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From Judgmental Projection to Time Series Forecast: Does it Alter the Debt Sustainability Analysis of Bangladesh?

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Debt Sustainability Analysis (DSA) conducted by the multilateral organisations like the World Bank and IMF falls under the domain of Judgmental Projection reflecting their views or judgment about the economy. The study incorporates time series forecast using ARIMA method to analyse debt sustainability in practice in Bangladesh. More specifically, macro, fiscal, current account and debt variables have been forecasted according to the requirement of debt sustainability framework (DSF) for use in a standard DSA template. Using the time series forecast based inputs, the study concludes that debt is sustainable for Bangladesh for the period 2013-2033 based on the standard country specific debt burden threshold. The study notes that the results produced by different methodologies broadly follow similar path. However, time series forecasts imply a better economic situation in terms of improved repayment capacity compared with judgmental projection.

Keywords: DSA, Bangladesh, ARIMA, Time Series Forecasting
JEL Classification: C22, C53

I. INTRODUCTION

Bangladesh has showed reasonable success in debt management over the past decades. In 2012, the external debt of Bangladesh was 23.5 billion US dollars and domestic debt was 1602.5 billion taka.[1] Though the share of external and

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[1]The source of external debt is Flow of External Resources into Bangladesh, published by Economic Relations Division (ERD) of Ministry of Finance. The source of domestic debt is Statistics Department and Monetary Policy Department of Bangladesh Bank.

domestic debt in the total debt to GDP are very close to each other (external debt to GDP ratio was 20.32 per cent and domestic debt to GDP ratio was 17.52 per cent in 2012), this has not always been the case in the past. The external debt to GDP ratio reached around 45 per cent in the mid 1990s and then it gradually went down in the subsequent years. On the other hand, domestic debt to GDP rate stayed at 16.91 per cent of GDP on average for the last ten years. Though debt management has been a success so far, constant monitoring on debt situation is required for Bangladesh as the budget deficit is filled up by taking loans from both domestic and external sources. Any mismanagement in borrowing strategy might later trigger a debt debacle. This is what happened in the European countries such as Greece which shows even advanced countries are not immune from debt distress. At the same time, successful debt management requires a careful evaluation of repayment capacity as continuous improvement in repayment capacity can only keep a country outside of debt distress. Debt sustainability analysis (DSA) is carried out to systematically evaluate all these aspects. From the policy maker's point of view, the outcome of the debt sustainability analysis is very important as a positive outcome (i.e. sustainability of debt) indicates a stable macroeconomic scenario, which implies that the country would be able to pay off the debt without facing problems. Failure to achieve sustainability would result in having resort to policy options that might be unpopular (i.e. cutting back government expenditure to achieve sustainability). That is why sustainability requires the country to repay the whole principal and service the interest payment without having resort to any major change in macroeconomic policy. Even though debt sustainability is directly related to the borrowing country in a sense that the country must have a clear idea about its own capability to repay and service the debt, the lending country or institutions are interested in examining the capabilities of the borrowing countries before they issue any loan. This is why the major lending institutions like the World Bank (WB) and the International Monetary Fund (IMF) started conducting DSA on a regular basis with the help of host countries' Government. This practice has been going on since the late 2000s.

With this end in view WB and IMF have jointly developed a DSA template to provide a standardised DSA for all the low-income countries (LICs) and other countries. Before the introduction of this template, the DSAs were conducted by the authorities by using qualitative information in an unstructured form and the results were not comparable across countries and over time. This encouraged WB and IMF to prepare a standardised DSA template and all the borrowing countries are encouraged to conduct DSA by using the same format with the help of WB

and IMF experts. Countries that conducted DSA so far include LICs such as Bhutan, Ghana, Nepal, Nigeria, Rwanda, Senegal and Somalia. Bangladesh, which is a moderately indebted low-income country, conducted DSA in 2006, 2008, 2009, and 2011 with the help of WB and IMF.[2]

The nature of existing DSA is forward-looking as it involves projection of macroeconomic outlook of future (IMF 2003). The Bank-Fund's methodology can be termed as judgmental projection.[3] Judgmental projection includes the view of the Bank-Fund authority about the evolution of indebtedness and repayment capacity of a particular economy. As Bank-Fund publishes these DSAs for a large number of countries regularly, judgmental projection allows them to respond to the change in the economy by changing the projections quickly. At the same time, Bank-Fund DSAs are done from creditor's perspective. So their judgment essentially entails the view of the creditors.

An alternative candidate for judgmental projection is known as time series forecast. In contrast to judgmental projection, time series forecast draws information from the past and draws the future exclusively on the basis of it. It does not include any qualitative judgments. This sort of forecasting depends on statistical modeling techniques. The critical assumption behind this analysis is that the historical pattern will continue in the forecast horizon.

For our study purpose, we conduct the debt sustainability analysis of Bangladesh (DSA 2012) using time series forecast for the horizon 2013-2033. The motivation to embark upon such a study is quite simple. The DSA has been implemented for Bangladesh five times till now by the Bank-Fund authority. Each time, they report that the debt is sustainable for Bangladesh. As their results incorporate judgment about the economy, we want to see whether deriving forecast based on the history keeps the debt of Bangladesh sustainable. This is particularly important for four reasons. *First*, using time series forecast gives us the opportunity to extract information from the history. Assuming past trend will follow in future, it gives us the evolution of future scenario based on the past information. *Second*, unlike the judgmental projection, time series forecast does

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[2]In 2005, a DSA for Bangladesh was conducted by the World Bank and the IMF. However, it was a preliminary attempt to conduct DSA as the format of this DSA was very simple in nature (i.e. projection horizon was only five years) compared to the later DSAs.

[3]It is a common practice to term the institutionalised forecast as judgmental projection/forecast. For example, see Bowman and Husain (2004). In their work, they term the projection of World Bank and IMF as Judgmental forecast.

not incorporate any view of either borrower or creditors, as it entirely relies on the history. This helps us to assess the result from a neutral perspective. At the same time, judgment is difficult to replicate as it depends on many factors (for example nature of the institutions, objective of the institution, etc). On the other hand, time series forecast depends on data and selected statistical model. So it is easy to replicate the result. *Third*, the template uses ten years of historical data for conducting stress tests. On the other hand, we use over thirty years of data for forecasting purposes. At the same time, by using the template we conduct stress tests as well. So, bank-fund authority uses historical data for conducting stress tests only, while we use historical data for conducting both forecast and stress tests. *Fourth*, when forecast about future is made, it is essential to use different methods and see the difference in the results. If the difference between historical data based forecast and judgmental projection is huge, it implies the expectation about future outcome is different than the past outcome. At the same time, minimal difference between the two types of method implies that judgment is broadly in line with the history.

For this purpose, we propose a two step procedures. At the beginning, we use time series techniques to forecast the explanatory variables. These variables are required for assessing debt sustainability. We make forecasts for the explanatory variables using ARIMA (Auto regressive integrated moving average) models. It should be mentioned that time series analysis, especially ARIMA analysis, is extensively used in the literature to forecast macroeconomic variables. [4] Then we insert these forecasts in a standard debt sustainability analysis template (developed by the Bank-Fund authority) to calculate debt indicators. Then the values of these debt indicators are compared against standard country specific debt burden threshold to assess debt sustainability. At the same time, we compare our result with the result produced by the Bank-Fund authority for Bangladesh for all the earlier DSAs. This enables us to examine whether any kind of significant change takes place due to the change in methodology from judgmental projection to time series forecast.

The rest of this paper proceeds in the following way. Section II reviews the literature on various aspects of debt sustainability. Section III describes the fundamentals of joint Bank-Fund's debt sustainability methodology. Section IV

[4] For instance, Favero and Marcellino (2005) use ARMA among other forecast models to model and forecast fiscal variables for the EURO area. They note simple time series models outperform forecast based on multivariate time series models for modeling fiscal variables and macroeconomic variables. These variables are relevant to determine debt to GDP ratio or deficit to GDP dynamics for the large countries in the EURO area.

deals with the data. Section V provides the quantitative forecasts of the explanatory variables using ARIMA method. Section VI gives us the result of DSA by using the joint Bank-Fund debt sustainability template. The inputs inserted in this template are derived by using ARIMA forecasts. Section VII concludes the paper.

II. LITERATURE REVIEW

The concept of operational DSA is relatively new. However, some related concepts to DSA are found in the literature. Sustainability discussion starts with the concept of solvency. Chuhan (2005) defines solvency problem as a situation where countries might never be able to service their current debt out of own resources. Theoretically, it requires the present value of the future primary surplus exceeds the present value of future primary deficit by a sufficient amount that covers the initial debt stock and present value of the terminal debt stock (Chalk and Hemming 2000).[5] To evaluate solvency, Hamilton and Flavin (1986) use stationarity test. They apply Dickey-Fuller test on the data series of debt and primary surplus of United States for the period of 1962-1984 and find they are stationary. They further apply generalised Flood Garber tests and restricted Flood Garber test to assess their results. For example, Wilcox (1989) shows that the work of Hamilton and Flavin fails to capture a structural shift in the data. They show this structural shift indicates an unsustainable fiscal policy situation, whereas Hamilton and Flavin imply it to be sustainable. After that several studies also use cointegration concept to check for sustainability.[6]

Apart from these econometric studies, some studies use indicator approach. For example, Buiter (1985) uses permanent deficit (the deficit that can attain solvency if continued) concept and shows if the difference between permanent deficit and current deficit is negative, then current deficit is too large to stabilise debt ratio named net worth to output. So, in this case, fiscal policy would deem as unsustainable. Blanchard, Chouraqui, Hagemann and Sartor (1990) introduce an operational tax indicator based procedure based on this solvency criterion. They use tax based indicators that reflect the gap between sustainable tax rate (the constant tax rate which would earn enough surplus so that government's future surplus can pay off the current debt) and current tax rate. These studies

[5]This framework is based on closed economy (so that calculation of external debt is not needed). Similar types of relationship can be derived for current account and external debt.

