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Impact of on financial stress on real economy in time of crisis using "Fiscal Macroprudential DSGE Model"[1]: "Case of "Tunisia

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Abstract

The aim of this paper is to investigate the extent to whether banks 'balance sheets structure could be a potential source of fluctuations in output, crowding -out effect and rising credit risk. Our model focuses on the Fiscal and banking sector of Tunisia which we have introduced public debt financing channels by banks: banks in the model accumulate a significant amount of treasury bonds. The objective is to investigate whether by accumulating significant treasury bonds in an environment where fiscal deficits are persistent and limited funded by international financial market, this assets can result in crowding out effect and influence the general risk-taking behavior of banks. We stress tested the resilience of the banking system to a potential sovereign risk by simulating two hypothetical scenarios based on simulations **via a "Fiscal and Macro prudential DSGE**" model that investigates the importance of endogenous macro-financial feedback effects: **Scenario 1 Severe stress: We assume a shutdown external funding and incapacity to mobilize external resources accompanied by a slowly adjustment of external funds of capital to fluctuations in CAR. Scenario 2 Moderate stress: We assume the country does not strike a deal with bilateral support in the medium term with flexibility of adjustment external capital funds.** Our simulations highlight the role of external funding, reduction in dividends and recapitalization in mitigating the impact of a shutdown external financing on the real economy. For the two scenarios , the direction of the responses are similar but the magnitude 's impact of the shock on all sectors are less pronounced in the case when external capital flows respond immediately to fluctuation in capital adequacy. The results show that under the severe stress, we would expect more increasing of NPL's while credit losses could significantly erode profitability and more decreasing of bank's private credit which cost to the economy appears more important.

Keywords: Fiscal DSGE model, proactive monetary police, inflation, sovereign debt service.

JEL Classification Code : E37, C55, C55, F17, O11.

[1] The macroprudential DSGE model is developped in Unit Research for central bank of Tunisia, supervised by Jaromir.Benes(BCC technical assistance, OGR).

1.Introduction

Since the Global Financial Crisis (GFC 2007), there has been a notable integration of banking sector into macroeconomic models. Policymakers have come to realize the crucial role that a healthy banking system plays in the real economy. Many studies have consisted of modeling financial frictions, embedded in a dynamic stochastic general equilibrium (DSGE) framework.

The Covid pandemic 2020 and recently the war of Russia-Ukraine has led a persistent and significant macroeconomic pressure on Tunisia's economy. Both recovery of economic activity and redressing external and fiscal balances has been marked by a slow growth.

The real GDP growth has slowed significantly over this period compared with previous decade, from an average annual rate of 4.6% between 2001-2010 to 1.4% between 2011-2019 and according to the IMF, the Tunisia's economic growth is expected to reach 1,3% at the end of 2023 (WEO April 2023), mainly due to the slowdown in domestic and foreign private investment and the decline in export dynamism.

The deterioration in international financial conditions, combined with the structural weaknesses of the economy has largely contributed to the worsening of the country's internal and external macroeconomic imbalances. The trade and budget deficits have risen to historically high levels, leading to growing imbalances in the current account, public finances, and the foreign exchange markets.

Table 1: Macroeconomic indicators

Indicator	2001-2010	2011-2019	2020	2021
Average annual growth rate GDP	4.6	1.6	-8.6	4.3
Trade balance (% GDP)	10.9	15.6	16.9	11.5
Investment (% GDP)	24.1	21.1	19.4	15
Total External Debt (% GDP)	39.5	46.2	61.9	56.3
FX reserves (months of imports)	6.2	3.7	5.4	4.4
Inflation rate (%)	4.1	5	5.6	5.7
Unemployment rate (%)	13	15.1	18	17.9
Budget deficit	2.5	5.1	9.7	6.6
Public Debt	49.1	56.2	78	79.5

In 2023, fiscal and external deficits will be around 12% of GDP. The country faces major hurdles to raise external funding and mobilizing the necessary internal resources. Banks in our economy accumulate a significant amount of treasury bonds that can lead a significant bank's exposure to the state and a rise of potential risks with increasing non-performing loans.

Our paper aims to extend the Fiscal DSGE model version developed (2021-2022) in Unit research of the Central Bank of Tunisia by adding the banking sector and regulatory tools. In this model, we have introduced public debt financing mechanisms or channels by banks. **The aim is to investigate whether by accumulating significant amount of treasury bonds in an environment where fiscal deficits are persistent and are predominantly funded by domestic borrowings due to the limited access to international financial markets; this asset allocation can result in crowding-out effect , fluctuations in output, rising sovereign risk and the amount of non-performing loans. Moreover, we have introduced the regulatory policies capital requirements to evaluate the impact on financial stability.**

We have developed two hypothetical scenarios based on simulations via **a "Macroprudential DSGE" model that investigates the importance of endogenous macro-financial feedback effects:**

- **Scenario 1 Severe stress**: We assume a shutdown external funding and incapacity to mobilize external resources leads to sovereign defaults on foreign currency debt.
- **Scenario 2 Moderate stress:** We assume the country strike a deal with bilateral support, but reform implementation remains shaky, resulting lower mobilized financing than required.

The particularity of this model to assess the non-linearities in the interactions of the real economy and financial system in times of crises. This model is constructed by taking the explicit banking sector who assets and liabilities interact with real sector. In addition, the stress-testing scenarios have built on top of complex macroeconomic scenario which have the advantage of integrating different types of risks as credit risk, forex market risk, short-term rate market risk, etc.

Our results show that a **Tunisian sovereign default might cost the bank system (9%-14.5%) of forecast nominal GDP at year –end-2023**. Under the severe stress, we would expect the depreciation of Tunisian Dinar and **a steep increase in interest on government debt which lead a significant crowding out effect and Central bank would increase its interest rate that put further pressures on corporate and retail's client's repayment capacity**. Overall, **the stock of Non-Performing Loans** continues to expand, while credit losses could significantly erode profitability, adding further pressure is to bank's already strained capitalization.

The design and development of the Macroprudential DSGE model has been based upon the following topics:

-***Top down design,***

-Well behaved steady state, comparative static analysis,

-Determination of interest rates and foreign position in small open economy,

-Stationary model to balanced growth model,

The rest of the paper is organized as follows:

- Section (1) describes the stylized facts of Tunisian economy.
- Section (2) presents the structure of the model.

- Section (3) determines calibration and simulation:
    - Interactions between macroprudential and monetary policies:
    - Sensitivity analysis/macroprudential policy reaction:
- And Section (4) to conclude.

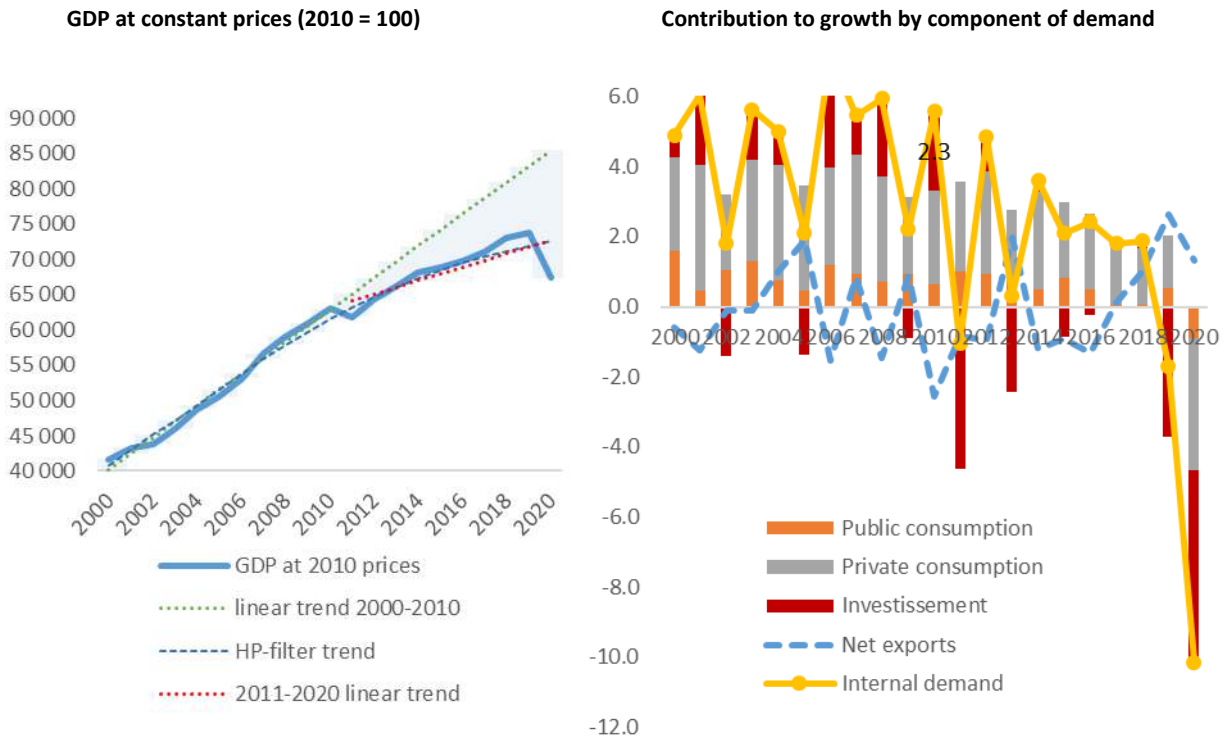
1. Stylized facts

1.1 Economic Growth

Since 2011, Tunisia has witnessed a growth decline affecting the main strategic activities (energy, phosphate and derivatives and tourism…) with significant impact of shocks (terrorist attacks, COVID-19…) widening the structural weaknesses of the economy.

