Public Debt Sustainability Assessment: A Stochastic Approach for Tunisia

Ben Hassine Khalladi, Hela

Faculté des Sciences Economiques et de Gestion de Tunis- Université Tunis El Manar

22 April 2019

Public Debt Sustainability Assessment: A Stochastic Approach for Tunisia

Hela Ben Hassine Khalladi

Assistant Professor of Economics
Faculty of Economics and Management of Tunis
Department of Economics
Research Unit « Monetary and Financial Economics »
University of El Manar
Campus Universitaire Farhat Hached d'El Manar- B.P. 248 - El Manar II - 2092 Tunis
Email : Hela.Benhassine@fsegt.utm.tn
Phone number: (216) 22537012
Fax: (216) 71 872 104

Abstract

To assess to which extent public debt in Tunisia is sustainable in the medium term, we apply a stochastic debt sustainability analysis (SDSA), developped by Celasun, Debrun and Ostry in 2006. In contrast with the conventional debt sustainability analysis (DSA), this methodology explicitly takes into account the uncertainty characterizing the emerging markets, i.e the risks stemming from the interaction of the endogenous fiscal and macroeconomic shocks (related to growth rates, interest rates and exchange rates).

Fan Charts are then derived from the projected debt paths, under a baseline and alternative policy scenarios.

Our baseline projections suggest that Tunisian public debt will be unsustainable, in average, over the whole period (2018- 2022). When comparing the baseline projections with alternative policy scenarios, we can ascertain the high importance of a timely and continuous fiscal policy response to debt accumulation; otherwise, Tunisian public debt will get out of control.

JEL : F32, F34, F35, G01

'Declarations of interest: none'

1- Introduction

The Sovereign Debt crisis that recently hit European countries has led to a great resurgence of interest in debt sustainability issues, either external or public. The highly rapid accumulation of public debt, especially in the context of financial instability and low growth has increased the need for a deeper assessment of governement debt viability.
One has to notice that debt issues are even more complex and uncertain for emerging countries. According to Wyplosz (2005), it would be impossible to assess correctly debt sustainability; each trial would lead to a wrong evaluation since the notion of sustainability implies uncertain forecasts and projections.
However, it would be possible to assess the positive impact of economic policies on sustainability: one should take into account the specfic features of emerging countries, in order to use a different methodology that the one used for developed countries.
Paret (2016) has indeed highlightened three main features one should take into account: (i) First, the exchange risk (« Original Sin »), highly determined by the fraction of public debt denominated in foreign currencies. This risk increases with inflows sudden stops and mimetism; (ii) Second, the low level of credibility of economic policies because of the lack of commitment from governements and monetary authorities; (iii) Finally, these economies are extremely volatile, regarding growth, interest and inflation rates for instance. The last feature turns to be exagerated by the first two points, since local depreciations can lead to larger crises and poor economic policies.

Hence, the projections of debt paths cannot be based on a unique reference scenario and a unique given path of the macroeconomic variables (growth, inflation, interest…). On the contrary, it would be more interesting to test a large range of scenarios when assessing debt sustainability, as well as the probability associated with their occurrence.

Debt sustainability analysis can be conducted using many methodologies. The « debt stabilizing primary balance », i.e the gap between the fiscal deficit achieved and the level required in order to stabilize the debt ratio, is a largely used concept (IMF, 2003).
Another measure consists of computing a ratio of the current level of the debt and a benchmark level, determined by the discounted value of future primary balances obtained under prudent scenarios. If the ratio exceeds one, the country would be over indebted.

As for emerging countries, a high public debt often hits political performance immediately and leads to debt crises, defaults, restructuring episodes (Argentina, Ecuador, Pakistan, Russia, Ukraine and Uruguay) and harmful fiscal difficulties.

However, debt crises did not only hit emerging markets. In 2010, developing countries started to face such problems with the occurrence of the Sovereign Debt Crisis in Europe. These recent developments have revived the debate around public debt issues, to its VIIIth century level when debt problems were highly frequent in France and Great Britain.

Tunisia, the first country to be affected by The Arab Spring, faces now a dramatic increase in public indebtness. A threatening social environment, combined with security problems and political instability have led to low growth rates, persistent unemployment, and struggling sectors (phosphate, tourism and industry).
In addition, the current deficit has reached unprecedented levels, and public spending grew dramatically, mainly in order to satisfy the population following the revolution (massive recruitments in the public administration, wages increases, infrastructure projects, reforms, elections organization…). Financing these spendings forced the government to borrow from abroad repeatedly. Public debt ratio jumped consequently from 40% to 70% between 2010 and 2017.

The remainder of this paper is structured as follows: Section 2 presents a literature review about debt sustainability. Section 3 introduces the Stochastic Debt Sustainability Assessment (SDSA) framework. Section 4 shows the empirical specification and the results for the estimation of the Fiscal Reaction Function. Section 5 discusses the structure and the selection of the VAR model for the non-fiscal macroeconomic determinants of public debt dynamics. Using fan charts, section 6 illustrates the core results of our paper: the projected public debt paths for Tunisia until 2022 under different scenarios. Finally, the basic findings and their implications for policymaking are summarized in section 7.

2- Debt Sustainability : Literature Review

Depending on the chosen time horizon, the literature distinguishes between three different forward-looking approaches to measuring debt sustainability:
1- Short term: refinancing profiles are examined, in order to assess liquidity and rollover risks;
2- Medium term: Debt paths are projected under different scenarios over a period of 5 to 15 years;
3- Long term: sustainability gaps are assessed for several decades, taking into account the effects of demographic changes and aging population on the fiscal balance.

As for the mid-term DSA, two approaches can be used. First, the conventional (or deterministic) approach, based on the standard equation of debt accumulation (see equation 1 below) in which key variables, i.e growth, interest and exchange rates

as well as primary balance, are not interdependent. The IMF, when conducting its DSA as part of the Article IV Consultations Report, mainly uses this approach. Another conventional approach is the so-called « *Debt stabilizing Primary Balance* ».

However, these conventional methodologies can undermine the debt risks (IMF, 2008).

Second, a new DSA approach has been recently identified: The *Stochastic Debt Sustainability Assessment* (SDSA). Here, the risks related to the middle term debt dynamics are explicitely taken into account through the interaction of the macroeconomic and fiscal shocks and their endogeneity. « Fan Charts » are finally used in order to clearly capture future debt trajectories (confidence intervals according to the degree of uncertainty). Hence, it becomes possible to quantify the probability that the debt is higher than a target value (determined by the IMF, Maastricht Agreements for European countries…etc.).

The standardized approach of Debt Sustainability followed by the IMF includes four steps:

1- One central baseline scenario over 5 years of the priamary balance (pb), the GDP growth rate (g), the real interest rates (r) and the exchange rates (z);
2- Calculation of the debt (d) evolution over the next 5 years on the basis of the following equation : $d_t - d_{t-1} = (r-g)\, d_{t-1} - pb_t$;
3- *Stress Tests*: each variable (r, g, z and pb) bears a shock of a ½ standard deviation variation over the whole horizon. Then all the variables bear simultaneously a shock of a ¼ standard deviation each over the whole horizon. Finally, a 30% depreciation of the local currency is tested once, at the begining of the horizon ;
4- Conclusion (or judgment) about the debt levels resulting from these stress tests; the debt is considered hence unsustainable if it reaches a very high level and exceeds a given threshold.

It should be noted that this threshold is not the same for all the countries, because the probability to face a debt crisis depends on several factors such as the initial level of debt, the current macroeconomic situation and the quality of economic and political institutions. The *Country Policy and Institutional Assessment* (CPIA) recently developped by the World Bank for low-income countries aims to determine an index to measuring the governance quality.

The main problem related to this standardized approach is the following: individual shocks borne by the variables in the stress tests are not correlated, while the simulnaeous shock borne by the three variables assumes a 100% total correlation. Hence, it would be interesting to use econometric techniques (such as VAR models) in order to estimate the way these variables were correlated in the past and respond to each of the shocks borne by the other variables.

Another fundamental limit of the IMF methodology is the absence of the governement reaction to shocks. However, it is well known that the primary balance reacts positively to an increase of the public debt for example.