[6]For a review, see Chalk and Hemming (2000).

share another common feature as they bring ex ante touch in the framework. For example, in the study of Blanchard *et al.* (1990), these gap based indicators are derived for three different time horizons in future, namely short term (one year), medium term (five years) and long term (forty years).

However, focusing on solvency condition poses weak restriction for operational purposes, as noted by Horne (1991) and Roubini (2001). For example, according to the theoretical criteria, a country could have a very large primary deficit for a long time as long as the discounted value of future primary surplus matches with current debt. However, there remain three practical problems with this criterion according to Roubini (2001). *First*, a government cannot credibly commit to such a path for a long time. *Second*, if a government takes high taxes to raise revenue at the distant future to make up for deficit, those taxes would hurt economic choices (labour, savings behaviour) in such a way which would in turn hurt economic growth in the long run. *Third*, if a government lowers long term expenditure to make up for large short term expenditure, it might create negative impact on the economy (i.e. it might be unfeasible or unfair).

Another branch of literature tries to find out the reasons for unsustainable debt situation. According to Berg and Sachs (1988), structural variables like extreme income inequality can cause heavy borrowing which might cause debt servicing problems. They explain that due to political pressure induced by extreme inequality, excessive borrowing might hamper macroeconomic management which, in turn, causes debt servicing problem. Recent studies on the causes of debt distress focus more on history and current policy. For example, Reinhart, Rogoff and Savastano (2003) note that the credit history of a country is very important to understand debt crisis. They denote credit history by indicators like percentage of years in the sample when a country is either in default on its external debt or undergoing restructuring of its debt, percentage of twelve months periods during a certain time period when annual inflation is very high (above 40 per cent), etc. They use two indicators, namely Institutional Investor Ratings (IIR) and external debt to GNP or external debt to export ratio. They assess the impact of credit history and external debt to GNP ratio on the perceived default risk as measured by IIR. They find, from the cross country results, that poor track record based on repayment or inflation lowers the IIR rating and increases the default risk. They also find that external debt to GNP ratio enters with negative coefficient for the perceived creditworthiness of the non-advanced countries (i.e. countries with low IIR) and opposite happens for advanced countries (i.e. countries with high IIR). Overall, their analysis indicates that previous

macroeconomic history of a country is relevant to forecast its ability to sustain various debt levels for many years into the future.

Kraay and Nehru (2006) supplement the above finding by saying not only the previous macroeconomic policy but also the contemporaneous policies and institutions matter to find out the likelihood of debt distress. The implication of this finding indicates improving the qualities of institutions and policies in the medium term improves the overall debt condition. The sample consists of 132 low-income and middle-income countries for the period 1970-2002. They identify debt distress episodes by indicating incidents like accumulation of large arrears and denoted normal times by mentioning five consecutive years when these debt distress episodes do not happen. They use probit regression model and three kinds of explanatory variables, namely traditional present value based debt burden indicators, qualities of policies and institutions as measured by CPIA (Country Policy and Institutional Assessments- an index published by World Bank), and shocks represented by real GDP growth, shock. They find debt distress incidence is positively correlated with debt burden indicators and is negatively correlated with quality of policy and institutions and shocks.

Manasee, Roubini and Schimmelpfenning (2003) use a panel data set for the period of 1970-2002 for market access countries to find out the role of macroeconomic fundamentals in affecting the risk of sovereign default and a debt crisis. They include the near default scenario (the default ultimately do not take place due to provision of large scale official financing by IMF) as well as original default scenario. They find that measures of solvency (such as high foreign debt to GDP), debt service obligations, low GDP growth and current account imbalance matter, among various other factors, for predicting crisis.

Following the work of Kraay and Nehru (2003), IMF (2004) too emphasises on the role of policy and institution. They derive country specific thresholds on the basis of probability of debt distress, situation of policy and institution shocks etc. This forms the empirical basis of the ex ante based operational debt sustainability framework jointly performed by World Bank and IMF for their member countries.

Now we look at the studies related to Bangladesh as we are examining the debt sustainability of Bangladesh. For ex post study, Islam and Biswas (2005) analyse the impact of interest rate, exchange rate, budget deficit and real GDP growth on the evolution of debt to GDP ratio for the FY1981-2006. They observe mixed trend in the debt to GDP ratio in the sample years. They also point out net effect of interest is stronger compared to real GDP growth and change in the

exchange rate on the evolution of debt to GDP. They observe the positive impact of declining fiscal deficit since the 1990s compared to previous decades, and its subsequent impact on the improvement of debt to GDP ratio. They also point out that the debt to GDP ratio of Bangladesh is low compared to South Asian countries like India, Pakistan and Sri Lanka. For ex ante studies, we have World Bank-IMF's debt sustainability analysis reports which are published in 2005, 2006, 2008, 2009 and 2011. For Bangladesh, they report sustainable debt situation in each publication. However, when domestic debt is included in the analysis, they express concerns regarding the contingent liabilities of Bangladesh.

Analysing the existing literature on the debt sustainability, we see a gap in the ex ante study which uses time series forecasts for analysing debt sustainability. More specifically, to the best of our knowledge, there is no ARIMA forecast based ex-ante study of debt sustainability analysis which uses an operational framework (Debt sustainability framework of Bank-Fund) and then compares the forecast against country specific debt burden threshold (such as Bank Fund's CPIA based threshold). The reason for the gap is that operational debt sustainability framework is mainly judgmental in nature, reasons for which we have discussed in section I. To accomplish our goal, we use the Bank-Fund DSA template to forecast debt sustainability of Bangladesh. We insert ARIMA based forecast of required macroeconomic variables into the template and get the result for debt burden indicators.

III. OVERVIEW OF DEBT SUSTAINABILITY FRAMEWORK

Debt sustainability framework (DSF) consists of concepts related to debt indicators, country specific debt burden thresholds and identities that are used in the template. Debt ratios that use present value of debt stock in the numerator are generally used to identify possible solvency problems (Painchaud and Stucka 2011). In the denominator, we use GDP, export and revenue for external debt stock. As a result, we have three indicators that are used to assess the external debt sustainability, namely PV of external debt to GDP, PV of external debt to export and PV of external debt to revenue. Now, a rising external debt to GDP ratio indicates that debt is growing faster than the size of the economy (Chuhan 2005). For public debt stock, we use GDP and revenue in the denominator. So, essentially we have two indicators, namely PV of public debt to GDP and PV of public debt to revenue. Another feature of the debt stock indicator is that it captures the future debt service burden inherent in the present debt (World Bank

and IMF 2004). That implies we can get an idea of what would be the future debt service burden of the current debt stock. On the other hand, debt ratios that use debt service (interest payment and amortisation) in the numerator are generally used to identify possible liquidity problems (Painchaud and Stucka 2011). We use export and revenue for external debt service and revenue for public debt service in the denominator. So for external debt, we have external debt service to export and external debt service to revenue. For public debt service, we have only one indicator, namely public debt service to revenue. A rising trend in the debt service to export or revenue would indicate the country is not able to use more of its resources for productive purposes. Rather, it spends more and more resources on debt service payment.

TABLE I
THRESHOLDS FOR EXTERNAL DEBT

Quality of policies and institutions			
Indicators	Weak CPIA ≤ 3.25	Medium 3.25<CPIA<3.75	Strong CPIA ≥3.75
NPV of debt to GDP	30	40	50
NPV of debt to exports	100	150	200
NPV of debt to revenue	200	250	300
Debt service to exports	15	20	25
Debt service to revenue	25	30	35

Source: World Bank and IMF (2010).

Now, let us describe the thresholds that are followed to create DSA by the Bank-Fund authority. As we are using Bank-Fund's debt sustainability approach, we also follow these thresholds to assess the debt sustainability of Bangladesh. The thresholds are based on empirical findings of IMF (2004), which suggest countries that have better institutions can sustain higher level of debt and countries with poor quality institutions can sustain lower level of debt. The DSA of the Bank-Fund authority is based on comparing the indicators against these established thresholds for external debt. According to World Bank and IMF (2010), these thresholds should be seen as guideposts for debt sustainability analysis rather than rigid ceilings. As the empirical finding suggests, the role of policy is very important in assessing debt sustainability and this policy performance is measured by an index called Country Policy and Institutional Assessments (CPIA). This index is compiled annually by the World Bank. CPIA

scores are average of 16 indicators of policy and institutional quality.[7] From Table I, we can see countries are described, based on the CPIA score, in three categories, namely weak, medium and strong. [8] The strong countries have higher thresholds for every indicators compared to the weak countries, reflecting the ability of strong countries to manage debt in a more prudent way. The current CPIA score of Bangladesh is 3.43, which places the country in the medium category in terms of policy performance. To perform debt sustainability analysis of low-income countries (LICs), a standard Microsoft excel based template is used in operation by the Bank-Fund authority. [9] According to World Bank (2006), once the required data are given as input, the template automatically produces the calculations. The template is based on two separate identities: external debt and public debt analysis. The implication of these identities depends on the driving factors of the evolution of debt. By changing the driving factors behind the evolution of debt, various types of sensitivity analyses are performed. From the perspective of debt sustainability, the reason to perform those tests is to see whether the debt remains sustainable in changed circumstances.

