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Estimating a fiscal reaction function to assess Egypt's debt sustainability

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Estimating a Fiscal Reaction Function to Assess Egypt's Debt Sustainability

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1. Introduction

Over the past decades, the broad-based debt accumulation has been a prevalent feature in the global economy, raising a big concern about debt sustainability and a fear of facing financial crisis. The global economy has witnessed four waves of broad-based debt accumulation since 1970. The first three waves ended up with financial crisis starting with the Latin American debt crisis in the 1980s, the Asia financial crisis in the late 1990s and the global financial crisis of 2007-2009. However, the new wave, which started in 2010, has been featured as the largest, broadest and fastest growing of the four (Kose et al, 2020).

The fourth wave has hit a new all-time high global debt-to-GDP ratio of over 322% in Q3 2019. The total debt reached almost $253 trillion, of which $72 trillion belongs to the emerging market debt (representing 223% of GDP) and $180 trillion for the mature markets debt (representing 383% of GDP) in Q3 2019 (Kose et al, 2020). According to an Institute of International Finance report, there is a diminishing returns on new debt as the global debt-to-GDP ratio grew at is fastest pace since 2016, specially that the global growth fell to its slowest pace since the 2008-2009 financial crises. It was also reported that the global debt has increased by over $70 trillion over the past decade, driven mainly by governments and non-financial corporate sector. The emerging market debt has doubled since 2010 to $72 trillion, driven mainly by the sharp accumulation of the non-financial corporate debt (from $20 trillion in 2010 up to $31 trillion in 2019); while for the mature markets the bulk of the rise has been driven mainly by general government debt (from $17 trillion in 2010 up to $52 trillion in 2019) (Tiftik et al, 2020).

Other than having a very high and rapidly rising debt-to-GDP, the industrial world is having a real interest rates average well below zero. According to Knut Wicksell, the real interest rate that balances saving and investment at full employment is referred to as "natural" or "neutral" real interest rate. As the neutral real interest rates are sufficiently low, the global economy is experiencing a secular stagnation, at which the desired levels of saving are exceeding the desired levels of investment, leading to shortfalls in demand and sluggish growth. Although there are some efforts in having stimulative monetary and fiscal policies, the growth rate is very slow and the inflation rate is very low (below central banks' 2 percent target). The issue is that there is no enough private investment equivalent or close to absorb all the private saving at the normal interest rate. Rachel and Summers (2019) suggest to have an expansionary fiscal policy that can reduce savings, raise neutral real interest rate and stimulate growth by having larger budget deficits, improving social security to reduce retirement saving, redistribution of income to the disadvantaged groups with higher spending propensities and having social insurance that reduces precautionary saving (Rachel and Summers, 2019).

Moving to the emerging markets and developing economies, Kose et al. claimed that they are more prone and vulnerable to the severity of the new significant debt-accumulation wave. The debt-to-GDP ratio in these economies has increased by 54% since 2010, reaching a historic peak of about 170% in 2018. The report has specified several reasons for the rapid buildup debt of the EMDEs and their vulnerabilities, including the low global interest rates since the global financial crisis; the major changes in the financial markets that include the rise of regional banks, the upsurge in local currency bonds issuance, and the expansion of the non-bank financial sector; their low economic growth in a fragile global economy; the growing fiscal and current account deficits; and last but not least a shift towards a riskier composition of debt (Kose et al, 2020).

Egypt has been considered as an EMDE and its debt, both external and domestic, has been significantly increasing and accumulating in the past decade. Egypt's total external debt jumped to $106.2 billion by the end of March 2019, reaching an external debt to GDP ratio of 34.4% (Ministry of Finance). According to the CBE, the domestic public debt is composed of three main parts: Government Debt, National Economic Authorities and National Investment Bank. Egypt's total government debt has reached $288.3 billion (EGP 4,801 billion), representing 90.2% of GDP in June 2019 (Ministry of Finance).

Charles Wyplosz (2005) argues that having a big debt does not always mean that it is unsustainable by providing the case of the British public debt for the period 1700 till 2004 as a proof, in which Britain reached a public debt to GDP ratio of 250% in 1820s, then sustaining it till it reached a ratio of around 20% in 1920s. Moreover, the ratio peaked again in 1950-60s (around 250%) and dropped again to less than 50% in 2004. According to Wyplosz, it depends on the country's economic performance. In Egypt's case, although the economic indicators showed an improvement starting the end of 2016, they are still not so promising.

Accordingly, this research study is focusing on assessing Egypt's debt sustainability; whether it is sustainable or explosive. In assessing debt sustainability, there is always a tradeoff between simplicity and certainty or precision as it is a forward-looking concept with no precise sustainability indicators. Thus, this paper will focus on certainty and precision over simplicity by applying the Autoregressive distributed lag (ARDL) as well as the Vector auto regression (VAR) to test for the fiscal reaction function. My research paper is addressing the gap in the literature concerning the assessment of Egypt's debt sustainability by constructing an econometric model as there is no recent empirical work on this topic as well as none of the work done has applied the fiscal reaction function test. This paper is divided into five further sections. Section 2 provides the stylized facts about Egypt's economy since early 2000s. Section 3 presents literature review on this topic, mainly focusing on the fiscal reaction function test and research done on Egypt's debt sustainability. Section 4 outlines the econometric methodology that will be adopted. Section 5 shows the empirical results, including data sources, unit root tests and models' estimation results. Section 6 includes the conclusion and recommendations for policymakers.

2. Stylized Facts about the Economy of Egypt

This section is dedicated to present and discuss the main trends of the Egyptian economy since the early 2000s. As mentioned earlier, debt can be sustainable if a country's economic performance is going well; however, the Egyptian economy has experienced a lot of economic trends and political events within the past two decades (from 2000 to 2020 – the period under study) that have significantly affected its debt stock.

In 1991, the Egyptian economy was prospering and growing after the efficient and well-managed implementation of the Economic Reform and Structural Adjustment Programme (ERSAP), which led to a reduction in inflation, improvement in the current account balance and large-scale investment in infrastructure and key projects. This was followed by an economic slowdown for few years (2001-2003) due to the September 11 attacks, which led to a slowdown in the world economy and security issues in the region. This incident affected Egypt's economy drastically, having a drop in revenues from tourism, oil and the Suez Canal and that was reflected in a large budget deficit and a high public debt reached 126% of GDP in 2003 (OECD, 2003). Then, the economy started to resume its growth pattern up until 2009 due to a number of economic reforms that was launched in mid-2004 by the Egyptian government. The reforms included transforming Egypt into a more market-oriented and private sector-led economy, expanding financial reforms, improving business and investment regulations, and lowering tariffs (Khan and Miller, 2016). Within this period, the economy was flourishing, specifically for the boom years of 2006-2009, where government embarked on a stance of improving the budget deficit given the favorable growth (reached an average of 7% between 2006 and 2008) and unemployment outcomes (reached its lowest, 8.52%, in 2008) (Khan and Miller, 2016).

The global financial crisis in 2009 has severely hit all the world economies, including Egypt. Although Egypt was fairly protected from financial shocks (since its financial system was less integrated into the world's financial system at that time), it was exposed to real shocks in the economy. Some sectors were significantly affected since they are directly related to the external shock such as Suez Canal (its receipts fell by 8.4%), tourism (fell by 3.1%), remittances (decreased by 8.8%), exports and foreign direct investment (Ministry of Finance). This was followed by the 25th of January 2011 revolution, where the primary deficit increased progressively due to the economic and political instability of this period (2011-2013). The real GDP growth rate fell drastically to 1.8% in 2011 and unemployment rate reached its peak of 13.4% in 2013. The Central Bank of Egypt lost over $20 billion of its foreign exchange reserves between end of 2010 and mid-2012 as they insisted on keeping the Egyptian pound stable (Khan and Miller, 2016).

Starting 2016, Egypt has implemented an economic reform program to stabilize the economy and stimulate growth through liberalization of the exchange rate, fiscal consolidation, and energy sector reforms. In December 2017, the World Bank's Board of Executive Directors approved $1.15 billion in a development policy financing loan to support Egypt's economic reform program, which is just a sub-amount of the three annual loans worth a total of $3.15 million provided over 2015 to 2017. Also, in 2016, the International Monetary Fund approved a three-year $12 billion bailout program to revive the economy and reduce the public debt. Consequently, an adjustment in the primary balance was conducted to maintain the economy on a sustainable path for public debt and that was part of the agreement with the IMF in 2016 targeting a primary surplus, which was achieved in 2018Q2 for the first time in Egypt's recent history. One of the main program objectives was to reduce the fiscal deficits considerably and placing the public debt on a declining path; accordingly, key policy measures were undertaken such as the introduction of VAT, a reduction of energy subsidies and the optimization of the public sector wage bill.

Moving back to the topic of this study, in order to assess Egypt's debt sustainability, the latter has to be defined; debt sustainability is meeting the current and future debt service obligations in full without defaulting, requiring debt relief or rescheduling. Accordingly, we have to look at how debt is serviced: while public debt is serviced out of government revenues, the external debt is serviced by the amount of revenues in foreign currency that the government can collect. Some data about these sources of revenues in Egypt are gathered. Fast-forward to the present statistics; according to the CBE, the state general budget (the budget sector) for 2018/2019 FY indicates that the total revenues and total expenditures represent 17.9% and 26.1% of GDP respectively, with an overall fiscal balance of -8.2% of GDP. The government's main source of revenue is the tax revenues, constituting around 78% of the total revenues. However, what is more critical is the allocation of these money in terms of productive versus current spending. Almost 40% of Egypt's total expenses are going to interest payments, around 20% are going to employees' wages, 4.6% are allocated for purchases of goods and services, and almost 21% are dedicated to subsidies, grants and social benefits. As a developing economy, the government revenues should be mainly directed and allocated to productive spending, represented in the health and education sectors; however, in Egypt around 85% of the total budget sector expenditures are directed towards current spending represented in interest payments, employees' wages, purchases of goods and services, and subsidies, grants and social benefits. On the other hand, one of the main sources of foreign currency is exporting; but unfortunately, Egypt has a trade deficit of $3.22 billion in October 2019 (Ministry of Finance).

As mentioned earlier, although Egypt's economic performance has been improving since 2016, it's still not promising; having a GDP growth rate of 5.4% in 2019, total debt-to-GDP ratio of 86% in 2019, primary balance of 0.9% of EGP in FY 2019/2020, negative trade balance of $41.93 billion in 2019, exchange rate (vs USD) of around EGP 16, and inflation rate of around 13.9% in 2019 (Ministry of Finance). This makes Egypt's debt sustainability a more interesting topic to study and explore.

2.1. Data Used and Sources

The data used in this research paper is quarterly data covering the period from year 2002Q3 to 2020Q2 (calendar quarter), which includes 72 observations. Collecting data for the topic variables was very challenging for several reasons: variation in variables' definitions before and after 2001, lack of availability and consistency of data, and availability of only annual data for certain years. However, these issues were dealt with by sticking to well-defined variables (such as the total debt), changing available annual data to quarterly data by interpolation using a cubic spline function (such as the primary deficit), and data verification from different sources. The data series include the following variables: primary deficit as a percentage of GDP, total debt as a percentage of GDP, real treasury bill interest rate (12 months), real GDP growth and exchange rate. More variables were used to calculate these variables such as real GDP, nominal GDP, overall deficit, government external debt, gross domestic budget sector debt, interest payment and inflation rate. The data series are extracted from the following sources: The Central Bank of Egypt (Monthly Statistical Bulletin and Online Times Series) and Ministry of Finance (Financial Monthly). Here are some definitions and the authors' calculations to get the final model variables:

1. Primary deficit as percentage of GDP:

- Definition: The primary deficit is extracted from the government budget on the Ministry of Finance website. The primary deficit is calculated using the "overall fiscal balance"; however, the latter is treated as fiscal deficit (ignoring the negative sign) as for most of the years, Egypt has a deficit and for the years with fiscal surplus, the sign was flipped to negative. Then, subtracting the interest payments from the overall fiscal deficit to get the primary deficit.
- Calculation: annual data of the primary deficit is used, then interpolated using a cubic spline function to get the quarterly series and divided by the nominal GDP.