In a series of papers aiming to improve the IMF standardized framework, Geithner called for more uniformity and discipline (IMF, 2002) suggesting a stochastic simulation approach instead of shocking variables individually with respect to a baseline scenario.

According to Geithner (IM, 2003), it is important to calculate the probability density function of the possible results of the debt ratio using a stochastic simulation.

Celasun, Debrun and Ostry (2006) have been the first authors to use stochastic simulations in order to assess debt sustainability of five emerging countries (Argentina, Brazil, Mexico, South Africa and Turkey).

Eller and Urvova have also used the same methodology in 2012. They showed that debt trajectories for four European emerging countries (Czech Republic, Hungary, Poland and Slovakia) were sustainable over the period 2012-2016.

Garcia and Rigobon (2005) have used stochastic simulations in order to study the case of Brazil. They showed that the debt remains sustainable in the absence of risks but some trajectories were clearly unsustainable. They also showed that debt dynamics properties were closely related to foreign denominated sovereign debt spreads.

In 2016, Paret has applied the same Monte-Carlo simulations with a country-specific fiscal reaction function (*instrumented quantile regression fiscal reaction function*) and a VAR model to simulate the behavior of macroeconomic variables, in order to assess debt sustainability of Argentina, Brazil, Turkey, Russia and Philippines.

The case of Romania has been studied by Niculae and Altar in 2013. Median projections of public debt showed a slightly upward trajectory but sustainable levels for 2013-2017. Hajdenberg and Romeu (2010) have enlarged the DSA by explicitly taking into account parameters forecast errors in the debt projection algorithm. This extension highlights uncertainty around the public debt projection stemming from the parameters forecast inacuracy of econometric models used for the projections. This new algorithm has been used to conduct a DSA for Uruguay.

As for Tunisia, despite high fiscal deficits accumulated since the revolution of 2011, the IMF, in his Second Review under the Extended Fund Facility (Country Report 18/120), confirmed that the "Tunisia's public debt remains sustainable but is increasing at a fast pace. Central government debt is expected to peak at 72 percent of GDP in 2018 (from an average of 45 percent 2010–14) before declining in the later years of the program following strong fiscal consolidation (the "baseline" scenario). The debt level breaches the emerging markets debt burden benchmark of 70 percent of GDP under the baseline, but Tunisia continues to benefit from long maturities and a stable creditor base with a high share of debt owed to IFIs and bilateral donors. Stress scenarios confirm the sustainability of debt, but also identifies significant risks from contingent liabilities and exchange rate depreciation, especially if combined with permanently lower growth."
Stress scenarios confirmed debt dynamics sustainability, despite the presence of increasing risks and the possibility that conditions could deteriorate significantly relative to baseline.

3- Debt Sustainability : Definition and Methodological Framework

First, one should clearly define the notion of debt sustainability and describe the blocks of the Stochastic DSA framework.
Consider the following law of motion for the evolution of public debt over time:

$$D_t = (1+ i_t)\, D_{t-1} - PB_t + S_t \qquad (1)$$

Where D_t represents the stock of pubic debt at the end of year t, i_t the nominal interest rate, PB_t the primary balance (government revenues minus public spending excluding interest payments), S_t represents the stock-flows adjustements (like contingent liabilities or extraordinary revenues stemming from privatizations). Assuming that S_t =0 and dividing equation (1) by nominal GDP we get:

$$\frac{Dt}{Pt\,Yt} = \frac{1+ it}{(1+\pi t)+(1+gt)}\,\frac{Dt-1}{Pt-1\,Yt-1} - \frac{PB}{Pt\,Yt} = d_t = \frac{1+ rt}{1+ gt}\, d_{t-1} - p_t \qquad (2)$$

Where d_t represents the debt-to-GDP ratio, p_t the primary balance-to-GDP ratio, r_t the real interest rate, π_t the inflation rate and g_t the real GDP growth rate. Under the assumption that r_t, g_t and pb_t remain constant over time, the debt ratio d remains stable as:

$\Theta = \frac{(1+rt)}{(1+gt)} <= 1$. If $\Theta>1$, i.e if r>g (positive Interest-rate- Growth-Differential or IRGD), a sufficiently positive primary balance is required in order to keep debt-to-GDP ratio stable.

However, the assumption of variables steadiness over the whole horizon is not very realistic. The main advantage of our approach is that it uses stochastic variations of these variables over the projection horizon.

Strict debt sustainability requires that the deb will be paid back at the end, i.e $\lim_{t\to\infty} E(dt) = 0$ (no-ponzi game condition) and that, in a stochastic world, the distribution of all possible realizations of d_t do not exceed any finite limit, i.e the forecasted variance of d_t is symptotically finite : $\lim_{t\to\infty} E(\sigma^2_{dt}) < \infty$.

Unfortunately, all these definitions turn to be usefulness in terms of empirical applications, since it is impossible to make forecasts over an infinite horizon. Ferrucci and Penalver (2003) have proposed a less strict definition: the debt remains sustainable as long as there is a reasonably high probability that d_t is not higher at the end of the forecast horizon than at the begining.

3-1 Three Blocks of the SDSA framework:

The SDSA framework consists in three blocks: a Fiscal Reaction Function (FRF), a VAR Model and the traditional debt accounting identity (equation 3 below).

Annual data are used for the first and the last blocks since accurate and reliable fiscal and institutional variables are available on an annual basis. VAR Model uses quarterly macroeconomic data, to be annualized before entry in the debt accounting identity (equation 3). In this section, we will briefly discuss these three blocks.

3-1-1 : Debt-Deficit Stock-Flow Identity :

Unlike developped countries, emerging ones, like Tunisia, issue to a certain extent a fraction of their debt in foreign currency (2/3 of total public debt for Tunisia). In order to take into account this feature, we have to rewrite equation (2):

$$d_t = (1+ g_t)^{-1} [(1+ r^f_t)(1+\Delta z)\, d^f_{t-1} + (1+ r_t)\, d^d_{t-1}] - p_t \qquad (3)$$

Where r^f is the foreign interest rate, r_t the domestic interest rate, Δz the Real Effective Exchange Rate depreciation, d^f the fraction of debt denominated in foreign currency and d^d the fraction of debt denominated in local currency.

In order to get a projection of d_t for the future period 2017-2021, we have to determine projections for variables of equation (3) using SDSA framework: primary balance projections (p_t) are produced thanks to a Fiscal Reaction Function (FRF) while macroeconomic variables projections (g_t, r^f_t, r_t and Δz) are obtained from a VAR Model.

3-1-2 The Fiscal Reaction Function (FRF):

The Fiscal Reaction Function makes the fiscal policy endogenous; so that political authorities react to the economic cycle, the lagged stock of debt, as well as others control variables (like inflation and institutional variables). Furthermore, fiscal policy persistence is taken into account using the lagged primary balance. Fiscal policy becomes hence a source of uncertainty if debt level deviates from the behavior predicted by the FRF.

The FRF is estimated as follows:

$$p_{i,t} = \alpha_0 + \delta\, p_{i,t-1} + \sigma\, d_{i,t-1} + \gamma\, ygap_{i,t} + X_{i,t}\,\beta + \eta_i + \varepsilon_{i,t} \qquad (4)$$
$$t = 1,\ldots,T \qquad i = 1,\ldots\ldots,N$$

Where $p_{i,t}$ represents the primary balance-to-GDP ratio of the country i for the period t, $d_{i,t-1}$ the public debt-to-GDP ratio at the end of the previous period, $ygap_{i,t}$ the output gap, η_i a unobserved country fixed effect, $X_{i,t}$ a vector of control variables and $\varepsilon_{i,t} \sim iid\ (0, \sigma^2\varepsilon)$.

The estimated Fiscal Reaction Function will be used in order to generate primary balance forecasts for the 2018-2022 period. These projections will be produced as follows :

$$p_{i,t+\tau} = \alpha_0 + \delta\, p_{i,t+\tau-1} + \sigma\, d_{i,t+\tau-1} + \gamma\, ygap_{i,t+\tau} + X_{i,t+\tau}\,\beta + \varphi_{i,t+\tau} \qquad (4.1)$$

Where $\varphi_{i,t}$ a random draw stemming from a set of 1000 shocks

$$\varphi_{i,t} \sim N\ (0, \sigma^2_{(\eta i + \varepsilon i,t)})$$

A set of 1000 forecasts of the primary balance is generated from equation (4.1) based on these stochastic shocks.

