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Constraints to Debt Sustainability in Egypt: Structural Response and Fiscal Fatigue

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Abstract: Public debt sustainability is a multidimensional process. Egypt maintains a sustainable general path in conducting its fiscal policy. However, the rising path of accumulated debt to GDP ratio implies critical restrictions on fiscal stance and fiscal space. The research tests the structural endogenous long-term response of the Egyptian government towards the accumulated stock of public debt. in addition to examining the fiscal fatigue hypothesis when debt jumps to high extreme levels. The research adopts the widely accepted approach proposed by Bohn to estimates a fiscal reaction function. the Autoregressive Distributed Lag ARDL technique is applied for the time period from 1981 to 2021. Empirical wise, two critical specified regressions are estimated. The first measures the response of the structural long-term primary balance as a percentage of GDP to the stock of public debt to GDP ratio. This provides a general judgement whether the fiscal policy is expansionary, neutral or restrictive. Second, a non-linear estimation is implemented to test for the possibility of fiscal fatigue. the existence of an inverse U-shaped response can be used to endogenously determine a debt threshold above which the government is unable to keep its fiscal position within the sustainability condition. Findings of the first regression indicate that the government is unable to adjust its structural primary balance positively with the increase in the stock of previous debt to GDP ratio during the examined time period. Thus, fiscal policy of the Egyptian government tends to be restrictive during the examined time period. Furthermore, the fiscal fatigue hypothesis applies as the magnitude of government fiscal response is conditioned by the level of accumulated public debt. At low levels of debt to GDP ratio the government adjustment of its primary balance is not structurally planned. Government show weak response. When the level of accumulated debt to GDP ratio goes high, government undertakes serious measures and effectively adjust the primary balance to GDP with the increased public debt. however, when the level of the previous debt to GDP ratio jump to extreme high levels, government is unable to maintain the positive response indicating the possibility of fiscal fatigue and fiscal default. The research emphasizes the necessity of a planned serious fiscal actions to correct the long-term response. Cyclical automatic response of the government should be revised. Moreover, Non-interest expenditures should be structurally adjusted to maintain the required level of government reasonable primary balance.

Keywords: Debt Sustainability, Fiscal Reaction Function, Bohn's Approach, Structural Primary Balance, Output Gap, Expenditure Gap, Fiscal Fatigue, Debt Threshold

1. Introduction

General government gross debt as a percentage of GDP in Egypt records huge amounts during the last 20 years starting from 71.6% in 2000 to 98.2% in 2005 which is extremely high [1]. It then followed a decreasing path until 2016 when Egypt applied the economic reform program. In 2017 government public debt reached 103% of GDP exceeding all debt limits settled by international organizations or agreements. The high increase in 2017 was mainly the result of increasing cost of debt due to currency depreciation in the previous year. In 2020, the percentage recorded 89.8%. the reason behind such increase was the crisis of COVID-19 pandemics.

Public debt management is a critical issue as it provides the general framework along which the government can stabilize the economic activity. The analysis of public debt sustainability provides the general framework that ensure the

ability of the government to perform efficiently. Public debt sustainability is the ability of the government to meet its intertemporal budget constrains (IBC). More specifically, it is the ability of the government to pay for its obligation in the current situation as well as the future. One can say that debt is sustained if the government's payment for its debt does not put a restriction on government spending on other economic activities.

Debt sustainability is generally defined as the ability of government to meet its current and future debt obligations without structural modification requirements in budget [2]. Fiscal reaction function is a historical based technique that use historical data to measure the reaction of government to debt levels. The approach aims at testing the response of fiscal policy to the accumulation of debt. This idea is considered as the main base of debt sustainability.

The estimation of fiscal reaction function is conditioned by the country circumstances. There is no single template reaction equation. Rather, each case is examined separately according to its own assumptions. The underlying explanatory variables in the equation are also selected due to their relative importance and effect significance over the primary balance.

Unsustainable fiscal policies lead to major critical consequences. They negatively affect macroeconomic performance and increase a country's volatility to exogenous shocks. Inefficient resource allocation, an enormous public debt stock that could damage future generations, and an increase in the inflation rate and its volatility are all other consequences of an unsustainable fiscal policy that could harm the welfare state. Thus, reaching a sustainable position in fiscal policy is very crucial.

The research aims at testing the structural long-term response of the government to the stock of debt to GDP ratio. The pattern of government fiscal response is more important than the value or the volume. The research also attempts to test the fiscal fatigue hypothesis. when cyclical or automatic movements are removed from the fiscal components, fiscal stance can be correctly measured, being given by the difference between government revenues and expenditures corrected by the effects that could be attributed to the economic cycle. Thus, providing useful information to identify the structural trends and to test whether the fiscal policy of a country is expansionary, neutral or restrictive for a given time.

Bohn [2] shows that fiscal effort increases with the debt level. It was assumed that primary balance responds positively at high levels of lagged debt to GDP ratio. In practice, it becomes increasingly hard to keep adjusting the primary balance through cutting primary expenditures or raising taxes. In other words, after a certain point, “fiscal fatigue” sets in where the primary balance may still be an increasing function of lagged debt but at a decreasing rate.

Estimating the structural response of the primary balance allows for excluding the automatic cyclical response from the measurement. A positive response of the structural primary balance indicates a stable structural long-term fiscal policy and vice versa. Furthermore, the magnitude of the response is more important. The non-linear estimation of the fiscal reaction function provides general insights about the ability of the government to sustain its fiscal position with the climbing extreme levels of accumulated debt. endogenously determining a debt threshold as a critical policy implication that is needed to shed light on it. It is important to mention that the debt sustainability nexus is a concept of mechanism rather than absolute judgements.

2. Theoretical Framework

2.1. Literature Review

Measuring debt sustainability is a major concern of both domestic and international policy advisors. Debt sustainability follows various approaches. Public debt to be tested in terms of sustainability requires a good understanding of the nature and structure of fiscal system as well as the economic environment. Debt sustainability is generally defined as the ability of government to meet its current and future debt obligations without structural modification requirements in budget. [2]

Relying on a specific approach to tackle debt sustainability is a confusing decision. As the term of sustainability is theoretically oriented and has valid implications in terms of solvency and liquidity, empirical measurement of sustainability requires a strong consideration of economic status and many exogenous factors [3]. Another critical consideration in the measurement of debt sustainability via different approaches was altered emphasizing that debt structure and the degree of risk is very crucial in debt measurement [4]. If debt amounts in a country induce high risk in terms of liquidity, maturity and currency strength, then specific approaches are available to measure debt sustainability.

Fiscal reaction function is a historical based technique that use historical data to measure the reaction of government to debt levels. The approach aims at testing the response of fiscal policy to the accumulation of debt. This idea is considered as the main base of debt sustainability. Under the approach, there is no necessity to test shocks and their probabilistic scenarios neither determining specific debt threshold [5]. The only concern regarding such approach is that it estimates the reaction of primary surplus to debt levels with narrow consideration to the current fiscal position. [6]

These tests can determine whether historical patterns in primary balance and public debt have been compatible with solvency. Any forecast is therefore predicated on the idea that the future will resemble the past to a satisfying degree [7]. The estimation base of the fiscal reaction function was proposed since the 1980s. the methodology witnessed many adjustments to result in reliable conclusions. Sometimes, the technique is relied upon as a sufficient indication for debt sustainability. Other situations require the adoption of some complementary methods to reach deep concrete results.

Historical data were firstly used to test solvency [8]. similarly, the method was utilized as a measurement for debt sustainability. The test give concern to stationarity of the two

time-series of primary balance and debt. A stationary time series' unconditional distribution remains constant across time, which suggests that the mean of a stationary variable is not trending. Stationarity in the primary balance series implies that public debt is also stationary if the solvency requirement is settled [9]. This implies that primary balance and debt are both non-stationary (or integrated). In contrast, solvency is nevertheless met if both series move in the same direction (are "cointegrated"), with higher debt being systematically correlated with larger primary balances. [10]

Bohn [2] extended the idea to conclude that the test neglects the general equilibrium condition -linking fiscal policy to the whole economy- through only considering time series characteristics. Bohn's model-based sustainability framework is a one widely used. The framework aims at estimating the conditional relationship that links public debt to primary balance. The framework is applied through a single equation model examining how primary balance explained by public debt, government expenditure and output gap. Bohn showed that a positive conditional response of the primary balance to public debt is sufficient to fulfill the solvency condition in a general equilibrium model under reasonable assumptions. This test has been widely used in the literature to assess whether fiscal policy was "responsible" in the sense of being broadly consistent with solvency. [7]

The required parameters to ensure fiscal welfare states were studied [11]. The study adopted the concept of fiscal space following Ostry and Gosh [12, 13]. The study examined the fiscal sustainability of a panel of 17 welfare states. a panel-data based model is applied to estimate fiscal reaction function and the vector regression model to set the interest schedule. It is found that Southern European welfare states are unsustainable if they do not immediately change their fiscal policies. Countries outside of Southern Europe are generally financially sustainable. However, the UK, the US, and France have in their recent actions exacerbated their financial sustainability. The results indicate that welfare spending does not necessarily weaken fiscal soundness, which depends on the type of welfare state.

In the same context, common trends to assess fiscal sustainability in Egypt were followed [14]. The study distinguished between cyclical and structural changes in public debt. Examining the level of debt-to-GDP ratio, the study clarified that the ratio in Egypt is relatively high. It is also the result of structural issues in the economic environment. Applying simulation approach, the study proved that fiscal sustainability requires structural changes in the fiscal policy to be achieved.