2. Total government debt as percentage of GDP:

- Definition: the total government debt in this study is defined as the government external debt (in billion US$) as well as the gross domestic budget sector debt (in billion EGP).
- Calculation: used government external debt (in billion US$) multiplied by exchange rate (EoP) to get the government external debt in local currency; then, added to the gross domestic budget sector debt (in billion EGP). To get it as

percentage of GDP, the total debt in one quarter is divided by the sum of four quarters of nominal GDP that ends in the same quarter as the total debt.

3. Real Treasury bill interest rate (12 months):

- Calculation: is computed as the nominal TBill rate minus inflation rate.

4. GDP growth rate:

- Calculation: is obtained from the Financial Monthly Bulletin, Ministry of Finance.
- Note: the Q-over-Q GDP growth rate is used as an alternative measure of the business cycle since the computation of the output gap measure in Egypt using statistical filters can be misleading due to the sudden drop in activity after the January 2011 revolution.

5. Exchange rate (vs USD):

- Definition: the exchange rate (vs USD), in level, is used in this study. The data is extracted from the Central Bank of Egypt website.

3. Literature Review

According to the literature, debt sustainability assessment is considered a mission impossible as it depends on predictions and forecasting; therefore, it does not have one practical definition, nor precise indicators to serve as a tool for policy prescription. The debt sustainability assessment provides probabilities: "there is a probability of x% that the debt is sustainable at a particular horizon" (Wyplosz, 2005). However, there are four main approaches for the debt sustainability assessment. These approaches are as follows: debt-stabilizing primary balance, International Monetary Fund (IMF) approach, Value-at-risk approach and fiscal reaction function test. Accordingly, this section is divided into three sub-section; of which one section is dedicated to the main measuring debt sustainability approaches; another section is focusing on the empirical literature of the Fiscal Reaction Function approach; and the last sub-section is shedding the light on the previous research work done on Egypt's debt sustainability.

3.1. Measuring Debt Sustainability Approaches

Debt Stabilizing Primary Balance

According to Wyplosz, the debt-stabilizing primary balance is considered the classical approach, which is concerned with the value of the primary balance required to stabilize the debt. Its objective is to stabilize the debt at its current level or at any other desirable level. It is simple, transparent and easily computed as it looks at the current debt-to-GDP ratio and computes the primary balance, at which this ratio would fixed/unchanged. This approach only requires two assumptions: the evolution of the real interest rate and the potential growth rate (Wyplosz, 2005).

Eduardo Ley (2010) shows that the debt-stabilizing primary balance equation is initially derived from the government budget constraint, having the stock of government debt at time t as the dependent variable and using the nominal interest rate, one period lagged stock of government debt, primary government balance, and seigniorage as the independent variables. Ley reached an expression for the change in the debt ratio and solved for primary balance to obtain the debt-stabilizing balance. Having a balance that is greater than the debt-stabilizing balance will bring the debt ratio down. From this equation, we also obtain the interest-rate-growth differential (IRGD), which is the interest rate minus the growth rate. This differential indicates the amount of surplus (balance) needed to reduce the debt-to-GDP ratio, in sense that if the interest paid on debt is lower than the economy growth rate, ceteris paribus, the debt will stabilize below the current level. This means that the economy will grow faster than the debt accumulation (Ley, 2010).

According to Escolano et al. (2011), it was found that there is a correlation between IRGD and GDP per Capita as in many emerging market economies or low-income economies, a negative IRGD helps in bringing the debt ratios down or in stabilizing the debt, even if there are primary deficits, as their growth is outweighing the interest rate, so they need less fiscal efforts to stabilize the debt-to-GDP ratio (Escolano et al., 2011). This was also referred to and confirmed by Ferrarini et al. in the “Public Debt Sustainability in Developing Asia”. They argued also that as long as the IRGD is negative and the debt-to-GDP ratio is falling, the government can borrow at lower interest rate to finance higher consumption and rollover debt (Ferrarini et al., 2012).

Although this approach is simple and easily implementable, it has its own limitations. As mentioned earlier, there is always a trade-off between simplicity and certainty. In “Debt sustainability in emerging markets: a critical appraisal”, Yilmaz Akyuz criticized this approach as it cannot be used as one thing fits all, in terms of having one safe debt-to-GDP ratio that could be applied to all countries. This approach only tells us the amount of surplus (either primary budget or current account) needed to stabilize the debt ratio for given values of its determinants, but not whether the debt can be sustained over time or not. Moreover, it does not take into account the dynamic interactions that might occur among the key variables that determine the evolution of debt ratios. It also treats the fiscal and external sustainability separately, disregarding any interactions that could occur between them (Akyuz, 2007).

IMF Approach

The IMF's approach to debt sustainability analysis differentiates between market-access countries, which have significant access to international capital markets, and low-income countries, which mainly depends on concessional support to meet their external financings needs. For advanced and emerging market economies, the IMF decided to standardize a debt sustainability assessment, which is the debt sustainability assessment framework. This framework aims to provide a simple, fully transparent and standardized tool that can be readily applied to all countries. It consists of two components: analysis of the sustainability of total public debt and that of total external debt; through the following four steps (for external debt):

1. Forecast the following variables that affect the evolution of the debt for a time horizon of 5 years: the primary account, GDP growth rate, interest rate, exchange rate and inflation.
2. Calculate the resulting evolution of the debt-to-GDP ratio over the next five years by using an equation similar to that of debt-stabilizing primary balance approach.
3. Conduct several stress tests on the variables forecasted in step 1 to test for the variables' shocks effect on debt.
4. Conclude with a judgement on whether the debt levels implied by any or all of the stress tests are too high for the debt to be considered sustainable.

In step 3, they shock each variable of the three variables, interest rate, GDP growth and primary current account, separately. Then, all the variables are simultaneously shocked over five years. The exchange rate is assumed to be depreciated once by 30% at the beginning of the simulation period. In step 4, IMF uses an additional procedure called Country Policy and Institutional Assessment (CPIA), developed by the World Bank. CPIA produces an index of governance quality for each country; the index ranges from 1 (lowest quality) to 6 (highest quality) based on 20 indicators. It is used to classify countries into three groups: countries with a low CPIA index are assigned a debt threshold of 30% of GDP, raised to 45% for the intermediate group of countries, and to 60% for the countries in the highest CPIA index group. These thresholds are chosen such that the probability of debt distress is 25% when they are reached. The IMF included this index in its assessment as the empirical research showed that the quality of economic and political institutions play an important role in determining the probability of debt distress or debt sustainability (Wyplosz, 2005).

On the other hand, the IMF provides a broader support for low-income countries (LICs) through surveillance and capacity building activities. The surveillance activities include continuous monitoring of economic and financial policies (focus on how their policies affect stability and explore policy adjustments). The capacity building activities are mainly concerned with how to boost domestic revenues, manage public finances and monetary policy, regulate the financial system and implement sound policies and good practices. The IMF provides concessional financial support for the low-income countries through Poverty Reduction and Growth Trust (PRGT), which is tailored to the needs of LICs. They provide poverty reduction strategies and policies to promote growth and reduce poverty. The PRGT has three concessional lending options: Extended Credit Facility (ECF); Standby Credit Facility (SCF); and Rapid Credit Facility (RCF). For the LICs that are macro-economically stable, they sometimes do not need financial assistance, so IMF provides them with nonfinancial assistance such as fund advice and support through the Policy Support Instrument (PSI) (IMF, 2018).

Although the IMF debt sustainability assessment framework seems simple, comprehensive and standardized for all countries, it has some drawbacks. The IMF approach for the LICs does not have any limitations as the IMF customize the procedures to be taken for each country to cater its needs, while the standardized framework for advanced and emerging market economies is criticized by some researchers. According to Wyplosz, the stress tests in the IMF approach ignores the correlation between the shocks as well as the linkage between borrowing and growth as there could be a growth-enhancing effect of external borrowing; in the sense that if the borrowing is wisely invested, the returns could cover more than the costs. Also, the CPIA index is not applied country by country. Instead, the countries are classified in three groups depending on their own CPIA index. The effect of governance is applied group by group, which implies that the effect is either exaggerated or underestimated for the countries whose CPIA indices do not lie in the middle of the range (Wyplosz, 2005). On the other hand, Akyüz draws some limitations for the IMF approach, such as it ignores the shortcomings of the standard framework, which I mentioned earlier for the debt-stabilizing primary balance approach; the projections for the fiscal and external debt are too optimistic, assuming that the markets are efficient in assessing and handling risks; and for the policy advice, IMF prioritizes meeting the debt service obligations over poverty and development objectives (Akyuz, 2007).

Value-at-risk

The value-at-risk approach is initially developed by financial institutions to explore the risks associated with portfolios. It measures and quantifies the level of financial risk within a firm, portfolio or position over a time horizon. However, in economics, this approach was adopted as a tool to assess debt sustainability of a certain economy over a specific time frame. This approach depends on two main ideas: 1- that history allows evaluating the probability of various events or combinations of events; 2- that reactions should consider both the possible severity of each event and its likelihood (Wyplosz, 2005).

In finance, there are three methods to apply the VaR approach, which are historical simulation approach, delta-normal approach and Monte Carlo simulation approach. The first method, historical simulation approach, depends on historical data of market rates and prices to be constructed for future portfolio profits and losses over a specific period of time. The second method, delta-normal approach, assumes that underlying market factors have a multivariate normal distribution in order to determine the portfolio profits and losses. The third method, Monte Carlo simulation approach, depends on statistical/frequency distribution that is assumed to approximate the possible changes in market forces (Ferrarini et al., 2012).

To further understand how the Value-at-Risk approach is used, we have first to introduce the so-called stress tests, which are shocks applied to the variables that affect the evolution of the debt. The stress tests are applied on some macroeconomic variables to test for the effect of shocks on the stock of debt in the baseline scenario. The stress tests results are presented and analyzed through a fan-chart diagram to show all the possible scenarios for the evolution of the debt. The stress tests are used in both the IMF approach and the value-at-risk approach, but applied differently. There are two methods for stress testing: deterministic stress testing and stochastic simulation method. The deterministic stress testing is applied by shocking each variable on its own and assessing how each one would affect the debt-to-GDP ratio. Over the past decade, the IMF has been applying these deterministic stress tests for debt sustainability analysis (DSA) in Article IV with member countries, represented in a fan chart (IMF 2002, 2003a). However, as previously mentioned, this method has its limitations as it neglects the correlation of the variables. The deterministic stress testing, also called the standard stress tests, could be used as an initial approximation for assessing fiscal sustainability to identify the economy's vulnerabilities and to provide some measures of the direct impact of some shocks on the debt ratio, but it could not assess the fuller impact of shocks on the debt path, which means that it does not account for the shocks' indirect effects on the economy (Koptis et al., 2016).

On the other hand, the stochastic simulation method corrects for the shortcomings of the deterministic stress tests by estimating the correlation pattern among the key macroeconomic variables to account for the direct and indirect effects of the shocks as well as to address the uncertainty level of the baseline debt projections. The stochastic simulations consist of combination of vector autoregression of all the macroeconomic variables that affect the debt dynamics, aided with one of the value-at-risk methods to indicate the severity and/or likelihood of each shock occurrence. Then, a range of possible debt projections associated with the level of likelihood is presented on a fan-chart diagram (Ferrarini et al, 2012). Based on the literature review, the Monte Carlo simulation approach is the most commonly used method in calculating the Value-at-Risk for debt sustainability as it incorporates analytical models that specify the manner in which variables change over time (Barnhill and Kopits, 2003). Although the stochastic approach remedies the limitations of the deterministic methods, it is more complex in terms of analysis and data requirements. Thus, many stochastic methods have been developed, but with little application on few countries.

Wyplosz (2005) simply listed the steps to estimate the value-at-risk as follows: first, to assume that historical correlations are likely to be relevant in the future; second, to consider all estimated correlations and imagine all the possible combinations of shocks; it associates each shock with a probability of occurrence; third, to test for each shock how would it affect the evolution of the debt (Wyplosz, 2005). However, this approach has been defined, classified, modified and applied in numerous ways in the literature review. Although it is known that the VAR is an essential part in the application of the VaR approach, Kopits, Ferrarini and

Ramayandi (2016) classifies the vector autoregressive (VAR) approach and the Value-at-Risk (VaR) analysis as two different stochastic methods that have been developed based on or as an extension to two deterministic methods, which are the standard debt sustainability analysis (DSA) template and the intertemporal balance-sheet approach respectively (Kopits et al., 2016).