3-1-3 The VAR Model for non-fiscal determinants of public debt dynamics:

A VAR Model for the macroeconomic determinants of debt dynamics is estimated for Tunisia (using quarterly data):

$$Y_t = \gamma_0 + \sum_{k=1}^{p} \gamma_k\, Y_{t-k} + \xi_t \qquad (5)$$

Where $Y_t = (r^f_t, r_t, g_t, \Delta z_t)$, γ_k is a vector of coefficients and $\xi_t \sim N(0, \Omega)$ is a vector of error terms with a variance-covariance matrix Ω.

Based on the variance-covariance matrix Ω of the VAR Model, a sequence of 1000 random vector is generated, exactly like the Fiscal Reaction Function simulations. Hence, the sequence of random vectors corresonds to $\xi_{t+\tau} = W\upsilon_{t+\tau}$, $\forall \tau \in [t + 1, T]$, $\upsilon_{t+\tau} \sim N(0,1)$ and $\Omega = W'W$ ($\upsilon_{t+\tau}$ is a random draw stemming from a normal standard distribution and W a Choleski factorization of Ω).
Consequently, the VAR Model, by allowing a dynamic joint answer of all the variables, generates a set of 1000 forecasts of macroeconomic variables. The projections of macroeconomic variables including stochastic shocks are then annualized and introduced, with the forecasts of the primary balance including fiscal stochastic shocks, in the stock-flow identity (3) in order to generate debt projections for 2018-2022.

4- The Fiscal Reaction Function

Many studies have recently assessed fiscal reaction functions (Mélitz, 1997; Galí and Perotti, 2003; IMF, 2003, 2004; Wyplosz, 2005; Celasun, Debrun and Ostry, 2006). The main goal is to estimate a FRF in order to get a primary balance-to-GDP forecast. We have hence estimated a FRF for a panel of 26 emerging countries for 10 years (2000-2017). We used a very large sample of similar countries (Staehr, 2008 ; Abaid and Ostry, 2005 ; Celasun, Debrun and Ostry, 2006 ; Ostry et al., 2010) because of the lack of long time-series related to fiscal data for emerging countries. Countries are the following: Algeria, Argentina, Brazil, Chile, China, Colombia, Egypt, Ecuador, Hungary, India, Indonesia, Malaysia, Morocco, Mexico, Peru, Philippines, Poland, Romania, Russia, South Africa, Thaïland, Tunisia, Turkey, Ukraine, Uruguay and Venezuela.

4-1 Empirical specifiation of the Fiscal Reaction Function:

The fiscal reaction function shows the response of the primary balance (in terms of GDP) to a set of macroeconomic and institutional variables, especially lagged public debt-to-GDP ratio and the business cycle (through the output gap). Hence, a positive answer of the primary balance to lagged debt is predicted.
Besides, if the primary balance is positively correlated with the output gap, favorable economic events woud improve the country's fiscal position (through an increase of fiscal revenues for example), showing hence a countercyclical fiscal response.
A negative coefficient for the output gap would rather show a procyclical response, while a non-significant coefficient an acyclical fiscal response.

Some authors include also the lagged output gap to take into account the persitence of the booms and recessions impact.
To better understand the changes of the primary balance ratio, we have also included different explanatory variables, able to generate a reaction from political authorities and usually used in the literature dealing with fiscal reaction function (Ghosh & al, 2013; Pommier, 2015…): the lagged primary balance in order to take into account the persistence of fiscal policies ; a dummy variable taking the value of 1 if the country is under an IMF lending arrangement; as welle as an institutional index.
We also try to capture the dependency of the emerging economies' fiscal accounts on commodity prices by including two measures of commodity price gap (Energy and Metal) measured by the gap respect to the long-run values.

As for output gap, we have followed the definition used by Eller and Urvova in 2012, according to which the output gap is measured using HP filter (with a smooting parameter of 6.25 as recommanded for annual data by Ravn and Uhlig in 2012). The variable turns out to be significant for our sample.
The lagged primary balance has been included in order to take into account residuals autocorrelation, in other words to get a dynamic version of the model. As noticed by the literature (Nickel, 1981), the estimation of the lagged dependent variable is in general biaised for limited periods. Besides, output gap and lagged debt turn to be endogenous (IMF, 2003). That is why we have chosen to use GMM technique, designed for dynamic panels (System GMM estimator of Blundell and Bond, 1998).

4-2 Estimation results:

Our panel includes 26 emerging countries and 18 years (2000-2017). The definition of used variables and the databases are detailed in Table A1 of the Appendix 1.
GMM estimation results are summarized in Table 1. Primary balance shows a very high degree of persistance: if primary balance-to-GDP improves by 1% in year t, it improves by 0.63% in year t+1.
As expected, the positive coefficient of debt ratio shows that primary balance improves when lagged debt ratio increases. If debt increases by 10% of GDP, primary balance reacts one year later and improves by 0.44% of GDP (if debt jumps from 50% to 60%, primary deficit decreases from 4% to 3.56% one year later for example).
The output gap shows a positive sign in terms of the primary balance of the same year. This shows that primary balance has a countercyclical effect for our sample. Metal Index gap turned out to be also significant.

Table 1 Estimation of the fiscal reaction function using Arellano-Bond dynamic panel data

	GMM System
Lagged Primary Balance	0.629***
	[0.089]
Lagged debt	0.044***
	[0.011]
Output Gap	0.083*
	[0.039]
Metal Index Gap	0.026***
	[0.003]
Constant	-4.673
	[2.032]

Source: Authors' calculations.
Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Robust standard errors are given in brackets

5- Non- fiscal determinants of public debt dynamics : VAR Model :

The aim of VAR Model in our SDSA framework (equation 3) is to provide a projection of macroeconomic determinants of public debt, such that they are simultaneously correlated. The SDSA framework takes also into account the uncertainty stemming from this projection and the resulting trajectory of debt.
This goal is achieved by generating not a unique but several possible sets of growth, interest and exchange rates projections (1000 in our case).
These projections include random shocks of joint distribution of variables. Variance-covariance matrix of these shocks has been estimated from the historical data with the VAR Model.

We have estimated a VAR Model with quarterly macroeconomic data (2000Q1-2017Q4) for Tunisia. Unlike Celasun, Debrun and Ostry (2006), we have chosen a two lag model for our analysis (after testing for lag order). Past studies have indeed proven that low lags models are more precise in average when used for prevision (Hafer and Sheehan, 1989).
We tested the series stationarity for our model (Augmented Dickey-Fuller test). We could not reject null hypothesis of non-stationarity for exchange rates. Conversely, growth, domestic and foreign interest rates turn out to be stationary. A single differentiation of exchange rates serie showed a stationarity of this variable. Exchange rates are then integrated of order 1 (I(1)).

The detailed estimation output of our model is given in the Table A2 of the Appendix.
Finally, we did not include reaction function results since we are not interested in impulse responses. The goal from VAR estimation is simply to get macro variables coefficients, and use them to take into account interactions between them.

6- **Trajectories of forecasted public debt and risks for debt sustainability :**

In this section, we will put together results of section 4 (endogenous fiscal policy) and section 5 (non-fiscal macroeconomic variables) in order to generate, through stochastic simulations, a very large set of debt trajectories for a forecast horizon of five years (2018-2022) for Tunisia.
The different trajectories of public debt are generated by two types of shocks: macroeconomic shocks (stemming from a joint distribution) resulting from the VAR Model; and fiscal shocks stemming from the Fiscal Reaction Function.
Fan Charts shown below summarize the statistic distribution of trajectories and depict the risks stemming from debt dynamics for Tunisia. The darkest shaded area reflects debt trajectories located in the 5th and 6th deciles of the distribution, thus representing a 20% confidence interval around the median projection. The overall colored cone reflects hence the 2nd to 9th deciles of the distribution and represents a confidence interval of 80% around the median projection.