The evolution of external debt depends on a simple balance of payment identity which is the following: [10]

$$D_t = C_t - NFDI_t + (1 + r_t)D_{t-1} + Z_t \quad (1)$$

Here D_t represents nominal external debt in US dollars at time t. The current account deficit is represented by C_t excluding interest, $NFDI_t$ is net foreign direct investment, r_t represents the nominal interest on nominal external debt and Z_t represents other factors such as change in gross reserve, etc. After several algebraic manipulations, the final form of the identity is given below with which the template analyses the external debt.

$$d_t - d_{t-1} = c_t - nfdi_t + \frac{r_t d_{t-1}}{1 + g_t + \Pi_t} - \frac{g_t d_{t-1}}{1 + g_t + \Pi_t} - \frac{\Pi_t (1 + g_t) d_{t-1}}{1 + g_t + \Pi_t} + Z_t \quad (2)$$

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[7]Three years moving average of CPIA is taken to avoid slight fluctuation. If the three years moving average of CPIA exceeds the average three years CPIA by 0.05 point, only then policy category will be shifted.

[8]However, in the recent publication of World Bank-IMF (2012), some preliminary works related to public debt threshold have been mentioned. However, it has not been used in the template or Bank-Fund's evaluation of debt sustainability for any country yet.

[9]The template can be downloaded free of charge from IMF's website. Low-income countries are those which have per capita income less than $1,025 according to 2011 GNI per capita.

[10]This is based on World Bank (2006).

The left hand side of the equation indicates the change in external debt to GDP. The right hand side of the equation identifies the factors (all are expressed as a proportion to GDP) behind this change. The evolution of external debt or the changes in external debt can be determined by identifying two factors, namely net debt creating flows and residual. Identified net debt-creating flows can be further decomposed into three parts. They are current account deficit excluding interest (first term of the right hand side equation), net foreign direct investment (second term of the right hand side equation) and endogenous debt dynamics. [11] Endogenous debt dynamics is comprised of change in nominal interest rate, real GDP growth and changes in price and exchange rate (third, fourth and fifth term of the right hand side equation 2). It is termed as endogenous as it is derived from a balance of payment identity. The nominal interest effect captures the changes in the concessionality of the loan. Most of the loans are given to LIC on interest rates which are very low compared to the market rate. So change in this low interest is captured by the change in nominal interest rate. Real GDP growth (g_t) reflects the earning capacity of a country. Sustainable and substantial real GDP growth lowers the external debt burden by increasing the output. Changes in price and exchange rate demonstrate the impact of exchange rate. For example, a nominal depreciation of exchange rate lowers the nominal GDP denoted in US dollar. At the same time, it decreases the GDP deflator (Π_t) denominated in US dollar. As the nominal GDP decreases with an unchanged indebtedness, debt burden increases (Painchaud and Stucka 2011). The last term represents non-debt creating flows such as changes in foreign reserve, debt relief, etc. In the case of total public debt, we have the inclusion of domestic debt as well. The evolution of the public debt can be decomposed into several factors like the evolution of external debt.[12]

The template analyses the evolution of both kind of debts, discussed above, in baseline and alternative scenarios. Baseline refers to the most likely scenario, whereas stress test refers how the different debt burden indicators would evolve

[11]The impact of interest rate is included in the endogenous debt dynamics. That is why it is not included in the current account deficit.

[12]Like external debt, the evolution of public debt is also based on an identity which can be found in Bank-Fund (2010). The implication of identity denotes the associated stress tests that can be performed. However, due to the unavailability of adequate domestic debt data, we are not able to perform stress tests on public debt. So we report only the baseline result for public debt.

under different assumptions compared to the baseline (Painchaud and Stucka 2011). For the external debt, following stress tests are performed.[13]

TABLE II

STRESS TESTS FOR EXTERNAL DEBT

Shock's Nature	Description
Permanent	A1. Key Variables at their historical average
	A2. New public sector loans on less favourable terms
Temporary	B1. Real GDP growth at historical average minus one standard deviation
	B2. Export value growth at historical average minus one standard deviation
	B3. US dollar GDP deflator at historical average minus one standard deviation
	B4. Net non-debt creating flows at historical average minus one standard deviation
	B5. Combination of B1-B4 using one half standard deviation shock
	B6. One time 30 per cent nominal depreciation relative to baseline

Source: Bank-Fund DSA LIC DSA Template.

The result of both baseline and stress test is important for analysing debt sustainability. While the baseline suggests a continuation of the expectation related to economy, the stress test suggests the resulting pathway due to unexpected shocks in future. However, it is agreed that stress test is a mere mechanical way to express shocks as we cannot say why the shocks would take place; rather we quantify the impact of the shocks mechanically as if they have taken place (World Bank and IMF 2010).[14] Based on each indicator's performance against its thresholds in baseline and stress test, four types of risk categories have been identified, namely low risk, moderate risk, high risk, and debt distress risk (World Bank and IMF 2010).

[13]Similar types of stress tests are performed for public debt as well.
[14]For details, see Painchaud and Stucka(2011).

IV. DESCRIPTION OF DATA AND VARIABLES

For the study of debt sustainability analysis of Bangladesh, we need the data which are related to four different categories, namely macroeconomic data, current account data, fiscal account data and debt data, according to the requirement of the template. For most of the data, the sample consists of annual observations from 1981 till 2012. Due to the structural change in the economy, we have not included the data from 1972 to 1980. In this section, we discuss some issues and sources of the data in brief.[15]

For debt account data, the data are divided into external debt and domestic debt data. The total external debt can be divided into MLT debt and other external debt. Under MLT debt, except debt of air craft, shipping, food, crude oil and IMF, all other debts are included. The excluded categories in the MLT debt create the category called other external debt. We use the other external debt as the PPG short term debt in the template. For the external loan (disbursed) sources, they are divided into five categories for the computational purpose. They are loans from IDA, loans from other multilateral organisations except IDA, loans from Japan, loans from other aid countries i.e. Paris club (except Japan), and loans from non-aid countries i.e. non-Paris club. IDA and Japan are separately analysed as they are the largest creditors in multilateral and bilateral categories respectively for Bangladesh. Regarding the payment of external debt, the available series are principal and interest payment of MLT debt. For domestic debt data, the only available data series are domestic debt outstanding and interest payment on domestic debt. The external debt data are obtained from ERD and the domestic debt data are obtained from Bangladesh Bank and Bangladesh Economic Review (BER). For current account data, the used data series for this study are export of goods and services, import of goods and services, remittance, current account balance, net FDI, gross reserve (flow), net current transfer, current transfer (official), current transfer private, exchange rate (period average) and exchange rate (end of the period). The data are obtained from World Bank and Bangladesh Bank. For fiscal account data, the required data series are public revenue with grants, grants and public expenditure. All the data series are obtained from various issues of BER. For the macro data (i.e. the data which give us a general overview of the economy and do not fall under any of the above category), the required data series for this study are real GDP, real GDP growth, percentage change in domestic GDP deflator, nominal GDP, and US domestic GDP deflator. These data are obtained from WB, WEO and BER.

[15]For a complete description of the data series, see Appendix A.1.

V. FORECAST OF INPUT VARIABLES

In this section, we first forecast the necessary variables for our analysis using ARIMA modeling technique and then we analyse the forecast result.

5.1 Stationarity Analysis

We use the variables of current account, fiscal account and debt account as a ratio of GDP rather than taking the variables simply on level terms. This ratio provides evolution of the variable relative to the size of the economy. That brings us to the calculation of GDP itself. At first, we are deriving the nominal GDP growth rate by using real GDP growth rate and percentage change in GDP deflator. Then by using nominal GDP growth rate, we forecast the nominal GDP and convert the nominal GDP into dollar using the forecast of exchange rate (period average) where necessary. Similarly, real GDP is calculated using real GDP growth. We use level form of the variable for forecast purpose for three variables. They are US GDP deflator, exchange rate (period average) and exchange rate (end of the period). Now let us come to the stationarity test, which is the first condition to fulfill to apply ARIMA models. We use log form of three variables (real GDP growth, percentage change in GDP deflator and loans from Japan) to reduce variance before applying stationarity test. For stationarity test, we apply Augmented Dickey Fuller (ADF) test. We use EVIEWS 7 software for performing all the econometric tasks. Table III sums up the stationarity result of all the variables.

TABLE III
STATIONARITY ANALYSIS OF ALL VARIABLES

Variable	Level	1st difference	Order of integration
LOG(RGDPG)	S		0
LOG(B_GDPD)	S		0
US GDP Deflator	NS	S	1
EXA	NS	S	1
EXE	NS	S	1
EX_GDP	NS	S	1
IM_GDP	NS	S	1
REM_GDP	NS	S	1
CAB_GDP	S		0

(Cont. Table III)

Variable	Level	1st difference	Order of integration
CTO_GDP	S		0
CTP_GDP	NS	S	1
NFDI_GDP	NS	S	1
GR_GDP	S		0
PRPG_NG	NS	S	1
PG_NG	S		0
PE_NG	S		0
SD_GDP	NS	S	1
MLTP_GDP	S		0
MLTI_GDP	NS	S	1
DDO_GDP	S		0
DDI_GDP	NS	S	1
IDA_GDP	S		0
O_MULTI_GDP	S		0
LOG(JAPAN_GDP)	NS	S	1
OPC_GDP	S		0
NPC_GDP	S		0

Source: Own Calculation.