Linking debt sustainability to economic growth was implemented studying the impact of debt accumulation over economic growth and examining the sustainability aspect over the period from 1981 to 2006 [15]. The study concluded that public debt obstacles growth in Egypt. The discussion upon sustainability indicated that public debt was sustained in Egypt during the period of examination.

The forces that derived government debt in Egypt are Examined for the period from 2001/2002 to 2016/2017 [16]. The study indicated that the main drivers behind the government to GDP ratio are primary deficit, exchange rate, real growth rate, interest rate and the stock of debt respectively. It also concluded using VAR analysis that the relative significance of the variables affecting debt accumulation are the primary balance, exchange rate, public business sector borrowing and interest rate. A fiscal reaction function is developed to asses fiscal sustainability in Egypt [6]. The study applied ARDL model as well as VAR model to test fiscal sustainability. the primary deficit was indicated to responds negatively to the increase of the debt-to-GDP, implying that there's fiscal response by the fiscal authorities in Egypt.

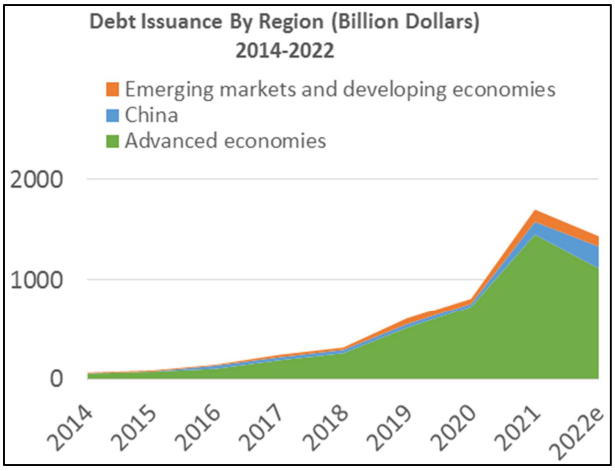
Fiscal sustainability in its historical meaning were examined [17]. They tested fiscal sustainability in Egypt from 1990 to 2018. Other approaches were applied to test sustainability. IMF approach was also adopted by many studies [3]. The IMF approach and fiscal reaction function were implemented to assess fiscal sustainability in Egypt indicating weak fiscal sustainability in Egypt.

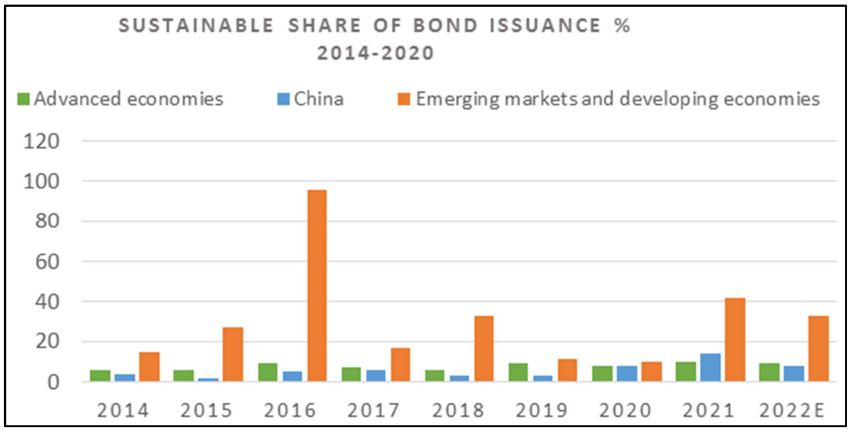
Solvency is considered as an essential criterion to reach sustainability. As literature assumes that sustainability is hard to be specifically defined, definitions about the exact meaning of debt sustainability is arbitrary. Public debt sustainability definition aims to answer the question of what debt limit government should never exceed. In other words, what is the debt amount that cannot be efficiently serviced? The IMF defined public debt to be sustainable "if it satisfies the present value budget constraint without a major correction in the balance of income and expenditure given the costs of financing it faces in the market" [18, 5]. The definition confirms that sustainability goes further than solvency does. The definition was then extended to confirm the central role of fiscal policy to realize fiscal sustainability expressed as "the ability of a government to service its debt without unrealistic fiscal adjustment". Hence, fiscal policy sustainability includes the same meaning as debt sustainability [19].

For market access countries, such as Egypt, IMF adopted a broad approach to define public debt sustainability which states that "public debt can be regarded as sustainable when the primary balance needed to at least stabilize debt under both the baseline and realistic shock scenarios is economically and politically feasible, such that the level of debt is consistent with an acceptably low rollover risk and with preserving potential growth at a satisfactory level [20].

2.2. The Magnitude of Public Debt

The largest one-year debt surge since World War II was observed in 2020 as a result of COVID-19 pandemics. Global debt recorded $226 trillion as the world was hit by a global health crisis and a deep recession. Debt was already going into a crisis given the dangerous recorded levels. Global debt rose by 28% to 256% of GDP in 2020 [21]. Governments in all regions had to issue debt in huge amount to satisfy their financial imbalances. Debt issuance in 2021 are shown in figure 1 for emerging market economies, China and low markets and developing economies. Values of sustainable share of bond issuance are also shown in the same regions.



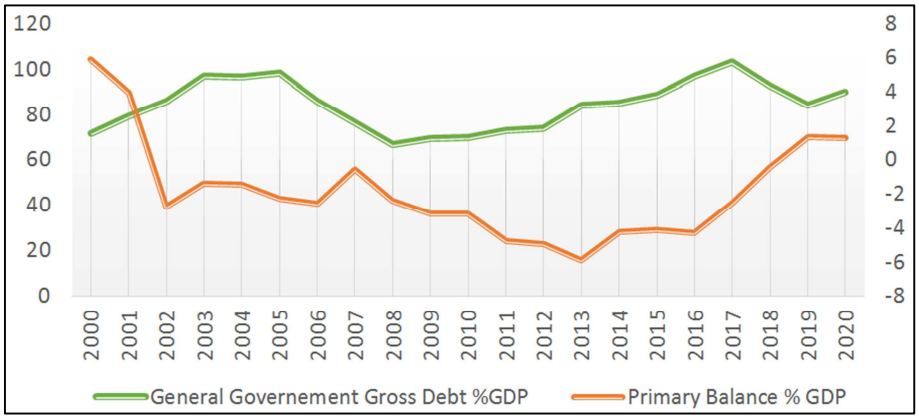


Source: Researcher, data from IEA, 2022

Figure 1. *Sustainable debt issuances by region (2014-2022).*

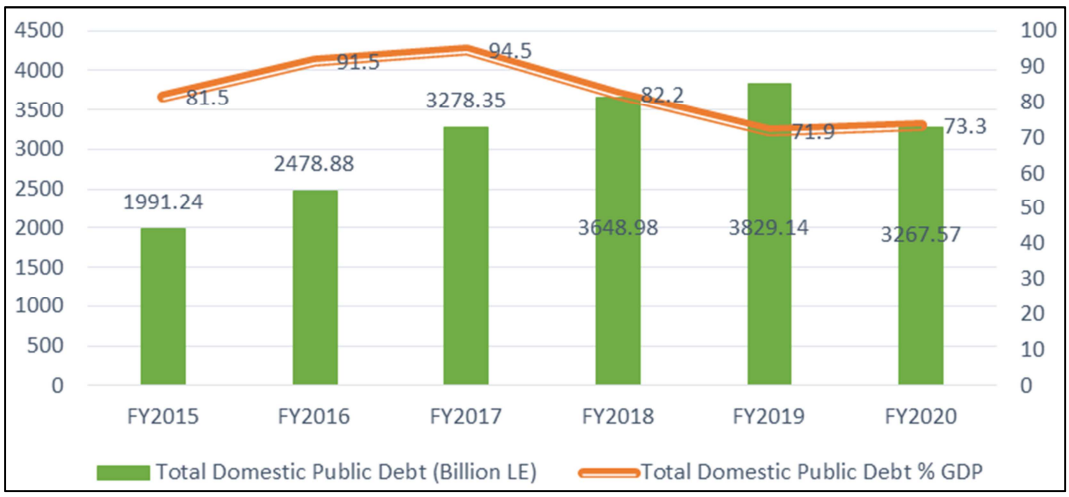
Egypt is one of the countries that witnessed historical debt dynamics over time. The discussion of public debt in Egypt is a critical challenge for policy makers. The adoption of 2016 reform program was the beginning to correct domestic and international imbalances. Reducing the total amount of public debt was one of the major challenges. IMF country report supported Egypt's macroeconomic performance [22]. The high public debt in Egypt obstacles growth plans as it limits investment opportunities and worsens financial conditions.

Discussion about public debt sustainability in Egypt is worth to start by looking to the two main debt sustainability indicators: Debt-to-GDP ratio and primary balance to GDP ratio. General government gross debt includes both domestic and external debt of the Egyptian debt. Figure 2 shows the evolution of the percentage in Egypt since 2000 to 2020.