We follow Eller and Urvova (2012) approach. We have applied our SDSA framework under five scenarios (cf. Figure 1). The first scenario is based on a primary balance estimated using our estimated Fiscal Reaction Function.
In the second scenario, we have replaced the coefficient of output gap (0.083) by zero: the aim is to examin the situation where primary balance does not react to business cycle (acyclical behaviour). In a third scenario, we have set the coefficient of the lagged debt to zero, a situation where the governement does not immediately and continuously react to an increase of the debt. Conversely, in the fourth scenario we have doubled this coefficient compared to the baseline scenario (0.088 instead of 0.044). Finally, for the fifth scenario we have replaced in equation (3) the primary balance estimated using the FRF by the values targeted by the Tunisian governement (-2.623% for 2018, -1.154% for 2019, 0.208% for 2020, 0.589% for 2021 and 0.553% in 2022). The primary balance remains however subject to stochastic shocks stemming from macro shocks. This last scenario provides information about how effectively the defined targets contribute to the stabilization of debt levels until 2022. Results are summarized in the graphs below as well as the tables A3 of the Appendix.

First, we will focus on the first scenario, i.e the baseline scenario. The median projections show a slightly increasing median debt path during the projected period for Tunisia, reaching 75.17% in 2022. Despite the low rhythm of the debt progression (+1.07%), these projections can indicate that public debt gets out of control until the end of the forecasting horizon, and can thus be qualified to be unsustainable over the period 2018- 2022. This upward path can be explained by fiscal or/and macro shocks. In other words, the fiscal reaction function is not responsive enough to prevent increasing debt paths, and/ or the macro variables

(namely the IRGD and the depreciation of the Tunisian currency) will have adverse effects on the public debt evolution. If we focus on the primary balance simulations, we will notice indeed that primary balance levels range between -1.13% and -6.77% of GDP over the whole projection period. The fact that the Tunisian government cannot make primary surpluses proves that further fiscal consolidation is needed. This has been confirmed by the IMF staff review mission in April 2019: "Sizeable imbalances continue to hamper Tunisia's growth and job potential. Growth remains too dependent on consumption, while investment and exports remain insufficiently dynamic. And Tunisia's large and growing external and public debts give rise to large financing needs and represent a strong burden for future generations."

The same conclusion can be derived from the second scenario, where we assumed that primary balance was acyclical and inelastic to business cycle. The observed debt levels (2nd scenario) show an upward debt trajectory reaching 75.16% in 2022. This is not surprising since the coefficient of output gap in our FRF estimation was initially very low (0.083).

The third scenario clearly shows that the absence of an immediate and strong reaction from the governement to the lagged debt can significantly change the debt trajectories. In case of an absence of reaction (third scenario), the median debt ratio follows an explosive upward trajectory, reaching nearly 90% in 2022. In this case, one can confirm that the debt becomes out of control, sustainability is here questioned. Admittedly, the first and the second scenarios also show an increasing trend but the average debt ratio growth is very low compared to the third scenario (+1.07% versus +4.76%). Hence, it turns out that the rythm of debt progression is more significant than the debt trajectory in terms of debt sustainability assessment.

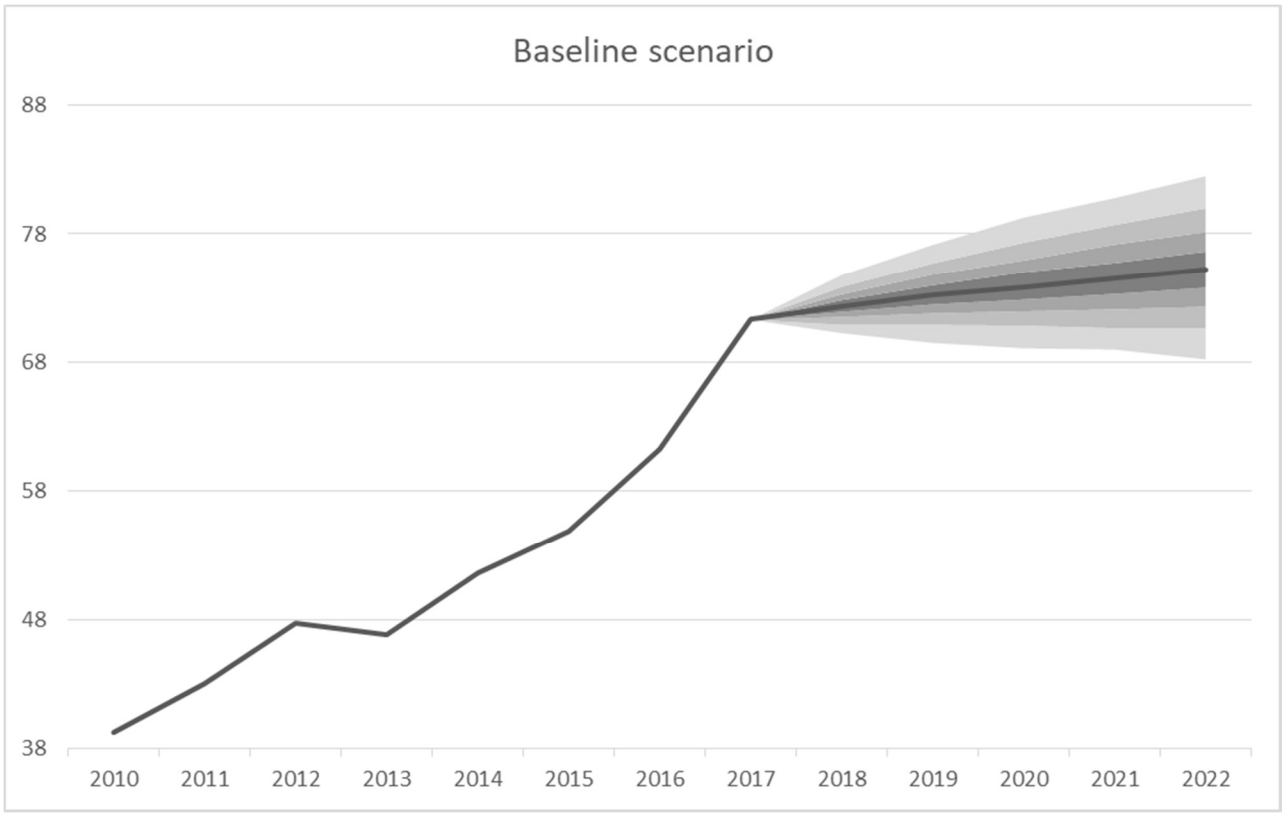
Conversely, in case of a strong adjustement of primary balance to an increase of lagged debt (scenario 4), risks will drastically decrease (as shown by the graph and the table), and debt will follow a clear downward trajectory (reaching a ratio of 62,7% at the end of the forecast period). This is the result of the fiscal consolidation and the strong response of the government to the lagged debt; primary balance can reach a peack of 2% of the GDP according to this scenario.

As for the last scenario, it seems that the achievement of targeted goals in terms of primary balance by the governement clearly reduces debt sustainability risks. The fan Chart (scenario 5) shows downward sloping debt trajectories during the whole projection period. Results are very similar to those related to the 4th scenario, where the reaction of the government to increasing debt is very high. This can be explained by the great differences between targeted primary balance values, fluctuating between -2.6% to 0.55%, and estimated ones (using the fiscal