Until 2017, the output has been driven basically by consumption boosted by wage increases (with a decline in other key growth drivers).
From 2018, the weaker growth of consumption is due to a restrictive fiscal policy.

Figure 1: GDP by components of demand



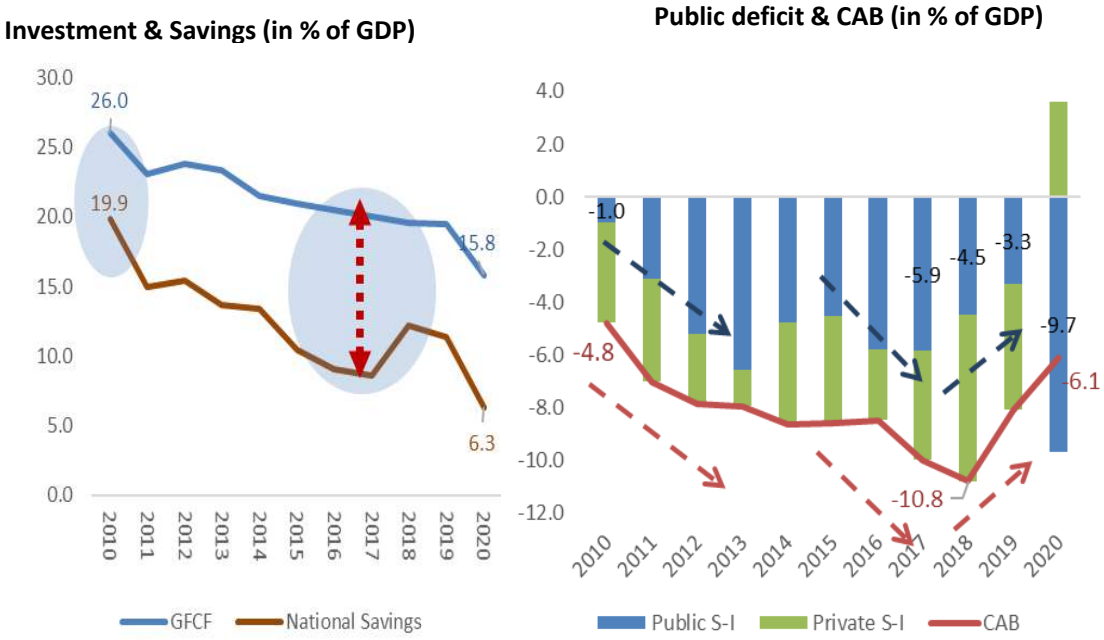
1.2 Investment & Savings

During the last decade, the investment and savings have seen a downward in their trend reflecting the wait-and-see attitude and crowding out effect. In 2020, the global pandemic COVID-19 has characterized by both supply and demand shocks on the economy.

Savings has been declining at a faster pace than investment, resulting in an increase in the GAP between these 2 macro-economic aggregates becoming above average, reaching more than 10% in 2017.

This internal imbalance is the equivalent of an external current account deficit. From the graph below, we can notice easily that the public and external deficit move in the same way (confirming they are twin deficit) through for example, the impact of oil price shock on public subsidies and imports in the same time. But the government deficit may influence the external deficit through expansionary fiscal policy as the rise in wages, during the last years, has created purchasing power that was partially import-oriented, widening in this way the trade deficit.

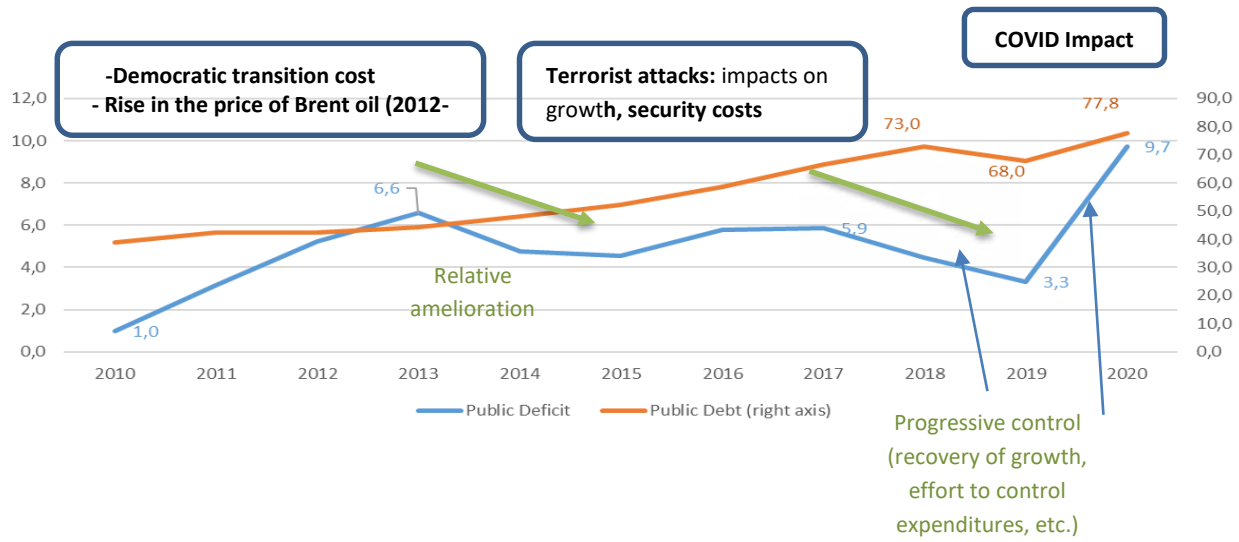
Figure 2: Investment & Savings GAP



1.3 Public finance

Public finances have been affected in recent years by an exceptional context characterized by an increase in current expenditures such as social expenditures, security and health costs, oil and commodity subsidies etc… and a pressure on revenues due to the sluggish growth in relation with internal and external shocks especially the pandemic effects. This these shocks, highlighting the structural weaknesses, hampered efforts to contain the budget deficit in the past.

Figure 3: Public deficit & debt (in % of GDP)



This situation leads a significant financing needs that would have pressures on domestic financing (higher bank liquidity needs) in a context of difficult external conditions and access to the international financial market, impacting the currency reserves.

1.4 GLOBAL BALANCES: MONETARY POLICY

Difficulties in the real sector (especially with the loose fiscal policy) are transmitted to external balances and monetary sphere.

Until 2018, the CAB, driven by fiscal deficit and external shocks, has affected the exchange rate and Net Foreign Assets.

Also, Overall volume of refinancing increased to reach 15.8 billion dinars in 2017 against 331 million only in 2010, mainly to refinance state bond issuance on local market.

As a result, we notice an inflationary pressure acceleration associated to wage price spiral, external unbalances & exchange rate pass through accelerating the imported inflation.

The monetary policy adopted in recent years, has contributed to a relative improvement in the overall balances, especially in 2019 (reducing inflation rates and the total volume of refinancing, controlling the current deficit and stabilizing the dinar...).

But pressure begin to appear again with the slow recovery from COVID and with the new shocks of Russian Ukrainian conflict, making the central bank intervene to anchor inflation expectations.

Figure 4: Current account deficit

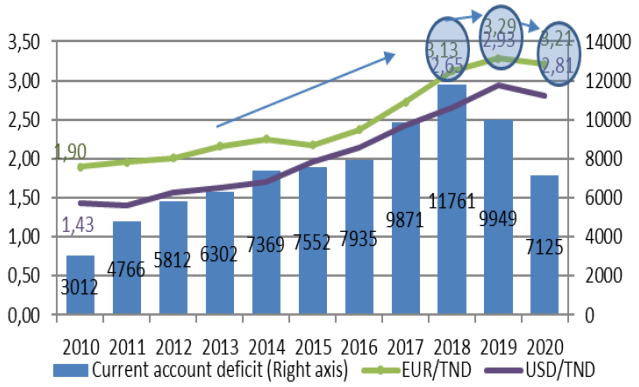


Figure 5: Net foreign assets

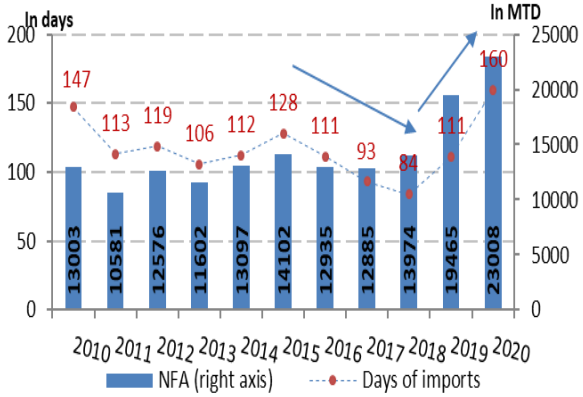


Figure 6: Overall volume of refinancing (end of period in MTD)

