Coronavirus Pandemic: A New Path To Rethinking Macroprudential Policy In Africa: *simulation of a DSGE model for Tunisia and South Africa*

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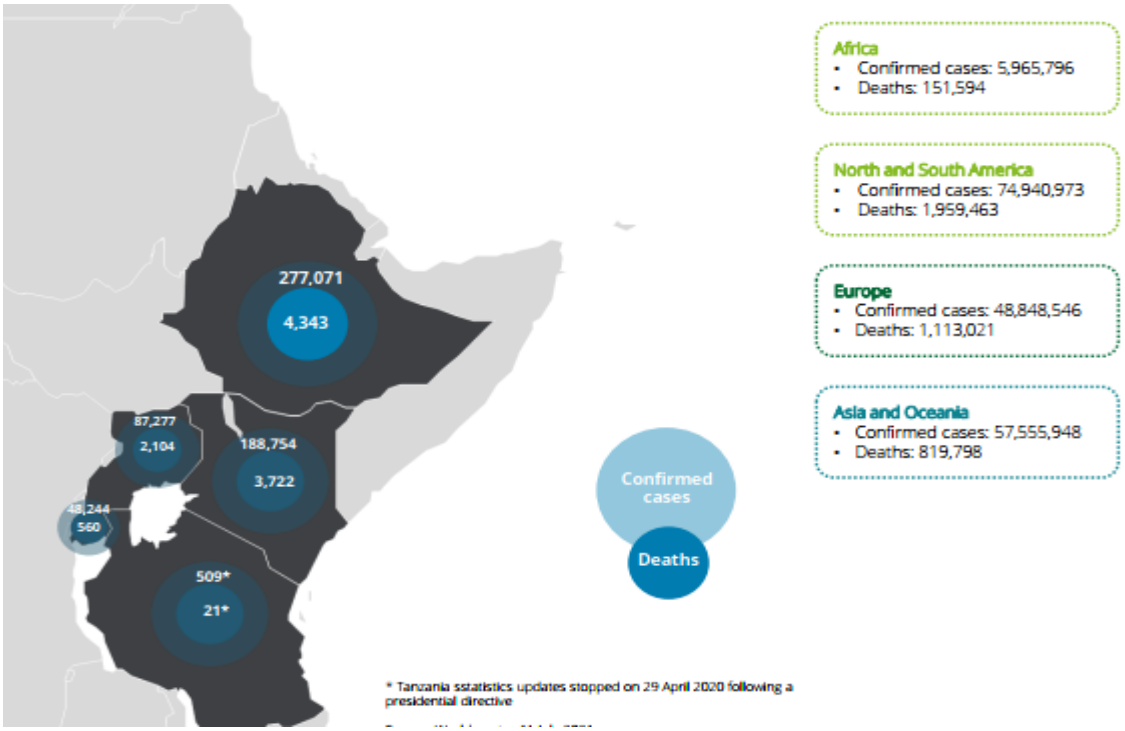
Introduction

About two years ago, the world was hit by a major unexpected shock: the COVID-19 pandemic. While this health and economic crisis has had, and continues to have, a severe impact on European citizens and businesses, the euro area banking sector has so far weathered the crisis well. Rather than being part of the problem, it has been part of the solution. The central banks in many African countries have managed to change their monetary and macroprudential tools. The banking sector also has managed to support the economy through continued lending, including to the sectors most affected by the lockdown measures.

Macroprudential policy actions focus on averting the emergence of financial imbalances and building resilience in the financial system in good times, with the aim of supporting financial intermediation and especially lending to the real economy in bad times.



1. Macroprudential instruments and Systemic risk: an unfinished revolution

Systemic risk emerges from the presence of financial distortions that can lead to a build-up of vulnerabilities over time and/or to structural vulnerabilities within the financial system. These vulnerabilities could amplify negative aggregate shocks, increase financial stability risks, and have serious adverse effects for the real economy through negative feedback loops. Systemic risk is multi-dimensional: it can be rising in one dimension while falling in another dimension, IMF2021

The main line of defense used by countries for coming out the systemic risk is the macroprudential policies. policies aim to reduce the likelihood of systemic financial crises, and limit their intensity and their costs when they occur, Quang and Scialo(2021). It aims also to cut the interconnections between financial system and risk concentration in order to protect the economy from systematic risk. this was materialized through the procyclicality of economic behaviors.