In 2003, Barnhill and Kopits were the pioneers of using the VaR approach in assessing debt sustainability by using the intertemporal balance sheet. They used this approach to calculate the effect of macroeconomic variables volatility, represented in exchange rate, interest rates, oil prices and output, on Ecuador's fiscal sustainability. Their objective was to measure the government's net worth as an explicitly stochastic process and to assess the probability of government default; they compared the present value of the economy's net flows (represented in estimating the above mentioned macroeconomic variables) to the value of its outstanding debt to get the economy's net worth (Barnhill and Kopits, 2003). Following their steps, Da Costa, Silva and Baghgdassarian adopted Barnhill and Kopits model to assess Brazil's contingent assets and liabilities. However, they could not find enough data for the asset side, the measure of tangible assets as well as the value of public sector enterprises were not available; and for the liability side, they did not model specific contingent liabilities. Instead, they just compared the government's outstanding debt to the present value of its primary balance (Da Costa et al., 2004). It is worth noting that they used 3 different approaches to complement one another in assessing Brazil's debt sustainability, of which the Value-at-Risk approach. However, Burnside criticized the Da Costa et al.'s case study as it neither explicitly accounted for contingent liabilities, provided enough details about their simulations, nor provided enough guidance to policy makers. Moreover, he criticized the Barnhill and Kopits' method itself as he believes that it should be used only for assessing specific contingent assets or liabilities, not in generic fiscal sustainability analysis focusing on the government's overall primary balance (Burnside, 2004). Furthermore, Adrogue (2005) adopted the VaR approach to calculate the probability distribution of the Debt-to-GDP ratios of several Central American countries. He followed the IMF 2003 stochastic simulation method. Adrogue applied both the traditional approach and the VaR approach and compared their findings, which resulted into the same conclusion of all Central American countries, except for Guatemala, that policy makers should make their public debt to GDP ratios sustainable. However, both approaches provided different characterization of risks to the debts as the factors that contribute to the risks differ across countries and that was revealed through the

VaR analysis. Adrogue pointed out in his paper that the VaR approach provides tentative results as it depends on historical data, has data limitations and does not consider the potential endogeneity of variables (Adrogue, 2005).

On the other hand, many authors adopted the VaR approach to address the uncertainty around the public debt sustainability, by using the IMF debt sustainability analysis template (IMF 2002, 2003a). The real GDP growth rates, interest rates, inflation rates, primary balances and exchange rates are the key sensitive parameters to shocks in most emerging market and developing countries. Ferrucci and Penalver (2003) were the first to introduce a method of analyzing public debt sustainability on a probabilistic basis (Ferrucci and Penalver, 2003). Then, this method was applied in 2004 by Garcia and Rigobon in their paper. In 2006, Celasun, Debrun and Ostry built on this method and addressed uncertainty in three different ways for five emerging market economies. They started with the basis of stochastic simulations by forming a VAR to estimate the effects of the variance and covariance of growth, interest rate and exchange rate on public debt; estimated a fiscal policy reaction function; and combined the estimates of both the stochastic simulations and the fiscal reaction function to generate stochastic simulations for the debt ratio projection with the aid of the Monte Carlo simulations to get yearly frequency distributions of the debt ratio, represented in a three-dimensional fan chart (their model is further explained in the FRF sub-section). Frank and Ley (2008) also contributed in further developing this method by allowing explicitly for structural breaks, relaxing the normality assumption in the probability of shocks having asymmetric tails, and estimating the fiscal reaction function in terms of a debt stabilizing primary balance. Based on these furnished basis, other authors applied this method with some modifications to fit into the circumstances and data of the economy in concern, such as Budina and Wijnbergen (2009), Giovanni and Gardner (2008) and Ferrarini and Ramayandi (2012, 2015).

Fiscal Reaction Function

The fiscal reaction function test uses past behavior to model or estimate a fiscal reaction function of the government. The objective of this approach is to test whether policy responds to debt accumulation (or not) as adequate policy reactions can mitigate the shocks, which is considered one effective way to debt sustainability. This approach does not require the estimation of likely shocks and their respective probabilities, nor is passing judgement on what the acceptable debt level (Wyplosz, 2005). However, it has only one limitation, which is only considering how variations in fiscal surpluses react to changes in debt and do not considering the actual fiscal position.

The estimation of the fiscal reaction function varies from one country to another and from one researcher to another as it depends on the past behavior of the authorities of each country towards shocks and this behavior could differ among countries. Also, the model determinants are selected based on their impact and significance on the primary balance of the targeted economy. This approach was initially presented in the late 1990s and it was used solely to assess an economy's public debt sustainability; however, it was developed overtime by researchers and economists and in some cases it was used as a complementary method in the debt assessment process. The fiscal reaction function is the approach that is adopted in this study to assess Egypt's debt sustainability; accordingly, the below sub-section is providing extensive details on how the fiscal reaction function is used in the literature, the methods and variables used to estimate the function, and the main findings of each study.

3.2. Empirical Literature of Fiscal reaction function

In 1998, Henning Bohn set the theoretical and empirical grounds of the fiscal reaction function approach. He was the first to assess the sustainability of the public debt by examining it in a time series context for the United States. He proved that although the U.S. debt-to-GDP ratio has unit root, which means that it is non-stationary or explosive, corrective action could lead to mean reversion. The study showed that the U.S. government has historically responded to the increases in the Debt-to-GDP ratio by raising the primary balance. Thus, the U.S. primary surplus is an increasing function of the debt-to-GDP ratio for 1916-1995 and various sub-periods as Bohn stated, "The positive response of the primary surplus to changes in debt also shows that U.S. fiscal policy is satisfying an intertemporal budget constraint." Bohn also believes that the fiscal reaction function is better than a univariate time series analysis of the debt-income ratio as it is subject to various shocks that make mean reversion not easily detected. Bohn ran a simple regression of primary surplus using OLS estimation as represented in the following equation:

$$ps_t = \rho b_{t-1} + \beta \tau_t + \varepsilon_t \qquad (\varepsilon_t \sim 0, \sigma 2)$$

Where ps_t is the primary surplus as a ratio of GDP; b_{t-1} is the debt-to-GDP ratio for the previous year; τ_t is temporary factors affecting primary surplus such as swings in government spending and business cycle. ρ measures the responsiveness of the primary surplus to changes in debt ratio and β is a vector coefficient that measures also the response of the primary surplus to temporary factors. According to Bohn's model, the coefficient of the lagged debt-to-GDP ratio, ρ, should possess a positive value to maintain a sustainable debt (Bohn, 1998).

The objective of Khalid et al.'s study was to estimate a fiscal policy reaction function and identify a fiscal policy transmission mechanism for Pakistan over the period 1965-2006. The authors, Khalid et al., estimated a vector autoregression (VAR) model of three variables, output gap and inflation acting as policy objectives and fiscal deficit as percentage of GDP as a fiscal instrument to estimate the fiscal reaction function and the effect of fiscal policy changes on economic indicators. They also estimated the impulse response functions to show the effect of different shocks on the three variables. It is worth-noting that their VAR model estimated the fiscal reaction function with only lagged variables as economic indicators; they used Near-VAR technique to avoid over parameterization by using only significant lagged variables in estimating the transmission mechanism. Their results showed a pro-cyclical response of fiscal authority to the economy as both output gap and inflation predict positive changes in fiscal deficit in one period ahead; and that fiscal policy changes have no significant impact on the economy, having insignificant coefficients of fiscal deficit in both equations of output gap and inflation. This indicates either that the monetary policy offsets the fiscal expansion impacts on output gap and inflation, or that this model is unable to capture the true dynamics of output gap and inflation. Moreover, they estimated the fiscal reaction function with dummy variables for the boom and recession to assess the response of the fiscal authority to changes in economic indicators over the business cycle. The results showed that the fiscal policy is endogenous and pro-cyclical, where the latter response is significant in boom periods and insignificant in recessionary periods. However, they have received the complete opposite results, when they reapplied the process by decomposing the fiscal instruments in tax revenue and government expenditures as percentage of GDP. Based on their model, they were not able to identify any transmission mechanism of fiscal policy for output gap and inflation, and advised to assess the dynamic effects of shocks in budgetary components on the fiscal deficit (Khalid et al., 2007).

Following the same empirical steps, Mello (2008) estimated the fiscal reaction function for Brazil, based on the intertemporal budget constraint, by regressing the ratio of primary surplus-to-GDP on the ratio of public debt-to-GDP, while controlling for other determinants of the fiscal stance. The primary surplus acted as the dependent variable on the following independent variables: lagged primary surplus, lagged debt-to-GDP ratio, a set of control variables and an error term. The control variables included the output gap to capture the impact of the business cycle on the budget; and inflation to account for shocks to seigniorage revenues. To test for Brazil's public debt sustainability, Mello estimated the fiscal reaction function for the consolidated public sector and different levels of government. As a result, he found that all levels of government strongly respond to changes in indebtedness by adjusting their primary budget surplus; that was reflected in the positive coefficient of the lagged debt-to-GDP ratio, which indicates that an increase in the level of debt is accompanied with an increase in the primary surplus. Moreover, Mello focused on the central government to estimate the responsiveness of revenue and expenditure to changes in indebtedness, using the error correction model. The results showed that the debt dynamics appear to be sustainable as changes in central government revenue are highly affected by expenditure as about two-thirds of the changes in primary spending are offset by higher revenue over the long term; however, the long term response of revenue to total expenditure is only 15 percent. The central government ensures its debt sustainability by following a spend-and-tax policy (Mello, 2008).

However, Afonso and Hauptmeier (2009) estimated dynamic panel data specifications to construct the fiscal reaction for the European Union for the period 1990-2005 with two main variables: the primary balance-to-GDP ratio and the debt-to-GDP ratio. They also used output gap, fiscal rule indicator, institutional, political and other control variables. Their analysis focused on the responsiveness of the primary budget balances and primary spending to these determinants. The results show that the existence of effective fiscal rules and lower degree of public spending decentralization positively contribute to the responsiveness of the primary surplus to government indebtedness; however, the electoral cycle (e.g. parliamentary elections) negatively impact the improvement of the primary balance. Also, the results support the responsiveness of primary balances to government indebtedness as the governments of the 27 members of the European Union increase the primary balance surplus as a response to the increases in the stock of government debt in order to align with their fiscal framework (Stability and Growth Pact guidelines in 1997; and European and Monetary Union in 1992 – both are added as explanatory dummy variables in the baseline regression) (Afonso and Hauptmeier, 2009).

Balazs Egert (2010) included some business cycle variables as independent variables to analyze the reaction of the fiscal policy to the cycle in OECD countries. He explained three approaches with their potential explanatory variables that one can adopt to analyze the cyclical nature of fiscal policy and its determinants. According to his study results, he found that fiscal policy in countries with high public debt and high government deficits tend to be pro-cyclical, while countries that have low public debt and have government surpluses are more likely to conduct a counter-cyclical fiscal policy. The pro-cyclical fiscal policy exists when governments choose to increase government spending and reduce taxes during a boom period; and reduce spending and raise taxes during a recession. The complete opposite applies for the counter-cyclical fiscal policy during an economic boom and/or a recession (Egert, 2010).