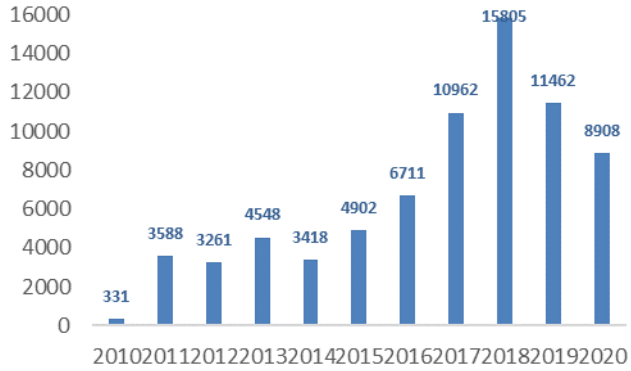
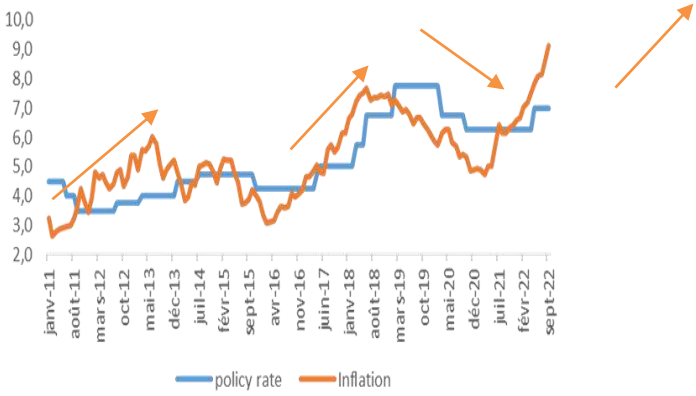


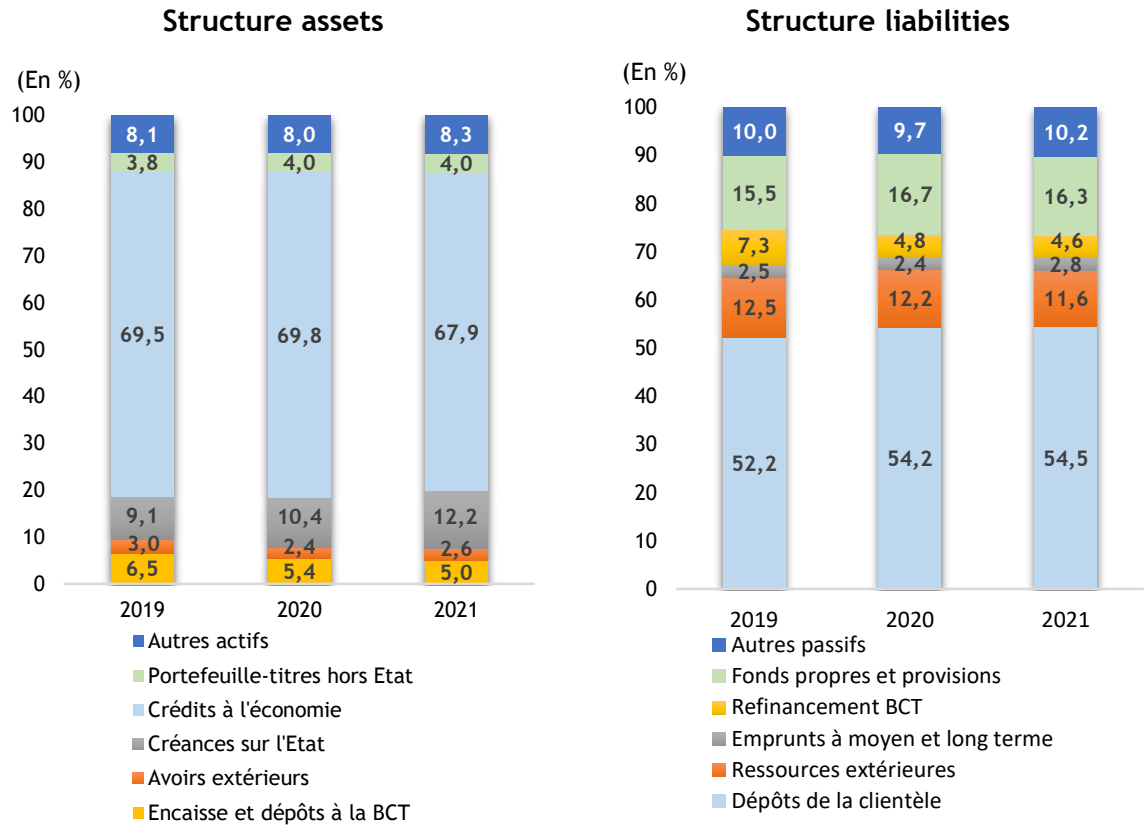
Figure 7: Inflation rate and policy rate



1.5 BANKING SECTOR

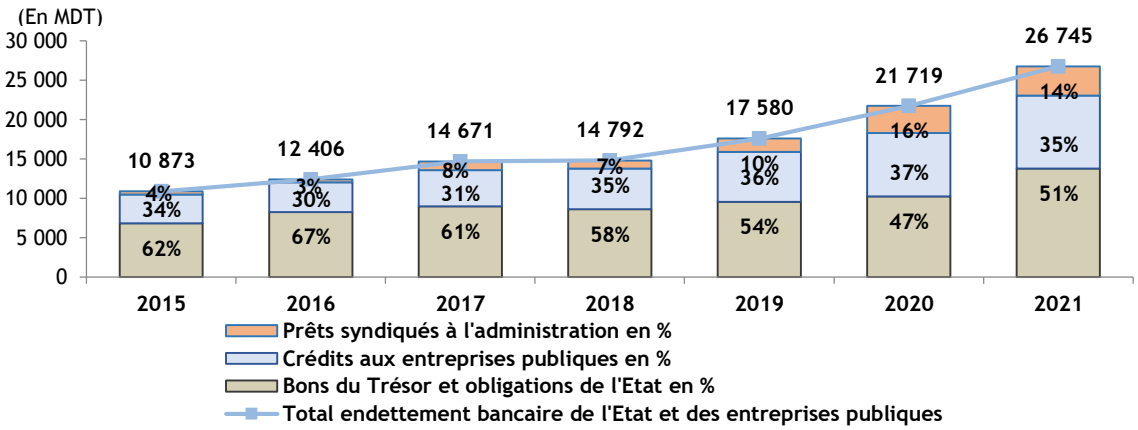
The balance sheets 'resident banks in 2021 was mainly impacted by the intensification of the use of the state and public enterprises on domestic bank debt, the prudential risk hedging and distribution of dividends. On the assets side, we note a fall in the share of credit to the economy and an increase in the share of government securities with the intensification of government recourse to domestic debt.

Figure 5: Structure of assets and liabilities of banks



In fact, the liabilities of the state and public enterprises increase by 23.1% to stand at 26.7 billion dinars at the end of 2021. i.e. representing 21.2% of the total assets of banks against 21.7 billions and 18.4% respectively at the end of 2020 (as shown in figure 5 and figure 6). This is showing an increase exposure 'banks to the public sector which nearly 71% of this increase is explained by new issues of Treasury bonds held in the portfolio of banks.

Figure 7: Evolution of the bank indebtedness of the State and public enterprises



It's important to understand this decomposition of balance sheet structure of banks that would have a significant impact effect on output.

Faced to these risks, Central Bank of Tunisia (CBT) continue to maintain its objective to preserve financial stability. This is how it required banks to put in place a system for preventing and resolving the Non-Performing Loans (NPL'S) to **a target level 7%** (2022- 2026).

Furthermore, the CBT reiterates its commitment to complete the process of convergence towards Basel standards and IFRS to develop the macroprudential supervision by the end 2023.

⇨ The model should reproduce the main stylized facts in Tunisia:

- Important exchange rate pass-through,
- Inflation expectations are sensitive to a fiscal position,
- Crowding-out effect in the long run,
- Restriction on capital market,
- Real and nominal rigidities (subsidies, wages, prices),
- The bank's active accumulation of public debt assets,
- External capital flows and capital requirements,

2.The model

a. Structure of the model –overview:

The country is inhabited by households who consume home and foreign consumption goods and supply labor. We assume that only a fraction of households can buy and sell assets (in particular, physical capital, domestic government debt and bonds). There are two types of households in the economy. First, an infinitely lived utility maximizing (Ricardian) households chooses how much to spend on consumption each period. The Ricardian households earns labor income from employment in domestic firms and government, interest of domestic and foreign assets. While the rest (liquidity –constrained households) does not smooth consumption across periods so they consume their disposable income and thus behave in a non-Ricardian fashion. Both types of households enjoy utility from government services. The structure of the model is presented in Fig.1.

Private production is split in three sub-sectors which consists of three stages: stage T-3 which used as input factor the labor supplied by households. Stage T-2 used the supply of such goods received from local producers in stage T-2 combining with imported goods.