Since the global financial crisis, macroprudental tools continue to develop to support macrofinancial analysis and ensure financial stability. Without being exhaustive, these tools can be summed up in countercyclical capital buffer, leverage ratio for banks, dynamic provisioning rules, caps on loan-to-value or debt-to-income ratios, limits on foreign currency loans, limits on risk concentration, (Cerutti et al., 2017). other tools allow allows to examine the extent to which asset valuations may have deviated from fundamentals (e.g., Equity Market–Valuation Multiples, Real Estate Markets Module) or to detect anomalies in bond prices (Bond Market Valuation Metrics), IMF (2021). These indicators can be banking sector specific—system-level FSIs (e.g., Financial Soundness Heatmaps) or bank-level information

(e.g., Bank Health Assessment Tool; Bank Analysis Tool)—or go beyond banks and the domestic economy (e.g., "Ms. Muffet", Cervantes and others, 2014; and the Systemic Risk Tracker, Iossifov and Dutra, 2021). These approaches allow for model-free, simple comparisons of vulnerabilities over time or across countries, IMF 2021.

Advances in the toolkit have also emphasized understanding the role of financial conditions and asset prices in financial stability, both from a domestic perspective and with a forward looking perspective. The Growth-at-Risk tool links the changes in financial conditions to the risks for future GDP growth, and its extensions (e.g., Capital Flows-at-Risk) allow to estimate the effects of macrofinancial vulnerabilities on the future distribution of capital flows and evaluate policy actions to mitigate associated risks. other tools allow allows to examine the extent to which asset valuations may have deviated from fundamentals (e.g., Equity Market–Valuation Multiples, Real Estate Markets Module) or to detect anomalies in bond prices (Bond Market Valuation Metrics), IMF (2021)

The main instrument of prudential regulation still consists of a risk-weighted capital ratio. The problem of this ratio is that its computation is based on a definition of risk that does not allow to capture either fat-tailed risks and/or risks with no historical record, which are precisely great sources of systemic risk. Such a definition entirely rests on mathematical models that define upcoming risk as to the mere reflection of risk as it materialized in the past. Implicitly, the capital constraints to which banks are subject are thus calculated according to a risk that is not supposed to differ radically from the way it has historically materialized. Such a hypothesis is completely irrelevant when the risks considered are, by nature, too rare to be statistically significant and thus accounted for in probabilistic models, Quang and Scialom(2021).

2. Covid-19 pandemic: a world storm

a- Socio-economic effect

The impact of the financial crisis in developing countries was not immediate like the industrialized countries, but the impact of covid is global and significant in the Africa region. The COVID-19 contamination led to the most profound "post-war" downturn and continued slump and kept on blurring the outlook.

The health crisis eliminated the domestic demand reducing the share of the investment to GDP and the deposit to GDP ratio by around 44% and 70% in 2020 relative to 2019. Simultaneously, decreased exportation and travel restrictions, reduced tourism by around 47%, and dropped industry and textiles' export by 27% in the mid-2020, World Bank (2020). It will also lead to urgent budget and balance of payments financing needs of 2.6 and 4.7 percent of GDP in 2020, respectively, with huge drawback risks due to exceptional uncertainty. (africa report)

These losses occur in already fragile countries by political instability (Libya, Tunisia, Algeria) and macroeconomic imbalances, they have greatly suffered from falling touristic revenues and remittances, both being fundamentals to sustain their balance of payments.

For rentier economies like Algeria and Libya, the COVID-19 crisis had had a far greater impact when the oil counter-shock of April 2020 led to a severe drop in global crude oil prices. As a result, the Libyan GDP dramatically contracted by 55,7% in 2020, in addition to a drastic deterioration of the foreign currency reserves and an increase in public debt.