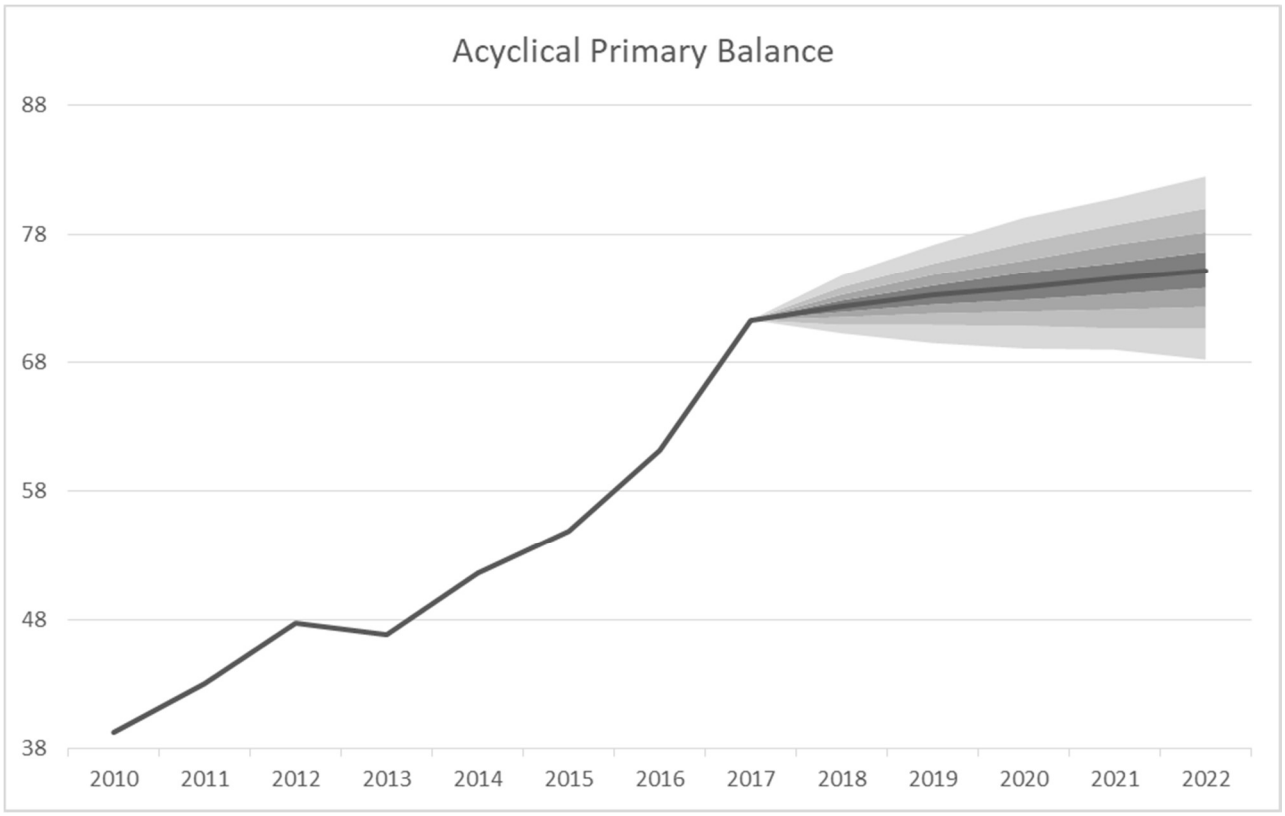
reaction function) not exceeding -3.6%. Hence, primary balance turns out to be a highly significant determinant of public debt paths, and therefore public debt sustainability.

Figure 1 *Fan Charts* for Tunisia

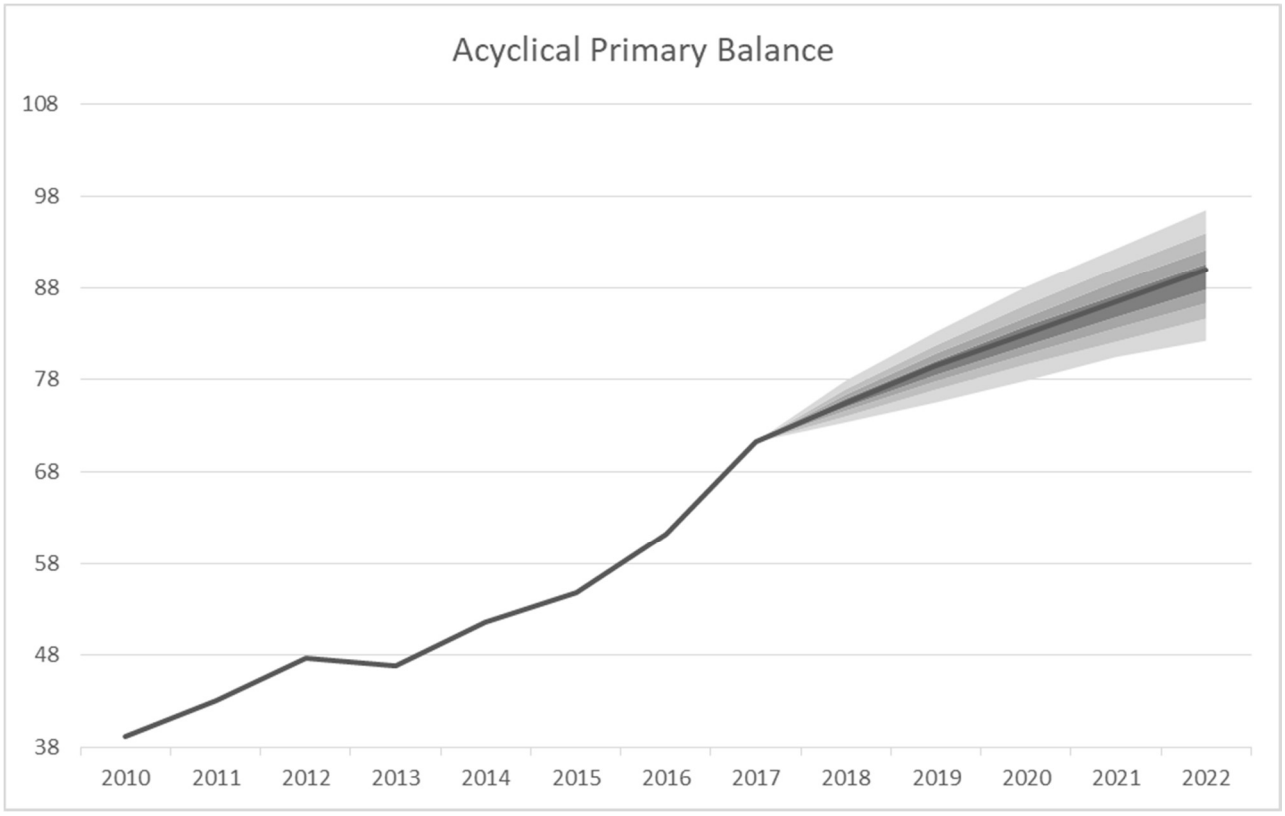
1st Scenario: Baseline scenario



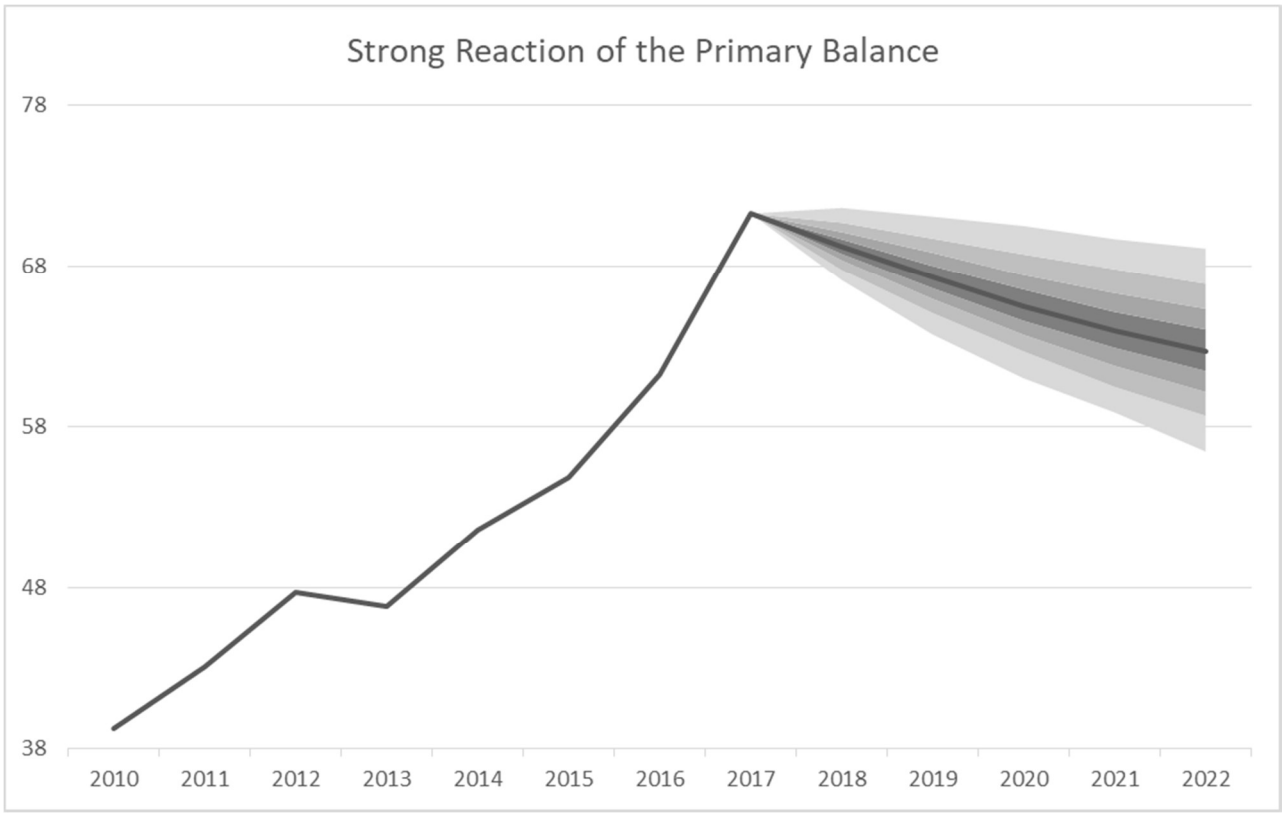
2nd scenario : No reaction to Output gap