The domestic intermediate and public capital are used in the next stage T-1 by the producers of final goods, resulting in final consumption. Intermediate goods producers use

labor services as production inputs. Cost minimization determines the amount of each input used per firm. **Furthermore, the stock of public capital (infrastructures, etc…) enters the private production function and thus increases private sector productivity.**

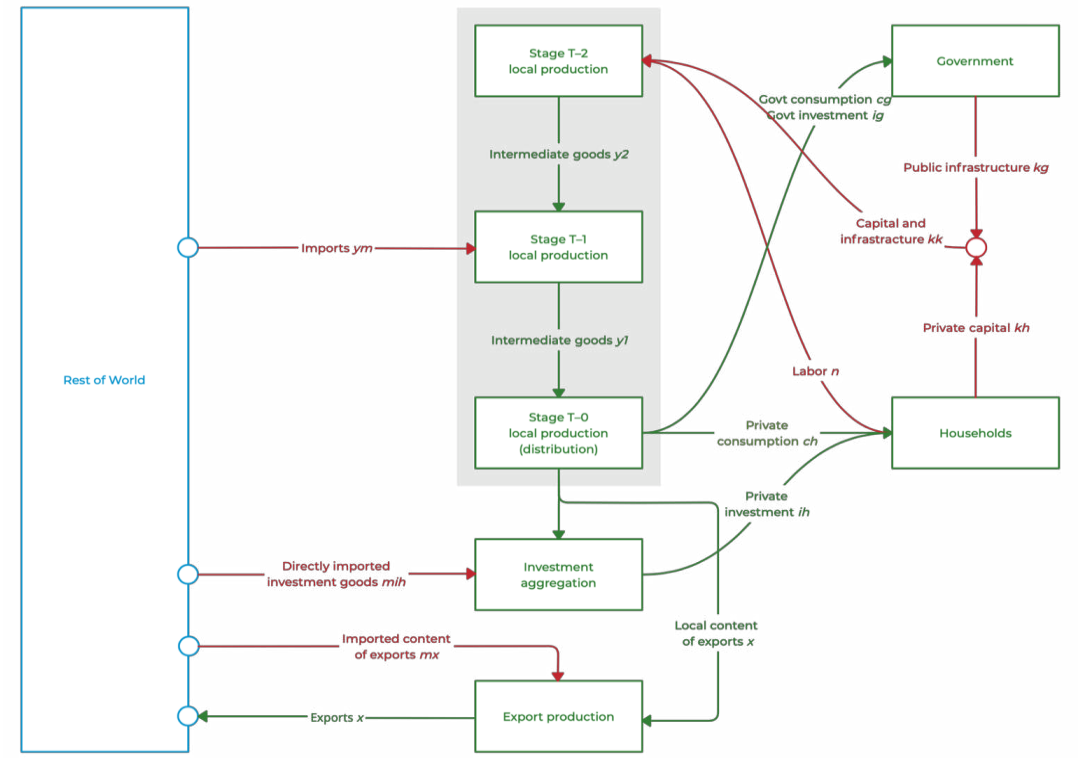
The demand of final goods comes from households for final consumption goods, from the fiscal authorities for final government goods, while exports are demanded from abroad.

Households buy consumption goods from final goods producers. The saving process consists of bank deposits in local and foreign currencies. When maximizing their utility, households face habit consumption with consumption preferences and labor disutility shocks influence their optimal decisions.
Labor market theory identifies many sources of real wage rigidities.

The monetary authority sets the nominal interest rate that responds to inflation as a primary long-term objective and exchange rate fluctuations as secondary short-term considerations.

On the fiscal expenditures side, we explicitly distinguish between public investment and public consumption. ***National fiscal authorities*** finance themselves by a combination of levying lump-sum taxes and issuing net fiscal debt (government bonds). On the other hand, government spends in privately produced consumption.

Fig 8: Flow of goods and Input factors

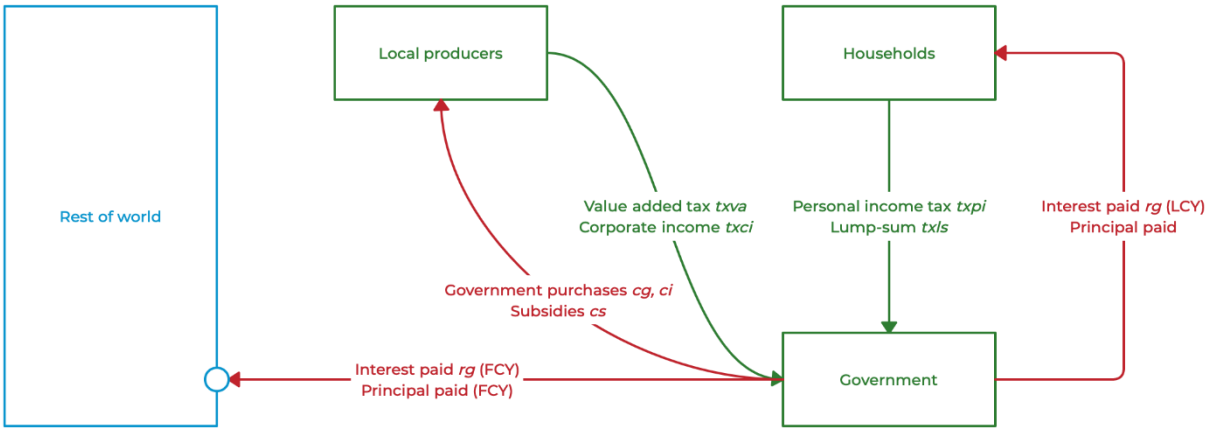


b. Overview of Fiscal taxes revenues in Tunisia

In this model, we consider a notable degree of disaggregation on the fiscal revenues. Government levies a wide range of taxes including Corporate Income Taxes (CIT), Value added Taxes (VAT), and lump-sum taxes/transfers (LST).

The fiscal receipts outlays have been described in the figure (9) as shown below:

Fig 9: Fiscal receipts outlays



There are some implications on the household's constraint budget, supply side and the design of fiscal policy.

1.2.1 Households

The economy is populated by a continuum of households. Each household is a consumer of variety of consumption goods, a monopoly supplier of a labor service. They maximize their expected lifetime utility function under the budget constraint:

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t [\log(ch_t - ch_t^{ref}) - \chi_{\mathrm{rci}} (\log ch_t - \log rci_t - \nu_{rci})^2 - \eta_0 \frac{1}{1+\eta} n_t^{\eta} + \beta_0 \frac{bh_t}{pch_t ch_t}] \quad (1)$$

With the reference level of consumption is given by (external habit):

$$ch_t^{ref} = \chi ch_{t-1} \exp \varepsilon_{ch,t}$$

The term rci_t is real current income given by the sum of labor income, parts of government consumption expenditures, and parts of other government expenditures:

$$rci_t = \frac{w_t n_t + \psi_{\mathrm{cg}} pcg_t cg_t + \psi_{\mathrm{og}} nog_t}{pch_t}$$

Subject to a sequence of budget constraints:

For $t = 0, 1, 2, \ldots \ldots \ldots$

$$dh_t - lh_t + bk_t = rh_{t-1}(dh_{t-1} - lh_{t-1}) + rbk_t bk_{t-1} + \backslash\mathrm{xoff} + w_t n_t + \Pi\backslash\mathrm{Ty}^{\backslash\mathrm{cit}} + \Pi\backslash\mathrm{Tx}^{\backslash\mathrm{cit}} + \Pi\backslash\mathrm{Tb}^{\backslash\mathrm{cit}} - \backslash\mathrm{xpch}\, ch_t - pih_t ih_t \quad (2)$$

Where:

- $\boldsymbol{bh_t^{lcy}}$, is the net position in local currency.
- $\boldsymbol{dh_t}$ is banks deposits,
- $\boldsymbol{lh_t}$ is bank loans,
- $\boldsymbol{bk_t}$ bank capital,
- $\boldsymbol{rh_{t-1}^{lcy}}$ is the real interest rate in local currency,
- $\boldsymbol{w_t}$ is labor income
- $\Pi_{\boldsymbol{y,t}}^{\boldsymbol{cit}}$ is the sum of after CIT period profits from the local production sector.
- $\Pi_{\boldsymbol{x,t}}^{\boldsymbol{cit}}$ is the sum of after CIT period profits received from exporters.
- $\boldsymbol{off_t}$ is the sum of other payments (on the financial account of the BOP) received by households from the rest of the world (e.g. equity investment income, remittances…, etc).
- $\boldsymbol{pch_t\, ch_t}$ are expenditures.
- rbk_t is the expost return on bank capital.

The Lagrange function is defined as Households should to optimize their utility by choosing the level of consumption, ch_thours worked,n_t, bank deposits , dh_t^{lcy} bank loans, lh_t^{lcy}.

$$\begin{aligned} \mathrm{E}_0 \sum_{t=0}^{\infty} \quad & \beta^t\{\log(ch_t - ch_t\backslash\mathrm{xref}) - \chi_{\mathrm{rci}}(\log ch_t - \log rci_t - v_{rci})^2 - \eta_0 \tfrac{1}{1+\eta} n_t \quad {}^{\eta} + \beta_0 \tfrac{bh_t}{pch_t ch_t} \cdots \\ & + vh_t[-(dh_t - lh_t) + rh_{t-1}(dh_{t-1} - lh_{t-1}) + \backslash\mathrm{xoff} + \cdots \\ & + w_t n_t + \Pi\backslash\mathrm{T}y^{\backslash\mathrm{cit}} + \Pi\backslash\mathrm{T}x^{\backslash\mathrm{cit}} + \Pi\backslash\mathrm{T}b^{\backslash\mathrm{cit}} - \backslash\mathrm{xpch}\, ch_t - pih_t ih_t]\} \end{aligned} \tag{3}$$

- All prices (including factor prices) are taken as given: pc_t, w_t.
- Profits are taken: $\Pi_{\boldsymbol{y,t}}^{\boldsymbol{cit}}$,$\Pi_{\boldsymbol{x,t}}^{\boldsymbol{cit}}$.