The downturn triggered by the pandemic threatened to affect the banking and financial sector, notably through an increased risk of defaults of financial institutions, prompting central banks to intervene.

b- Financial effect

The impact of the coronavirus disease 2019 (COVID-19) is likely to have a lasting and detrimental effect on the economy. While the depth and length of the economic downturn remain uncertain, there is already evidence of stress at both the household and business levels, with small businesses of particular concern. Even in the financial side the damage cause by the coronavirus pandemic is very important than in those of the financial crisis.

These instrument aims to resolve financial risk. The COVID-19 shock which affects the world are sources of triggering of these risks do not coincide with the financial crisis. Consequently, the effectiveness of macroprudential measures remains limited to materialize the effect of the financial crisis.

3. Understanding the macroprudential policy gap

Systemic risk is multi-dimensional: it can be rising in one dimension while falling in another dimension. Therefore, policymakers should start with a comprehensive and rigorous analysis of systemic vulnerabilities (IMF, 2014b) to form a view about the extent of systemic risk and its sources. These vulnerabilities can be time-varying or structural and can be broad-based or sectoral. Hence, To assess the build-up of systemic vulnerabilities over time, the analysis should consider, where relevant: (i) economy-wide vulnerabilities from excessive growth in total credit; (ii) sectoral vulnerabilities (e.g., balance sheet health of households, financial and non-financial corporates, and governments) and the potential for macrofinancial feedback loops; and (iii) vulnerabilities from excessive maturity and currency mismatches. IMF(2021)

In the financial crisis, Systemic risk emerges from the presence of financial distortions that can lead to a build-up of vulnerabilities over time and/or to structural vulnerabilities within the financial system (IMF, 2014b). These vulnerabilities could amplify negative aggregate shocks, increase financial stability risks, and have serious adverse effects on the real economy through negative feedback loops. The macroprudential policy seeks to contain those vulnerabilities and increase the resilience of the system to aggregate shocks, and ultimately to reduce the frequency and severity of financial crises.

Despite that the covid crisis call for radical reform to limit the damage, the financial regulation remains largely imbued with macroprudential measures used in the context of the financial

crisis. Now the origin of the crisis is different and the economic and financial situation of many countries differ also.

4. Decision-making under radical uncertainty: case study of monetary and macroprudential measures in Tunisia and South Africa

Compared to past crisis episodes, there are two main reasons why the covid-19 and is not like the others. First, after the financial crisis, the banking system has paled different roles to manage the damage of both crises. in terms of capital and liquidity, the banking sector in many countries around the world was much better prepared than it was before the great financial crisis. This was not least due to the progress made over the past decade in strengthening the regulatory standards for banks and moving towards bank technologies.

South Africa has a strong and resilient banking system with adequate levels of capital and significant liquidity buffers to manage this stress. The Basel framework, around which bank regulations are structured, has built-in buffers on both the capital and liquidity elements of the regulation for banks to draw on during times of financial stress.

SARB takes many measures to mitigate the impact of COVID-19, while at the same time pointing out that South Africa's banking system is robust and well-capitalized. the South African Reserve Bank (SARB) carries out regulatory relief measures as well as guidance to banks in managing the crisis. The regulatory relief measures are provided for in three areas, namely capital relief on restructured loans that were in good standing before the COVID-19 crisis, a lower liquidity coverage ratio (LCR), and lower capital requirements.

in addition it modifies the law on Restructured restructures, which means that for the duration of the crisis, loans restructured as a result of the impact of COVID-19 will not attract a higher capital charge. This amendment covers loans to households, small- and medium-sized businesses and corporates, and for specialized lending.

On the macroprudential side, several national authorities either announced a full release of countercyclical capital buffers or revoked previously announced increases to these and other buffers. Together, the micro- and macroprudential measures were a strong signal to banks that they should make use of their existing capital buffers to continue to provide key financial services and absorb losses while avoiding abrupt and excessive deleveraging that would be harmful to the economy.