Source: Researcher based on World Bank Cross-Country Database of Fiscal Space, 2021

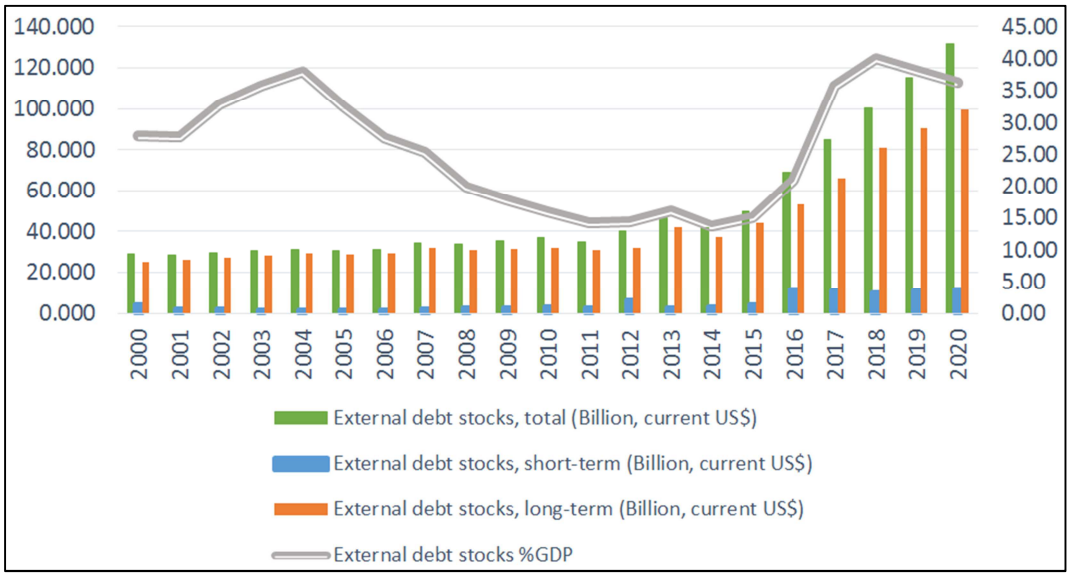
Figure 2. *General Government Gross Debt and Primary Balance % GDP in Egypt 2000-2020.*



Source: Researcher, Using data from Ministry of Finance.

Figure 3. *Public Domestic Debt by Billions LE and % GDP in Egypt 2000-2020.*

In time of global crises, the more important is to look at the external position of the country. It is critical to examine the magnitude of external debt in Egypt. External debt involves more vulnerabilities that could affect the country's economic stability. External debt in Egypt is wide spreading. Egypt's high level of debt, especially external debt, and elevated gross financing needs leave the country vulnerable to rollover risks. Government attempts to return to the pre-COVID-19 primary surplus to ensure fiscal stability. It was estimated that achieving and maintaining primary surpluses of about 2% of GDP would apply a reduction in public debt from 92% of GDP projected for FY2020/21 to around 75% by FY2025/26 [23]. This will strengthen market confidence and create fiscal space—including through lower interest payments— for much-needed social and investment spending. The surge in external debt of Egypt both in absolute terms and as a percentage of GDP is obvious in figure 4. Long-term external debt is stimulated since 2016 after the economic reform program. However, short-term external debt elapsed since 2020 during COVID-19 pandemics putting extra risks and even hard pressures on the external balances of the country.

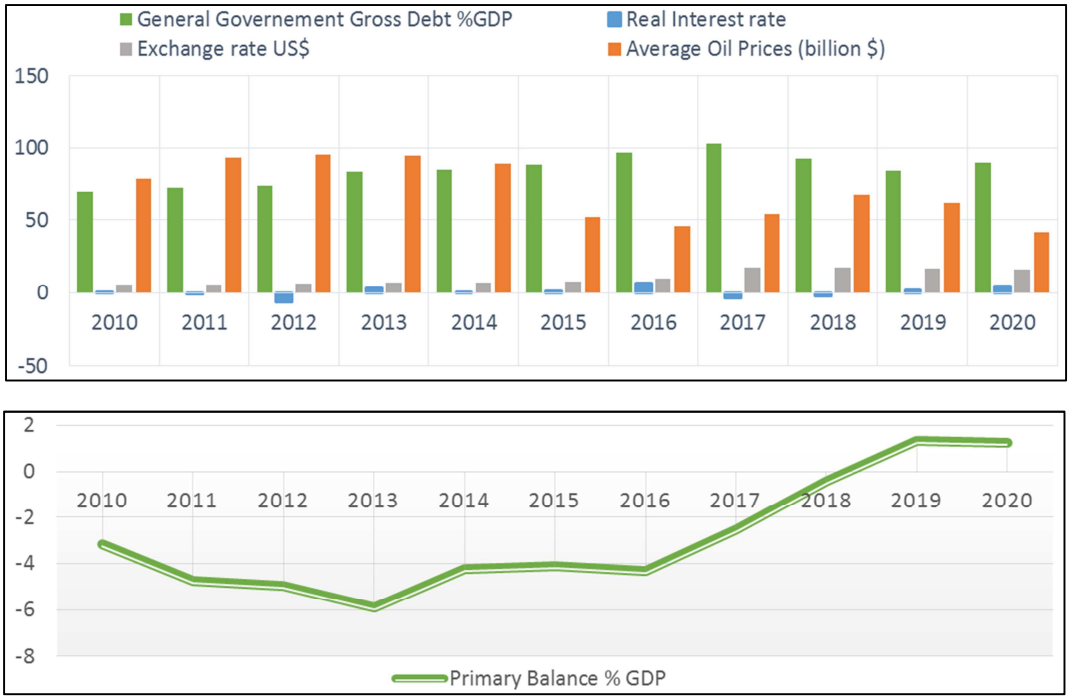


Source: Researcher, Using WDI.

Figure 4. *Total External Debt (short-term & Long-term (in Billion Dollars & Percentage of GDP (2000-2020).*

Primary Balance responds in a sensitive way to key macroeconomic variable during the period from 2010 to 2020. Fiscal policy adjustment reflects the ability of the government to respond to different economic shock. It also provides a significant analysis to control variables that could sharply hit fiscal sustainability. Figure 5 present the interaction of primary balance, expressed as a percentage of GDP to cyclical key factors including debt to GDP ratio, real interest rate, exchange rate and average oil prices. Government response to cyclical changes is a critical condition to keep debt sustained.

Debt sustainability is a macro-interactive concept that cannot be treated excluding macroeconomic dynamics.



Source: Researcher, Using WDI and IMF debt database.

Figure 5. *Primary Balance %GDP Response to Cyclical Factors in Egypt 2010-2020.*

3. Methodology

3.1. Theoretical Framework

In testing the sustainability of public debt in Egypt, the research follows Bohn's Approach in measuring debt sustainability through developing a fiscal reaction function between primary balance and the stock of debt-to-GDP ratio. Bohn's approach is considered most suitable for many reasons [24]: The approach does not require any specific assumptions regarding the discounted factors such as interest rates and growth rates as well as the interaction between them. The test gives focus on the results fiscal policy operates over sustainability rather than the mechanism through which debt is controlled and managed. Thus, there is no necessary requirement for the exact knowledge of debt management process.

The approach is considered as non-discriminating compared to the proposed integration and cointegration based tests of the intertemporal budget constraint IBC that can produce some misleading conclusions in terms of the nature of the IBC condition holding. it is highly suitable for economies with high level of risk and uncertainty. Therefore, it fits in the case of developing countries and market emerging economies. In time of crisis, such as those observed in 2020 and 2022, as well as capturing the economic reform since 2016, the approach is considered more appropriative. The test introduces the debt variable in the primary surplus regression equation. In addition, the approach emphasizes the core rule of sound theoretical understanding in achieving debt inclusion.

A general framework was introduced to test the sustainability of fiscal policy and public debt based on historical data for the United States of America [25]. In Bohn's approach, primary surplus is considered as a function of the debt stock and other macroeconomic determinants. Bohn's starting point in debt analysis was a general equation linking government deficit to government revenues and expenditures as well as public debt. government deficit is expressed as the difference between revenues and expenditures. It is generally considered the change in public debt. it is presented algebraically as follows:

$$\mathrm{DEF}_t = \mathrm{EXP}_t - \mathrm{REV}_t + \mathrm{i}_t.\mathrm{D}_{t-1} \quad (1)$$

Variables are expressed in nominal terms where (DEF_t) is the with interest deficit in year t, (REV_t) is total revenues, (EXP_t) is non-interest expenditures, (D_{t-1}) is public debt at the end of year t-1 and (i_t) is the interest charge. The total debt stock is then expressed as the summation of the with interest deficit and previous stock of debt:

$$D_t = DEF_t + D_{t-1} \quad (2)$$

The primary deficit (Pd_t) which is the difference between (EXP_t) and (REV_t) is worth to be included in the equation to separate the total debt stock from the expenditures and revenues and to get a dynamic equation for debt that are scale invariant. From equation (1) and (2), we can write budget equation in nominal terms as follows:

$$D_t = EXP_t - REV_t + (1 + i_t).D_{t-1} = Pd_t + (1 + i_t).D_{t-1} \quad (3)$$

Introducing equation (3) in real terms, a GDP ratio is expressed by dividing the equation to output (Y) interpreted as the nominal growth rate.

$$\frac{D_t}{Y_t} = \frac{Pd_t}{Y_t} + \left(\frac{1+i_t}{1+Y_t}\right).\frac{D_{t-1}}{Y_{t-1}} \quad (4)$$

Equation (4) can be modified by including the primary surplus (PS_t) which is ($-Pd_t$) and introducing (r_t) which is the return on debt. in addition, assuming all symbols to be generally expressed as generic proxies' correspondent to the proposed terms of fiscal variables, either nominal, real or ratio.

$$d_t = pd_t + (1 + r_t).d_{t-1} = (1 + r_t).d_{t-1} - ps_t \quad (5)$$

Where (d_t) is the total stock of debt (nominal, real or ratio) at year t, (pd_t) is the primary deficit at year t (nominal, real or ratio), (r_t) is the return on debt at year t (nominal, real or ratio), (d_{t-1}) is the previous stock of debt and (ps_t) is the primary surplus at year "t" (nominal, real or ratio). Equation (5) implies that debt variables are now analyzed on a scale-invariant nature regardless their terms of measurement (nominal, real or ratio). It also excludes alternative tax and expenditures policies unless they have an exact effect over primary surplus (ps_t) or return on debt. Moving equation (5) from the Ad Hoc sustainability[1] analysis and the specific stationarity tests, Bohn [25] introduced an alternative approach based on a feedback relationship from the stock of initial debt to the primary surplus expressing surpluses as a function of initial debt. in the simplest way Primary surplus to GDP ratio is considered as an increasing linear function of initial debt to GDP ratio.

$$pb_t = \rho.sd_t + \varepsilon_t + u \quad (6)$$

Where (pb_t) is the primary balance to GDP ratio for the year t, (sd_t) is the stock of initial debt to GDP ratio at the beginning of year t, (ε_t) is a composite of other determinants of the primary balance, (u) is the error term. And (ρ) is a coefficient estimating the way primary balance responds to initial debt. Public debt is assumed to be sustainable when long-run coefficient (ρ) is positive and significantly large (ρ > 0). Which means that changes in public debt in the previous years are significantly and largely covered by a correspondent increase in primary balance of current period. The measurement of the response of primary balance to change in stock of previous debt to GDP ratio is conditional by other non-debt determinants of primary balance to GDP ratio. The determinants are generally reverted to fluctuations of business cycle as approved in main existing literature.