Demand for consumption and financial positions

The first order conditions determine the Demand for consumption and financial positions:

- Consumption:

$$vh_t pc_t = \frac{1}{ch_t - ch_t\backslash\mathrm{xref}} - \chi_{\mathrm{rci}}(\log ch_t - \log rci_t - v_{\mathrm{rci}})\frac{1}{ch_t} \tag{4}$$

- Financial position in local currency:

$$vh_t = \beta E_t\left[vh_{t+1} rh_t^{lcy}\right] \quad (5)$$

- Financial position in foreign currency:

$$vh_t = \beta E_t\left[vh_{t+1}\frac{e_{t+1}}{e_t}\right] \; rh_t^{fcy} \quad (6)$$

Combined the conditions for local and foreign currency positions determine the Uncovered Interest rate parity:

$$r_t \approx r_t^{fcy} E_t\left[\frac{e_{t+1}}{e_t}\right] \quad (7)$$

The first order conditions determine the interest parity between local and foreign currency interest rates. We impose exogenous assumptions:

$$\frac{bh_t^{fcy}}{bh_t^{fcy} + bh_t^{lcy}} = \Psi_2 \quad (8)$$

1.2.2 Labor

The optimization problem of households determines the optimal wage, w_t^{flex} rate that would prevail with no labor market rigidities.

Upward sloping labor supply curve with being the inverse wage elasticity:

$$vh_t w_t^{flex} = \eta_0 n_t \quad (9)$$

The limit case for, $\eta = 0$ (infinitely elastic labor supply) used as proxy for an indivisible labor assumption:

$$vh_t {w_t}^{flex} = \eta_0 \quad (10)$$

The parameter η_0 is only a scaling factor (e.g determining the labor and wage units) and has absolutely no impact on the properties of the model.

1.2.3 Labor market rigidities

- Labor market theory identifies many sources of real wage rigidities. The actual real wage rate is rigid in response to optimal (fully flexible) wage rate determined by household's optimal choice.

$$log\left[\frac{w}{pc}\right]_t = \rho_w \, log\left[\frac{w}{pc}\right]_{t-1} + (1-\rho_w) log\left[\frac{w_{flex}}{pc}\right]_t + \varepsilon_{w,t} \quad (11)$$

1.2.4 Local Production

Three production stages are defined in this step:

1. Stage *T-3* is local production used as input the local labor,

2. Stage *T-2* is a production that combines the local production in the previous step with imported goods.
3. Stage *T-1* is Cobb Douglas function of public capital and production $y_{2,t}$.
4. Stage *T-0*: (distribution) resell domestically as consumption final goods.

The Stage *T-3 production function:*

$$y_{3,t} = (aw_t ay_t)\, n_t \qquad (12)$$

The period profits:

$$\pi_{3,t} = p_{y3,t} y_{3,t} - w_t n_t \qquad (13)$$

The Stage *T-2 production function:*

Leontief production function (no elasticity substitution)

$$y_{2,t} = min\left\{\frac{y_{1,t}}{1-\gamma_M},\ \frac{m_t}{\gamma_M}\right\} \quad (14)$$

Optimal choice of inputs:

$$y_{3,t} = (1-\gamma_M) y_{2,t} \qquad (15)$$

$$m_t = \gamma_M y_{2,t} \qquad (16)$$

Period profits

$$\pi_{y2,t} = py_{2,t} y_{2,t} - py_{3,t} y_{3,t} - pm_t m_t \qquad (17)$$

The stage T-1:

$$y_{1,t} = {k_{gt}}^{\gamma_{kg}} {y_{2,t}}^{1-\gamma_{kg}} \qquad (18)$$

The first order condition is defined by this equation

$$py_{1,t} = py_{2,t}\left(\frac{1}{1-\gamma_{kg}}\right)\left(\frac{y_{1,t}}{k_{gt}}\right)^{\gamma_{kg}}$$

Where $\boldsymbol{k_{gt}}$ is a public capital and $\boldsymbol{\gamma_{kg}}$ is a parameter which determines the dependency of the private production sector on public infrastructure

The stage T-0 (distribution)

At this moment, no public consumption and investment:

$$y_{0,t} = y_{1,t} \qquad (19)$$

Downward sloping demand curve faced by the representative distributor (seller):

$$y_{0,t} = \overline{y_{0,t}} \left(\frac{p_{y0,t}}{\overline{p_{y0,t}}} \right)^{\mu/\mu-1} \qquad (20)$$

With μ is Lerner's of monopolistic power.

Before -CIT period profits

Before-CIT period profits including a prices adjustment cost and the VAT paid:

$$\pi_{y0,t} = \left(\frac{1}{1 - tr_t^{VAT}} py_{0,t} - py_{1,t} \right) y_{0,t} - \frac{1}{2} \varepsilon_{py} (\Delta log py_{0,t} - j_t)^2 \overline{py_{0,t} y_{0,t}} \qquad (21)$$

Where $py_{0,t}$ and $y_{0,t}$ are prices and quantities selected by an individual (representative) distributor (seller); $\overline{py_{0,t} y_{0,t}}$ are aggregate (market-wide) prices and quantities are not internalized by an individual distributor; j_t is a price indexation variable such that in steady state: $j_{ss} = \Delta log py_{0,t}{}_{ss}$ and ε_{py} is an adjustment cost parameter if $\varepsilon_{py} = 0$ that means fully flexible prices; tr_t^{VAT} is the VAT rate and tr_t^{cit} is the CIT rate.

The first part of the right equation (21) present the imposed VAT on the total value of sales and the second part means the slow adjustment of final prices respond to a different level of taxes.

Optimal Price setting problem

Producers optimize the stream of:

$$E_0 \sum_{t=0}^{\infty} \beta^t \, vh_t \left[\pi_{yo,t} - tx_t^{cit} \right] \qquad (22)$$

Optimal Final prices:

- **Steady state**

In steady state, simple mark-up pricing (adjustment cost disappears):

$$py_{0,t} = \mu_{py} py_{1,t} \, (1 + tr_t^{VAT}) \qquad (23)$$

Where μ_{py} is a mark-up over marginal cost given by:

$$\mu_{py} = \frac{\varepsilon}{\varepsilon - 1} + \Psi_{cit} tr_t^{cit} \qquad (24)$$

- **Dynamics**

Markup pricing with an adjustment cost:

$$py_{0,t}\{1 + (\mu_{py} - 1)\varepsilon_{py}[\varepsilon_{py}(\Delta logpy_{0,t} - j_t)^2 - \beta(\Delta logpy_{0,t+1} - j_{t+1})^2]\} = \mu_{py} py_{1,t} (1 + tr_t^{VAT}) \quad (25)$$

Total profits of local production sector

Sum up the periods before CIT profits across the individual production stages

$$\pi_{y,t} = \pi_{y0,t} + \pi_{y1,t} + \pi_{y2,t} + \pi_{y3,t} \quad (25)$$

After substituting for profits at individual production stages:

$$\pi_{y,t} = pc_t ch_t - pm_t m_t - w_t n_t \ (26)$$

Corporate income tax paid

Corporate income tax is not paid on losses (negative profits):

$$tx_t^{cit} = max\{tr_t^{cit}\pi_{y0,t}, 0\} \quad (27)$$

After CIT profits:

After CIT profits are distributed to the household budget:

$$\pi_{y,t}{}^{cit} \equiv \pi_{y,t} - tx_t^{cit} \quad (28)$$

1.2.5 Exports

Real exports are an exogenous endowment (with no cost production involved):

$$x_t = ss\_x;$$

Where $ss_x$the parameter for the steady state exports and export prices is are linked to the general world price level.

Exporter periods revenues and profits:

$$\pi_{x,t} = px_t x_t \quad (29)$$

International linkages :

- Import and export prices,
- Balance of payments,

- Country credit risk,
- Denomination in net foreign assets.

For import and export prices they are taken as given linked to an underlying world price index, pw_t^{fcy}:

$$pm_t = e_t pm_t^{fcy};$$

$$px_t = e_t {px_t}^{fcy};$$

$$pm_t^{fcy} = \left[\frac{pm}{pw}\right]_t pw_t^{fcy}$$

$$px_t^{fcy} = \left[\frac{px}{pw}\right]_t pw_t^{fcy}$$

1.2.6 Balance of payments

The net foreign assets are equal to revenues received in local deposits and foreign deposits plus revenues of exports minus expenditures imports

$$\left[\frac{nfa}{ngdp}\right]_t = \frac{r_{t-1}^{lcy} * bh_{t-1}^{lcy}}{ngdp_{t-1}} + \frac{r_{t-1}^{fcy} * bh_{t-1}^{fcy}}{ngdp_{t-1}} * \left[\frac{e_t}{e_{t-1}}\right] + \frac{{px_t}x_t}{ngdp_t} - \frac{{pm_t}m_t}{ngdp_t} \quad (30)$$

The LHS is the net assets position in ratio of nominal GDP with the rest of the world equals to primary income (interest paid on nominal deposits) plus nominal exports minus nominal imports divided by nominal GDP.