Ghosh et al. (2011) decided to extend the fiscal reaction function literature and introduce the notion of fiscal space, which is defined as the difference between a country's current debt level and its debt limit, where beyond this limit fiscal solvency fails. They followed the basics of Bohn in their theoretical framework; however, they consider his sustainability findings of the primary balance always responds positively to lagged debt to satisfy the government's intertemporal budget constraint is a "weak sustainability criterion" that rules out the case of an ever increasing debt-to-GDP ratio, which in return would need a primary surplus that exceeds GDP. To address this shortcoming, Ghosh et al. adopted a more strict sustainability criterion, by which "public debt should be expected to converge to some finite proportion of GDP". This indicates that the primary balance responsiveness would be greater than that of the interest rate-growth rate differential. After applying their framework on a sample of 23 advanced economies for the period of 1970-2007, they found that there is a non-linear relationship between the primary balance and public debt. According to their results, the primary surplus responsiveness is positively related to the increases in debt, then starts to weaken and declines at very high levels of debt (90-100% of GDP). Moreover, they found that although the 23 economies' debt limits are within the range of 150-250 percent of GDP, their corresponding fiscal space greatly varies; only Australia, Korea and the Nordic countries have positive fiscal space (Ghosh et al., 2011).

Westphal and Zdarek (2017) estimated a FRF for 18 euro area countries and extended on Ghosh et al.'s notion of fiscal space by deriving a simple approach to measure fiscal fatigue as well as investigate its risk in these countries. They detected the fiscal fatigue by using both linear and non-linear FRF; however, they found weak evidence for fiscal fatigue using the non-linear FRF for the 18 countries (Westphal and Zdarek, 2017).

On the other hand, Celasun, Debrun and Ostry (2006) combined both the fiscal reaction function and value-at-risk approaches altogether to reach a comprehensive public debt sustainability analysis. They constructed a model that includes simulation for the public debt path subject to macroeconomic variables' realistic shocks (shocks to growth rate, interest rate and exchange rates) and endogenous policy response to these shocks as well as the possible shocks arising from fiscal policy itself. Celasun et al. argue that the previous literature was focusing on macroeconomic data and ignoring the public debt evolution constraints produced by the endogenous fiscal policy response to debt shocks. They also highlighted that many researchers assume fiscal policy is invariant to the shocks in their DSA; however, in reality, the primary surplus responds to changes in public debt and to the business cycle. They applied this model to the following emerging market economies: Argentina, Brazil, Mexico, South Africa and Turkey. Celasun et al. estimated the fiscal reaction function using five methods; the first three specifications are for linear reaction function, while the other two are for non-linear reaction function. In the first regression, they used the limited information maximum likelihood (LIML), which eliminates the country effects by using first differences and instruments for the lagged change in debt and contemporaneous change in the output gap, using as instruments lags of one-year U.S. bond rates, changes in real oil prices, lagged fiscal costs of banking crises, and import demand in industrial-country trading partners. In the second regression, they used Blundell-Bond (1998) system-GMM (SGMM), which jointly estimates the level and differenced forms of the equation, using lagged differences and levels of the endogenous regressors as instruments in addition to the exogenous instruments used in the LIML regression. In the third regression, they estimated a version with country dummies, instrumenting only the output gap with import demand in industrialized trade partners (GMM-DV). The results of all three estimations indicate a positive response of primary surpluses to the debt. The primary balances are estimated to be countercyclical since the coefficient of the output gap is positive (Celasun et al., 2006).

Burger, Stuart, Jooste and Cuevas (2012) followed and extended on Celasun et al. method. They emphasized the role of policy reaction to the evolution of public debt and estimated a new fiscal reaction function for South Africa that incorporates debt service costs. They also produced an asymmetrical reaction of the primary balance to the output gap, represented in a fan chart. The main objective was to assess how the current primary balance-to-GDP ratio responds to the one period lagged public debt-to-GDP ratio. To address the problem of possible non-stationarity of the variables, they estimated the FRF using three methods: 1. Using OLS as if the data are stationary; 2. Using state-space and TAR models assuming non-linearities in behavior; 3. Using VECM treating the debt-to-GDP ratio and primary balance as percentage of GDP as non-stationary. From all these models, they found that the South African government maintained a sustainable fiscal policy since 1946, by reducing the primary deficit or increasing the surplus as a result of an increasing debt (Burger et al., 2012).

Several authors also adopted Celasun et al. method in assessing public debt sustainability for different economies. Medeiros (2012) used the VAR/FRF method to simulate debt ratios for fifteen EU member states. His results showed that the public debt paths are not normally distributed, accompanied by Ghosh's discovery of "Fiscal Fatigue", which indicates that primary balance tends to decline at very high levels of debt-to-GDP ratios (mean reversion to historical trends). Eller and Urvova (2012) applied this methodology to a group of the Central, Eastern and Southeastern Europe (CESEE) countries: Czech Republic, Poland, Hungary and Slovakia. They just modified the model to include various fiscal policy determinants such as lagged primary balance, inflation rate, quality of fiscal institutions, political events (e.g. elections), foreign business cycle shocks, and other factors such as revenue windfalls, natural disasters, infrastructure investments and social security reforms. Based on their results, the public debt projections in these countries are sustainable for the period 2012-2016; however, there are considerable risks to these projections due to the joint dynamics of macroeconomic shocks and the fiscal policy itself, which should be addressed by policy-makers.

3.2. Egypt's case

As previously mentioned, only few studies about Egypt's debt sustainability are available in the literature, of which only four studies are based on empirical research along with IMF reports. In 2004, Alba, Al-Shawarby and Iqbal assessed Egypt's debt sustainability as Egypt's public debt reached 126% of GDP in 2003. They initially started by studying and analyzing Egypt's key fiscal trends, exploring whether these trends are structural or cyclical, and then simulating its debt-to-GDP ratio for 15 years under certain assumptions about key macroeconomic variables. The latter include growth rate, inflation rate, domestic and foreign interest rates, foreign debt and exchange rate. They conducted their simulation using a deterministic approach, similar to that of IMF, by shocking each variable separately. The simulation results for all scenarios showed that the debt-to-GDP will persistently grow till 2018. Also, they found that Egypt's debt is driven by structural factors/weaknesses, including weak taxation system and high government expenditure on wages, subsidies and interest payment. They advised at that time to have both fiscal adjustment and economic growth to achieve sustainability (Alba et al., 2004).

In 2005, the World Bank conducted a study about Egypt's debt and tested its sustainability by two different ways. First, they adopted the debt-stabilizing primary balance approach to know the primary surplus that they need to reach in order to maintain the current debt level; although, it might not be sustainable. The results showed that the needed primary surplus was to be above 2.4%. Second, they adopted the deterministic approach as well, referring to it as "The Fiscal Accounting Approach", in which they developed a baseline scenario with specific assumptions for the following macroeconomic variables: growth rate, inflation rate, nominal exchange rate, nominal effective interest rate on foreign debt, imports-to-GDP, and external debt. Then, they applied 3 different shocks, represented in a fall in the growth rate, an increase in the average interest rate and a deterioration in the revenue-to-GDP, in order to depict the path of the debt-to-GDP under downside risk (World Bank, 2005).

El Mahdy and Torayeh (2009) assessed the impact of the public debt on economic growth by estimating an equation, where the growth rate is the independent variable, and the following as dependent variables: a vector of control variables, debt-to-GDP ratio and a residual. They adopted an econometric technique of co-integration and error correction modeling (ECM) and used the VAR for the estimation. Then, they provided two approaches to assess debt sustainability: 1. the debt-stabilizing primary balance approach; and 2. the stress test/ deterministic approach. They simulated the debt ratio with 5 scenarios other than the baseline scenario; however, only one scenario that resulted in unsustainable debt, where they worsened all the values of the used macroeconomic variables (El Mahdy and Torayeh, 2009).

A recent study, conducted by Al Nashar (2019), provides an analysis of the theoretical and empirical foundations of government debt dynamics in Egypt. The results show that the primary deficit ratio followed by the valuation effect caused by exchange rate depreciations are the main contributors to the accumulation of debt in Egypt. The results also indicate that the domestic debt is partially inflated away. It is worth noting that a stock-flow adjustment residual is found in the debt dynamics decomposition, which accounts for around third of the increase in the debt-to-GDP ratio in some periods. Other than the backward looking approach, Al Nashar ran a structural VAR of 4 endogenous variables, which generates 16 impulse responses representing the response each of the four variables to each of the four structural shocks. The results showed that the exchange rate has a double effect on the government debt level as after applying a one standard deviation shock to the exchange rate, both the level of the primary deficit and the pace of growth in total government debt have risen. Also, the exchange rate shock showed a negative impact on the change in the real interest rate. On the other hand, the primary deficit shock also led to an increase in the government debt growth, had a short-lived effect on the exchange rate depreciation and led to an increase in the real interest rate. Accordingly, Al-Nashar concluded based on the above mentioned results that the exchange rate depreciation has a similar impact on the debt accumulation as that of the primary deficit on the long run (Al Nashar, 2019).

On the other hand, there are some papers that discussed the issue of Egypt's high public debt level. In 2007, Abdel Khalek addressed Egypt's rising public debt by discussing its size, structure, indicators and government policy. He linked achieving Millennium Development Goals (MDGs) to that of the debt sustainability (Abdel Khalek, 2007). In 2018, ElGhouty tackled the issue post the Egyptian Revolution of 2011 by identifying the reasons behind that increase in public debt and analyzing the relationship of public debt to economic growth. She also provided some guidelines for policymakers regarding this issue (ElGhouty, 2018).

The IMF conducted 7 reports about Egypt's economic performance from 2005 till 2018, under Article IV of the IMF's Articles of Agreement. By the end of 2016, the IMF executive board approved the three-year Extended Fund Facility to support Egypt's economic reform program. Accordingly, the last report released in 2018 discusses the economic situation in Egypt after going through some reforms. As part of the report, the IMF staff assesses the public as well as the external debt of Egypt. Following the IMF approach, the public debt simulation results for the baseline scenario are favorable (projected debt ratio declines to 87% in 2018/2019); however, "it remains above the benchmark of 70 percent of GDP for emerging markets until 2022/23, and gross financing needs are on average 35 percent of GDP during the projection period compared to the 15 percent benchmark." (IMF, 2018). They also applied stress tests of certain macroeconomic variables to debt ratio. The most severe scenario, which is combining all shocks altogether, resulted in a debt-to-GDP ratio of 106%, compared to 87% in the baseline scenario for the same year (IMF reports).

Assessing Egypt's debt sustainability from a completely different perspective, Allen, Banerji and Nabil (2004) studied the impact of Egypt's budgetary institutions on long-term fiscal sustainability. They provided both theoretical and empirical evidences on how the lack of transparency and accountability of the financial institutions as well as the lack of short-term control of expenditures could lead to fiscal crises. They highlighted the importance of adopting a performance-based budgeting reform system by the governments and discussed the positive relationship between the quality of budget institutions and the quality of overall governance and their causality effect. After examining Egypt's budgetary rules and procedures with respect to transparency and accountability, they found that Egypt has clear and defined budgetary rules, but they do not promote for fiscal sustainability nor work for certain development objectives. It focuses on managing short-term financial flows and their compliance with the law. They do not set priorities nor limits when it comes to the government expenditure; they just adjust and modify the new budget based on the previous one accounting for new initiatives. Over and above, findings indicate lack of transparency and accountability as budget details are not shared with the public, insufficient data on actual expenditures are released to be compared with the budgeted expenditures, no detailed analyses are provided for developmental objectives and how public expenditures would achieve them, and incomprehensive budget omitting significant items that is critical to fiscal sustainability. To ensure fiscal sustainability, the authors suggest the Egypt should consider an institutional reform that promotes for transparency and accountability as well as adopts an effective change management strategy (Allen et al., 2004).

4. Econometric Methodology

In this study, the Autoregressive distributed lag (ARDL) approach and the Vector auto regression (VAR) model are used for our time series econometric modelling. To begin with, the ARDL approach was initially used by Pesaran and Shin (1999) to examine its use for the analysis of long-run relations when the underlying variables are I(1). Then, the approach was further developed by Pesaran, Shin and Smith (2001) to test for the relationship between the dependent variable and set of regressors, irrespective of whether the underlying regressors are I(0) or I(1) stationary. The ARDL model consists of the dependent variable; and lagged dependent variable, vector of explanatory dynamic variables, vector of exogenous static variables and mean-zero uncorrelated error term as independent variables. Accordingly, our model specification would be as follows:

$$y_t = \alpha_0 + \sum_{i=1}^{P} \alpha_{1i} y_{t-i} + \sum_{j=0}^{q} \beta_j' X_{t-j} + \gamma' Z_t + \varepsilon_t, \qquad (1)$$

where y_t is the primary deficit as a percentage of GDP (PD), X_t is a vector of explanatory dynamic variables that includes the total debt as a percentage of GDP (D2GDP) and the real GDP growth rate (RGDPG), Z_t is a vector of exogenous static variables that includes real treasury bill interest rate (12 months) (RTBIR) and exchange rate (ER) acting as shocks to the model, and ε_t is a mean-zero uncorrelated error term. The specification in equation (1) is an ARDL (p,q) model.