Following tax smoothing theory, fiscal balance is affected by recessions as well as temporarily high non-interest expenditures. As expenditures are financed mainly by tax revenues or through debt, tax burden can be managed -keeping stable tax rate- through running budget deficit or surplus [26].

1 Ad Hoc definition of sustainability assumes that "A fiscal policy satisfies ad hoc sustainability, if it is on a trajectory such that the expected present value of future primary surpluses equals the initial debt"

Tax smoothing theory justifies the utilization of budget deficit during periods of high temporary non-interest expenditures as well as during a contraction. Such mechanism enables government to keep fixed stable tax rate when it is experiencing abnormal high expenditures or low output level. Thus, the theory provides the two non-debt cyclical determinants of primary balance including variations in output and variations in non-interest expenditures [25]. Variations of GDP around the trend expressed as "Output Gap" and variations in public non-interest expenditures around trend expressed is as "Expenditure Gap". An argument supposed that including tax smoothing theory variables corrects for the potential impact of omitted variables [25], thereby warranting a correctly specified and consistent model. Thus (ε_t) can be expressed as follows:

$$\varepsilon_t = \beta_y\, GDPvar_t + \beta_g\, EXPvar_t \quad (7)$$

Capturing those fluctuations is implemented using Hodrick–Prescott (HP) filter to extract the trend and cyclical components of the time series. Substituting equation (7) in (6) we obtain:

$$pb_t = \beta_0 + \rho.sd_t + \beta_y\, GDPvar_t + \beta_y\, EXPvar_t + u_t \quad (8)$$

The tax smoothing theory assumes that a high, temporary non-interest expenditures -especially in key sectors such as security, transportation and infrastructure- decrease primary balance. On the other hand, the effect of output variations over the primary balance is conditioned by the trend of government non-interest expenditures. Output gap is very critical as government takes actions to stimulate economic activity during contractions through deficit financing. Output gap and variations in government non-interest expenditures both work as instruments to capture the influence of government previous debt over primary balance.

It is also critical to add a representative factor for economic structure. Thus, we extend the equation to include the current account balance (CAB) as a percentage to GDP [27]. The inclusion of the CAB variable is based upon the twin deficit hypothesis. Twin deficit hypothesis assumes that there is a strong positive association between the fiscal balance and current account balance. However, literature on testing the direction of the causation is still inconclusive. Chocks in the fiscal balance are moved to current account balance [28, 29]. Yet, the effect is conditioned by the degree of economic openness of the country. Changes in current account as well as macroeconomic variables are linked to fiscal chocks especially in deficit-running countries [30]. Thus, the inclusion of CAB provides a chance to test for the twin deficit hypothesis in Egypt. Current account balance as a percentage to GDP is expected to be highly positively linked to primary balance to GDP ratio. Expressing the stock of debt to GDP ratio in the lag term to control for historical stock of debt as a percentage to GDP transforms equation (8) to the following dynamic form:

$$PB_t = \beta_0 + \beta_1 Sd_{t-1} + \beta_2\, GDPvar_t + \beta_3\, EXPvar_t + \beta_4\, CAB_t + u_t \quad (9)$$

The sign and degree of significance of (β_1) is central to the fiscal sustainability condition. specifically, it measures the primary balance to GDP ratio response to changes in the debt to GDP ratio, which should be between zero and one to satisfy the fiscal sustainability condition. A larger positive value of (β_1) will imply a stronger response of primary balance to debt ratio. On the other hand, a zero or negative (β_1) suggests either no response or a weak insufficient response to more debt. Fiscal Fatigue is also worth to be discussed by testing for nonlinearity in the fiscal reaction function. Fiscal fatigue described as the inability of government to adjust its primary balance in response with high debt levels. The discussion of fiscal space and fiscal fatigue is central to the topic of debt sustainability. Fiscal space is the gap between the actual government debt ratios and its estimated debt limit [13]. Thus, once a government does not have room for fiscal maneuver due to the high level of debt especially when the debt level reaches its limit the issue of fiscal space will lead to a failure of fiscal adjustment to generate necessary surpluses able to compensate for the increase of government debt "Fiscal Fatigue". This shows how a problem of fiscal space can easily turn into a problem of fiscal fatigue.

3.1.1. Extended Structural Specification

Controlling for structural response of the government fiscal policy, we distinguish between discretionary and automatic response of primary balance of government actions including the increased level of the stock of debt to GDP ratio. discretionary and automatic response can be captured by the structural component of public primary balance and by cyclical component of public primary balance [31]. Primary balance is decomposed in a long-run trend component (the structural primary balance) SPB and in a cyclical component (the non-structural primary balance) NSPB. Hence, Primary Balance equals Structural primary balance plus Non-structural primary balance. The decomposition of the two components is obtained through the Hodrick-Prescot (HP) filter. In a long run relationship, the automatic or "passive" fiscal policy, represented quantitatively by the nonstructural component of primary public balance, should not be considered as a part of the dependent variable. Therefore, we concentrate on the existence of a systematic relation between debt to GDP ratio and structural primary balance to GDP, sometimes referred to as the cyclically adjusted primary balance, as an indication to the long-term government response for the increased stock of debt to GDP ratio. Thus, the functional dynamic form of fiscal reaction is expressed as follows:

$$Spb_t = \beta_0 + \beta_1 Sd_{t-1} + \beta_2 GDPvar_t + \beta_3 EXPvar_t + \beta_4 CAB_t + u_t \quad (10)$$

Where (SPB_t) is the structural primary balance to GDP ratio. If the two debt variables including the structural primary balance to GDP ratio and debt to GDP ratio are both non-stationary and a long-term cointegration relationship exists, there is no need to run a regression for remaining controlling variables explicitly. When cyclical or automatic movements are removed from the fiscal components, fiscal stance can be correctly measured, being given by the difference between government revenues and expenditures corrected by the effects that could be attributed to the economic cycle. Thus, providing useful information to identify the structural trends and to test whether the fiscal policy of a country is expansionary, neutral or restrictive for a given time.

3.1.2. Non-Linear Specification

The research goes an extra mile through examining the non-linearity in the relationship between primary balance and debt ratios. The main objective is to test the fiscal fatigue hypothesis [13]. A fiscal reaction function relating primary balances to lagged debt will be formulated in a cubic function to capture the two inflection points in the curvature of the response. This will give an overall insight for fiscal fatigue.

Fiscal effort increases with the debt level [2]. It was assumed that primary balance responds positively at high levels of lagged debt to GDP ratio. In practice, it becomes increasingly hard to keep adjusting the primary balance through cutting primary expenditures or raising taxes. In other words, after a certain point, "fiscal fatigue" sets in where the primary balance may still be an increasing function of lagged debt but at a decreasing rate.

the cubic function seems to be a reasonable description of the primary balance function [13]. That is, at low levels of debt, there may be little or even a negative relationship between the primary balance and debt; as debt increases, the relationship turns positive, but at sufficiently high levels of debt, the curve flattens out. Once the increase in the primary balance (in response to higher debt) does not keep in stride with the mounting interest payment, there will be a debt limit at which the primary surplus is insufficient to meet the interest payment; thus, debt increases further, and in the absence of an extraordinary fiscal effort, the debt dynamics become explosive and the government necessarily defaults. For these reasons, the baseline model has been extended by adding lagged polynomial terms of public debt [27]. Therefore, the non-linear form of the fiscal reaction function is approximated as a cubic form as follows:

$$Pb_t = \beta_0 + \beta_1 sd_{t-1} + \beta_2 sd_{t-1}^2 + \beta_3 sd_{t-1}^3 + \beta_4 GDPvar_t + \beta_5 EXPvar_t + \beta_6 CAB_t + u_t \quad (11)$$

The fiscal fatigue proposition of response of the primary balance to rising debt in an increasing rate and then decreasing rate is expressed when $\beta_3 < 0$ in (a cubic specification) or $\beta_2 < 0$, $\beta_3 = 0$ (in a quadratic specification). The estimated coefficient of the polynomial forms of the debt to GDP ratio can be utilized to endogenously define a debt threshold for which the response of the primary balance to lagged debt is at its maximum. above this debt threshold, the response starts to decline (fiscal fatigue).

