].

The estimated threshold value for domestic debt as percentage of GDP ranges from 28.26 to 35.32. If level of domestic debt is less than 29.329 percent of real GDP, then previous and current level of domestic debt has positive impact on real GDP. previous year domestic debt causes real GDP to increase by 0.002 percent and in current year increase in level of domestic debt causes real GDP to increase by 0.025 percent. In the range from 28.261 to 35.329 percent it has no impact on real GDP. But when domestic debt approaches or exceed 35.32 percent of GDP then real GDP tends to decrease. If domestic debt increases any further then, in previous year real GDP has shown decline by 0.026 percent but in current year decline in real GDP is 0.009 percent.

The results indicate that below the level of 68.18 percent of real GDP, increase in public debt has insignificant impact on economic growth but when debt to GDP ratio exceed this limit then extra accumulation of debt deter economic growth. Beyond 68.18 one percent increase in debt as percent of GDP will decrease economic growth by 0.003 percent. Checherita and Rother (2010) indicate that there are various channels through which public debt affects economic growth such as total factor productivity (TFP), private saving, sovereign long-term nominal and real interest rates, and public debt.

Our findings of threshold level of debt are consistent with previous studies on developing countries. Caner, *et al.* (2010) estimates an optimal value of 64 percent for public debt to GDP ratio for developing countries. However, our estimated threshold level of public debt is lower as compared to estimated threshold value for developed countries but higher than developing countries.

At the end we would like to mention some of the short comings of our analysis. Although the model used in this research is supported by a series of papers mentioned above but different studies [Pescatori, *et al.* (2014); Baglan and Yoldas (2013); Eberhardt and Presbitero (2013); Minea and Parent (2012)] could not find robust non-linear nexus between debt and economic growth. Greiner (2012) also criticised the non-linear relation and he concluded that there is no well specified model that can confirm non-linear relationship between debt and economic growth. Therefore, the results of our study need to be carefully interpreted.

5. CONCLUSION

Public debt both external and domestic debt are important tolls to finance twin deficit. From several decades Pakistan is heavily dependent upon debt. However, several studies have proved that debt is beneficial for economy only up to a certain level. The key motivation of our study was to find the long-run and short-run effect of external and domestic and public debt on real GDP along with estimation of threshold value for three kinds of debts. ARDL bound test threshold models were used to achieve the objective.

ARDL Bound test reveals that there exists long-run co-integration between real GDP and external domestic and public debt and other control variables as debt services, gross fixed capital formation, trade openness and real effective exchange rate. Threshold model reveals non-linear relationship between external, domestic and public debt with real GDP and shows that external, domestic, and public debt turn bad at 34, 35 and 68 percent of GDP respectively. This shows that tipping point found in this study are below the current level of domestic (44.5 percent) debt and well above the current level of external debt (19 percent) measured as share of GDP.

Our findings have strong implications for policy-makers in Pakistan. First, debt accumulation must be checked and should be brought around the estimated threshold levels. Second, as the tipping point of external debt is above the current level of external debt government should resort to external sources instead of domestic debt sources. The domestic sources seems to be already exhausted as tipping point of domestic debt is above the estimated threshold level of domestic debt. To achieve above mentioned objective government need to show will to increase tax to GDP ratio to generate extra revenue. Exports need to be encouraged to fill trade deficit; this in turn is expected to discourage excess accumulation of public debt. Finally, enforcement of debt limitation act 2005 must be ensured to save economy from the negative impacts of excessive borrowing by the government. However the ceiling of 60 percent debt to GDP ratio given in the act may be reconsidered.

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