Note: 1. S means stationary, NS means non-stationary.

2. RGDPG=Real GDP growth, B_GDPD= Percentage change in domestic GDP deflator, US GDP Deflator=GDP deflator of US, EXA= Exchange rate (Average), EXE=Exchange rate (End), EX_GDP=Export of goods and services to GDP, IM_GDP=Import of goods and services to GDP, REM_GDP= Remittance to GDP, CAB_GDP= Current account balance to GDP, CTO_GDP=Current transfer (official) to GDP, CTP_GDP= Current transfer (private) to GDP, NFDI_GDP=Net foreign direct investment to GDP, GR_GDP=Gross reserve (flow) to GDP. PRPG_NG=Public revenue with grants to GDP, PG_NG=Grants to GDP, PE_NG=Public expenditure to GDP, SD_GDP=Short term debt to GDP, MLTP_GDP=MLT debt principal payment to GDP, MLTI_GDP=MLT debt interest payment to GDP, DDO_GDP= Domestic debt outstanding to GDP,DDI_GDP= Domestic debt interest payment to GDP, IDA_GDP= IDA loan to GDP, O_MULTI_GDP= Other multilateral group's loan to GDP, Japan_GDP= Japan's loan to GDP, OPC_GDP= Other Paris Club's loan to GDP, and NPC_GDP= Non-Paris Club's loan to GDP.

5.2 Modeling of Input Variables

In this section, first we describe the fundamentals of ARIMA models which we use to forecast, then we estimate the parameters of ARIMA models.

Fundamentals of ARIMA

ARIMA stands for Auto Regressive Integrated Moving Average. This model is also known as Box Jenkins model as the model is popularised by George Box and Gwilym Jenkins in the early 1970s (Makridakis, Wheelwright and Hyndman 1998). ARIMA model is based on the philosophy "let the data speak for themselves" (Gujrati 2005). This is implemented by analysing the observation in terms of past observations and error terms. To illustrate this, we follow Makridakis *et al.* (1998). We describe the implication of AR and MA terms in the ARIMA model first, then ARMA and ARIMA are discussed.

AR model

Suppose we want to forecast time series Y_t (observation at time t). Auto Regression (AR) stands for regressing forecast variable Y_t on its lagged values. For example, an Autoregressive model of order one or AR (1) would imply Y_t depends on Y_{t-1} (observation at time t-1). This can also be described as ARIMA (1, 0,0) model which implies the following:

$$Y_t = b_0 + b_1 Y_{t-1} + e_t \quad (3)$$

Here e_t is the error term and b_0 is the intercept. The higher order auto regressive model would include more lagged values.

MA model

For Moving Average (MA) model and we regress Y_t on the past errors as explanatory variables. Moving Average model of order one would imply Y_t depends on the error term e_t and also previous error term e_{t-1}. As a result, MA (1) or ARIMA (0,0,1) implies the following :

$$Y_t = c + e_t - k_1 e_{t-1} \quad (4)$$

The minus sign is placed before e_{t-1} because of the convention of ARIMA model. The higher order MA model would include more lagged error terms.

ARMA model

When we combine AR(1) and MA(1) to analyse Y_t, we get ARIMA (1,0,1) or ARMA(1,1). This can be written in the following way:

$$Y_t = c + b_1 Y_{t-1} - k_1 e_{t-1} + e_t$$

Using the backshift notation B, above can be written as [16]

$$(1-b_1B)\ Y_t = c + (1-k_1B)\ e_t \quad (5)$$

ARIMA model

To use this modeling technique, data need to be stationary. Therefore, if difference method is used to make the data stationary, then we get the order of integration based on the number of difference. For example, if the first difference of the series is found to be stationary, then it is known as integrated of order one. Then we can apply AR or MA term into it for modeling purpose. For instance, if we use AR(1) and MA(1) on a series that is differenced once to make it stationary, we have ARIMA (1,1,1) model. This ARIMA (1,1,1) can be written as:

$$(1-b_1B)\ (1-B)\ Y_t = c + (1-k_1B)\ e_t \quad (6)$$

Estimation of ARIMA models

We follow Makridakis *et al.* (1998) for our modeling process. We estimate several ARIMA models based on the pattern of ACFs and PACFs in the correlogram. Emphasis is given on the size of the spike of the ACFs and PACFs. Then we select the models based on least AICs and SICs on the most cases. However, as ARIMA is parsimonious in nature, if the model with least AIC and SIC includes higher lag order, we select a model with lower lag order with a bit high AIC and SIC (compared to least AIC and SIC based model) to get a simpler model. At the same time, for a smaller sample, AIC is given more importance to SIC. The residuals of the finally selected model are checked to ensure white noise.

TABLE IV
SELECTED ARIMA MODELS FOR ALL THE VARIABLES

Name	ARIMA order	Regressors
LOG(RGDPG)	(0,0,2)	C***
		T***
		MA(2)***
LOG(B_GDPD)	(0,0,1)	C***
		MA(1)***
US GDP Deflator	(1,1,1)	C***
		AR(1)**
		MA(1)***

(Cont. Table IV)

[16]Back shift operator shifts the data. For example, $BY_t = Y_{t-1.}$

Name	ARIMA order	Regressors
EXA	(0,1,1)	C*** MA(1)**
EXE	(0,1,6)	C** MA(6)**
EX_GDP	(1,1,1)	C*** AR(1)*** MA(1)***
IM_GDP	1,1,1	C*** AR(1)*** MA(1)***
REM_GDP	0,1,1	C* MA(1)**
CAB_GDP	2,0,0	C*** T*** AR(2)*
CTO_GDP	1,0,1	AR(1)*** MA(1)***
CTP_GDP	0,1,5	C** MA(5)**
NFDI_GDP	0,1,4	MA(4)*
GR_GDP	1,0,1	C** AR(1)*** MA(1)***
PRPG_NG	(2,1,2)	AR(1)*** AR(2)* MA(1)*** MA(2)***
PG_NG	(2,1,2)	AR(2)*** MA(2)***

(Cont. Table IV)

Name	ARIMA order	Regressors
PE_NG	(0,0,2)	C*** T*** MA(2)***
SD_GDP	0,1,1	C** MA(1)***
MLTP_GDP	1,0,0	C*** AR(1)***
MLTI_GDP	1,1,1	AR(1)*** MA(1)***
DDO_GDP	1,0,0	C*** AR(1)***
DDI_GDP	0,1,3	C*** MA(3)***
IDA_GDP	1,0,1	AR(1)*** MA(1)***
O_MULTI_GDP	1,0,0	C*** AR(1)***
LOG(JAPAN_GDP)	0,1,3	MA(3)**
OPC_GDP	2,0,2	AR(2)*** MA(2)***
NPC_GDP	1,0,0	C*** AR(1)***

Source: Own Calculation.

Note: ***, ** and * represent 1%, 5% and 10% level of significance respectively. C represents constant and T represents linear trend.

5.3 Analysis of Forecasts

In this section, we analyse the forecast of macroeconomic conditions. Using these inputs, debt sustainability indicators are analysed in the next section.

TABLE V
TRENDS OF MACROECONOMIC VARIABLES

Name	Sample (1981-2012)						Forecast (2013-2033)			
	1981-85	1986-90	1991-95	1996-00	2001-05	2006-12	2013-17	2018-22	2023-27	2028-33
Real GDP Growth	3.72	3.74	4.39	5.21	5.43	6.30	7.35	8.24	9.29	10.59
Inflation	10.79	8.26	4.20	3.82	3.72	7.03	5.53	5.35	5.35	5.35
Nominal GDP Growth	14.92	12.30	8.77	9.23	9.37	13.77	13.28	14.04	15.14	16.51
Export *	5.50	5.97	9.27	13.33	15.70	21.73	25.25	28.62	32.12	35.98
Import *	14.02	13.36	15.00	18.99	21.80	29.77	33.08	36.49	40.24	44.39
Name	1981-85	1986-90	1991-95	1996-00	2001-05	2006-12	2013-17	2018-22	2023-27	2028-33
Remittance *	2.69	2.85	2.99	3.73	6.00	10.57	11.99	13.49	14.98	16.61
Current Account Balance*	-2.54	-2.09	0.06	-0.93	-0.02	1.77	2.25	2.87	3.57	4.33
Net FDI *		0.01	0.02	0.35	0.58	0.92	0.81	0.81	0.81	0.81
Public Revenue with Grants*			11.26	10.67	11.16	12.14	13.49	13.48	13.49	13.49
Public Expenditure*			13.80	13.65	14.81	15.92	16.74	17.54	18.32	19.18
Fiscal Gap* (Including Grants)			2.54	2.98	3.65	3.78	3.25	4.06	4.83	5.69

Source: Own Calculation.
Note:
1. * indicates in percentages of GDP at current market prices.
2. The base year of real GDP is 1995-1996.
3. Inflation is measured by percentage change in domestic GDP deflator. Nominal GDP growth is calculated using real GDP growth and domestic GDP deflator.
4. Export and import are inclusive of goods and services.
5. Public revenue with grants includes public revenue (tax revenue and non tax revenue) as well as grants. Public expenditure includes revenue expenditure (non development revenue expenditure), ADP and other expenditure (expenditure on food and capital). Fiscal gap is calculated as the difference between the two mentioned above.