3.2. Data

The study is based on secondary time series data for the period from 1981 to 2021. The time interval is selected upon data availability of main variables as well as the analysis

statistical requirements. Data are collected from different main sources. Data for GDP in constant and current terms are collected from The World Bank world development indicators (WDI), Data for general government debt to GDP ratio and current account balance to GDP ratio are collected from the international monetary fund IMF data sets and data for the Egyptian budget are gathered from the ministry of finance including government revenues and expenditures as well as interest payments to calculate the primary balance. Data of public finance are measured on a fiscal year basis including primary balance on its general and structural terms and non-interest expenditures. The stock of government debt to GDP, real GDP and current account Balance are based on the calendar year. The specification of all variables included in the equation is discussed in table 1 in terms of variable description, abbreviation, and unit of measurement.

Table 1. *Specification of Variables.*

Variable	Abbr.	Description	Unit
Primary Balance	PB	Government Revenues minus government Expenditures excluding interest payments as a percentage to GDP	In percentage
Structural Primary Balance	SPB	Represents the long-run trend component of the primary balance to GDP ratio extracted using Hodrick-Prescott (HP) filter	
Stock of initial Debt	SD	General government debt as a percentage to GDP	In percentage
Output Gap	GDP*var*	Business cycle of output described as the difference between actual and potential GDP. It is calculated as the cyclical component of real GDP in constant billions national currency using Hodrick-Prescott (HP) filter	In Percentage
Expenditure Gap	EXP*var*	Business cycle of government non-interest expenditures estimated as the cyclical component of general government non-interest expenditures in billions national currency using Hodrick-Prescott (HP) filter	In percentage
Current Account Balance	CAB	Current Account Balance as a percentage of GDP	In percentage

Variables are chosen and formed according to theoretical background and previous studies analysis. As represented in equation (9), the primary balance to GDP ratio (Pb) is the dependent variable, the stock of previous debt as a percent of GDP (sd) is the main debt independent variable, expenditure gap (EXPvar), output gap (GDPvar) and current account balance to GDP ratio (CAB) are all control variables. Variations of actual GDP around potential GDP expressed as "Output Gap" and variations in public non-interest expenditures around trend expressed as "Expenditure Gap" are estimated using Hodrick–Prescott (HP) filter used to extract the trend and cyclical components of a time series. Applying the filter to the primary balance to GDP ratio generates an interesting mechanism to distinguish between the structural primary balance and non-structural primary balance. Structural primary balance (SPB) refers to the long-run trend value of the primary balance to GDP ratio. Sometimes it's referred to as the cyclically adjusted primary balance (CAPB).

A general look in the main statistics describing the variables in the considerable sample reflects the suitability of the data. The dependent variable (PB) has a mean value of (-2.6227) reflecting an average primary deficit to GDP during the examined period. It also ranges within a minimum-maximum range of (-9.12 – 5.07) with a moderate standard deviation of (3.21). The structural primary balance (SPB) has a mean value of (1.77) with a minimum-maximum range from (0.64-2.45) with more stable deviations from the mean value.

Table 2. *Descriptive Statistics.*

	PB	SPB	SD	GDP_VAR	EXP_VAR	CAB
Mean	-2.622771	1.777078	92.26868	-4.41E-12	-2.05E-12	-1.343902
Median	-3.360376	1.848749	87.95097	-0.103018	0.147172	-2.100000
Min	-9.127914	0.639441	66.76061	-4.391021	-13.92946	-8.100000
Max	5.070729	2.447726	129.8320	4.120707	24.19362	8.300000
Std. Dev	3.216253	0.435367	17.53651	2.006184	8.879222	3.267878
Sum	-107.5336	72.86020	3783.016	-1.81E-10	-8.39E-11	-55.10000
Obs	41	41	41	41	41	41

Source: Author using E-views

3.3. Empirical Estimation

3.3.1. Unit Root Test

The study tests the unit root for all variables using both Augmented Dickey-Fuller (ADF) test [32] and Philips-Perron (PH-P) test [33]. The null hypothesis is that there is a unit root in the data. Null hypothesis is rejected when p-value is less than 5% which means that the series is stationary. The test uses Akaike Info Criterion for the ADF Test and Newey-West Bandwidth for Phillips-Perron Test. All data are stationary either at I(0) or I(1). Output gap and cyclical non-interest expenditures are stationary at level as cyclical components of a time series are usually stationary. The primary balance to GDP ratio shows high level of stationarity at the first difference. The structural primary balance to GDP ratio is stationary at level when including the trend with the intercept and at the first difference when including the intercept only as indicated using ADF test. The stock of government debt to

GDP as well as current account balance to GDP are both stationary at first difference.

Table 3. *ADF Test and Phillips-Perron Test.*

	level				First difference			
	Intercept		Trend & Intercept		Intercept		Trend & Intercept	
	ADF	PH-P	ADF	PH-P	ADF	PH-P	ADF	PH-P
PB	-2.1050 (0.2438)	-2.2382 (0.1966)	-2.2693 (0.4399)	-2.4265 (0.3611)	-6.3819 (0.0000)	-6.3801 (0.0000)	-6.2940 (0.0000)	-6.2934 (0.0000)
SPB	1.4901 (0.9989)	-2.2686 (0.1867)	-4.3242 (0.0086)	-2.1399 (0.5087)	-3.3883 (0.0189)	-1.4751 (0.5354)	-3.2312 (0.0964)	-1.0959 (0.9168)
SD	-3.2451 (0.0247)	-2.3297 (0.1680)	-3.5066 (0.0526)	-2.5066 0.3235	-4.2998 (0.0016)	-4.3015 (0.0015)	-4.1020 (0.0153)	-4.4376 (0.0056)
GDP_VAR	-3.6831 (0.0087)	-3.3107 (0.0210)	-3.6552 (0.0389)	-3.2972 (0.0813)	-4.3315 (0.0016)	-5.3582 (0.0001)	-4.2741 (0.0093)	-5.2505 (0.0006)
EXP_VAR	-5.1505 (0.0001)	-5.1338 (0.0001)	-5.1029 (0.0009)	-5.0821 (0.0010)	-9.7928 (0.0000)	-13.679 (0.0000)	-9.6963 (0.0000)	-12.567 (0.0000)
CAB	-2.6872 (0.0853)	-2.2555 (0.1909)	-2.7053 (0.2401)	-1.9829 (0.5926)	-4.9738 (0.0002)	-6.6233 (0.0000)	-5.0326 (0.0012)	-12.724 (0.0000)

Source: Author using E-views
*P-value are in parentheses

3.3.2. ARDL Estimation

The economic theory suggests that some variables are linked by a long-term relationship, which implies that the variables may drift apart from each other in the short-term. Therefore, it is critical to investigate the presence of a cointegrating relationship between the study variables. The key approaches for testing cointegration include the Granger two-step approach based on assessing whether single-equation estimates of equilibrium errors are stationary [34], the Johansen test based on the VAR technique [35] and the Pesaran Autoregressive Distributed Lag (ARDL) bounds test approach [36]. The choice of the approach is based upon the stationarity properties of the variables under examination.

Granger technique is economically consistent [34]. However, it has critical limitations in our model as it is inapplicable in the presence of more than one cointegrating relationship since it assumes that there is a unique cointegrating variable. In addition, a first step generated error will be moved in the second step since it is a two-step approach. Furthermore, it carries out a finite sample bias regarding accounting for short-run dynamics in estimation. The Johansen approach handles the first limitation as it fits in the presence of multiple cointegrating relationships. However, both methods are inappropriate when the variables are integrated in different orders either I(0) or I(1).

Therefore, the study applies (ARDL) approach as it highly fits when variables are integrated in different orders, but at level or the first difference [36]. It is also advantageous as it has no endogeneity problem, fits for small samples and highly efficient in forecasting and for separating long-run relationships from short-run dynamics. However, it is only applicable in a single equation and on the assumption of one cointegration.

Extended estimation replaced the primary balance to GDP ratio with the structural long-term trend component of the primary balance to GDP ratio. Equation (10) is specified according to ARDL specification as follows:

$$\Delta SPB_t = \alpha_0 + \sum_{i=1}^{p}(\alpha_1 \Delta \mathrm{SPB}_{t-i}) + \sum_{i=0}^{q}(\alpha_2 \Delta \mathrm{sd}_{t-i}) + \sum_{i=0}^{q}(\alpha_3 \Delta \mathrm{GDP}var_{t-i}) + \sum_{i=0}^{q}(\alpha_4 \Delta \mathrm{EXPEN}var_{t-i}) + \sum_{i=0}^{q}(\alpha_5 \Delta \mathrm{CAB}_{t-i}) + \beta_1 SD_{t-1} + \beta_2 GDPvar_t + \beta_3 EXPvar_t + \beta_4 CAB_t + u_t \quad (12)$$

Where α_0 is the intercept, β_1 to β_4 are the long-term parameters and u_t is the error term. The lag order is chosen based on Akaike Info Criterion (AIC) after comparing its value to other criteria. The model shows that the dependent variable is a function of its lagged values as well as the current and lagged values of the explanatory variables. An error correction model is established in line with the long-run relationship to estimate the short-run dynamics and to examine the rate of adjustment. The error correction model is specified according to the following form:

$$\Delta SPB_t = \alpha_0 + \sum_{i=1}^{p}(\alpha_1 \Delta \mathrm{SPB}_{t-i}) + \sum_{i=0}^{q}(\alpha_2 \Delta \mathrm{SD}_{t-i}) + \sum_{i=0}^{q}(\alpha_3 \Delta \mathrm{GDP}var_{t-i}) + \sum_{i=0}^{q}(\alpha_4 \Delta \mathrm{EXPEN}var_{t-i}) + \sum_{i=0}^{q}(\alpha_5 \Delta \mathrm{CAB}_{t-i}) + \theta ECM_{t-1} + u_t \quad (13)$$

Where Δ is the first difference operator, α_0 is the intercept and α_1 to α_5 are short-run dynamic coefficients, and θ is the rate of adjustment to long-run equilibrium. The selection of optimal lags based on Akaike Info Criterion (AIC). Optimal lags are determined based on three sequence regressions when including the explanatory variables. Regression one includes the two main variables for fiscal sustainability: the primary balance to GDP ratio and the lagged debt to GDP ratio. Regression two augments regression one with output gap and expenditure gap. Regression three adds the current account

balance to GDP ratio. The first extended regression "Regression1" is settled with maximum lags of 8 based on AIC estimation. The AIC lags order for regression1 was settled as (2,2). Baseline2 suggests maximum lag length of 6, The AIC lags order for Regression2 is settled as (2,5,6,6). Maximum lags for regression3 is estimated to be 6 according to Akaike Info Criterion. Lag order in regression3 is (2,1,1,3,5).