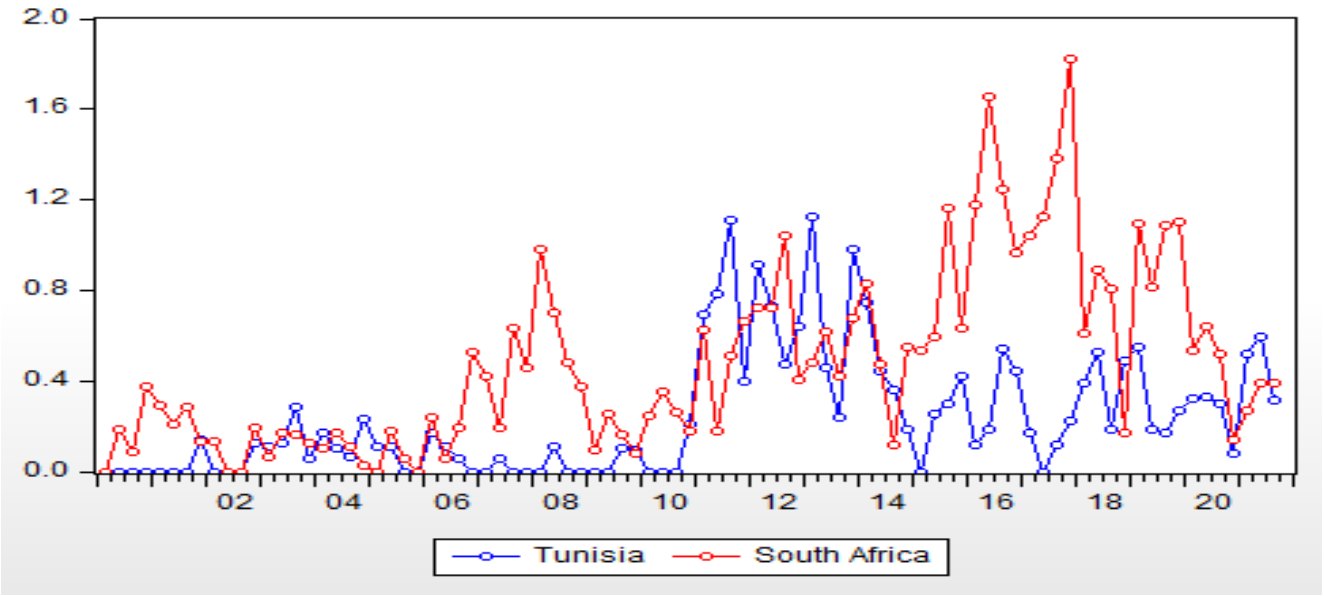
The Prudential Authority of SARB has announced regulatory relief measures and published guidance for banks to ease the impact of COVID-19 pandemic. The Prudential Authority has issued Directives on temporary measures to aid compliance with liquidity coverage ratio or LCR (D1/2020), to provide temporary capital relief (D2/2020), and on treatment of restructured credit exposures (D3/2020). The Prudential Authority also issued guidance notes on matters related to IFRS 9 (G3/2020) and on recommendations for distribution of dividends on ordinary shares and payment of cash bonuses to executive officers and material risk-takers (G4/2020).