The ARDL model is selected for this study for its flexible properties and advantages over conventional co-integration testing. The standard co-integration analysis requires pretesting the variables to classify them into I(0) and I(1); however, the ARDL model can be applied irrespective of whether the underlying variables are I(0) and I(1) or a combination of both. But it does not allow for I(2) variables to be included in the model. Moreover, it also allows for fractionally-integrated series since it is difficult to assert the level of integration of the model variables with a reasonable degree of accuracy. Another important feature is that different variables can be assigned different lag lengths as they enter the model, which offers flexibility and avoids overfitting. It is also worth noting that the ARDL is featured as a dynamic single model equation, which allows for focusing on the variable of interest, facilitates its implementation and the interpretation of the results. To test for co-integration among the variables, the bounds test methodology of Pesaran and Shin (1999) and Pesaran et al. (2001) is used, which is simpler in application and doesn't require certain assumptions about the existence of trends in data and in the co-integrating relationship itself. When co-integrating vectors are identified, the ARDL model is reparameterized into ECM and its results provide both short-run dynamics and long run relationship of the variables of a single model.

Accordingly, we run the following regression:

$$PD_t = \alpha_0 + \sum_{i=1}^{P} \alpha_{1i} PD_{t-i} + \sum_{j=0}^{q1} \beta_{1i} D2GDP_{t-j} + \sum_{j=0}^{q2} \beta_{2i} \mathrm{RGDPG}_{t-j}$$

$$+ \gamma_1 RTBIR_t + \gamma_2 ER_t + \varepsilon_t \qquad (2)$$

The dynamic regressors are allowed to have different lag structures denoted by p and q_i, i = 1, 2. The lags (p, q_1, q_2) will be selected according to the Schwarz information criterion (SIC), which is a criterion for model selection among a finite set of models. Then, applying the Bounds Test through the following regression:

$$\Delta PD_t = \tilde{\alpha}_0 + \sum_{i=1}^{P} \tilde{\alpha}_{1i} \Delta PD_{t-i} + \sum_{j=0}^{q1} \tilde{\beta}_{1i} \Delta D2GDP_{t-j} + \sum_{j=0}^{q2} \tilde{\beta}_{2i} \Delta \mathrm{RGDPG}_{t-j}$$

$$+ \check{\gamma}_1 RTBIR_t + \check{\gamma}_2 ER_t + \delta_0 PD_{t-1} + \delta_1 D2GDP_{t-1}$$

$$+ \delta_2 \mathrm{RGDPG}_{t-1} + \eta_t \qquad (3)$$

The Bounds Test is an F-test of the hypothesis, $H_0 = \delta_0 = \delta_1 = \delta_2 = 0$ against the alternative that H_0 is not true. The purpose of this co-integration testing is to test for the absence of long-term equilibrium relationship between variables. This absence is presented in zero coefficients of the following variables PD_{t-1}, $D2GDP_{t-1}$ and RGDPG_{t-1} in equation (3). The rejection of H_0 implies that there is a long-run relationship. Since we can't have an exact critical values for F-test of an arbitrary mix of I(0) and I(1) variables, Pesaran and et al. (2001) provide bounds on the critical values for the asymptotic distribution of the F-statistic. They give lower and upper bounds on the critical values, where the lower bound is based on the assumption that all variables are I(0) and the upper bound is based on the assumption that all variables are I(1). There are 3 scenarios for the computed F-statistic: 1. If it is less than the lower bound, then the variables are I(0) and no co-integration; 2. If it is more than the upper bound, then there is co-integration; and 3. If it lies between the two bounds, then the test is inconclusive.

An error correction model (ECM) can be estimated in case there is co-integration by adding an ECM term in equation (3) with a coefficient representing the speed of adjustment parameter. The ECM term would be the lagged residual (ξ_{t-1}) from the following long-run regression:

$$PD_t = \varphi_0 + \varphi_1 D2GDP_t + \varphi_2 OG_t + \varphi_3 RTBIR_t + \varphi_4 ER_t + \xi_t, \quad (4)$$

where all the coefficients in equation (4) represent the long-run response in the co-integrating relationship.

The second method used is the Vector autoregression (VAR) model, which was initially proposed by Christopher Sims, macro-econometrician, in 1980 to model the joint dynamics and economic relationships among a set of macroeconomic variables. The VAR is the generalization of the univariate autoregressive (AR) model that allows for more than one evolving variable. It consists of a system of variables that each has an equation explaining its evolution based on its own lagged values, the lagged values of the other model variables, and an error term. This model only requires that the list of variables selected are hypothetically affect one another intertemporally. Also, the VAR model works when all the model variables are stationary at first difference, and it assumes that all variables are endogenous. The VAR model has proven to be a coherent and reliable tool for data description, forecasting, structural inference and policy analysis. The properties of the VAR model are usually analyzed using Granger causality, impulse responses and forecast error variance decomposition.

Accordingly, we estimate an unrestricted VAR model including a set of determinants of debt dynamics with the following specification:

$$Y_t = \beta_0 + \sum_{k-1}^{P} \beta_k Y_{t-k} + \epsilon_t,$$

where Y_t is a vector of variables including real GDP growth, real treasury bill interest rate (12 months) (RTBIR) and exchange rate (ER); β_k is a vector of coefficients; and ϵ_t is a vector of well-behaved error terms, white noise process satisfying E [ϵ_t] = 0, E [$\epsilon_t \epsilon'_{t-s}$] = 0, and E [$\epsilon_t \epsilon'_t$]

= ∑, where ∑ is a positive definite matrix. Following Celasun et al. (2006), this method is used for two purposes: first, the variance-covariance matrix of residuals (∑) shows the joint statistical properties of the contemporaneous disturbances in the equation affecting the debt dynamics; and second, the VAR is capable of generating forecasts of Y that are consistent with the simulated shocks as it produces joint dynamic responses of all elements in Y at each period shocks occur.

5. Empirical Results

5.1 Unit Root Tests

The core question of this study is whether or not the debt-to-GDP ratio is stationary. Accordingly, we examined the stationarity of not only the debt-to-GDP ratio, but also all model variables through two tests: Augmented Dickey-Fuller (ADF) test and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test. The ADF tests for the non-stationarity of the variable, having a null hypothesis that the variable has a unit root; while the KPSS is the opposite with a null hypothesis that the variable is stationary. Table 1 presents the ADF and KPSS tests' results for all model variables at both level and first difference. According to the ADF test, the debt-to-GDP ratio is an I(1) variable at 1% level, but is an I(0) variable at 1% level according to the KPSS test. The primary deficit ratio is I(0) variable at 1% level in both ADF and KPSS. The real GDP growth, treasury bill interest rate and exchange rate are all I(0) variables according to both the ADF (at 5% level) and KPSS (at 1% level) tests. This means that all the model variables are mean-reverting with a mix of I(0) and I(1) variables; accordingly, the use of ARDL model is appropriate for this data set.

Table 1: Augmented Dickey-Fuller and Kwiatkowski-Philips-Schmidt-Shin unit root tests

Variable	**ADF**		**KPSS**	
	At Level	**First Difference**	**At Level**	**First Difference**
Debt-to-GDP	-1.358	-6.830***	0.216***	0.112
Primary Deficit	-3.603***	-2.521	0.272***	0.172
Real GDP Growth Rate	-3.512**	-6.325	0.164***	0.044
Treasury Bill Interest Rate (12 months)	-3.515**	-6.227	0.107***	0.067

Exchange Rate	-3.107**	-6.563	0.159***	0.034

ADF is the augmented Dicky-Fuller test with a null hypothesis that the variable has a unit root. The KPSS is Kwiatkowski-Phillips-Schmidt-Shin test with a null hypothesis that the variable is stationary. The 1%, 5% and 10% critical values for the ADF test are -3.53, -2.91 and -2.59 respectively. The asterisks denote rejection of the unit root null at 1% (***) and 5% (**). For the KPSS, the 1%, 5% and 10% critical values are 0.74, 0.46 and 0.35 respectively.

5.2. ARDL Model Estimation Results

As mentioned earlier in the methodology section, the ARDL model is applied with the primary deficit as the dependent variable and debt-to-GDP, exchange rate[1], real GDP growth and real Treasury bill interest rate. Table 2 shows the estimation results of the ARDL model. The chosen lag structure is according to the Schwarz criterion. The results show a distributed lag effect with up to 4 lags of the primary deficit showing statistical significance as the p-value is zero for all. The coefficient on the debt-to-GDP variables is significant at the 10% level with the correct sign (negative sign); as the debt-to-GDP increases, the primary deficit is reduced pointing to some form of “fiscal reaction” on the part of the fiscal authorities. GDP growth has a significant second lag, while an exchange rate depreciation prompts fiscal adjustment possibly to contain the inflationary effects of the devaluation.

Table 2: ARDL model estimation results

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
PRIM_DEF(-1)	3.130019	0.098024	31.93112	0.0000
PRIM_DEF(-2)	-3.849692	0.270512	-14.23113	0.0000
PRIM_DEF(-3)	2.191272	0.271275	8.077671	0.0000
PRIM_DEF(-4)	-0.483090	0.100188	-4.821809	0.0000
DEBT_TO_GDP	-0.001422	0.000786	-1.808022	0.0761
RGDP_GROWTH	0.002684	0.002979	0.901117	0.3715
RGDP_GROWTH(-1)	-0.001507	0.003084	-0.488425	0.6272
RGDP_GROWTH(-2)	-0.009271	0.003074	-3.016421	0.0039
REAL_TBILL_RATE_12MON	-0.000988	0.000777	-1.270887	0.2091
EXCH_RATE	-0.003499	0.001609	-2.174742	0.0340
C	0.220280	0.053982	4.080591	0.0001
R-squared	0.999810	Mean dependent var	2.657110	
Adjusted R-squared	0.999775	S.D. dependent var	1.885295	

[1] Instead of the exchange rate (vs USD), we have tried the Nominal Effective Exchange Rate (NEER) and all the ARDL results are qualitatively similar.

S.E. of regression	0.028275	Akaike info criterion	-4.142631
Sum squared resid	0.043973	Schwarz criterion	-3.777688
Log likelihood	147.7068	Hannan-Quinn criter.	-3.998425
F-statistic	28891.42	Durbin-Watson stat	2.200908
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

This regression is well-specified as the residual are free from serial correlation at the 1% level according to the LM test, and the residuals are normally distributed with the p-value from the Jarque-Bera test statistics at 0.42. The Bounds test resulted in an F-statistic equal to 6.92 which exceed the I(1) upper bound (at the 1% level) of 5.61, indicating the presence of co-integration among the variables. This means that there is a stable long-run relation among the variables. The long-run regression results are reported in table 3 below:

Table 3: ARDL – Long Run Regression Results

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DEBT_TO_GDP	-0.123722	0.110021	-1.124535	0.2657
RGDP_GROWTH	-0.704351	0.269056	-2.617856	0.0114
REAL_TBILL_RATE_12MON	-0.085965	0.069626	-1.234679	0.2222
EXCH_RATE	-0.304493	0.109376	-2.783917	0.0073
C	19.170505	10.138569	1.890849	0.0639

The results indicate that a key long-run determinant of the fiscal stance is the business cycle in Egypt. In boom times, the government undertakes fiscal consolidation, which means that policies are undertaken to reduce government deficits and debt accumulation; while in bust times, an increase in fiscal outlays is undertaken to support the economy, represented in more government spending and a reduction of taxes. On this measure, there is evidence of the conduct of counter-cyclical fiscal policy during the period under study since the results show an inverse relationship between the real GDP growth and the primary deficit, represented in the statistically significant negative coefficient. The exchange rate also has a statistically significant long-term coefficient: depreciation is accompanied by fiscal contraction to counteract the inflationary effects of the former.