Country credit Risk

Local interest rate for foreign currency denominations is marked up over world foreign-currency interest rate:

$$r_t^{lcy} = rw_t^{fcy} prem_t \quad (31)$$

The country credit risk premium:

$$prem_t = \exp(\emptyset_0 - \emptyset_1 \left[\frac{nfa}{ngdp}\right]_t \quad (32)$$

Net foreign assets to GDP ratio:

$$\left[\frac{nfa}{ngdp}\right]_t = \frac{b_t + b_t^{fcy}}{ngdp_t} \quad (33)$$

1.2.7 Monetary Policy

Response in short-term money rate

* Autoregression (conservatism, uncertainty)

* Steady state (long-run level)

* Reaction term

$$rm_t^{lcy} = \rho_{rm} rm_{t-1}^{lcy} + (1 - \rho_{rm})(rm_{ss} + react_t) + \varepsilon_{rm,t} \quad (34)$$

Where reaction term is defined as:

- Response to deviations in consumer price inflation from the target.
- Response to fluctuations in the nominal exchange rate.

$$react_t = \kappa_{pc}\left(\widehat{\boldsymbol{pch}}_{\boldsymbol{t+1}} - \boldsymbol{targ}\right) + \kappa_e(\widehat{\boldsymbol{e}}_{\boldsymbol{t}} - \widehat{\boldsymbol{e}}_{\boldsymbol{ss}})$$

1.2.8 Fiscal Finance in steady state:

Dynamic fiscal budget equation:

$$dg_t^{\text{lcy}} + dg_t^{\text{fcy}} + dg_t^{\text{imf}} = dg_t^{\text{lcy}} + dg_t^{\text{fcy}} + dg_t^{\text{imf}} \cdots + \left(rg_{t-1}^{\text{lcy}} - 1\right) dg_{t-1}^{\text{lcy}} + \left(rg_{t-1}^{\text{fcy}} - 1\right) dg_{t-1}^{\text{fcy}} \frac{e_t}{e_{t-1}} + \left(rg_{t-1}^{\text{imf}} - 1\right) dg_{t-1}^{\text{imf}} \frac{e_t}{e_{t-1}} \cdots + pc_t cg_t + pig_t ig_t - tx_t^{\text{ls}} - tx_t^{\text{vat}} - tx_t^{\text{cit}} \quad (35)$$

Where taxes revenues have defined as follows:

$$tx_t^{VAT} = tr_t^{VAT} py_{0,t} y_{0,t} \quad (36)$$

$$tx_t^{CIT} = max\{tr_t^{CIT} \pi_{y,t}, 0\} + max\{tr_t^{CIT} \pi_{x,t}, 0\} \quad (37)$$

With government consumption:

$$ng_t g_t = pc_t cg_t + pig_t ig_t \quad (38)$$

$$pc_t cg_t = \sigma_{cg} ngdp_t \quad (39)$$

Public capital (infrastructure):

$$k_{gt} = (1 - \delta_g) k_{gt-1} + i_{gt} \quad (40)$$

Target level of the public capital is assumed to be in fixed proportion on productivity:

$$k_{gt}{}^{targ} = \sigma_{kg} (aw_t ay_t) \quad (41)$$

The dynamic of public capital is defined as follows:

$$\log k_{gt} = log\ \widehat{ay}_{ss} k_{gt-1} + \tau_{kg} \left(\log k_{gt}{}^{targ} - log k_{gt}\right) \quad (42)$$

Fiscal debt in steady state:

$$dg_t = \sigma_{dg} ngdp_t \quad (43)$$

The steady state path of the lump sum taxes is implicitly determined by these equations.

Issuing a new debt:

$$dg_t^{\text{lcy}} = (1 - \lambda_{\text{lcy}}) dg_{t-1}^{\text{lcy}} + dg_t^{\Delta,\text{lcy}}$$
$$dg_t^{\text{fcy}} = (1 - \lambda_{\text{fcy}}) \frac{e_t}{e_{t-1}} dg_{t-1}^{\text{fcy}} + dg_t^{\Delta,\text{fcy}}$$
$$dg_t^{\text{imf}} = \left(1 - \lambda_{\text{imf}} - \varepsilon_{t,\lambda\text{imf}}\right) \frac{e_t}{e_{t-1}} dg_{t-1}^{\text{imf}} + dg_t^{\Delta,\text{imf}} \quad (44)$$

1.2.9. Structure of the model –overview (banking sector)

The model features an explicit aggregate balance sheet of the banking sector. The unit of all the assets and liabilities is Tunisian Dinar (TND):

AGGREGATE BANK BALANCE SHEETS

ASSETS		Liabilities	
LOANS TO THE PRIVATE SECTOR	lh_t	Non-equity funding	d_t
LOANS TO THE GOVERNMENT SECTOR	lg_t		
LOANS OTHER SECTORS	lo_t	Bank capital	bk_t
NET ASSETS WITH NON-RESIDENTS	F_t^{fcy}		

The basic balance sheet assumes that assets are the loans on the private sector (lh_t), loans on the government sector, loans to other sectors and the net assets with non-residents. The model distinguishes between non-equity (deposits) and equity (bank capital) liabilities.

The Bank balance sheet identity is as follows:

$$lh_t + lg_t + lo_t + f_t = d_t + bk_t$$

(1) Total Assets (in % GDP):

$$tba_t = lh_t + lg_t + lo_t \qquad (45)$$

(2) The Risk weighted asset

$$rwa_t = riskw_{lh} * lh_t + riskw_{lg} * lg_t + riskw_{lo} * lo_t \qquad (46)$$

a. Loan portfolio :

The loan portfolio in Tunisia account for about 80% of all assets of banks -which 21% are the government assets (for state and public enterprises)- and drives a large part of the model dynamics by linking the performance and dynamics of the private and public loan portfolio to the real economy.

A life cycle of loan is modeled as follows, when in each period, a portion $\theta_{lh}, \theta_{lg},$ of the outstanding private and public loan is paid back, along with interest. The inverse of the parameter θ determines the average maturity of the loan portfolio. The stock of loans evolves simply as:

$$lh_t = (1 - \theta_{lh})lh_{t-1} + lh_t^{\Delta} - \ lh_t^{\Delta woff} \quad (47)$$

$$lg_t = (1 - \theta_{lg})lg_{t-1} + lg_t^{\Delta} \quad (48)$$

$$lo_t = (1 - \theta_{lo}) + lo_t^{\Delta} \quad (49)$$

Where lh_t^{Δ} represents the new loans to the private sector as the model progresses in time for "closing" balance rolled over from previous t-1 of the opening balance at time t. θ_{lh} is the portion of the outstanding loan value lh_t is paid back, along with interest. $lh_t^{\Delta woff}$ is the outflow of lost credit that is being written-off in the presence of credit risk.

Where $lg_t$the gross is bank credit to the government and lg_t^{Δ} represents a new loan to the government.

b. Bank Credit Performance

The gross bank credit to the private sector, lh_t comprises a fraction of credit lost (non recoverable, non-performing loans) which interest accrues only on bank credit net of lost value, $lh_t - \ lh_t^{lost}$. Every period, there's newly lost credit, $lh_t^{\Delta lost}$, depending on macroeconomic conditions and out of lost credit that's being written off, $lh_t^{\Delta woff}$,

$$lh_t^{lost} = lh_{t-1}^{lost} + lh_t^{\Delta lost} - lh_t^{\Delta woff} \quad (50)$$

The newly lost credit is a proportion of existing credit, and the proportion is determined by macroconditions:

$$lh_t^{\Delta lost} = qh_t(lh_{t-1} - lh_{t-1}^{lost}) \quad (51)$$

Where the $qh_t$is the default rate prevailing in the economy at time t.