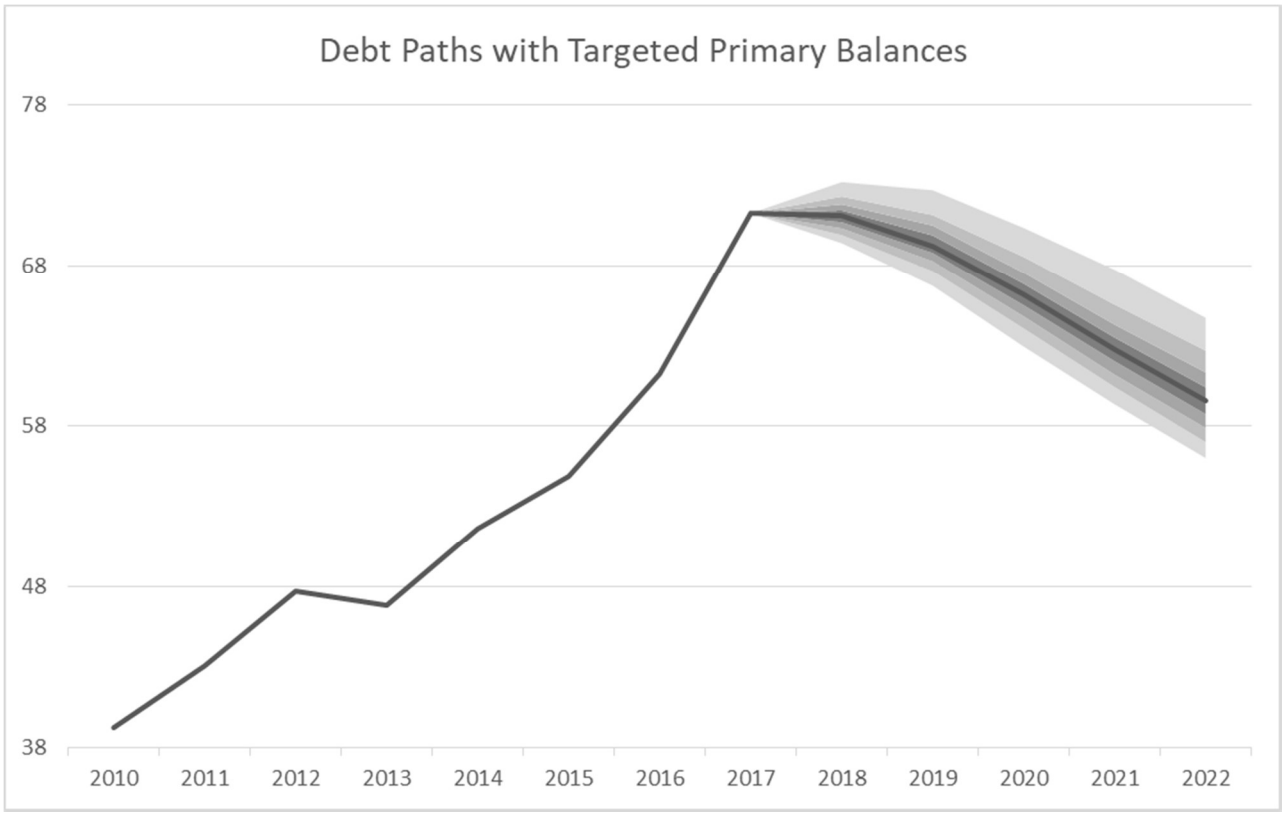
3rd scenario : No reaction to lagged debt



4th scenario : Stronger Reaction to lagged debt



5th scenario: Scenario with targeted fiscal balance



At this stage, one can ask if the Tunisian government is able to conduct public debt trajectories to downwards. According to our scenarios, this can be achieved only through a fiscal consolidation (scenarios 4 and 5). Let's focus on the actions conducted by the Tunisian governement since 2018.
The IMF Country Report 18/291 released in October 2018 (Fourth Review under the Extended Fund Facility) listed three Quantitative Performance Criteria (QPC) related to fiscal sustainability:

- Quarterly floor on the primary balance of the central government (cash basis, excluding grants);
- Quarterly ceiling on total current primary expenditure of the central government;
- Quarterly floor on social spending (starting from end-September 2018);

In 2018 and 2019, the Tunisian government took these following actions:

1- Quarterly application of the automatic fuel price adjustment mechanism. Hence, fuel prices have been increased four times in 2018 (January, March, June and September) and March 2019;
2- As for tax regime, the adoption of the 2019 Budget law (i) eliminating the preferred tax regime for off-shore companies; (ii) and increasing the Value Added Tax rate for liberal professions from 13 to 19%;
3- The adoption of the Organic Budget Law, leading to good governance, transparency, accountability and control for better management of budget allocations.

Finally, it would be interesting to compare our SDSA analysis with alternative conventional methodologies like IMF DSA, a significant element of IMF country reports.
The first Curve at the left of the Figure A1 of the Appendix (from the IMF Country Report 18/120) shows the public debt trajectory for Tunisia for the period 2018-2023 (baseline scenario and stress tests). The baseline scenario shows a peak at 73.3% of GDP in 2019 before declining following strong fiscal consolidation, reaching 68% in 2023. The baseline scenario is based on a growth recovering to 4% over the medium term, an inflation deceleration, as well as a gradual improvement of the fiscal adjustment by 4.3% throughout 2023
According to the IMF DSA, public debt remains sustainable under all the scenarios, even the combined macro- fiscal shock.

7- Conclusion :

In this paper, we have assessed public debt sustainability for Tunisia on the medium term (2018-2022). To do so, we have used a Stochastic Debt Sustainability Assessment (SDSA). This approach allows forecasting a

distribution of debt trajectories until 2022 under different scenarios of joint shocks. Median projections stemming from our analysis show risks associated with future debt trajectories.

According to median debt projections of our baseline scenario, we can conclude that public debt is unsustainable over the forecast period. Even if debt progression seems quite low, debt will continue to rise without bounds until the end of the projection period, reaching 75.17% of GDP in 2022 according to the baseline scenario.

Our results also show that a strong reaction of the governement to lagged debt leads to a drastic reduction of debt ratios. The respect of targeted primary balances will also lead to the same results. Conversely, an absence of a governement reaction tends to significantly deteriorate debt trajectories.

The comparaison of our SDSA analysis with the IMF conventional DSA shows a significant difference and divergent conclusions as the Tunisian public debt sustainability.

One has to notice that the traditional approach does not take into account interactions between macroeconomic debt determinants when conducting stress tests (on growth, interest and exchange rates), hence results were overestimated and optimistic. This limit is outreached through the stochastic approach, used in this paper. A larger and more realistic distribution of future realizations of the debt is hence provided.

References

Abiad, A. and J. D. Ostry. (2005). Primary Surpluses and Sustainable Debt Levels in Emerging Market Countries. IMF Policy Discussion Paper 05/6.

Barro, Robert J., (1979). On the Determination of Public Debt. *Journal of Political Economy*, Vol. 87 (October), pp. 940–71.

Blundell, R. and S. Bond. (1998). Initial Conditions and Moment Restrictions in Dynamic Panel Data Models. In: Journal of Econometrics 87(1). 115–143.