Real GDP growth forecast, which is one of the main indicators of economy, has a steady increase in the forecast horizon, keeping up with the past trend. Inflation forecast is below six per cent for the entire period, which shows a stable price level. Though, in the history, we see fluctuation in inflation at different phases, it remains below 6.5 per cent on average during 1981-2012. So forecast of inflation indicates an even better management of various macroeconomic measures, which keeps the price level stable. The forecast of import and export indicates that the share of import and export is expected to increase in the economy. Share of import exceeds the share of export, which indicates a trade deficit in the forecast horizon. The forecast of remittance indicates occupying an increasing share of the GDP. This explains the current account balance surplus in the forecast period. Public revenue with Grants' forecast shows moderate increase, whereas public expenditure shows more increases in the later phases of forecast horizon. This is illustrated by a moderate increase in average fiscal gap in the projection years (4.51 per cent) compared to the average of sample period (3.29 per cent).

Now we compare these forecasts with different projections published by various government agencies as well as the Bank-Fund authority. There exist two major planning documents, published by government agencies, that contain projections for various macro variables of Bangladesh. One of them is the Sixth Five Year Plan (2011) and the other is the Long Term Perspective Plan.[17] The Sixth Five Year Plan carries projection for a shorter span (2011-2015), while the Long Term Perspective Plan carries government's "target" for few variables for a longer time horizon (2010-2021). For our analysis purpose, we take the projection for 2013-2015 from the Sixth Five Year Plan as we have the actual values for 2011 and 2012. At the same time, the latest Bank-Fund DSA was published in 2011 which had projections for 2012 to 2032 for some variables. For this study, we take the projection for 2013 to 2032. Let us compare the ARIMA based forecasts with these three types of projection.

[17] The statistics of long term perspective plan are taken from MTBF (2011).

TABLE VI
COMPARISON BETWEEN FORECAST AND VARIOUS PROJECTIONS FOR FUNDAMENTAL MACRO VARIABLES

Name	Sixth Five Year Plan (2013-2015)*	Our forecast (2013-2015)*	Long Term Perspective Plan's target for FY-2021	Our Forecast for FY-2021	Bank-Fund DSA (2013-2032)**	Our Forecast (2013-2032)**
Real GDP Growth	7.6	7.19	10	8.44	6.59	8.83
Inflation	6.5	5.65	5.20	5.35	5.36	5.40
Nominal GDP Growth	14.1	13.25	15.72	14.24	8.35	14.71

Source: Sixth Five Year Plan, MTBF (2011), Bank-Fund DSA and Own Calculation.
Notes:

1. CPI based inflation for Sixth Five Year Plan and Long Term Perspective Plan.
2. Nominal GDP growth for Long Term Perspective Plan is derived using real GDP growth and CPI based inflation.
3. * indicates the average rate projected for 2013-2015 and ** indicates average rate projected for 2013-2032.
4. For Bank-Fund DSA, nominal GDP growth means nominal dollar GDP growth.

We find that the government projection is slightly higher compared to our forecast, while Bank-Fund DSA projection is lower than our forecast for real GDP growth. As the historical trend shows, Bangladesh has enjoyed a steady increase in real GDP growth over the last 30 years; a higher real GDP growth compared to Bank-Fund DSA is a more likely scenario. On the inflation front, apart from the Sixth Five Year Plan, all other projections are less than six per cent, indicating a stable price level situation is expected from both the government authority and the Bank-Fund authority. Subsequently, nominal GDP growth is projected slightly higher compared to ARIMA forecast in government projections, while the DSA projection for nominal GDP growth is very low compared to all other projections. The reason behind higher government projection for nominal GDP growth is the expected increase in real GDP growth while the inflation remains stable.

TABLE VII

COMPARISON BETWEEN FORECAST AND VARIOUS PROJECTIONS OF EXTERNAL SECTOR

Name	Sixth Five Year Plan (2013-2015)*	Our Forecast (2013-2015)*	Long Term Perspective Plan's target for FY 2021	Our Forecast for FY 2021	Bank-Fund DSA's Projection for FY 2032	Our Forecast For FY 2032
Export	23.0**	24.6**	82 (Bill $)	82.88 (Bill $)	32.9**	37.0**
Import	31.4**	32.5**	110.5 (Bill $)	105 (Bill $)	39.9**	45.5**
Remittance	10.17**	11.7**	38.5 (Bill $)	38.96 (Bill $)	48.2 (Bill $)	226.93 (Bill $)
Current Account Balance**	-0.2**	2.15**	-	-	-	-
Net FDI	0.97**	0.81**	-	-	-	-

Source: Sixth Five Year Plan, MTBF (2011), Bank-Fund DSA and Own Calculation.

Notes:

1. * indicates the average rate projected for 2013-2015.
2. ** indicates percentage as share of GDP at market prices.

For the external front, we find our forecast is slightly more for some variables compared to the other projections. The target of Long Term Perspective Plan is in line with our projection for export and remittance and is slightly different for import. At the longer horizon, Bank-Fund's projection and our projection differ by roughly 4.1 per cent of GDP for export and 5.5 per cent of GDP for import. From the historical trend, we have seen that as the GDP increases, so does the share of its components. As Bank-Fund DSAs projects lower nominal GDP growth, this difference in projection is expected.

For the current account balance, we observe an existence of current account deficit in the projection of Sixth Five Year Plan. It projected current account deficit in year 2011 and 2012 as well when Bangladesh actually had current account surplus. Remittance plays a major role behind the current account surplus of Bangladesh which we have seen from the historical trend. ARIMA based forecasts indicate that the same trend is expected to continue in the forecast horizon as well.

TABLE VIII
COMPARISON BETWEEN FORECAST AND PROJECTIONS OF FISCAL SECTOR

Name	Sixth Five Year Plan (2013-2015)	Our forecast (2013-15)
Public Revenue with Grants	14.53	13.49
Public Expenditure	19.00	16.56
Fiscal Gap (Including Grants)	4.47	3.07

Source: Sixth Five Year Plan and Own Calculation.
Note: All are expressed as a per cent of GDP.

According to Sixth Five Year Plan, we see an increase in public revenue (with grants) as well as in public expenditure compared to our forecast, which is reflected by the fiscal gap to GDP (1.4 per cent of GDP higher compared to projected ARIMA based fiscal gap). As ARIMA forecast takes the information from the history, we see that revenue with grants as a per centage of GDP historically stayed almost same (11.38 per cent of GDP on an average for 1991-2012). So we do not have much variation in our forecast for revenue as well. For the public expenditure, we see a steady increase in the history as well as in the forecast based on ARIMA analysis. In the projection of Bank-Fund authority, fiscal gap is projected on an average 2.3 per cent of GDP for FY2012. Their reasoning behind this low fiscal gap illustrates their expectation regarding improvement in revenue collection, especially by introducing new income tax laws and implementation of the tax modernisation plan (World Bank and IMF 2011).

VI. ARIMA BASED DSA 2012 FOR BANGLADESH

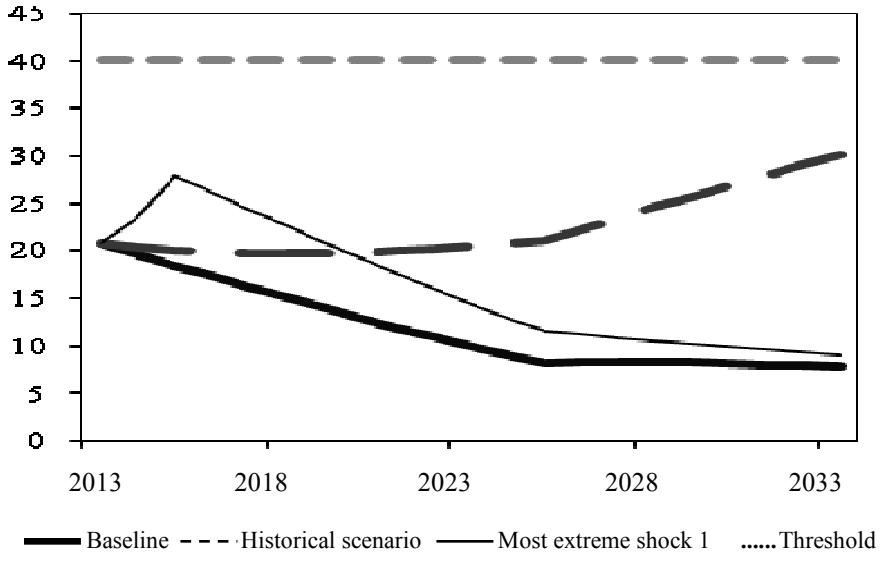
In this section, we report the main analysis of debt sustainability of Bangladesh for the period of 2013-2033. The value of various debt indicators is found after inserting the ARIMA based forecasts in the Bank-Fund DSA template. After analysing the result for both external and public debt, we compare it with judgmental projection.