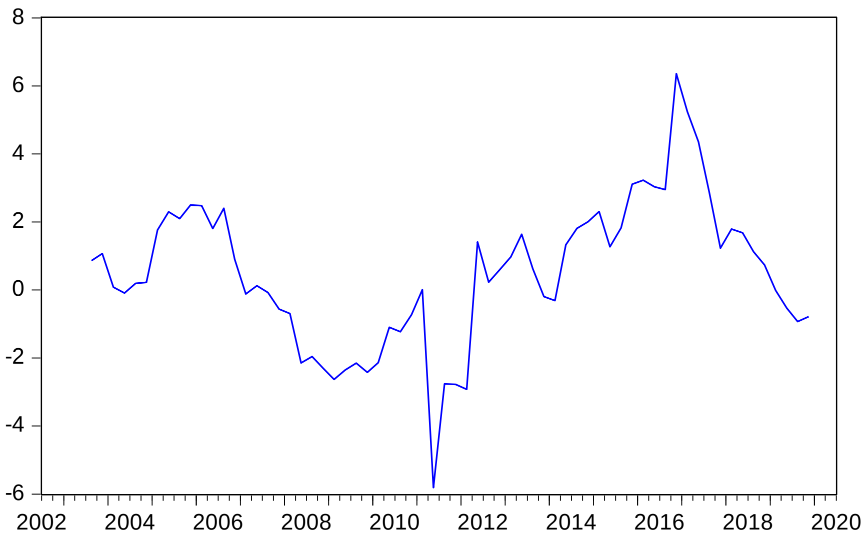
After identifying the co-integrating vectors, the error correction model is estimated to provide both short-run dynamics and long run relationship of the variables of a single model. As reported in the table 4, the implied error correction model shows that the coefficient of the ECM term is -0.01, which is statistically significant at the 5% level. This coefficient represents the speed of adjustment parameter, so the -0.01 implies quite a slow rate of mean reversion to equilibrium.

Table 4: Error Correction Model (ECM)

Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PRIM_DEF(-1))	2.141510	0.099104	21.608787	0.0000
D(PRIM_DEF(-2))	-1.708182	0.173752	-9.831126	0.0000
D(PRIM_DEF(-3))	0.483090	0.100188	4.821809	0.0000
D(DEBT_TO_GDP)	-0.001422	0.000786	-1.808022	0.0761
D(RGDP_GROWTH)	0.002684	0.002979	0.901117	0.3715
D(RGDP_GROWTH(-1))	0.009271	0.003074	3.016421	0.0039
D(REAL_TBILL_RATE_12MON)	-0.000988	0.000777	-1.270887	0.2091
D(EXCH_RATE)	-0.003499	0.001609	-2.174742	0.0340
CointEq(-1)	-0.011491	0.004684	-2.453056	0.0174

Finally, figure 1 shows the residual from the long-run regression which shows the nature of the equilibrating relationship. During the boom years of 2006-2009, government embarked on a stance of improving the budget deficit given the favorable growth (reached an average of 7% between 2006 and 2008) and unemployment outcomes (reached its lowest, 8.52%, in 2008) during this period. This was followed by a reversed stance with the primary deficit increasing progressively from 2011 onwards due to the economic and political instability of this period, and clearly becoming disassociated from its long-run determinants by the end of 2016. Subsequently, an adjustment in the primary balance was necessary to maintain the economy on a sustainable path for public debt. Indeed, part of the agreement with the IMF in 2016 included targets for a primary surplus, which was achieved in 2018Q2 for the first time in Egypt's recent history. One of the main program objectives was to reduce the fiscal deficits considerably and placing the public debt on a declining path; accordingly, key policy measures were undertaken such as the introduction of VAT, a reduction of energy subsidies and the optimization of the public sector wage bill.

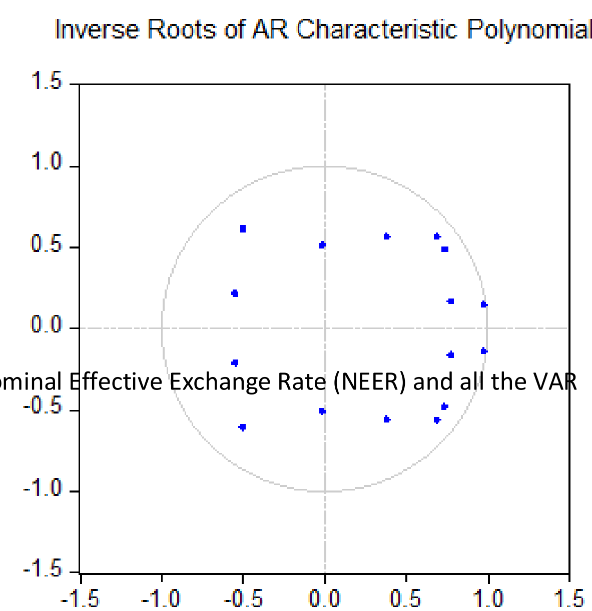
Figure 1:Co-integration Graph



5.3. VAR Model Estimation Results

The VAR model is applied in this paper to complement the ARDL model as a robustness check as well as to provide and analyze the dynamic interaction among the model variables. As mentioned earlier, the VAR model was estimated using the following endogenous variables in the level form: primary deficit as percentage of GDP, debt-to-GDP, real Treasury bill 12 month interest rate and GDP growth rate; and the exchange rate[2] as an exogenous variable (Refer to table 7 in annex). A four lag structure was applied in the estimation with referral to the Akaike information criterion (AIC) and the Schwarz information criterion (SC) as the VAR lag order selection criteria (Refer to table 8 in annex). Although the AIC showed that the optimal lag structure is at the 8th lag and the SC showed at the 3rd lag; a four lag structure was chosen to have a

Figure 2: Inverse Roots of AR Characteristic Polynomial



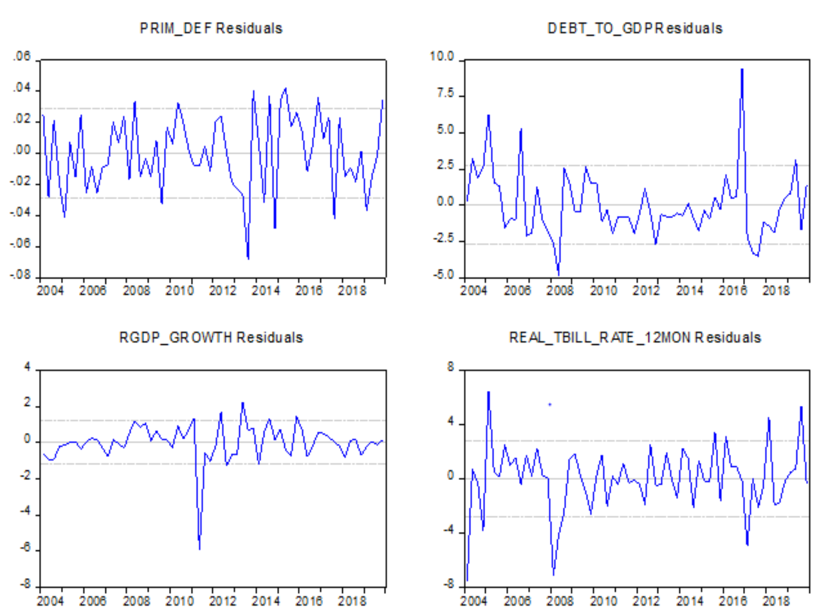
[2] Instead of the exchange rate (vs USD), we have tried the Nominal Effective Exchange Rate (NEER) and all the VAR results are qualitatively similar.

parsimonious model. In this case, a 2 year's past behavior of the model variables will support in predicting and analyzing their current values. Based on the inverse roots of AR characteristic polynomial, the estimated VAR is stationary as all roots (the variables and their lags) have modulus less than one and lie inside the unit circle. However, there are two points on the boarder of the unit circle indicating a non-stationary behavior (refer to figure 2).

From the endogenous graphs, it can be inferred that the five variables are stationarity; this is also aligning and confirming the results of unit root tests (both ADF and KPSS). Although the five variables curves seem fluctuating over the covered period of time, they are all more or less converting to stationarity at a specific point/location (Refer to figure 7 in annex).

As a double check for the stationarity (or non-stationarity) of the time series variables, the Johansen co-integration test is conducted for the four variables to investigate the correlation of non-stationary variables and to model the long-run relationships in the time series data. Referring to table 9 in annex, the test is applied assuming no deterministic trend in data and with four lag intervals. The null hypothesis indicates that there is no co-integration equation and the decision criteria is based on both values of the trace and maximum eigenvalue statistic; if they are bigger than the 5% critical value, the null hypothesis is to be rejected. According to the test results, both the trace and maximum eignevalue statistic values are bigger than that of their corresponding critical values only at none, rejecting the hypothesis at the 0.05 level. This means that there is one co-integrating equation, confirming that the series exhibit long-run relationship. It implies that the variables are related and can be combined in a linear fashion.

Figure 3: Graphing VAR Residuals



According to the residuals graphs (figure 3), the total debt-to-GDP and GDP growth rate are experiencing sudden and significant deviation in specific periods considered as outliers. The down spike of the GDP growth rate in 2011 is representing the political and economic instability occurred due to the Egyptian revolution on January 25, 2011. The economic impact of the revolution was drastic and it was reflected on various economic indicators by having low foreign direct investment, high budget deficit, high unemployment rate, high poverty rate and low standard of living. The GDP growth rate dropped from 5.15% in 2009/2010 to 1.77% in 2011/2012.

Concerning the debt-to-GDP outlier, it occurred by the end of 2016 as a reflection for the Egyptian devaluation. The Central Bank of Egypt floated the Egyptian pound on the 3rd of November 2016 in an attempt to stabilize the economy, meet a key demand by the International Monetary Fund in order to secure a $12 billion loan over three years, gain external competitiveness through a weaker currency and encourage foreign investors. The consequences of this decision was severe, but short-termed as the currency devalued by 48%, where the Egyptian pound reached 13 to the dollar, up from nearly nine on the official market, and reached 18.25 pounds on the unofficial market.. As mentioned earlier in the data section, the total debt-to-GDP includes the external debt, which was initially available in dollars and then converted to Egyptian pound using the exchange rate end of period; therefore, the devaluation of the pound was reflected in the total debt-to-GDP, significantly affecting it. During this period, there was a shortage of foreign currency, a boom in the inflation rate reaching a record high of 35% in July 2017, an increase in interest rates by 300 basis points, and a cut in energy subsidies. However, the economy started witnessing progress in several indicators in 2017 and 2018 after implementing the economic reform program since mid-2016. The major successes were decreasing both the inflation rate and unemployment rates and boosting foreign reserves.

Table 5: Autocorrelation Lagrange multiplier test

Included observations: 64

Lags	LM-Stat	Prob
1	30.44403	0.0158
2	12.21594	0.7290
3	8.227103	0.9418
4	17.68402	0.3427
5	13.52116	0.6343

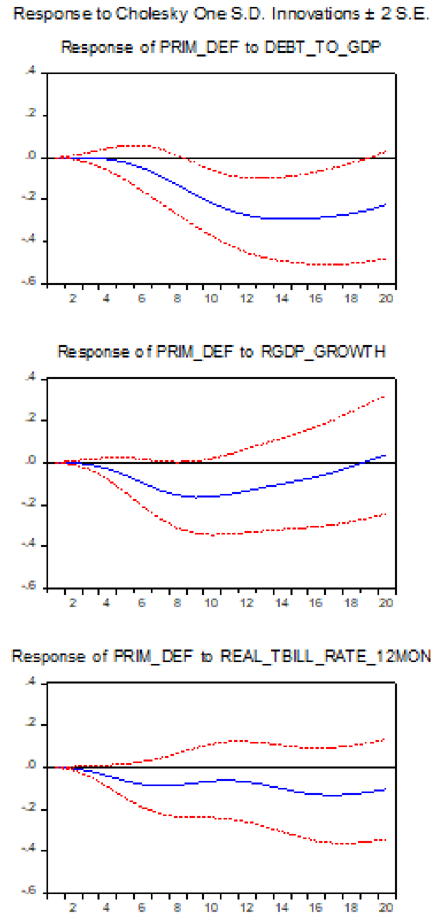
Probs from chi-square with 16 df.