Celasun, O., X. Debrun and J. D. Ostry. (2006). Primary Surplus Behavior and Risks to Fiscal Sustainability in Emerging Market Countries: A 'Fan-Chart' Approach. IM F Staff Paper 53/3.

Economic Policy Committee (2001). Budgetary Challenges Posed by Ageing Populations. EPC/ECFIN/655/01-EN final (Brussels: European Commission, October).

Eller M. and Urvova J. (2012). How Sustainable are Public Debt Levels in Emerging Europe? Evidence for Selected CESEE Countries from a Stochastic Debt Sustainability Analysis. Focus on European economic integration Q4/12

Ferrucci, G. and Penalver A. (2003). A ssessing sovereign debt under uncertainty. In: Financial Stability Review. December. 91–99.

Galí, Jordi, and Roberto Perotti (2003). Fiscal Policy and Monetary Integration in Europe. *Economic Policy*, Vol. 37 (October), pp. 535–72.

Garcia & Rigobon (2004). A Risk Management Approach To Eemerging Market's Sovereign Debt Sustainabiolity With An Application To Brazilian data. NBER WP 10336

Hafer, R. W. and R. G. Sheehan. (1989). The Sensitivity of VAR Forecasts to Alternative Lag Structures. In: International Journal of Forecasting 5. 399–408.

Hajdenberg A. & Romeu R. (2010). Parameter Estimate Uncertainty in Probabilistic Debt Sustainability Analysis, IMF Staff Papers Vol. 57, No. 1

International Monetary Fund (2001). World Economic Outlook, May 2001

International Monetary Fund (2002). Assessing Sustainability, Approved by Geithner T., May 2002

International Monetary Fund (2003). World Economic Outlook, September 2003.

International Monetary Fund (2003). Sustainability Assessments—Review of Application and Methodological Refinements Approved by Timothy Geithner June 10, 2003

International Monetary Fund (2003). Public Debt in Emerging Markets: Is it too High? Chapter III in *World Economic Outlook*, September (Washington: International Monetary Fund).

International Monetary Fund (2004). Has Fiscal Behavior Changed Under the European Economic and Monetary Union? in Chapter II of *World Economic Outlook*, September (Washington: International Monetary Fund).

International Monetary Fund (2008). Staff Guidance Note on Debt Sustainability Analysis for Market Access Countries. IMF Policy Development and Review Department.

International Monetary Fund (2018). 2017 Article IV Consultation, Second Review under the Extended Fund Facility. IMF Country Report 18/120, March

International Monetary Fund (2018). Fourth Review under the Extended Fund Facility. IMF Country Report 18/291, October

Medeiros, J. (2012). Stochastic debt simulation using VAR models and a panel fiscal reaction function: results for a selected number of countries. In: Economic Papers 459. July.

Mélitz, J. (1997). Some Cross-country Evidence About Debts, Deficits and the Behaviour of Monetary and Fiscal Authorities. CEPR Discussion Paper No. 1653 (London: Centre for Economic and Policy Research).

Nickell, S. (1981). Biases in Dynamic Models with Fixed Effects. In: Econometrica 49(6). 1417–1426.

Niculae A. and Altar M. (2013). Public Debt Sustainability: A probabilistic Approach- The Case of Romania. Academy of Economic Studies, Doctoral School of Finance and Banking

Ostry, J., A. R. Ghosh, J. I. Kim and M. S. Qureshi. (2010). Fiscal Space. IMF Staff Position Note 10/11.

Paret, A. (2016), Which lever to enhance sustainability in emerging market countries? A stochastic approach to better grasp public debt dynamics. Management International Conference, Pula- Croatia 1-4 June 2016

Ravn, M. O. and H. Uhlig. (2002). O n adjusting the Hodrick-Prescott filter for the frequency of observations. In: The Review of Economics and Statistics 84(2). 371–375.

Staehr, K. (2008). Fiscal Policies and Business Cycles in an Enlarged Euro Area. In: Economic Systems 32(1). 46–69.

Turner, D., et al (1998). The Macroeconomic Implications of Ageing in a Global Context. OECD Economics Department Working Paper No. 193 (Paris: Organization for Economic Cooperation and Development).

Wyplosz Ch. (2005). Debt Sustainability Assessment: Mission Impossible. Review of Economics and Institutions, Vol.2, No.3, Fall 2011, Article 1

Wyplosz Ch. (2007). Debt Sustainability Assessment: The IMF Approach and Alternatives, HEI Working Paper No: 03/2007

Appendix

Table A1 Variables used in the estimation of the FRF

Variable	Notation	Description	Unit	Source
Primary Balance	pb	Lending/ Borrowing of General Government excluding interest payments	%GDP	World Economic Outlook & Fiscal Monitor
Public Debt	d	Gross Consolidated Debt of General Governement	%GDP	World Economic Outlook & Fiscal Monitor
Output gap	ygap	GDP deviation from its HP trend	% of potential GDP	World Economic Outlook & Fiscal Monitor
Influence of International Financial Institutions	IMF dummy	1 if the country is enrolled in an IMF Program, 0 otherwise	[0,1]	IMF, History of countries Lending Arrangements
Commodity Price Gap (Energy and Metal)	Energy Index Gap Metal Index Gap	Deviation from HP Trend of average energy prices (petrolium, natural gas and coal) and petrolium	% of commodity prices trend	Primary Commodity Prices, IMF
Institutional Index	Institindex	Average of six institutional indices : Political stability and absence of violence, Voice and accountability, Governement effectiveness, Regulatory quality, Rule of law, Control of corruption	[0,1]	World Bank

Table A2 Quarterly Variables Used in the VAR Models

Variable	Notation	Description	Unit	Source
Real foreign interest rate	Fori	US nominal long-term government bond yield adjusted for CPI inflation	%	MacroTrend
Real domestic interest rate	Domi	Domestic nominal long-term government bond yield adjusted for CPI inflation	%	Central Bank of Tunisia (BCT)
Real GDP growth	g	Quarterly GDP growth	% change	National Institute of Statistics (INS)
Real effective exchange rate	logREER	Difference of the log of the index	Log	International Financial Statitistics (IMF IFS)

Table A3 VAR Estimation of non-fiscal macroeconomic determinants

	Foreign interest	Domestic interest	Growth rate	REER
Foreign interest				
L1	0.310***	0.213***	0.091	0.031
L2	-0.435***	0.023	0.029	0.001
Domestic interest				
L1	0.012	0.192	-0.048	-0.004
L2	0.296	0.231***	0.221	-0.001
Growth rate				
L1	0.057	0.001	0.130	0.0003
L2	0.144	0.063	0.097	-0.002
REER				
L1	2.898	5.565	-4.798	0.303***
L2	6.347	-0.739	-1.641	-0.419***
Constant	-0.041	-0.484***	0.704***	-0.009***

***: significant at 5%

Table A4 Debt Trajectories according to the scenario

Scenario 1

	2018	2019	2020	2021	2022	Min	Max
10% decile	70,24	69,49	69,07	68,97	68,21	68,21	70,24
20% decile	70,89	70,89	70,82	70,63	70,61	70,61	70,89
30% decile	71,49	71,78	71,93	72,09	72,29	71,49	72,29
40% decile	71,90	72,48	72,85	73,29	73,78	71,90	73,78
50% decile	72,31	73,22	73,86	74,48	75,17	72,31	75,17
60% decile	72,81	73,97	74,99	75,72	76,61	72,81	76,61
70% decile	73,26	74,81	75,93	77,17	78,14	73,26	78,14
80% decile	73,85	75,69	77,32	78,70	80,00	73,85	80,00
90% decile	74,76	77,14	79,27	80,79	82,49	74,76	82,49

Scenario 2

	2018	2019	2020	2021	2022	Min	Max
10% decile	70,24	69,49	69,06	68,97	68,20	68,20	70,24
20% decile	70,88	70,89	70,82	70,62	70,60	70,60	70,89
30% decile	71,49	71,78	71,93	72,08	72,28	71,49	72,28
40% decile	71,89	72,47	72,85	73,29	73,77	71,89	73,77
50% decile	72,31	73,22	73,86	74,48	75,16	72,31	75,16
60% decile	72,80	73,96	74,99	75,72	76,60	72,80	76,60
70% decile	73,26	74,81	75,92	77,16	78,14	73,26	78,14
80% decile	73,84	75,69	77,31	78,69	79,99	73,84	79,99
90% decile	74,76	77,14	79,26	80,78	82,49	74,76	82,49