6.1 Analysis of External Debt Sustainability

Analysis of Debt Indicators related to Solvency

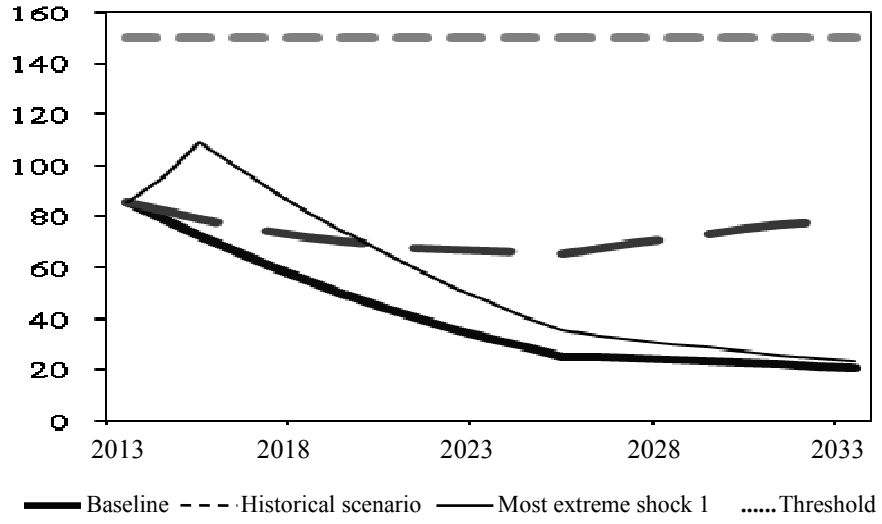
We look at three indicators, namely PV of debt to GDP, PV of debt to export and PV of debt to revenue.

FIGURE 1: **PV of Debt to GDP**



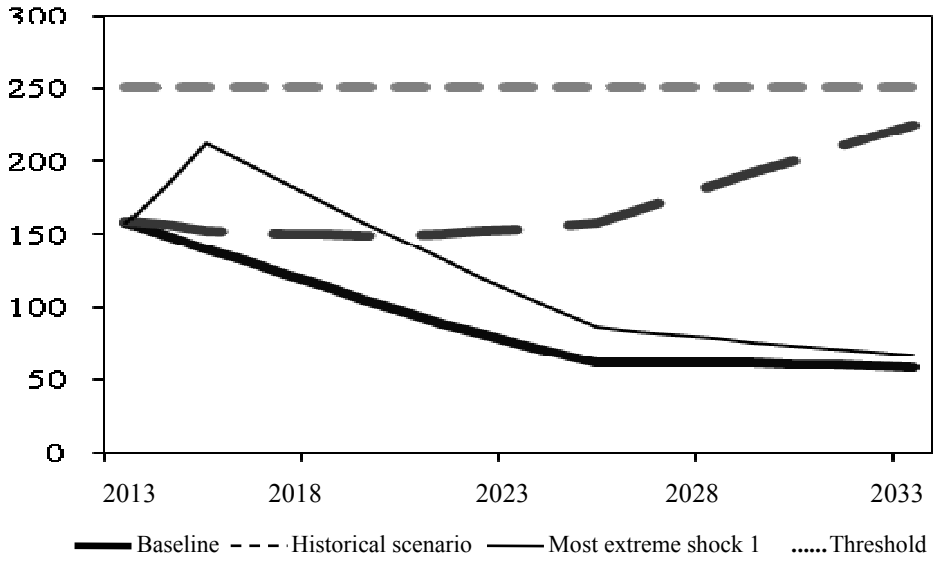
Source: Own Calculation.

FIGURE 2: **PV of Debt to Export**



Source: Own Calculation.

FIGURE 3: **PV of Debt to Revenue**



Source: Own Calculation.

In all three cases, debt indicators remain below the thresholds in both baseline and stress tests. So from the perspective of solvency, Bangladesh is in a steady position. The fact is further illustrated by the decreasing indicators in baseline in all three cases over the forecast period of 2013-2033. Next, let us look at the stress tests (permanent shocks). For the historical scenario, we see an increasing trend. However, still they are very below compared to the threshold. In the historical scenario four variables, namely non interest external current account balance, net FDI, real GDP growth and GDP deflator in US dollar terms are set to their 10-year historical average from the start of second year of forecast and last over the entire forecast period. The remaining variables are kept unchanged. In last the 10 years for Bangladesh, average real GDP growth rate was 6.2 per cent, non interest external current account surplus was 1.4 per cent of GDP, net FDI was 0.9 per cent of GDP and change in GDP deflator in US dollar terms was 3 per cent. As the repayment capacity was lower in the last ten years compared to the repayment capacity in the forecast period, this lower repayment capacity and unchanged indebtedness cause debt indicators to increase in the

forecast horizon. This difference in baseline and historical scenario also implies our projection of baseline is optimistic according to Bank-Fund DSA guidelines.

TABLE IX
RESULT OF THE STRESS TESTS FOR EXTERNAL DEBT

Stress Tests	PV of Debt to GDP	PV of Debt to Export	PV of Debt to Revenue	Debt Service to Export	Debt Service to Revenue
A1. Key variables at historical average	**20.3**	**66.2**	**153.16**	**5.1**	**11.8**
A2. New Public Sector loans on less favourable terms	13.1	42.6	98.40	4.4	10.1
B1.Real GDP growth historical average minus one standard dev.	10.2	32.1	76.54	3.83	9.1
B2. Export value growth historical average minus one standard dev.	11.7	43.9	87.72	4.9125	9.8
B3. US dollar GDP deflator historical average minus one standard dev.	10.7	32.1	80.18	3.83	9.6
B4. Net non debt creating flow historical average minus one standard dev.	13.3	43.3	100.14	4.64	10.7
B5. Combination of B1-B4 using half standard deviation shock	**14.3**	**46**	**107.51**	**4.9129**	11.5
B6. One time 30 per cent nominal depreciation relative to baseline	13.9	32.1	104.97	3.83	**12.5**

Source: Own Calculation.
Note: 1. All the ratios are for the year 2023.
2. A1-A2 stand for permanent test, B1-B6 stand for temporary tests.

In the template, there are various kinds of stress tests for temporary shocks. The shock that increases the debt burden most in the year 2023 among all the shocks is known as most extreme shock. The most extreme shock for all the three solvency indicators in our study is the combination of various shocks. More specifically, four types of shocks (by reducing the historical average by one half standard deviations for all) are given to real GDP, exports, GDP deflator and net private transfer and FDIs and they are applied in the second and third year of the projection only. This shock created negative impact on the repayment capacity. That is why there is an increasing pattern till 2015 (the shocks are applied to 2014 and 2015). However, the reduction in variables is not compensated by the increase in subsequent years. That is why there is some permanent level impact which keeps the shock above the baseline.

Analysis of Debt Indicators related to Liquidity

We see in the baseline, both of the indicators remain significantly below the threshold. We see a sudden decline after 2025 in the debt servicing according to the simulation (because debt service of old external debt of 2012 has been paid off within 2025). Under the historical scenario and the most extreme shock (the combination shock which was used in debt indicators related to solvency), debt service to export ratio remains significantly below the thresholds.

For debt service to revenue, the extreme stress test is different in nature in this time. The stress test in this case is "one time nominal depreciation of domestic currency." It implies "one time nominal depreciation of 30 per cent of the domestic currency" in the second year of the projection period and for the rest of the time in projection period, nominal exchange rate returns to its path which is depicted in baseline scenario (Painchaud and Stucka 2011). The author illustrates, the exchange rate shock reduces the domestic GDP measured in dollars and as the revenue to GDP ratio is assumed to stay constant (revenue is expressed in foreign exchange), revenue falls down too. As the measure of the indebtedness is assumed to remain same as before, there is a slight increase of the indicator under the stress test. However, as Bank Fund authority repeatedly points out these shocks are purely mechanical in their reports, it does not raise any significant concern.

FIGURE 4: **Debt Service to Export**

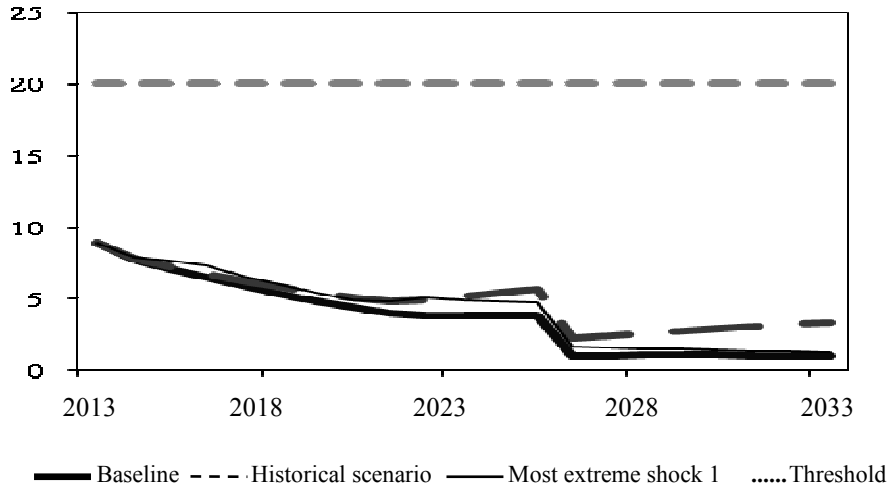
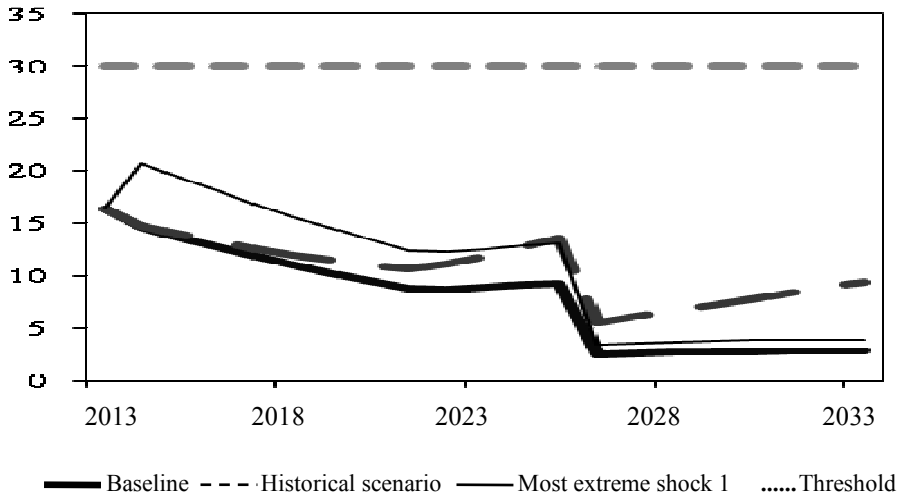