The autocorrelation Lagrange multiplier test ensures that there is no serial correlation in the residuals, except for the first lag since the null hypothesis is not rejected as none of the p-values is less than 0.05 (refer to table 5). This means that the residuals from the second lag are independent of one another and the statistical significance of the regression coefficients are reliable.

The impulse response function is an essential tool in the VAR model to analyze its dynamic properties and measure the changes in the future responses of all variables in the model when a variable is shocked. Accordingly, the impulse response function was applied twice in this paper to assess the reaction of both the primary deficit and the total debt-to-GDP when applying different shocks on the other model variables over 20 periods (5 years). Figures 4 and 5 are representing the impulse response function of the primary deficit to the following shocked variables: debt-to-GDP, GDP growth and real treasury bill (12 months) interest rate, but with two different Cholesky orderings to check if this would change the results to be obtained. In figure 4, the ordering of the variables is random on no theoretical basis. When the debt-to-GDP was exposed to a positive shock (increased), the primary deficit responded by a gradual decline reaching a trough at the 13th or 14th quarter. This response is statistically significant from the 9th till the 18th quarter since the confidence intervals are beyond zero. This means that the primary deficit is responsive to the debt-to-GDP, confirming that there is a fiscal reaction function dynamic and this supports the results of the ARDL model. However, both the GDP growth and the real Treasury bill interest rate have no significant impact on the primary deficit.

In figure 5, the Cholesky ordering of the variables is changed following theoretical and economic assumptions. It was assumed that the interest rate is the first changing variable, affecting the economic growth. Generally,

Figure 4: IRF - Order: prim_def debt_to_gdp rgdp_growth real_tbill_rate_12mon



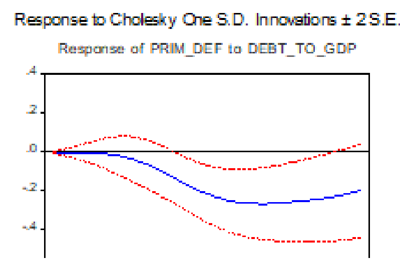
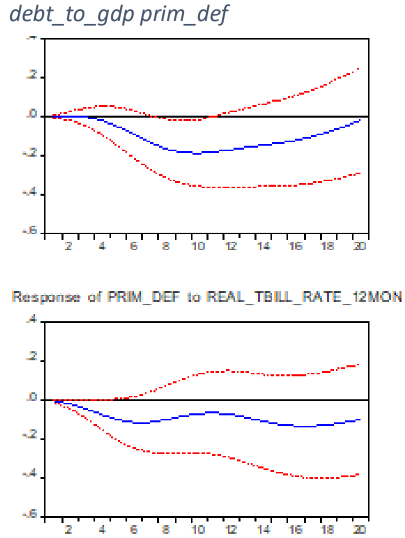
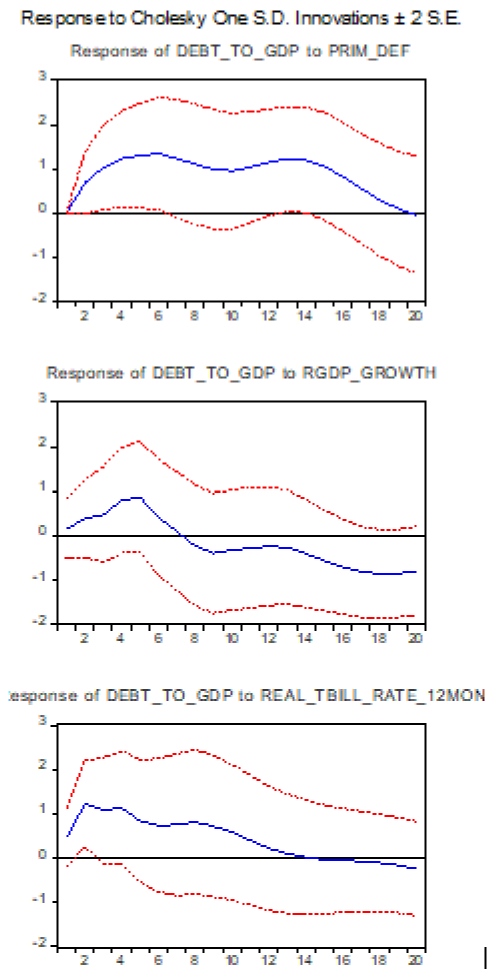


Figure 5: IRF - Order: real_tbill_rate_12mon rgdp_growth debt_to_gdp prim_def



lowering the interest rate stimulates growth as it encourages borrowing and investing; however, lowering it too much could lead to stagnation and increase inflation, which will undermine the sustainability of the desired economic expansion. Also, the GDP growth rate will eventually affect the debt-to-GDP as mentioned earlier in the literature review section, the debt-to-GDP ratio could be lowered by having a negative IRGD, in sense that if the interest paid on debt is lower than the economy growth rate, ceteris paribus, the debt will stabilize below the current level. The primary deficit is placed as the last variable in the order as it gets affected accordingly. Although the ordering of the variables has completely changed, the impact of the changes in the variables is more or less the same on the primary deficit, except for the response to the growth rate, the primary deficit responded with a significant decline between the 7^{th} and 11^{th} quarters when the growth rate was shocked positively (increased). After applying different orderings, it is worth noting that all the impulse response function results are confirming that there is fiscal reaction function, which validates the results of the ARDL model. On the other hand, when applying the impulse response function of the debt-to-GDP, the result shows that an increase in primary deficit causes an increase in the debt-to-GDP, while the other variables have no significant impact on the debt-to-GDP (as shown in figure 6).

Figure 6: IRF - Order: real_tbill_12mon, gdp_gr, debt_to_gdp, prim_def_interp



According to the variance decomposition of the primary deficit, after 4 quarters (or one year) 90% is explained by its own dynamics (the primary deficit itself) with a minor contribution of real treasury bill interest rate (9%). At year 2, both the growth rate and interest rate started to contribute in the variation of the primary deficit with 14% and 13% respectively. The growth rate contribution has peaked in quarter 12 (almost 25%) and the debt-to-GDP started to play a role in the variation of the primary deficit with a 27%. As going for more future period, the debt-to-GDP is becoming the major contributor to the primary deficit dynamics at year 4 and 5 (at the 16th and 20th quarters), which is considered another evidence for the fiscal reaction function as almost 40% of the variation in the primary deficit is attributed to the debt-to-GDP ratio.

Concerning the variance decomposition of the debt-to-GDP, the debt-to-GDP itself is the main attributor to the variation of the debt-to-GDP over the 5 years period. However, both the primary deficit and the real Treasury bill interest started to contribute in the variation as well starting from the second year, but with lesser weight than the debt-to-GDP. By the 5th year, the contribution of both the primary deficit and the debt-to-GDP are dominating the variation of the debt-to-GDP with 33% and 42% respectively.

Table 6: Variance Decomposition of Primary Deficit and Debt-to-GDP

Variance Decomposition of PRIM_DEF:					
Period	S.E.	PRIM_DEF	DEBT_TO_GDP	RGDP_GROWTH	REAL_TBILL_RATE_12MON
4	0.299932	90.56791	0.031231	0.390290	9.010573
8	0.627241	67.22617	4.909798	14.16537	13.69866
12	0.856419	37.72663	27.24614	24.81523	10.21200
16	1.099170	28.96223	39.06704	21.39763	10.57310
20	1.307937	33.78382	39.27863	16.18347	10.75408
Variance Decomposition of DEBT_TO_GDP:					
Period	S.E.	PRIM_DEF	DEBT_TO_GDP	RGDP_GROWTH	REAL_TBILL_RATE_12MON
4	4.860122	12.86881	65.03344	4.422530	17.67521
8	6.181649	24.31049	52.95175	5.352715	17.38505
12	6.751639	29.80931	47.97567	5.330912	16.88411
16	7.175961	35.58869	42.72497	6.711878	14.97446
20	7.533965	33.02058	42.28982	10.92430	13.76531
Cholesky Ordering: REAL_TBILL_RATE_12MON RGDP_GROWTH DEBT_TO_GDP PRIM_DEF					

6. Conclusion and Policy Implication

This paper assesses Egypt's debt sustainability using the fiscal reaction function approach, which tests whether the government responds (or not) to debt accumulation with adequate policy reactions to mitigate any kind of shocks. Based on the two econometric models, ARDL and VAR, the results show that Egypt's debt can be sustainable under the period of study since the primary deficit responds negatively to the increase of the debt-to-GDP, implying that there's fiscal response by the fiscal authorities in Egypt. The GDP growth also shows a statistically significant impact on reducing the primary deficit through both model results. On the other hand, the ARDL results show that an exchange rate depreciation prompts fiscal adjustment possibly to contain the inflationary effects of the devaluation.

According to the Bounds test in the ARDL model and Johansen test in the VAR model, the results confirm that there's co-integration among the variables, implying that the series exhibit a long-term equilibrium relation. However, the ECM coefficient indicates quite a slow rate of mean reversion to equilibrium. The results also reveal that the business cycle is a key long-run determinant of the fiscal stance in Egypt. Following a counter-cyclical fiscal policy, the government seeks fiscal consolidation during boom times and fiscal outlays during recession times.

The policy implications of this paper's findings are mainly focusing on several critical issues and policies: first, having a sound and transparent debt management in order to acquire low interest rates of borrowing, manage the composition of debt (in terms of maturity, currency and composition), and strike a proper balance between the benefits and costs of additional debt; second, imposing robust macroeconomic policy frameworks and financial regulation and supervision that support sustainable debt accumulation in public and private sector; third, adopting a fiscal reform strategy that focuses on improving the tax structure and administration, which should include broadening the tax base and increasing tax buoyancy, developing a tax system that follows international standards and improve tax progressivity, incentivizing the informal sector to join the formal sector, and restricting tax evasion; fourth, managing the exchange rate policy to avoid large depreciations that cause a sudden upsurge in the value of government external debt as well as lessening the dominated foreign currency debt; Fifth, acquiring fiscal consolidation strategy to reduce their deficits and accumulation of debt stock as well as boosting the economy as economic growth is another major determinant of debt sustainability. Sixth, enhancing the business environment in order to attract and retain both domestic and foreign investment as this act could increase the country's revenues tremendously. Finally, it's crucial to acquire an efficient allocation strategy of debt, which could be attained if it is well-spent in financing output-enhancing purposes. Thus, leading to an extensive means of income generation the boost the economy and reduce the budget deficit.