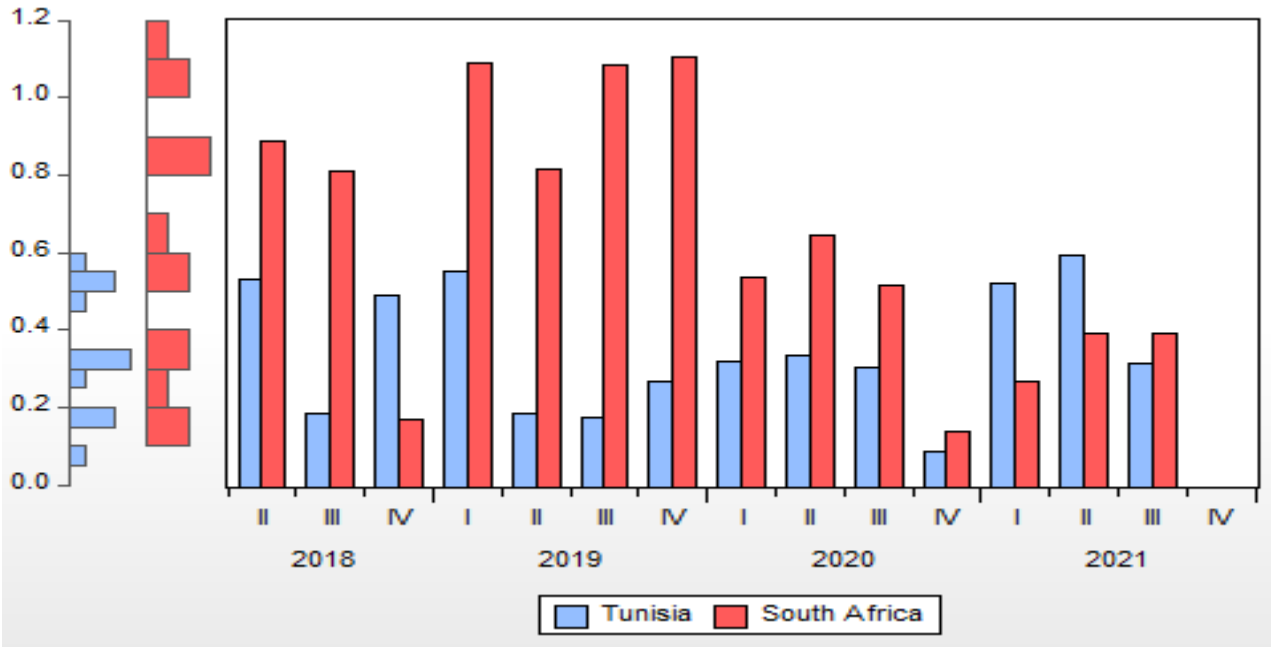
Reducing the fiscal deficit to 3.9 percent of GDP in 2019 will require unwavering discipline. The authorities' strategy relies on strong revenue collection, targeted energy subsidy reforms with improved communication, and tight wage bill management. The budget allows for maintaining growth-enhancing investment and increasing social spending, but there is no room for relaxing the effort on taxes or current expenditure after the recent increase in civil service wages.

Central bank	Monetary policy framework	Sustainable objective
Central Bank of Tunisia	Inflation target framework Use the policy interest rate as a main instrument	Monetary policy needs to focus on maintaining price stability. Additional policy rate hikes would be warranted if inflation projections for December 2019 exceed the target. Success with disinflation will also depend on reducing central bank refinancing and on reforming the collateral framework, while preserving financial stability
SARB	Use the policy interest rate and central banking reserve as a main instrument Inflation target framework	The primary purpose of the Bank is to achieve and maintain price stability in the interest of balanced and sustainable economic growth. Together with other institutions, it also plays a pivotal role in ensuring financial stability. achieve and maintain stable financial conditions in the country "The primary objective of the Bank shall be to protect the value of the currency of the Republic in the interest of **balanced and sustainable economic growth in the Republic**"

Going forward, central banks face the challenge of appropriately modulating their policy response to the stage of the pandemic and the strength of the recovery. In addition, after a protracted period of accommodative monetary policy, macroprudential policy is key to contain risks for financial stability.

Finally, some emerging market economies may need to use other instruments of the toolkit, such as foreign exchange intervention or capital flow management measures, to preserve stability.





5. The Structure of the DSGE model with COVID-19

This section presents the model structure for both Tunisia and South Africa economies. the DSGE model build from the model of Rannenber (2016) and Can and al (2021).