FIGURE 5: **Debt Service to Revenue**



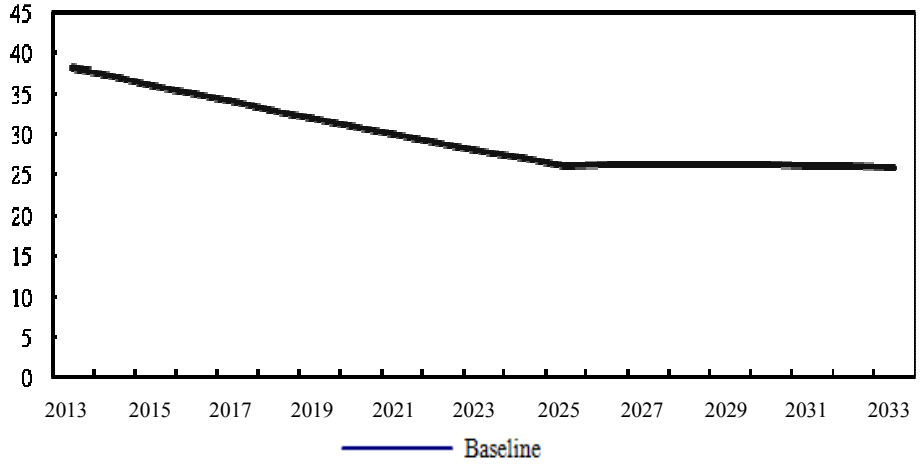
6.2 Analysis of Public Debt

For the public debt, we add domestic debt with the external debt. We cannot run stress tests due to limitation of domestic debt data. So we analyse only baseline.

Analysis of Debt Indicators related to Solvency

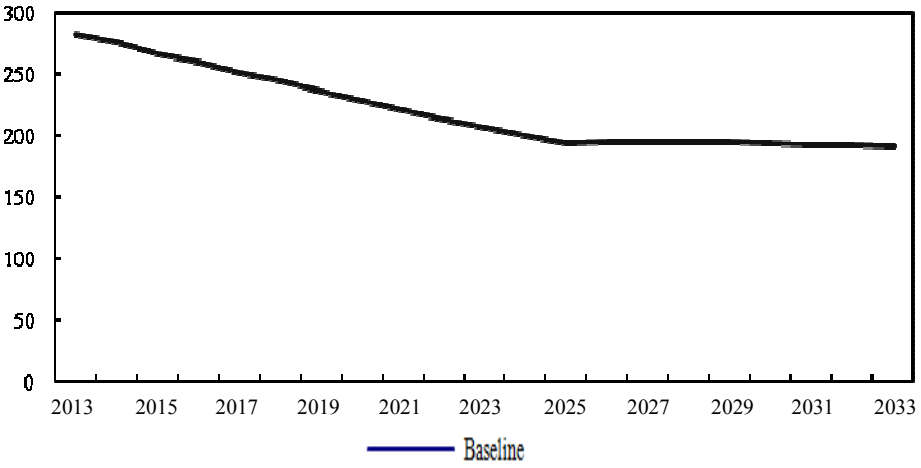
For the public debt in baseline, we see PV of debt to GDP ratio and PV of debt to revenue decline till 2025 and stay relatively unchanged in the following years during the projection period. Table X illustrates the contribution of PV of external debt to the PV of public sector debt to GDP.

FIGURE 6: **PV of Public Debt to GDP**



Source: Own Calculation.

FIGURE 7: **PV of Public Sector Debt to Revenue**



Source: Own Calculation

TABLE X
TREND IN PV OF PUBLIC SECTOR AND EXTERNAL DEBT TO GDP

Duration	PV of public sector debt to GDP	PV of external sector debt to GDP
2012-2017	36.08	18.33
2018-2022	30.80	12.85
2023-2027	26.67	8.65
2028-2032	26.04	8.00

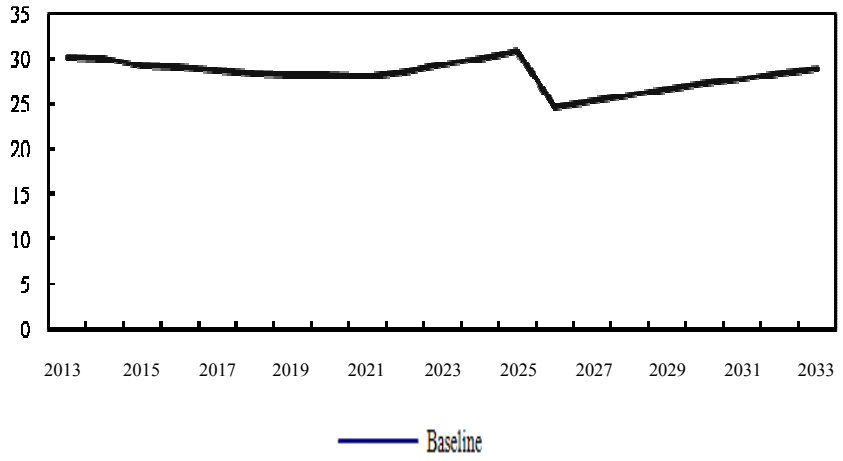
Source: Own Calculation.

We find at the end, PV of the public sector debt decreases due to the decline in PV of external sector debt to GDP.

Analysis of Debt Indicators related to Liquidity

From the perspective of liquidity, we find a brief relief in terms of debt service payment after 2025 (the slight shift in 2025 happens due to the repayment of old external debt stock).However, as the forecast of revenue (including grants) to GDP ratio stays low in the forecast horizon (around 13.49 per cent of GDP during 2013-2033) in line with the history of more than two decades (11.38 per cent of GDP during 1991-2012), due to the low amount of revenue (including grants), debt service to revenue again starts to rise. As a result, unless our revenue stream becomes stronger through various tax measure improvements, Bangladesh will continue to spend a hefty portion of revenue on debt servicing.

FIGURE 8: **Debt Service to Revenue**



Source: Own Calculation.

6.3 Comparison with Judgmental Projection

In this section, we compare the result of debt sustainability for Bangladesh based on judgmental projection and time series forecast. For judgmental projection, we use the DSA reports of Bank-Fund authority. As the DSA reports have been published in different years, the projection horizon of each report varies. The projection horizon of DSA 2006 is 2006 to 2026, the projection horizon of DSA 2008 is 2008 to 2028, the projection horizon of DSA 2009 is 2010 to 2030, the projection horizon of DSA 2011 is 2012 to 2032 and for this study, the forecast horizon is 2013 to 2033.

TABLE XI
COMPARISON BETWEEN JUDGMENTAL PROJECTION AND TIME SERIES FORECAST

Type	Topic	Judgmental Projection	Time Series Forecast
External Debt	Baseline	No breach of threshold. All the indicators fall during the projection horizon.	No breach of threshold. All the indicators fall during the forecast horizon.
	Historical scenario	No breach of threshold. However, historical scenario shows lower debt burden compared to baseline according to 2011's DSA.	No breach of threshold. Historical scenario shows higher debt burden compared to baseline.
	Stress test (Temporary Shocks)	Only single breach took place for PV of debt to revenue ratio according to 2008's DSA.	No breach of threshold for any indicator.
	Debt Accumulation rate	Steady accumulation.	Fluctuation in accumulation.
Public Debt	PV of Public Debt to GDP (Baseline)	Reduction in PV of public debt to GDP is smaller.	Reduction in PV of public debt to GDP is larger.
	Debt Service to Revenue(Baseline)	Very minimal reduction according to all DSAs.	Very minimal reduction.

Source: Bank-Fund DSAs (2006, 2008, 2009 and 2011) and own calculations.