7. Annex

Table 7: VAR Estimation

	PRIM_DEF	DEBT_TO_GDP	RGDP_GROWTH	REAL_TBILL_RATE_12MON

PRIM_DEF(-1)	3.041054	24.36052	10.63379	1.099813
	(0.12946)	(12.1130)	(5.49715)	(12.7109)
	[23.4904]	[2.01111]	[1.93442]	[0.08653]
PRIM_DEF(-2)	-3.666560	-58.81485	-32.20189	3.746501
	(0.34578)	(32.3528)	(14.6824)	(33.9497)
	[-10.6039]	[-1.81792]	[-2.19323]	[0.11035]
PRIM_DEF(-3)	2.056189	52.81009	31.50922	-11.25563
	(0.33769)	(31.5962)	(14.3391)	(33.1557)
	[6.08900]	[1.67141]	[2.19744]	[-0.33948]
PRIM_DEF(-4)	-0.452092	-15.98142	-10.41035	6.206971
	(0.12017)	(11.2436)	(5.10262)	(11.7986)
	[-3.76216]	[-1.42137]	[-2.04020]	[0.52608]
DEBT_TO_GDP(-1)	0.000711	0.781982	0.049952	-0.212053
	(0.00150)	(0.14051)	(0.06377)	(0.14745)
	[0.47366]	[5.56519]	[0.78334]	[-1.43815]
DEBT_TO_GDP(-2)	-0.001764	0.102733	0.027240	0.174380
	(0.00198)	(0.18503)	(0.08397)	(0.19416)
	[-0.89215]	[0.55524]	[0.32440]	[0.89814]
DEBT_TO_GDP(-3)	6.65E-05	-0.168753	0.026490	-0.124714
	(0.00207)	(0.19355)	(0.08784)	(0.20311)
	[0.03215]	[-0.87187]	[0.30158]	[-0.61404]
DEBT_TO_GDP(-4)	-0.000312	0.211133	0.016281	0.194094
	(0.00164)	(0.15308)	(0.06947)	(0.16063)
	[-0.19072]	[1.37928]	[0.23436]	[1.20833]
RGDP_GROWTH(-1)	-0.000531	0.163787	0.214510	-0.513578
	(0.00315)	(0.29510)	(0.13392)	(0.30967)
	[-0.16837]	[0.55502]	[1.60172]	[-1.65848]
RGDP_GROWTH(-2)	-0.009507	0.271822	0.083822	-0.148182
	(0.00326)	(0.30481)	(0.13833)	(0.31985)
	[-2.91837]	[0.89179]	[0.60597]	[-0.46329]
RGDP_GROWTH(-3)	0.000159	0.626588	0.240845	-0.097182
	(0.00349)	(0.32624)	(0.14805)	(0.34234)
	[0.04556]	[1.92065]	[1.62674]	[-0.28388]
RGDP_GROWTH(-4)	-0.004091	0.360233	-0.277006	-0.121709
	(0.00318)	(0.29712)	(0.13484)	(0.31179)
	[-1.28817]	[1.21240]	[-2.05431]	[-0.39036]
REAL_TBILL_RATE_12MON(-1)	-0.001602	0.363848	0.016157	0.991241
	(0.00151)	(0.14137)	(0.06416)	(0.14835)
	[-1.06050]	[2.57375]	[0.25184]	[6.68193]
REAL_TBILL_RATE_12MON(-2)	-0.000489	-0.249840	-0.022604	-0.210610
	(0.00220)	(0.20566)	(0.09333)	(0.21581)
	[-0.22244]	[-1.21481]	[-0.24219]	[-0.97590]

REAL_TBILL_RATE_12MON(-3)	0.001477	0.200411	0.136124	-0.022080
	(0.00218)	(0.20383)	(0.09250)	(0.21389)
	[0.67787]	[0.98324]	[1.47159]	[-0.10323]
REAL_TBILL_RATE_12MON(-4)	0.000855	-0.124350	-0.130814	-0.070469
	(0.00148)	(0.13804)	(0.06265)	(0.14485)
	[0.57932]	[-0.90083]	[-2.08817]	[-0.48649]
C	0.276737	-10.06340	-4.634989	2.407953
	(0.09005)	(8.42561)	(3.82373)	(8.84147)
	[3.07315]	[-1.19438]	[-1.21216]	[0.27235]
EXCH_RATE	-0.005358	0.470240	-0.214316	-0.082937
	(0.00159)	(0.14916)	(0.06769)	(0.15652)
	[-3.36108]	[3.15259]	[-3.16603]	[-0.52987]
R-squared	0.999832	0.933784	0.731072	0.788292
Adj. R-squared	0.999770	0.909313	0.631685	0.710053
Sum sq. resids	0.038141	333.9098	68.77033	367.6852
S.E. equation	0.028795	2.694236	1.222705	2.827217
F-statistic	16136.01	38.15867	7.355844	10.07535
Log likelihood	146.7989	-143.6757	-93.11252	-146.7591
Akaike AIC	-4.024967	5.052365	3.472266	5.148721
Schwarz SC	-3.417781	5.659551	4.079452	5.755907
Mean dependent	2.616395	91.27742	4.375000	0.615415
S.D. dependent	1.900233	8.946707	2.014708	5.250487
Determinant resid covariance (dof adj.)		0.064549		
Determinant resid covariance		0.017227		
Log likelihood		-233.2870		
Akaike information criterion		9.540218		
Schwarz criterion		11.96896		

Table 8: VAR Lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-605.4261	NA	8920.677	20.44754	20.72678	20.55677
1	-362.6419	437.0116	4.661030	12.88806	13.72580	13.21575
2	-289.4853	121.9275	0.700397	10.98284	12.37907	11.52899
3	-231.7977	88.45439	0.178490	9.593257	11.54798*	10.35786
4	-207.1695	34.47942*	0.139499	9.305651	11.81886	10.28871*
5	-189.9111	21.86065	0.143044	9.263705	12.33541	10.46522
6	-169.1684	23.50848	0.135252*	9.105612	12.73581	10.52558
7	-157.8494	11.31893	0.183524	9.261648	13.45034	10.90007
8	-135.5273	19.34587	0.183941	9.050909*	13.79809	10.90779

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Figure 7: Endogenous Graphs

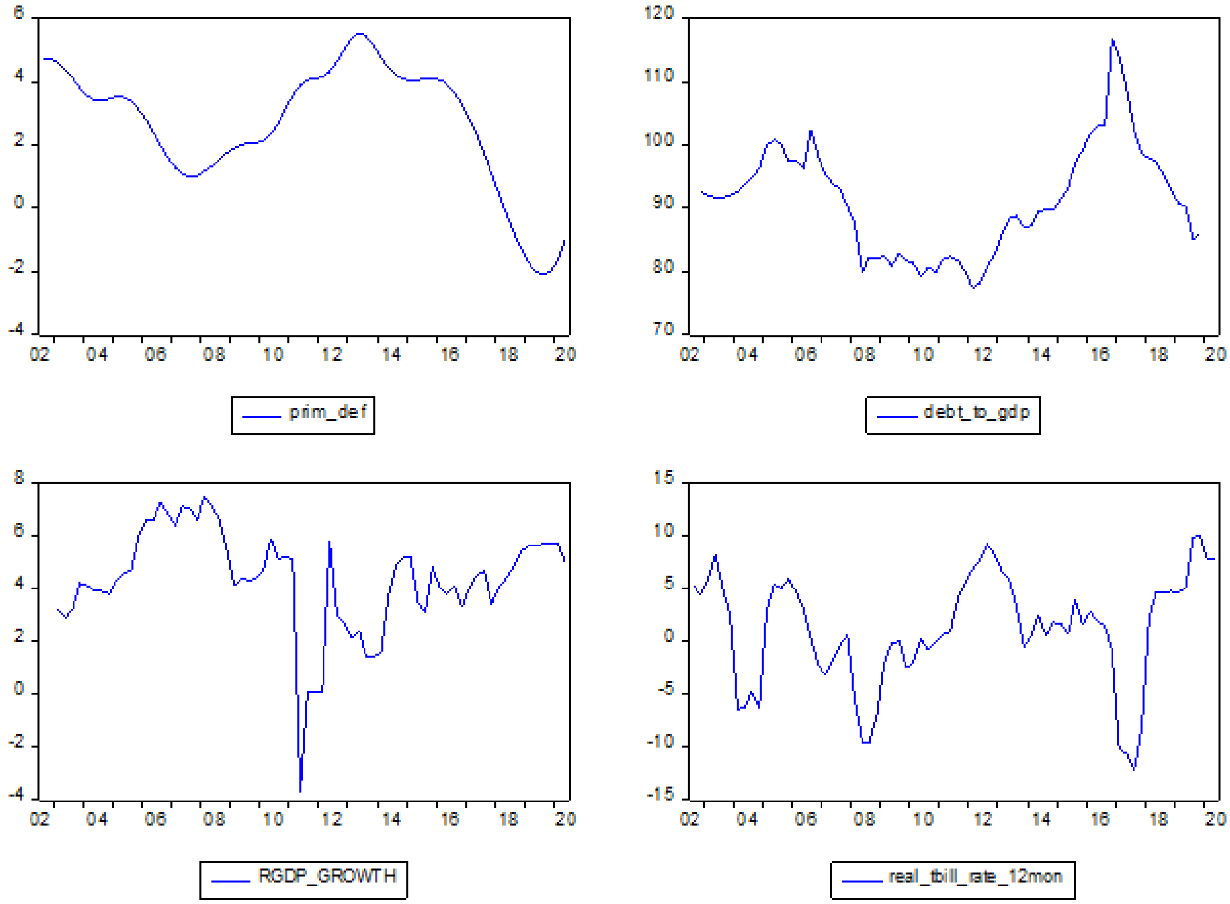


Table 9: Johansen Co-integration Test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.464468	61.11310	40.17493	0.0001
At most 1	0.183896	21.76990	24.27596	0.1002
At most 2	0.127761	8.967462	12.32090	0.1710
At most 3	0.005633	0.355883	4.129906	0.6137

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

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**

None *	0.464468	39.34320	24.15921	0.0002
At most 1	0.183896	12.80244	17.79730	0.2408
At most 2	0.127761	8.611579	11.22480	0.1390
At most 3	0.005633	0.355883	4.129906	0.6137

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

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

PRIM_DEF	DEBT_TO_GDP	RGDP_GROWTH	REAL_TBILL_RATE_12MON
1.616526	-0.167735	1.610724	0.131829
-0.885289	0.026858	0.222522	0.203159
-0.279730	-0.011034	0.240772	-0.232997
0.456561	-0.013861	0.374485	-0.094774

Unrestricted Adjustment Coefficients (alpha):

D(PRIM_DEF)	-0.006791	0.008866	-0.003593	-0.000969
D(DEBT_TO_GDP)	1.130811	-0.466410	-0.528273	-0.057535
D(RGDP_GROWTH)	-0.290223	-0.018162	-0.270522	0.049972
D(REAL_TBILL_RATE_12MON)	-0.951947	-0.561964	0.037548	-0.084665

1 Cointegrating Equation(s): Log likelihood -227.5145

Normalized cointegrating coefficients (standard error in parentheses)

PRIM_DEF	DEBT_TO_GDP	RGDP_GROWTH	REAL_TBILL_RATE_12MON
1.000000	-0.103763	0.996411	0.081551
	(0.00703)	(0.10532)	(0.03446)

Adjustment coefficients (standard error in parentheses)

D(PRIM_DEF)	-0.010977
	(0.00659)
D(DEBT_TO_GDP)	1.827986
	(0.56150)
D(RGDP_GROWTH)	-0.469154
	(0.25446)
D(REAL_TBILL_RATE_12MON)	-1.538847
	(0.48470)

2 Cointegrating Equation(s): Log likelihood -221.1132

Normalized cointegrating coefficients (standard error in parentheses)

PRIM_DEF	DEBT_TO_GDP	RGDP_GROWTH	REAL_TBILL_RATE_12MON
1.000000	0.000000	-0.766912	-0.357997
		(0.21928)	(0.16483)
0.000000	1.000000	-16.99381	-4.236084
		(2.18684)	(1.64375)

Adjustment coefficients (standard error in parentheses)		
D(PRIM_DEF)	-0.018826	0.001377
	(0.00711)	(0.00066)
D(DEBT_TO_GDP)	2.240894	-0.202204
	(0.62723)	(0.05781)
D(RGDP_GROWTH)	-0.453075	0.048193
	(0.29008)	(0.02674)
D(REAL_TBILL_RATE_12MON)	-1.041346	0.144582
	(0.53062)	(0.04891)

3 Cointegrating Equation(s):		Log likelihood	-216.8074

Normalized cointegrating coefficients (standard error in parentheses)

PRIM_DEF	DEBT_TO_GDP	RGDP_GROWTH	REAL_TBILL_RATE_12MON
1.000000	0.000000	0.000000	1.448484
			(0.61960)
0.000000	1.000000	0.000000	35.79325
			(14.3148)
0.000000	0.000000	1.000000	2.355525
			(0.88065)

Adjustment coefficients (standard error in parentheses)			
D(PRIM_DEF)	-0.017821	0.001417	-0.009830
	(0.00712)	(0.00065)	(0.00628)
D(DEBT_TO_GDP)	2.388667	-0.196374	1.590445
	(0.61720)	(0.05636)	(0.54422)
D(RGDP_GROWTH)	-0.377402	0.051178	-0.536646
	(0.28361)	(0.02590)	(0.25007)
D(REAL_TBILL_RATE_12MON)	-1.051849	0.144167	-1.649333
	(0.53660)	(0.04900)	(0.47315)

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