. Households

The economy features by a representative household who is infinitely-lived and determine their consumption,C_t , and labor supply, l_t ,, so that to maximize the following utility function:

$$U^f = E_t\left\{\sum_{i=0}^{\infty}\beta^i\left[covid_t^{\,covidshock1}\ln(C_{t+i} - hC_{t+i-1}) + \tau_l covid_t^{\,covidshock2}\ \frac{\nu}{1+\varphi}\ (1 - l_{t+i}^{s})^{1+\varphi}\right]\right\} \quad (1)$$

Where E_t is the expectation operator,β^i is the household's subjective discount rate and h denotes the degree of internal habit formation. τ_l is a preference parameters associated to leisure and φ is the intertemporal elasticity associated with labor supply. Covid is a random variable which represent as a first order autoregressive process, i.e AR (1). In this paper, we suppose that the Covid-19 shock affects households via the consumption and labor supply and bank via its effect on the result of the expected final wealth. This shock is independent of the other shocks and identically distributed.

The household saves by depositing funds with banks and by buying government bonds at a nominal risk-free rate[1].

This household is subject to the following budgetary constraint: $P_tC_t = w_tP_tl_{t+}\,P_t\,prof_t + R_{t-1}B_{t-1}^T - B_t^T - P_tT_t$

The household receives the real wage,w_t from supplying labor to retailers and derive profit income from their ownership of retail firms and capital goods producers. $B_{t-1}^T$is the financial assets (deposit and government bonds) owned by the households at the end of period t-1 remunerated in period t with a nominal risk-free rate, R_{t-1}. These revenues are exploited in the purchase of retailer goods C_t at an aggregate price P_t, payment taxes T_t, and invest their financial assets.

2. Capital Goods Producers

Capital goods produce are owned by households. They produce new capital goods using a technology that yields $1 - \frac{\eta_i}{2}\left(\frac{I_{t+i}}{I_{t+i-1}} - 1\right)^2$ capital goods for each unit of investment expenditures I_t, with $\eta i \geq 0$ denoting the curvature of the investment adjustment cost. Capital goods are sold to entrepreneurs at currency price P_t Q_t. The real expected profits of the capital goods producer are then given by

$$E_t\left\{\sum_{i=0}^{\infty}\frac{\varrho_{t+i}}{\varrho_t}\beta^i I_{t+i}\left[Q_{t+i}\left(1 - \frac{\eta_i}{2}\left(\frac{I_{t+i}}{I_{t+i-1}} - 1\right)^2\right) - 1\right]\right\} \quad (2)$$

ϱ_t denotes the marginal utility of real income of the household.

[1] We assume that both assets have the same maturity and therefore they are perfectly substitutable and earn the same interest rate.

3. Retailers

The retailers are indexed by i and produce the varieties of the products consumed. Each retailer operates under monopolistic competition and is owned by households, with the demand for its product given by $Y_t(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\epsilon} Y_t$

Where : $\epsilon > 1$ is the elasticity of substitution between different varieties. Retailers use the labor force $l_t(i)$ of the households and rent capital services $K_t^s(i)$ at the rental rate r_t^k from entrepreneurs. Hence, the production of the retailer firm i is as follow:

$$Y_t(i) = \exp(\Omega_t)\,(K_t^s(i))^{\alpha}(e)l_t(i))^{1-\alpha} \quad (4)$$

Retailers are subject to nominal rigidities in the form of Calvo (1983) contracts witch mean that only a fraction, $1 - \xi^P$, is allowed to optimize their price in a given period. The firms that are not allowed to optimize their prices index them to past inflation at a rate γ_P and the steady-state inflation rate at rate $1 - \gamma_p$.

4. Bankers

The financial intermediation is risk-neutral and dies with a fixed probability $1 - \theta$ after receiving the interest income on the loans they supply in the precedent period. If banker q dies, he consumes his accumulated real net worth $N_t^b(q)$ at the end of period t. Dying bankers are substituted by new ones who receive a transfer N_n^b from households, which under the calibration presented very small, as Badarau and Popescu (2014).