Now we can observe some general trends from Table XI. *First*, debt is sustainable according to both judgmental projection and time series forecast. As a result, change in methodology does not bring any change in the sustainability of debt for Bangladesh. *Second*, all the debt indicators fall during the each time horizon. This implies Bangladesh does not face any type of either solvency or liquidity problem regarding the debt. At the same time, the repayment capacity of Bangladesh improves in the coming decades according both judgmental projection and time series forecast. However, the improvement in repayment capacity differs according to these two types, which we can understand by simple measures like real GDP, export, remittance, etc. Still this difference in repayment capacity does not make substantial difference in the overall result of debt sustainability, which can be observed from the indicators. *Third*, the rate of accumulation of external rate fluctuates according to time series forecast due to the full repayment of old external debt within 2025, whereas all the DSAs of Bank-Fund authority indicate a stable rate of external debt accumulation. *Fourth*, ARIMA forecast of domestic debt is lower than projection of domestic debt, which is why PV of public debt to GDP is lower according to time series forecast than judgmental projections. *Fifth*, both types of methodology indicate that debt service payment (public) compared to government revenue would decline by a minimal amount over the coming decades. This implies from the liquidity perspective that government has to spend almost same amount of money on debt servicing every years which cannot be spent on productive purposes. This increase in debt servicing happens due to two reasons mainly. One of the reasons is lower government revenue forecast based on the past history. On the other hand, debt servicing on domestic debt increases, which aggravates the overall debt situation.

VII. CONCLUSION AND POLICY SUGGESTIONS

Analysing the sustainability of debt is indeed challenging as the task is forward looking in nature. However, as it is very costly to overcome a debt crisis, the importance of analysing debt sustainability beforehand cannot be overemphasised. At the same time, any unforeseen event might change the whole calculation of sustainability at any time. That is why debt sustainability analysis is a continuous process rather a one-time calculation.

The past studies have focused more on theoretical and empirical aspects, while current studies in this arena focus more on operational tools which can

actually be applied in real life situation. That is why from the realm of academic arena, debt sustainability analysis has become a major concern in today's policymaking for the creditors and borrowers.

In this study, we apply time series forecasting tool in analysing the debt sustainability of Bangladesh. Though, in the literature, the role of the history is acknowledged, time series modeling based forecast has not been applied in the DSA before. This research aims to fill up that gap by introducing ARIMA based forecasting in the DSA. In this study, we aim to analyse debt sustainability of Bangladesh for the period of 2013-2033. We derive the forecast by applying ARIMA modeling technique. Our sample consists of macro data, current account data, fiscal data and debt data. We analyse both external debt and public debt. At the same time, for calculating the debt sustainability indicators, we use a standard operational tool, that is, Bank-Fund DSA template.

Analysing the debt sustainability incorporates the task of analysing the economy at the same time. The forecast, based on the past observations of sample, shows Bangladesh is not facing any sustainability issue related to any kind of debt. The crucial assumption of this forecast is the assumption which says historical pattern will be followed in the forecast horizon. In our finding, we see the prospect of increasing real GDP growth of Bangladesh in the forecast horizon. Coupled with a steady price level, this situation indicates a steady and stronger Bangladesh economy in the coming years. In the external sector, remittance plays a crucial role in maintaining the stability of our current account balance. In the fiscal sector, government revenue source still does not look bright. To increase government revenue, special attention needs to be given in collection of tax as tax/GDP ratio is very low in Bangladesh compared to other developing countries in the world.

In the external debt front, we see a decreasing trend of foreign assistance. The domestic debt forecast indicates an increase in the forecast horizon, but it does not raise any concern given the available quantitative information. As the foreign financing opportunity is shrinking, Bangladesh has to depend largely on domestic financing in the coming years. The challenge for government is not to crowd out private investment while taking loans to fill up the fiscal gap.

In this study, we forecast the future of Bangladesh based on the historical observations. However, in the future there might be some shocks that have not been experienced in the past. To mimic those scenarios to some extent, stress tests are used on external debt and no serious concern is observed. However, still

these are merely efforts as future is not possible to draw by using this sort of mechanical tools. For example, if Bangladesh continues to have steady improvement in economic front, then Bangladesh might become a middle-income country. At that time, opportunity to take concessional loans will end and it has to borrow from market.

Comparing to the judgmental projection of Bank-Fund authority, we see our time series based forecast broadly matches with their result. However, history seems to indicate a more optimistic scenario for Bangladesh compared to judgmental projection. Nonetheless, main conclusion, that is sustainability of debt, remains the same according to both types of methodology. In this study, we also compare our forecast with the official projection published by various government agencies. Our forecast is broadly in line with their projection as well. This brings to an interesting technical point, that is, these government agencies and also the Bank-Fund authority spend a lot of resources for the purpose of projections. At the same time, they use very complicated modeling techniques and software. For example, the Sixth Five Year Plan has used dynamic computable general equilibrium technique. For the debt sustainability analysis, Bank-Fund uses their in-house model such as RMSM-X (source: UNCTAD's website). This complex resource intensive nature creates obstacles for the low-income countries to evaluate debt sustainability on their own. As this study shows, univariate ARIMA modeling can also be used to assess the sustainability of debt. Moreover, this can be helpful for the academic researchers to assess the sustainability of a particular economy using time series modeling techniques.

The sustainability of debt that is drawn in this study largely depends on the macroeconomic stability of Bangladesh in the coming decades. Though the overall scenario does not raise any red flag in the coming years, we have to remember this forecast is based on the past history and future can take unprecedented turn which cannot be predicted based on the currently available information. This unpredictable turn can either bring a better or worse situation in future.

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APPENDIX A1
Description of Data

Type	Data	Description
Macro	Real GDP and Real GDP growth	Real GDP growth data was calculated for 1981-2012 from the real GDP data of 1980-2012. For 1980-2011, data was obtained from World Bank's website. For 2012, data was obtained from BER (2012).
	Nominal GDP	For nominal GDP (in US dollar), data was obtained from World Bank's website for the period of 1981-2011. For nominal GDP (in taka) this data was obtained for 1991-2011 from World Bank (WB). For 2012, the data was taken from BER (2012) and for US dollar, it was converted in US dollar using annual period average exchange rate of 2012.
	Percentage change in domestic GDP deflator	For 1981-2011, data was obtained from World Bank's website. For 2012, GDP deflator index of 2012 was made using the nominal GDP and real GDP. Then per centage change in domestic GDP deflator in 2012 was calculated using the GDP deflator index of 2011 and 2012.
	US gross domestic GDP deflator	The data was taken from WEO database for 1981-2012
Current Account	Exchange rate (period average)	Data was obtained from Bangladesh Bank for 1981-2012
	Exchange rate (end of the period)	Data was obtained from Bangladesh Bank for 1981-2012
	Export of goods and services	For 1981-2011, data was obtained from WB. For 2012, data was obtained from monthly economic trend (February, 2013) and was converted into dollar using exchange rate (period average).
	Import of goods and services	For 1981-2011, data was obtained from WB. For 2012, data was obtained from monthly economic trend (February, 2013) and was converted into dollar using exchange rate (period average).

(Cont. Table A.1)

Type	Data	Description
	Remittance	For 1981-2011, data was obtained from WB. For 2012, data was obtained from monthly economic trend (February, 2013) and was converted into dollar using exchange rate (period average).
	Current Account Balance	For 1981-2011, data was obtained from WB. For 2012, data was obtained from monthly economic trend (February 2013) and was converted into dollar using exchange rate (period average).
	Net FDI	For 1986-2011, data was obtained from WB. For 2012, data was obtained from monthly economic trend (February, 2013) and was converted into dollar using exchange rate (period average).
	Gross reserve (flow)	Gross reserve (flow) was counted from gross reserve (stock) for the period of 1981 to 2011. The data was obtained from Bangladesh Bank.
	Net Current Transfer	For 2002-2011, data was obtained from WB. For 2012, data was obtained from monthly economic trend.
	Current Transfer (official)	From 1981-2012, data was obtained from various issues of monthly economic trend and converted into dollar using period exchange rate. Earlier it was known as unrequited transfer (official).
	Current Transfer (private)	For 1981-2012, data was obtained from various issues of monthly economic trend and converted into dollar using period exchange rate. Earlier it was known as unrequited transfer (private).
Fiscal Account	Public revenue with grants	Data was taken from BER for 1991-2012. Public revenue includes both tax and non-tax revenue.
	Grants	Data was taken from BER for 1991-2012.
	Public expenditure	Data was taken from BER for 1991-2012. Public expenditure includes revenue expenditure, ADP expenditure and other expenditure.
Debt Account	MLT Outstanding	Data was taken from ERD for the period of 2002-2012.
	Other External Debt	Data was taken from ERD for the period of 1981-2012. Debt of air craft, shipping, food, crude oil and IMF are included in other external debt. This other external debt forms the short term debt for our study.

(Cont. Table A.1)

Type	Data	Description
	MLT principal payment	Data was taken from ERD for the period of 1981-2012.
	MLT interest payment	Data was taken from ERD for the period of 1981-2012.
	Domestic Debt Outstanding	Data was taken from Bangladesh Bank for the period of 1997-2012.
	Domestic Debt Interest payment	Data was taken from BER for 1988-2012.
	IDA	Data was taken from ERD for the period of 1981-2012.
	Other multinational Organisations (Except IDA)	This category includes ADB, EU, IDB, IFAD, OPEC and NDF. Data was taken from ERD for the period of 1981-2012
	Japan	Data was taken from ERD for the period of 1981-2012.
	Other Paris club	This category includes those aid countries which gave Bangladesh loans during the period of 1981-2012. They are Belgium, Denmark, France, Germany, Netherland, Norway, Russia, Sweden, Switzerland, UK, and US. Data was taken from ERD.
	Non Paris club	This category includes those non aid countries which gave Bangladesh loans during the period of 1981-2012. This category includes India, Kuwait, Saudi Arab, Spain, UAE, South Korea, China, Czech Republic,Hungary, Iraq, Iran, Pakistan, Romania, Yugoslavia and Suppliers Credit. Data was taken from ERD.