The write-off is gradual and follows the following process:

$$lh_t^{\Delta woff} = \omega lh_t^{lost} \quad (52)$$

c. Credit creation process

The creation of new loans depends on supply factors (lending conditions) and demand factors (real economic activity). The credit creation is money creation and money serve transactions. These transactions are related to newly created value approximated by the value-added GDP:

$$lh_t^{\Delta} = \zeta_{lh}(pc_t c_t + pi_t ih_t + pk_t k_t) \qquad (53)$$

Where $pc_t c_t$:the nominal consumption; $pi_t ih_t$: nominal investment and $pk_t k_t$: $bank\ capital.$

The new net government borrowing is defined as follows:

$$\boldsymbol{lg_t^{\Delta} = \zeta_{lg} dg_t^{\Delta lcy}} \quad \mathbf{(54)}$$

Where $\boldsymbol{dg\ is}$ **the government debt.**

The new government debt is issued in both external and internal market:

$$\boldsymbol{lg_t^{\Delta} = lg_t^{\Delta lcy} + lg_t^{\Delta fcy}} \quad \mathbf{(55)}$$

Where the new net government borrowing, in foreign currency is defined as follows:

$$\boldsymbol{lg_t^{\Delta fcy} = (\varepsilon + \sigma_{\varepsilon}) * lg_t^{\Delta}} \qquad \mathbf{(56)}$$

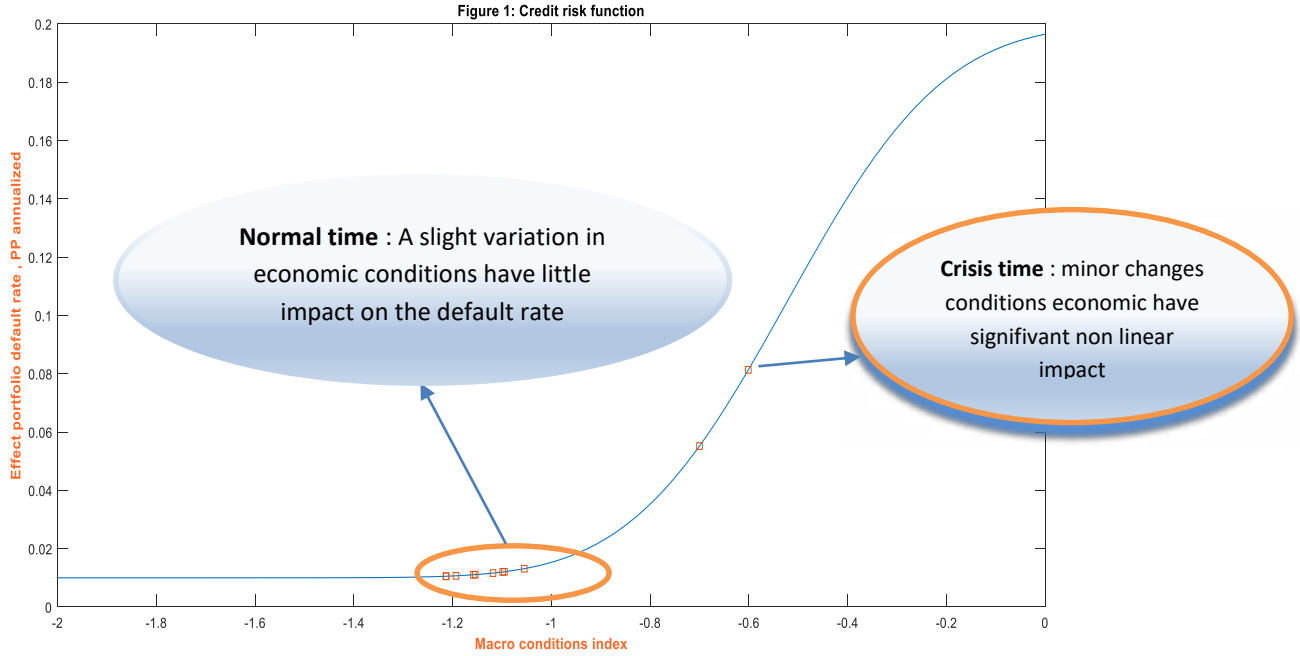
Where ε is the part for foreign debt that have been issue in the foreign financial market and σ_{ε} is the shock for example: the shutdown external funding?

4. Credit Risk

The interaction of the real and financial spheres is modelled through a credit risk that relates the macroeconomic conditions to the default rate on bank loans. The credit risk function takes the following form:

$$q_t = q\_aut_t + \left(qh\_max_t - qh_{auto_t}\right) * \left[\frac{1}{1+\exp\left(\frac{riskf - riskoff}{\sigma}\right)}\right]^{expv} \qquad (57)$$

parameter	Description
$riskf$	Risk credit factor
$riskoff$	Local parameter: moves the curve left-right
σ	Dispersion of credit risk (scale parameter : makes the curve steeper /flatter)
v	Shape parameter: makes the curve asymmetric
q_aut_t	Lower bound
qh_max_t	Upper bound



An important feature of the function is that it should be "nonlinear and asymmetry". Empirically**, in "normal times"** changes in economic conditions have only a small impact on q_t . With a worsening macroeconomic situation, the impact on q_t increases disproportionately.

c. Bank profitability and optimization

Each bank seeks to maximize the profit function before taxation and before external flows. The profit function has two components: the actual profit/losses, and the expected cost of regulatory capital shortfall.

The actual before CIT before XCF bank profits/losses are given by:

$$\pi_{b,t} = (rlh_{t-1} - 1)(lh_{t-1} - lh_{t-1}^{lost}) + (rlg_{t-1} - 1)(lg_{t-1} - lg_{t-1}^{lost})$$
$$+(rlo_{t-1} - 1)(lo_{t-1} - lo_{t-1}^{lost}) + (rm_{t-1}^{fcy}\frac{e_t}{e_{t-1}} - 1)f_{t-1}^{fcy}$$
$$-(rf_{t-1} - 1)(tba_{t-1} - bk_{t-1})$$
$$-lh_t^{\Delta lost} \qquad (58)$$

The profit function that is maximized by the banks includes also the expected regulatory capital $E_t\ [Q_{t+1}]$ Which is the product of a nonlinear function, the distance between the actual capital adequacy ratio, and its regulatory minimum and the size of the asset portfolio :

$$\mathbf{E_t\ [Q_{t+1}] = qx_t\,.\,tba_t = g.\,(car_t - car_t^{min}).\,tba_t} \qquad \mathbf{(59)}$$

Assuming that the banks take the portfolio of credit to the government and other sectors as given, the optimization problem is given by:

$$\mathbf{max_{\{lht,bkt\}}\ \ E_t\ \beta\Lambda_{t+1}\left[\pi_{b,t+1} - qx_t\,.\,tba_t\right] - \Lambda_t bk_t} \qquad \mathbf{(60)}$$

Where the first term, $\mathbf{E_t\ \beta\Lambda_{t+1}\left[\pi_{b,t+1} - qx_t\,.\,tba_t\right]}$ is the ewpected profits less regulatory shortfall, and the second term $\Lambda_t bk_t$ is the cost of investment in bank capital from the point of view of households, either evaluated at its respective shadow price of budget constraint, subject to the balance sheet identity :

$$tba_t = lh_t + lg_t + lo_t + f_t\ = d_t\ + bk_t \qquad (61)$$

The first order condition with respect to bank credit to the private sector yields an optimal lending rate setting equation:

$$\mathbf{E_t}\left[\frac{1+rh_t}{1-qh_{t+1}}\right] = 1 + rd_t + qx_t \qquad (62)$$

Where the lending rate set at time t includes to the cost of funding liabilities rd_t***, the expected risk of regulatory capital shortfall*** qx_t **.**

Finally we find that the gross rate of return on bank capital:

$$rbk_t = 1 + \frac{\pi_{b,t}}{bk_{t-1}} \qquad (63)$$

Bank explicitly tracked on the balance sheet and used to keep track of bank capital position by the CAR. Banks can accumulate capital from internal (net income: net interest income, provisioning and write-offs, other net income) or external flows (profit distribution, recapitalization) that usually negative in the form of dividends. The dynamics of bank capital take the form:

$$bk_t = bk_{t-1} + \pi_t + xcf_t \qquad (64)$$

Gross rate return on bank capital is then given by:

$$rbk_t = 1 + \frac{\pi_{b,t}}{bk_{t-1}} \qquad (65)$$

d. External flows of capital

External capital flows can be positive (capital injections) but are usually negative as in the form of dividend payments. The model equation links the external capital flows to capital position – weak capital position induces the banks to reduce dividends or potentially inject additional capital, and vice. Two Costs of any external flows of capital:

$$\varepsilon_{bk1}/_2 \quad [\log bk_t - log bk_t^0]^2 \qquad (66)$$

ii. Cost of deviation from a long-run target:

$$\varepsilon_{bk2}/_2 \quad [car_t - car_t^{tar}]^2 \qquad (67)$$

Where ε_{bk2} controls the degree of responsiveness of external capital flows to bank capital position.

4. Scenario Building

We use the shock-minus control simulations. These simulations are usually run from a steady-state and serve to build insight into macro financial interactions rather than predict the actual developments of the economy in the future.
We have simulated two scenarios:

- **Scenario 1 Severe stress**: We assume a shutdown external funding and incapacity to mobilize external resources leads to sovereign defaults on foreign currency debt. In this scenario, we assume that external flows adjust slowly to the regulatory minimum capital adequacy (CAR).
- **Scenario 2 Moderate stress:** We assume the country strike a deal with bilateral support in a medium term and the external flows adjust instantaneously to the CAR.