The model assumes that Banks derive income from offering loans to nonfinancial firms[2]. Banker attributes two kinds of credits. The first kind is "risky inter period loans". The $B_t(q)$, to entrepreneurs who need to purchase their capital stock at the period t+1. These credits are due at the starting of period t + 1. The second kind is "risk-free intro period working capital loans", $L_t^r(q)$, to retailers who used to pay for the labor and capital services dedicated to the production at the end of period t.

The financial friction is introduced in the model through the fact that, after collecting deposits, the banker can distract a fraction of assets collected from the household and declare bankruptcy, if the bank is not adequately profitable(the moral hazard problem). This implies that the ability of a bank to attract deposits and to extend loans to entrepreneurs is positively related to its current net worth and its expected future wealth. Therefore, the intermediaries' leverage ratio is facing an endogenous constraint. This constraint held on bank capacity to offer credit is playing an amplification role similar to the financial accelerator in the Bernanke et al. (1999) model. This problem of moral hazard only concerns the management of inter period credit and friction in a banks-entrepreneurs relationship.

Specifically, a banker can deflect a part $0 \leq \lambda \leq 1$ of loans to entrepreneurs and use it. In this case, the banker declares bankruptcy and households recuperate the residual assets. This signifies that households will only make deposits if the banker has no incentive to default, that is, if $[V_t^b(q) > \lambda L_t^e(q)]$, where $V_t^b(q)$ denotes the value of banker q's expected final wealth

$$V_t^b(q) = E_t\left\{\sum_{i=0}^{\infty}(1-\theta)\theta^i covidshock_t\left(\frac{1}{\prod_{j=0}^{i} R_{t+1+j}^r}\right)N_{t+1+i}^b(q)\right\}, \quad R_{t+1}^r = \frac{R_t}{\Pi_{t+1}} \quad (5)$$

[2]Gertler and Karadi (2011) assume that banks derive profit by buying equity stakes, which makes them owners

In the management of intra-period credits, there is no moral hazard problem between bankers and depositors, and also no friction in the bank–retailer relationship. Hence, the equilibrium credit rate equals the deposit rate, indicating that banks do not attract profit in this management. The intra-period credits activity thus is not affected by $N_t^b(q)$ and $V_t^b(q)$, and therefore does not affect on lending to entrepreneurs.

To offer credit, the bank uses its own net worth (accumulated capital), $N_t^b(q)$, and the nominal deposits collected from households $B_t(q)$. Hence, $P_t L_t^e(q) = P_t N_t^b(q) + B_t(q)$.

The bank net worth is given by:

$$P_t N_t^b(q) = [R_t^b P_{t-1} L_{t-1}^e(q) - R_{t-1} B_{t-1}(q)]\exp(e_t^z)$$
$$= P_{t-1}\left[\left(R_t^b R_{t-1}\right)L_{t-1}^e(q) + R_{t-1} N_{t-1}^b(q)\right]\exp(e_t^z) \quad (6)$$

Where R_t^b is the net average return the bank wins on the inter period loan supply in period t-1. e_t^z is an exogenous capital shock. The model assumes that all banks choose the identical ratio between inter period loans (loans to entrepreneurs) and their net worth. Therefore, $L_t^e = \emptyset_t^b N_t^b$, where $\emptyset_t^b$ is the endogenous bank leverage. The variability $\emptyset_t^b$ is crucial for the results and it presents the main parameters for the total leverage, i.e. the ratio of total loans to bank net worth L_t / N_t^b

N_t^b is composed of the net worth of bank exist in the mark at the period t, N_{et}^b, and net worth of new bankers, N_n^b.

$$N_t^b = N_{et}^b + N_n^b$$

N_{et}^b is given by $\mathrm{N_{et}^b} = \theta_{\mathrm{Z_{t-1,t}}}\mathrm{N_{t-1}^b}$,

$Z_{t-1,t} = \frac{[(R_t^b - R_{t-1})\emptyset_{t-1}^b + R_{t-1}]}{\pi_t}\exp(e_t^z)$

where $Z_{t-1,t}$,t is the growth rate of the real net worth of the bankers in period t − 1 and who is already in activity in period t.