The F-bounds cointegration test is conducted to examine the existence of a long-run relationship between the variables in the Three regression models. Regression1 includes single long-run explanatory variable "lagged debt to GDP ratio". Regression2 includes three long-run explanatory variables represented in the lagged debt to GDP ratio, output gap and expenditure gap. Regression3 includes 4 long-run variables in the cointegrated long-run relationship after adding the current account balance to GDP.

The non-linear response of the primary balance to GDP ratio to the lagged debt to GDP ratio is examined by a cubic function to test for the possibility of fiscal fatigue in Egypt. Non-linear response provides an evidence for the mechanism government response to higher level of public debt. The cubic form in equation (11) is written according to ARDL specification as follows:

$$\Delta PB_t = \alpha_0 + \sum_{i=1}^{p}(\alpha_1 \Delta \mathrm{PB}_{t-i}) + \sum_{i=0}^{q}(\alpha_2 \Delta \mathrm{sd}_{t-i}) + \sum_{i=0}^{q}(\alpha_3 \Delta \mathrm{sd}^2{}_{t-i}) \sum_{i=0}^{q}(\alpha_4 \Delta \mathrm{sd}^3{}_{t-i}) + \sum_{i=0}^{q}(\alpha_5 \Delta \mathrm{GDP}var_{t-i}) + \sum_{i=0}^{q}(\alpha_6 \Delta \mathrm{EXPEN}var_{t-i}) + \sum_{i=0}^{q}(\alpha_7 \Delta \mathrm{CAB}_{t-i}) + \beta_1 SD_{t-1} + \beta_2 SD^2{}_{t-1} + \beta_3 SD^3{}_{t-1} + \beta_4 GDPvar_t + \beta_5 EXPvar_t + \beta_6 CAB_t + u_t \quad (14)$$

Where α_0 is the intercept, β_1 to β_6 are the long-run coefficients and u_t is the error term. The lag order is chosen based on Akaike Info Criterion (AIC) after testing for the best lag criterion. The model shows that the dependent variable is a function of its lagged values as well as the current and lagged values of the explanatory variables. Lagged debt to GDP ratio SD(-1) is specified as a cubic form including the variable in a quadratic form and in a cubic form. An error correction model is established in line with the long-run relationship to estimate the short-run dynamics and to examine the error correction term in order to measure the speed of adjustment. The error correction model is specified according to the following form:

$$\Delta SPB_t = \alpha_0 + \sum_{i=1}^{p}(\alpha_1 \Delta \mathrm{PB}_{t-i}) + \sum_{i=0}^{q}(\alpha_2 \Delta \mathrm{sd}_{t-i}) + \sum_{i=0}^{q}(\alpha_3 \Delta \mathrm{sd}^2{}_{t-i}) + \sum_{i=0}^{q}(\alpha_4 \Delta \mathrm{sd}^3{}_{t-i}) + \sum_{i=0}^{q}(\alpha_5 \Delta \mathrm{GDP}var_{t-i}) + \sum_{i=0}^{q}(\alpha_6 \Delta \mathrm{EXPEN}var_{t-i}) + \sum_{i=0}^{q}(\alpha_7 \Delta \mathrm{CAB}_{t-i}) + \theta\, ECM_{t-1} + u_t \quad (15)$$

Where Δ is the first difference operator, α_0 is the intercept and α_1 to α_7 are short-run dynamic coefficients, and θ is the rate of adjustment to long-run equilibrium. The non-linear effect was examined based on three sequence regressions when including the explanatory variables. Cubic regression one includes the two main variables for fiscal sustainability: the primary balance to GDP ratio and the lagged debt to GDP ratio in a cubic form. Cubic regression two augments regression one with output gap and expenditure gap. The Final regression "Cubic three" adds the current account balance to GDP ratio. The F-bounds cointegration test is conducted to examine the existence of a long-run relationship between the variables in the Three cubic regression models. Cubic1 includes the lagged debt to GDP ratio in a cubic form. Cubic2 regression model adds the cyclical control variables including output gap and expenditure gap. Cubic3 regression model augments Cubic2 by adding the current account balance to GDP.

4. Results and Discussion

The multidimensional empirical examination of the debt sustainability implemented in the previous section is very interesting and worthen. As the conclusion on public debt sustainability is highly variant based on the specification adopted. Going into deep in the topic clarifies hidden risks and opportunities. The main core is how government respond to the increase in the debt to GDP ratio. If the increase in debt to GDP ratio is offset by a larger increase in the government primary balance as a percentage to GDP, public debt will be considered sustained and government will be considered solvent.

4.1. Structural Extended Findings

When cyclical or automatic movements are removed from the fiscal components, fiscal stance can be correctly measured. The results of the extended estimation are measured through three consequent regression models. Summing up all instruments and control variables, results of bounds test confirm the existence of a cointegration relationship. The value of F-statistics is greater than all upper bounds. Thus, the null hypothesis of no cointegration is rejected. It is then approved that there is a cointegration relationship between the structural primary balance to GDP ratio and the stock of previous debt to GDP ratio, the output gap, the expenditure gap and the current account balance to GDP.

The long-term coefficients represented in table 5 showed that the coefficient of lagged debt to GDP ratio is (-0.027) and statistically significant. Such conclusion is very critical as government fails to respond positively with adjusting its structural primary balance when the stock of debt to GDP ratio increase by 1%. Instead the amount lies below the increase by 0.02%. Meanwhile, the government is far away satisfying the main conditions of debt sustainability. The estimation results reflect high reliability as the value of R-squared is 0.99 and the significance of the model is very high considering the value of

F-statistics. The regression shows a rate of adjustment in the short-term by 2% per year to return to the equilibrium position.

In addition, regression2 in the extended estimation supports the same conclusion after adding the two cyclical instruments, the output gap and the expenditure gap. Regression2 emphasizes the existence of a cointegration relationship between the structural primary balance to GDP and the stock of previous debt to GDP along with the GDP gap and expenditure gap. The results of bound test confirm such conclusion as the value of F-statistics is (37.395) which is greater than all the upper bounds at every significance level. Thus, the null hypothesis of no cointegration is rejected and the alternative hypothesis is accepted.

Table 4. *Results of Bounds Test for Extended Specification.*

F-Statistics		**F-Bounds Test**					
		Regression1		**Regression2**		**Regression3**	
		7.806131		**37.39563**		**152.8148**	
Bounds		**I(0)**	**I(1)**	**I(0)**	**I(1)**	**I(0)**	**I(1)**
Significance	10%	3.02	3.51	2.37	3.2	2.68	3.53
	5%	3.62	4.16	2.79	3.67	3.05	3.97
	2.5%	4.18	4.79	3.15	4.08	3.4	4.36
	1%	4.94	5.58	3.65	4.66	3.81	4.92

Source: Author using E-views

The long-term results of regression2 shown in table 5 supports the conclusion of debt unsustainability of the structural primary balance to GDP in response to the increase in previous debt. the coefficient of lagged debt to GDP ratio is (-0.027) and is statistically significant. This result reflects the government inability to adjust its structural primary balance to GDP with every 1% increase in the stock of previous debt. the coefficient of the output gap is equal to (-0.163) and is statistically significant. The structural fiscal policy is then considered as pro-cyclical. The government adjusts its structural primary balance to GDP when the level of output is below the potential level. The results confirm the fact that fiscal policy is strong during the economic crises and contraction much more than any other time "automated response pattern".

The expenditure gap witnesses a positive coefficient of (0.0165) with statistically significant level. The coefficient induces that the structural primary balance to GDP adjusts positively when the non-interest expenditures is above its trend value. However, the adjustment is very weak, 0.01% for each 1% increase. For the whole regression model, the value of R-squared is (0.999) which means that 99.9% of the total variations in the structural primary balance to GDP is captured by the rise in the stock of previous debt to GDP ratio along with the fluctuations in output gap and expenditure gap. The adjusted R-squared records a consistent value of (0.999). the significance of the whole regression is very high considering the value and significance level of F-statistics. Short-term rate of adjustment is 4%. The structural fiscal policy adjusts only four times per year to return to its long-term equilibrium.

Regression3 sums up all instruments and control variables by adding the current account balance to GDP to the sustainability equation. The results of bounds test confirm the existence of a cointegration relationship. The value of F-statistics is greater than all upper bounds. Thus, the null hypothesis of no cointegration is rejected. It is then approved that there is a cointegration relationship between the structural primary balance to GDP ratio and the stock of previous debt to GDP ratio, the output gap, the expenditure gap and the current account balance to GDP.

The long-term results of regression3 deepen and correct the discussed conclusion. The value of R-squared is estimated to be (0.999) reflecting that almost 99.9% of the total adjustment in the structural primary balance to GDP ratio is explained by variations in the stock of previous debt to GDP ratio, fluctuations in output gap and expenditure gap as well as the balance of current account to GDP. The value of adjusted R-squared is also consistent, taking into account the sample size and degrees of freedom. The value of F-statistics is highly significant reflecting the goodness of fit for the model.