5. Impact of shut down on macroeconomic variables

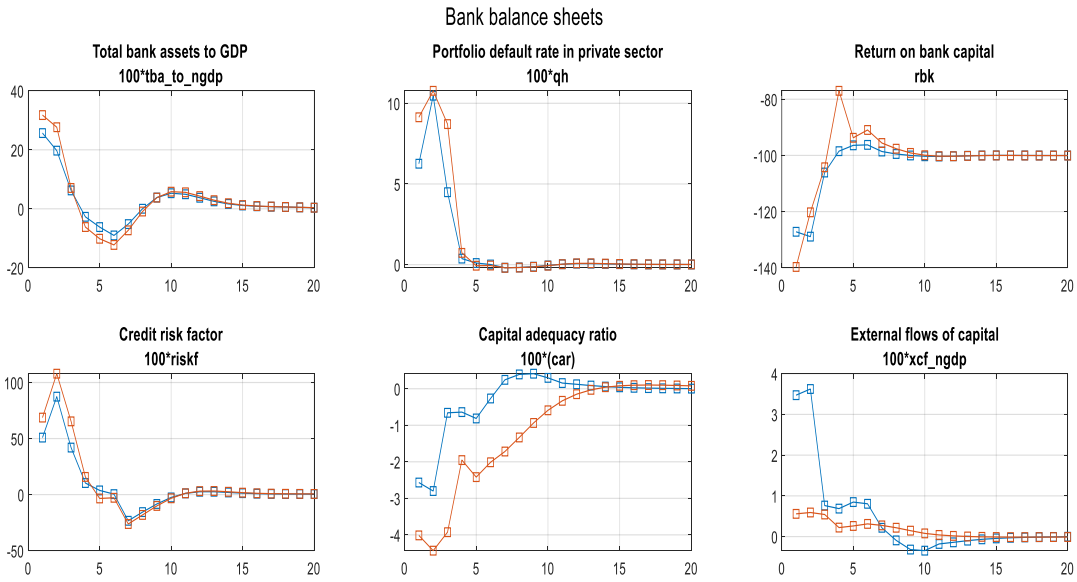
The simulation evaluates the economic and financial impact of a shut-down external financing public debt with instantaneously adjustment of external capital flows to fluctuations in capital adequacy (blue line) compared with the case of slowly adjustment external capital flows to CAR (Red line).

The shock of new financing needs by placing debt on international financial market (shock _upsilon=0) leads an increasing in the government debt over GDP by 30% for one and two years after crisis due to the contraction of real economy activity. The stock of foreign debt slows gradually which is replacing by locally Government Issue debt increasing by 30% from its initial steady state over the 5 years.

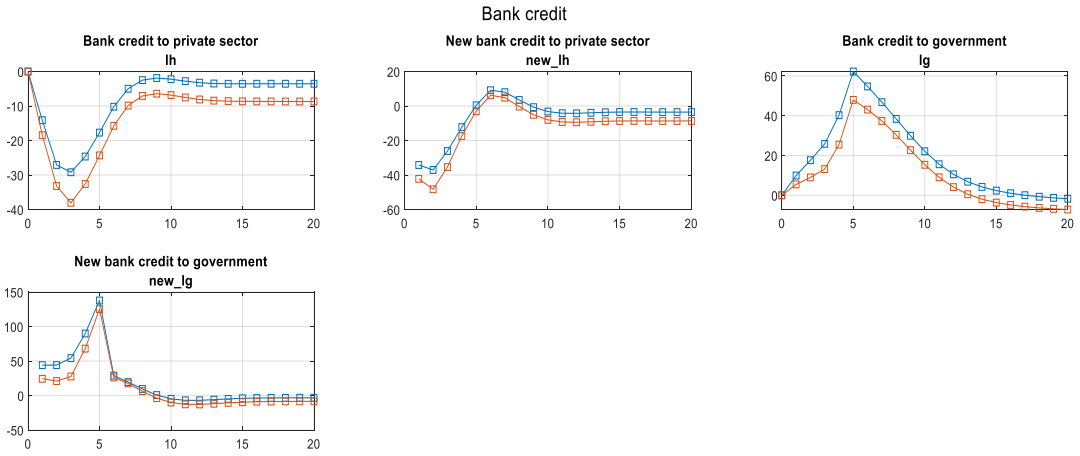
The external capital flows are made up of i) profit distribution, ii) equity issuance, iii) recapitalization. If the external capital flows respond slowly to fluctuation in capital adequacy ratio of banks and banks owners do not adjust external flows (dividends) (red line).

The CAR falls from its target and there is a risk surcharge from the CAR differential conducting to a significant increase in the default rate to 10% per year (means 2.5% per quarter) resulting a rise of the volume of NPLs. Losses in terms of return on capital are explained by the decline in the rate of new credit to the private sector and holding an important amount of treasury bonds. This situation, would have risen and lead a worsening of the lending conditions which discourages the credit creation and leads a significant and permanent crowding-out effects. The sovereign default might cost the banking system 8%-18% of GDP at the end of forecast nominal GDP (2024-2026) (without adjustment of external funds of capital) compared to 6% -10% of nominal GDP(204-2026) with adjustment external funds of capital .

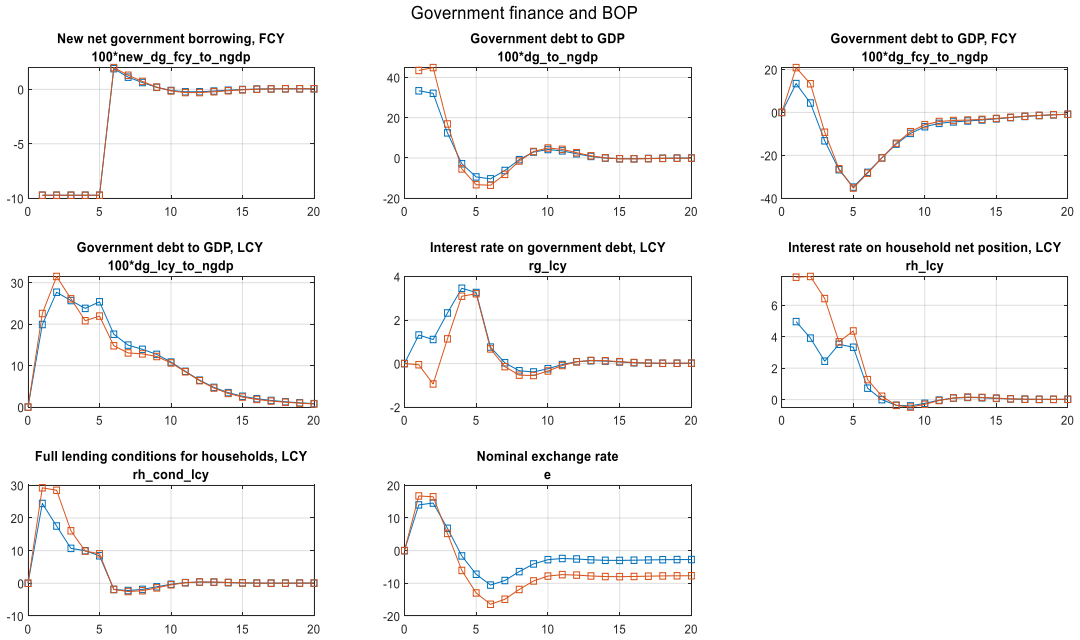
(i) <u>Impact on Bank balance sheets</u>



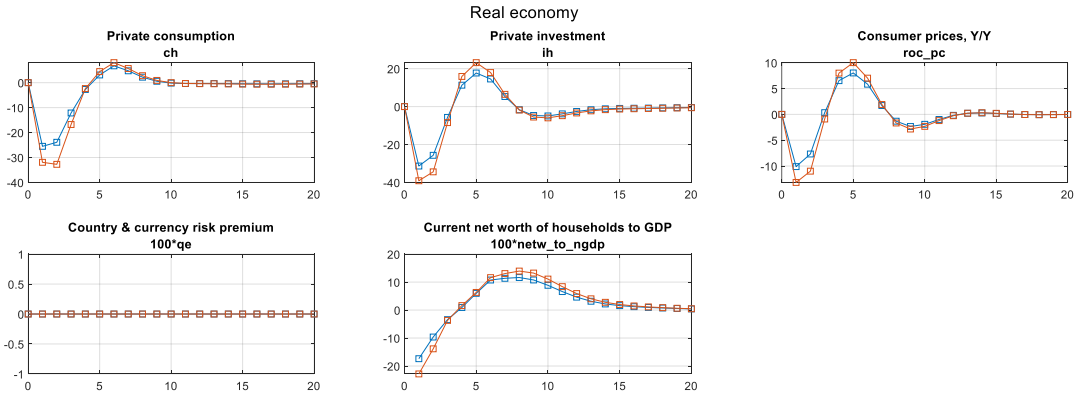
(ii) Impact on the banking sector



(iii) Impact on the BOP and Government



VI. Impact on the real economy



The interest rate on government debt increases by 3% from its steady state (without premium risk) and the depreciation of exchange rate is by 15% for one and two years). The private consumption and private investment falls by 20%, this leads a decreasing inflation due to the pressures on domestic demand. In these simulations , scenario with instantaneously adjustment of external capital flows show its performance as it keeps the impact of this shock lower than the severe scenario.

Conclusion

In developing countries where fiscal deficit is persistent and banks represent the bulk of financial system and bank's exposure to the state remains significant, assessing the linkages between, fiscal, macro prudential and monetary policies at the level of bank's balance sheets is paramount.

In our model we have incorporated in detail the fiscal and the Tunisian banking system and their interactions with the real economy. Our simulations highlight the role of external funding of capital (reduction in dividends, recapitalization) in mitigating the cost of shutdown external financing due to sovereign default on foreign currency debt. The results show that under the severe stress, we would expect more increasing of NPL's while credit losses could significantly erode profitability and more decreasing of bank's private credit which cost to the economy appears more important.

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