Scenario 3

	2018	2019	2020	2021	2022	Min	Max
10% decile	73,38	75,53	77,88	80,45	82,22	73,38	82,22
20% decile	74,02	77,02	79,74	82,27	84,73	74,02	84,73
30% decile	74,63	77,91	80,94	83,82	86,63	74,63	86,63
40% decile	75,03	78,64	81,94	85,15	88,30	75,03	88,30
50% decile	75,44	79,44	82,97	86,53	89,92	75,44	89,92
60% decile	75,94	80,18	84,24	87,79	91,63	75,94	91,63
70% decile	76,40	81,06	85,20	89,48	93,36	76,40	93,36
80% decile	76,98	81,95	86,69	91,20	95,42	76,98	95,42
90% decile	77,90	83,48	88,81	93,55	98,35	77,90	98,35

Scenario 4

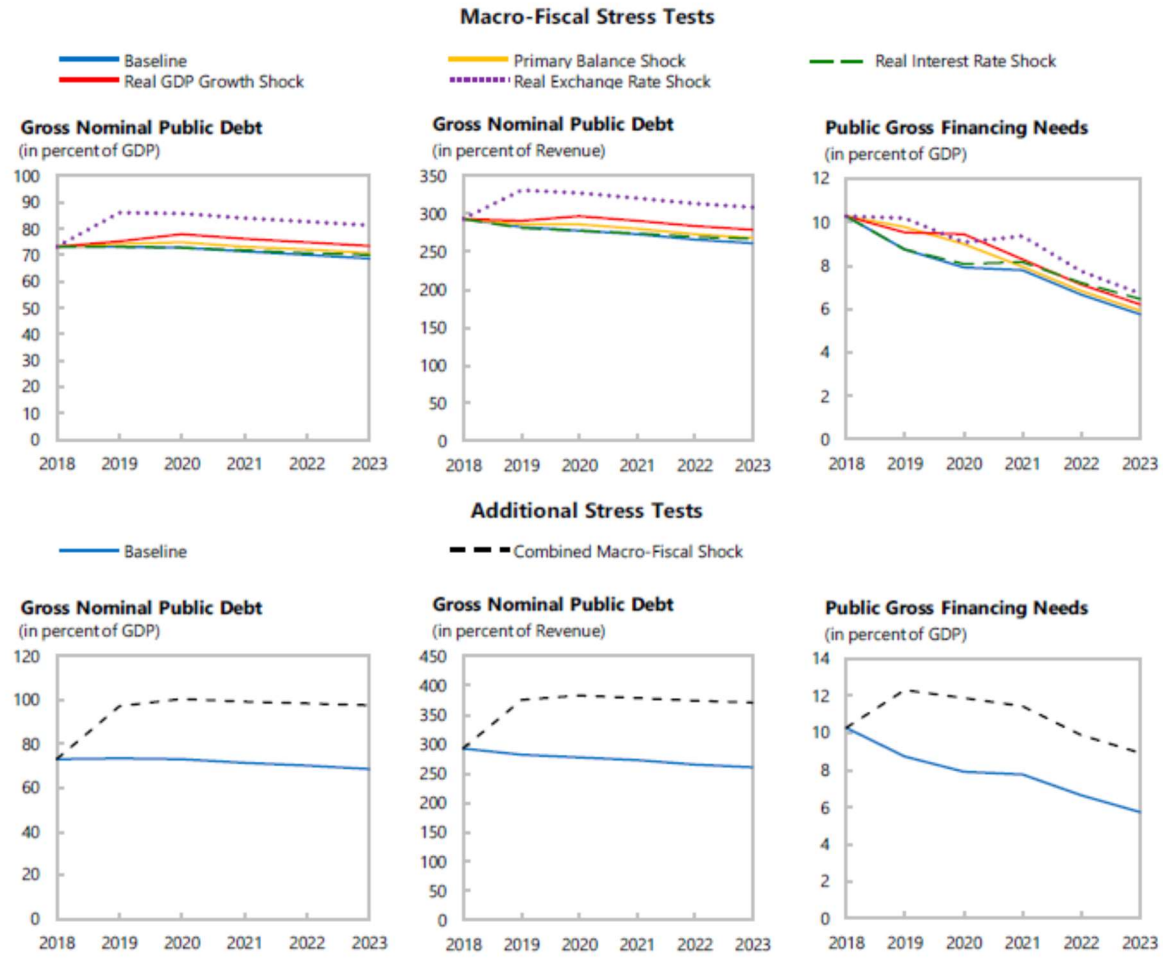
	2018	2019	2020	2021	2022	Min	Max
10% decile	67,11	63,72	61,01	58,89	56,47	56,47	67,11
20% decile	67,75	65,05	62,67	60,47	58,69	58,69	67,75
30% decile	68,36	65,93	63,70	61,78	60,16	60,16	68,36
40% decile	68,76	66,60	64,57	62,90	61,46	61,46	68,76
50% decile	69,17	67,29	65,50	63,95	62,70	62,70	69,17
60% decile	69,67	68,00	66,53	65,12	64,04	64,04	69,67
70% decile	70,12	68,83	67,43	66,30	65,32	65,32	70,12
80% decile	70,71	69,72	68,73	67,80	66,88	66,88	70,71
90% decile	71,63	71,08	70,50	69,68	69,09	69,09	71,63

Scenario 5

	2018	2019	2020	2021	2022	Min	Max
10% decile	69,41	66,73	62,94	59,35	56,01	56,01	69,41
20% decile	69,92	67,65	64,07	60,42	57,00	57,00	69,92
30% decile	70,34	68,28	64,82	61,18	57,87	57,87	70,34
40% decile	70,72	68,80	65,52	62,02	58,74	58,74	70,72
50% decile	71,16	69,24	66,17	62,76	59,58	59,58	71,16
60% decile	71,45	69,89	66,86	63,50	60,41	60,41	71,45
70% decile	71,83	70,52	67,56	64,30	61,33	61,33	71,83
80% decile	72,32	71,17	68,56	65,55	62,69	62,69	72,32
90% decile	73,22	72,71	70,36	67,75	64,73	64,73	73,22

Figure A1 IMF DSA for Tunisia (2017-2023)

(From the 2nd Review under the EFF- Country Report 18/120, March 2018)



Underlying Assumptions

(in percent)

Primary Balance Shock	2018	2019	2020	2021	2022	2023
Real GDP growth	2.4	2.9	3.4	3.6	4.0	4.2
Inflation	6.4	5.6	4.5	4.3	3.8	3.7
Primary balance	-2.6	-1.8	-0.8	0.4	0.6	0.6
Effective interest rate	4.0	3.8	4.0	3.9	4.3	4.3
Real Interest Rate Shock						
Real GDP growth	2.4	2.9	3.4	3.6	4.0	4.2
Inflation	6.4	5.6	4.5	4.3	3.8	3.7
Primary balance	-2.6	-0.8	0.2	0.4	0.6	0.6
Effective interest rate	4.0	3.8	4.2	4.4	5.0	5.2
Combined Shock						
Real GDP growth	2.4	1.1	1.6	3.6	4.0	4.2
Inflation	6.4	5.2	4.1	4.3	3.8	3.7
Primary balance	-2.6	-1.8	-1.0	0.4	0.6	0.6
Effective interest rate	4.0	4.7	4.1	4.3	5.0	5.2

Real GDP Growth Shock	2018	2019	2020	2021	2022	2023
Real GDP growth	2.4	1.1	1.6	3.6	4.0	4.2
Inflation	6.4	5.2	4.1	4.3	3.8	3.7
Primary balance	-2.6	-1.4	-1.0	0.4	0.6	0.6
Effective interest rate	4.0	3.8	4.0	3.9	4.3	4.3
Real Exchange Rate Shock						
Real GDP growth	2.4	2.9	3.4	3.6	4.0	4.2
Inflation	6.4	15.6	4.5	4.3	3.8	3.7
Primary balance	-2.6	-0.8	0.2	0.4	0.6	0.6
Effective interest rate	4.0	4.7	3.8	3.7	4.1	4.1

Source: IMF staff.