Long-term coefficients confirm the conclusion. The coefficient of lagged debt to GDP ratio is equal to (-0.0047) and is highly significant. The government is unable to adjust its structural primary balance positively for every 1% increase in the stock of previous debt to GDP ratio during the examined time period. In other words, each 1% increase in the stock of previous debt to GDP ratio in one year is not offset by equal adjustment in the value of structural primary balance to GDP in the following year. Rather, the structural primary balance is below the increase in lagged debt amount by 0.0047%. Although the amount is relatively small, it is considered as a critical mis-correction in terms of fiscal policy adjustment.

The coefficient of output gap is estimated to be (-0.07) with high level of significance. The structural primary balance is negatively linked to the output gap. Therefore, the structural fiscal policy is considered as pro-cyclical during the study period. Government adjusts its structural primary balance when the level of output is below the potential level, that is, during economic recessions. This result is consistent with the literature [31].

Table 5. *Long-Term Coefficients of Extended Specification.*

	Long-Run Fiscal Sustainability Coefficients					
	Regression1		**Regression2**		**Regression3**	
	Coefficient	**Prob.**	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**
SD(-1)	-0.027397 (0.007471)	0.0009	-0.027466 (0.003254)	0.0000	-0.004721 (0.001827)	0.0187
GDP*var*			-0.163775 (0.058596)	0.0162	-0.076141 (0.016178)	0.0002
EXPEN*var*			0.016563 (0.006863)	0.0327	-0.020515 (0.007019)	0.0091
CAB					-0.077206 (0.014817)	0.0001
Observations	39		35		36	
R-squared	0.999088		0.999909		0.999953	
Adj. R-squared	0.998950		0.999743		0.999908	
F-statistic	7232.596		6002.232		22399.87	
Prob(F-statistic)	0.000000		0.000000		0.000000	

Source: Author using E-views
*Standard Errors are in parentheses

Table 6. *Short-Term model and ECM of the Extended Estimation.*

	Error Correction Estimates for ARDL Model					
	Regression1		**Regression2**		**Regression3**	
	Coefficient	**Prob.**	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**
CointEq(-1)*	-0.024478 (0.004912)	0.0000	-0.046769	0.0000	-0.036086	0.0000
SD(-1)	0.000502 (0.000218)	0.0282	0.000825 (0.000102)	0.0000	-0.000895 (0.000338)	0.0162
GDP*var*			0.004110 (0.000766)	0.0002	-0.000502 (0.000603)	0.3372
EXPEN*var*			-0.000307 (0.0000)	0.0035	-0.000228 (0.000512)	0.0003
CAB					0.002840 (0.000230)	0.0000
Observations	39		35		36	
R-squared	0.970484		0.998774		0.999193	
Adj. R-squared	0.967954		0.997395		0.998771	
Durbin-Watson stat	0.329896		1.927237		1.624286	

Source: Author using E-views

The expenditure gap is also negatively associated with the structural primary balance to GDP ratio. The coefficient is equal to (-0.02) with high level of significance, below the 1%. The value is more consistent with the results of previous literature [37]. The government ability to adjust its structural primary balance is low when the non-interest expenditures is above the trend level. Every 1% increase in the non-interest expenditures is associated by deterioration in structural policy adjustment by 0.02%. the logic behind the value is that government finance its activities through debt harming the pattern of the structural primary balance. In addition to the cointegration force between the output gap and the expenditure gap.

The hypothesis of the twin deficit is not apparent in the model as the coefficient of the current account balance as a percentage of GDP. The coefficient of the current account balance is equal to (-0.07) with high level of significance. Each 1% improvement in the current account balance to GDP is reflected with a 0.07% deterioration in the structural primary balance to GDP ratio.

The reason behind is the temporal nature of the current account in consistence with the trend nature of the structural primary balance. In other terms, the improvements in the primary balance influenced by current account surpluses are mostly captured in the cyclical response of the primary balance to GDP ratio rather than the structural aspect. For the final estimation, the short-term coefficients are more logic with a rate of adjustment equal to (-0.036). the structural primary balance adjusts 3% per year to return to the equilibrium long-term relationship.

Diagnostic tests reflect the accuracy of the three Extended regression models. Results of diagnostic tests are shown in table 7 representing the values of each test according to the significance level. There is no serial correlation in all extended regression models as the p-values from the Breusch-Godfrey serial correlation LM test are significant. The models are all homoscedastic since the results of the Breusch-Pagan test are higher than 0.05. The results for the ARCH effects test indicate that the errors are not autoregressive conditional heteroskedastic for both models since the p-values are significant at the 5 percent level of significance. The results show that the error term is normally distributed at the usual 5% threshold level for the three models. The study provides more evidence for normality using Jarque-Bera graphs in the appendix. The study also finds that there is no omitted variable bias at 5 percent since the p-values for all the variables are higher than the conventional threshold.

There is an evidence for parameter stability since the test statistic values for the recursive CUSUM and CUSUM OF SQUARED tests do not exceed the 5 percent critical levels. The recursive CUSUM and CUSUM OF SQUARED plots show that the parameters for the various models are stable

since the CUSUM plots do not move out of the critical lines at the 5 percent level of significance.

Table 7. *Short-Term model and ECM of the Extended Estimation.*

	Diagnostic Tests		
	Regression1	**Regression2**	**Regression3**
Serial correlation	0.0501	0.4634	0.7023
Heteroskedasticity	0.2120	0.9886	0.9187
ARCH effect	0.0588	0.8980	0.3668
Normality	0.1809	0.0501	0.6040
Ramsey RESET	0.5979	0.0586	0.3610
CUSUM and CUSUM of Squares	Within the significance bounds	Within the significance bounds	Within the significance bounds

Source: Author using E-views

The automatic response of the government fiscal policy is considered as the first step to meet the sustainability condition. For the government to keep an expansionary strong fiscal stance. The structural response should also remain positive. However, for the examined time interval, the government of Egypt is unable to maintain a long-term positive response for the previous debt to GDP accumulation. The structural trends in the discussed extended model emphasize that fiscal policy of Egypt is restrictive for the examined period.

Keeping public debt sustainability in the long-term requires the existence of an expansionary or even neutral fiscal policy. Unless the government is able to effectively adjust to any sudden or structural rise in the stock of previous debt, fiscal sustainability will experience huge critical limitations. The long-term structural response is more important and meaningful than the non-structural cyclical response. The post crises implications are then a serious challenge for the government fiscal policy.

4.2. Non-Linearities "Possibility of Fiscal Fatigue"

The sustainability of fiscal policy tends to hesitate in high levels of debt to GDP ratio. Hence, non-linear estimation is built to test the fiscal fatigue hypothesis in line with Gosh [13]. The cubic estimation provides some critical insights in terms of debt sustainability, fiscal stance and fiscal fatigue. The cubic form allows for the rate of response of the primary balance to GDP ratio to highly increased debt to GDP ratio. The cubic estimation is implemented through three sequent regressions aiming to confirms the accuracy of the results. Cubic1 regression includes a polynomial form of the primary balance to GDP ratio over the debt to GDP ratio. The cointegration relationship is confirmed in the cubic estimation as the results of bounds test indicate. The value of F-statistics in cubic1 regression is greater than all upper bounds allowing for the rejection of the null hypothesis at all significance levels.

Table 8. *Results of Bounds Test for Non-linear Estimation.*

F-Statistics		**F-Bounds Test**					
		Cubic1		**Cubic2**		**Cubic3**	
		7.371438		**26.35955**		**4.465067**	
Bounds		**I(0)**	**I(1)**	**I(0)**	**I(1)**	**I(0)**	**I(1)**
Significance	10%	2.01	3.1	1.81	2.93	1.75	2.87
	5%	2.45	3.63	2.14	3.34	2.04	3.24
	2.5%	2.87	4.16	2.44	3.71	2.32	3.59
	1%	3.42	4.84	2.82	4.21	2.66	4.05

Source: Author using E-views

The long run coefficients of the lagged debt to GDP ratio in a cubic estimation are (-1.88), (0.038) and (-0.00018) respectively with all the coefficients statistically significant. The results are very critical in two ways. First, at low levels of debt to GDP ratio the government adjustment of its primary balance is not structurally planned. Government show weak response in terms of primary balance. When the level of accumulated debt to GDP ratio goes high, government undertakes serious measures and effectively adjust the primary balance to GDP with the increased public debt. however, when the level of the previous debt to GDP ratio jump to extreme high levels, government is unable to maintain the positive response suggesting the possibility of fiscal fatigue and fiscal default.

Moreover, the results are consistent with the conclusion of a restrictive fiscal policy of the Egyptian government during the examined time period. As the government is restricted in its long-term response to the accumulated debt, the possibility of effective management through and within high debt to GDP ratio is diminishing.

The model shows high reliability as the value of R-squared is (0.92) indicating that around 92% of the total variations in the primary balance to GDP is captured by the magnitude of the debt to GDP ratio. Additionally, the value of F-statistics is highly significant reflecting the goodness of fit of the regression. The short-term results also reflect a cointegrating pattern. The rate of adjustment is estimated to be 23%. Thus, the primary balance to GDP ratio adjust 23 times per year to

return to its long-term equilibrium condition.

Table 9. *Long-Term Coefficients of Non-linear Estimation.*

	Long-Run Coefficients					
	Cubic1		**Cubic2**		**Cubic3**	
	Coefficient	**Prob.**	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**
SD(-1)	-1.882608 (0.802824)	0.0289	-3.236458 (0.663342)	0.0165	-2.493108 (0.469969)	0.0005
$SD(-1)^2$	0.038417 (0.016871)	0.0334	0.066608 (0.013797)	0.0169	0.051051 (0.009727)	0.0005
$SD(-1)^3$	-0.000189 (0.008500)	0.0369	-0.000330 (0.00685)	0.0171	-0.000253 (0.004831)	0.0005
GDP*var*			7.261009 (1.899826)	0.0315	4.067798 (1.114069)	0.0053
EXPEN*var*			1.118404 (0.190396)	0.0098	0.748220 (0.144342)	0.0006
CAB					0.694734 (0.245004)	0.0195
Observations	37		36		37	
R-squared	0.926574		0.998328		0.962054	
Adj. R-squared	0.874128		0.980493		0.848216	
Durbin-Watson stat	2.136264		2.826322		2.983903	

Source: Author using E-views

Cubic2 regression augments the first regression by controlling the fiscal instruments including the output gap and expenditure gap. The results of bounds test confirm the cointegration relationship between the primary balance to GDP ratio, the output gap and the expenditure gap. The null hypothesis of no cointegration is rejected as the value of F-statistics is above all the upper bounds.

The long-run coefficients of the lagged debt to GDP ratio in the cubic form are (-3.230, (0.066) and (-0.00033) for the linear, quadratic and cubic specifications. The coefficients are statistically significant. The values emphasize the same conclusion in cubic1. The possibility of fiscal fatigue in the high level of debt to GDP ratio is very significant. The coefficient of the output gap is equal to (7.26) and significant at the 5% level of significance. The primary balance responds positively when the level of output is above its potential level. The fiscal policy then is considered as a counter-cyclical.

The expenditure gap is also linked positively to the primary balance to GDP ratio. Every 1% increase in the non-interest expenditures enables government to adjust its primary balance by 1.11%. The relationship between the level of non-interest expenditures and the output gap is obvious although. The R-squared value indicates that 99% of the total variation in the primary balance to GDP ratio is captured by the cubic function of lagged to GDP ratio, the output gap and the expenditure gap. Results in the short-term strengthen the conclusion. It takes 52 times of adjustment per year for the primary balance to maintain the long-term equilibrium condition.

Table 10. *Short-Term and ECM of the Non-linear Estimation.*

	Error Correction Estimates for ARDL Model					
	Cubic1		**Cubic2**		**Cubic3**	
	Coefficient	**Prob.**	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**
CointEq(-1)*	-0.232391 (0.040033)	0.0000	-0.525179 (0.025573)	0.0003	-0.036086	0.0000
SD(-1)	3.302474 (1.108901)	0.0072	3.208984 (0.783262)	0.0263	0.259961 (0.046003)	0.0003
$SD(-1)^2$	-0.038289 (0.011531)	0.0032	-0.045421 (0.008313)	0.0120	-0.049903 (0.012404)	0.0030
$SD(-1)^3$	0.000148 (0.000396)	0.0012	0.000200 (0.000946)	0.0065	0.000186 (0.042803)	0.0018
GDP*var*			1.404179 (0.116799)	0.0012	0.771544 (0.181187)	0.0021
EXPEN*var*			0.099904 (0.016520)	0.0091	0.045407 (0.031920)	0.0188
CAB					-0.707879 (0.138824)	0.0006
Observations	37		36		37	
R-squared	0.837387		0.996443		0.915962	
Adj. R-squared	0.756080		0.984439		0.798309	
Durbin-Watson stat	2.136264		2.826322		2.983903	
AIC	3.164719		0.221169		2.991099	

Source: Author using E-views

A further deep specification is achieved in cubic3 regression after controlling for the current account to GDP ratio in the sustainability measurement. The bounds test emphasizes the cointegration relationship in presence of the current account balance. Long term coefficients of the lagged debt to GDP ratio in its cubic form are estimated to be (-2.49), (0.051) and (-0.0048) respectively with high level of significance. At low levels of debt to GDP ratio, government response is weak and unstructured. When the stock of debt rises, government formulates its fiscal policy to strongly respond to the increased public debt. at high levels of previous debt to GDP ratio, government is restricted and unable to

respond positively. It becomes hard for the government to adjust its fiscal policy through cutting expenditures or raising tax revenues.

The output gap records a positive association with the primary balance to GDP ratio. Government adjust its primary balance by 4.06% when the level of output exceeds the potential output by 1%. The value is statistically significant. The expenditure gap also shows positive association. For every unit increase in the non-interest expenditures the government is yet able to adjust its primary balance to GDP ratio by 0.74%. The coefficient of the current account to GDP ratio confirms the hypothesis of twin deficit. When the current account balance as a percentage of GDP improves, the government primary balance shows extra improvement by 0.69%. the value is significant at 5%.

The value of R-squared indicates that 96.2% of the total variations in the government primary balance to GDP ratio is attributed to the cubic form of lagged debt to GDP ratio, the instrumental control of the output gap and expenditure gap and the current account balance as a percentage to GDP. The short-term rate of adjustment is 3% indicating that the primary balance adjusts 3 times a year to maintain its equilibrium status.

Table 11. *Diagnostic Tests for Non-linear Estimation.*

	Diagnostic Tests		
	Cubic1	**Cubic2**	**Cubic3**
Serial correlation	0.4365	0.1165	0.1245
Heteroskedasticity	0.5833	0.7976	0.5869
ARCH effect	0.7728	0.2575	0.1176
Normality	0.0506	2.8656	1.7197
Ramsey RESET	0.4143	0.7696	0.1241
CUSUM and CUSUM OF SQUARES	Within the significance bounds	Within the significance bounds	Within the significance bounds

Source: Author using E-views

Diagnostic tests reflect the accuracy of the three cubic regression models. Results of diagnostic tests are shown in table 11 representing the values of each test according to the significance level. There is no serial correlation in all nonlinear regression models as the p-values from the Breusch-Godfrey serial correlation LM test are significant. The models are all homoscedastic since the results of the Breusch-Pagan test are higher than 0.05. The results for the ARCH effects test indicate that the errors are not autoregressive conditional heteroskedastic for both models since the p-values are significant at the 5 percent level of significance. The results show that the error term is normally distributed at the usual 5 percent threshold level for the three models. The study provides more evidence for normality using Jarque-Bera graphs in the appendix. The study also finds that there is no omitted variable bias at 5 percent since the p-values for all the variables are higher than the conventional threshold. There is an evidence for parameter stability since the test statistic values for the recursive CUSUM and CUSUM OF SQUARED tests do not exceed the 5 percent critical levels. The recursive CUSUM and CUSUM OF SQUARED plots show that the parameters for the various models are stable since the CUSUM plots do not move out of the critical lines at the 5 percent level of significance.

5. Conclusion & Policy Recommendations

The design of government policy is considered as a pro-cyclical framework. In other words, Egypt's government fiscal policy shows distinguished pattern of response when examining the structural long-term adjustment of the primary balance as a percentage of GDP to the debt accumulation during the examined period from 1981 to 2021. The automatic response of primary balance of government actions including the increased level of the stock of debt to GDP ratio reflects a satisfying level of public debt sustainability. In this context, Automatic response can be captured by the cyclical component of public primary balance. Even though, the more important is to examine the long-lasting response of the primary balance to debt growth through removing the cyclical component of such response. Primary balance is decomposed into a long-run trend component (the structural primary balance) to test for the long-term aspect of debt sustainability. Testing for a systematic relation between debt to GDP ratio and structural primary balance to GDP yields different conclusions in terms of debt sustainability. Findings reveals that the government is unable to adjust its structural primary balance positively for every 1% increase in the stock of previous debt to GDP ratio during the examined time period. The case is more even worse when dealing with a regular climbing public debt.

Another critical conclusion is represented in the fact that the structural primary balance is negatively linked to the output gap. Therefore, the structural fiscal policy is considered as pro-cyclical during the study period. Government adjusts its structural primary balance when the level of output is below the potential level, more specifically, during economic recessions. The government ability to adjust its structural primary balance is low when the non-interest expenditures is above the trend level. government finances its activities through debt harming the long-term structural pattern of the fiscal position. In addition to the cointegration force between the output gap and the expenditure gap, sustainability of fiscal policy tends to hesitate in high levels of debt to GDP ratio.

therefore, non-linear estimation is built to test the fiscal fatigue hypothesis in line with. The non-linear relationship provides some critical insights in terms of debt sustainability, fiscal stance and fiscal fatigue. It is useful in allowing for capturing the rate of response of the primary balance to GDP ratio to highly increased debt to GDP ratio.

The automatic response of the government fiscal policy is considered as the first step to meet the sustainability condition. For the government to keep an expansionary strong and stable fiscal position, the structural response should also remain positive. In contrast, for the examined time interval, the government of Egypt is unable to maintain a long-term positive response for the previous debt to GDP accumulation. The structural trends in the estimated extended model emphasize that fiscal policy of Egypt tends to be restrictive. managing public debt sustainability in the long-term requires the existence of an expansionary or even neutral fiscal policy. Unless the government is able to effectively adjust to any sudden or structural rise in the stock of previous debt, fiscal sustainability will experience huge critical limitations. The long-term structural response is more important and meaningful than the non-structural cyclical response. The post-crises implications are then a serious challenge for the government fiscal policy.

Further studies are expected to shed light on the exact explicit threshold above which debt sustainability shows uncertainties. In the same context, examining the influence of the rate of growth the debt witnesses over the primary response will be considered as a great addition to the literature of debt sustainability. In addition, focus should be given to the mechanism through which the government adjust its primary balance as well as the feasibility of such mechanism. In times of crises, such as the current time, cycle-adjusted pattern of response is one of the major required policies with great critical importance.

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