In the equilibrium, we assume that V_t^b (q) = λL_t^e (q), and thus λ is calibrated so that it check this incentive compatibility constraint. If we divide both sides of the incentive constraint by $N_t^b(q)$ we obtained $\lambda\emptyset_t^b = \frac{V_t^b}{N_t^b}$ (remember that $L_t^e = \emptyset_t^b N_t^b$,).

Where $\frac{V_t^b}{N_t^b}$, measure the bank profitability since it presents the ratio of the anticipated value of being a banker to the net worth of the bank in the period t. this constraint can be expressed as

$$\widehat{\emptyset}_t^b = \hat{L}_t^e - \hat{N}_t^b$$
$$\widehat{\emptyset}_t^b = E_t\left\{\theta\beta^2 Z^2 \widehat{\emptyset}_{t+1}^b + \emptyset^b \frac{R^b}{R}\left(\hat{R}_{t+1}^b - R_t\right)\right\} \quad (7)$$

The equation shows that the Bank leverage positively related to the anticipated sum of profit margins on loan supply in period t and $\hat{R}_{t+1+i}^b - R_{t+i}$d after.

1. Entrepreneurs

At the end of period t, the risk-neutral entrepreneur j buys capital K_t^j for price P_t Q_t. In period t + 1, the entrepreneur rents part of his capital stock to retailers at a rental rate P_{t+1}

R_{t+1}^{k} and then sells the non-depreciated capital stock at price$P_{t+1}Q_{t+1}$. The average return to capital across entrepreneurs is given by

$$R_t^K = \Pi_{t+1} \frac{r_{t+1}^k + Q_{t+1}(1-\delta)}{Q_t} \quad (8)$$

The gross nominal return on capital is affected by an idiosyncratic shock,ω_{t+1}^j, generating a posterior heterogeneity among entrepreneurs. It presents in a log-normal distribution with mean 1, and variance σ^2. Thus, the posterior assets return of the entrepreneur are $\omega_{t+1}^j R_{t+1}^K K_t^j P_t Q_t$.

To finance investment, the entrepreneur uses his net worth, $P_t N_t^j$, and the credit, $P_t L_t^j$, borrowers from the bank at a gross nominal loan rate, R_t^L. Where $P_t L_t^j = P_t(Q_t K_t^j - N_t^j)$. Loan and interest are repaid in period t + 1. Therefore, there exists a threshold value, ϖ_{t+1}^j, below which the return to the investment project is not sufficient to refund the bank loan. This threshold is defined such thus the posterior gross return on capital is equal to the loan borrowed by the bank: $\omega_{t+1}^j R_{t+1}^K K_t^j P_t Q_t = R_{t+1}^L P_t L_{t+1}^j$

The presence of idiosyncratic risk gives rise to asymmetric information between the borrower and the bank regarding the outcome of the investment project. The bank proceeds to a costly state verification (Townsend 1979) only if the entrepreneur defaults, that is, when $\omega_{t+1}^j < \varpi_{t+1}^j$. In this case, the bank pays a fraction, μ, to check "the true value" of the borrower and which is proportional to the posterior gross return, $\mu\omega_{t+1}^j R_{t+1}^K K_t^j P_t Q_t$.

Like the bank's program, the model supposes that after the realization of ω_{t+1}^{j} R_{t+1}^{K}, entrepreneurs die with a fixed probability $1-\gamma$. Dying entrepreneurs consume their equity V_t. This assumption ensures that entrepreneurs never become fully self-financing. The fraction $1-\gamma$ of entrepreneurs who have died are replaced by new entrepreneurs in each period who receive a transfer. We form households, which under our calibration is very small.

Following Christiano and al. (2010), any debt contract between the entrepreneur and the bank (L_t^j, R_t^L) has to yield an expected revenue to the bank such that its expected return on these loans equals Et Rtb+1. Hence, the participation constraint of banks in the market for loans to entrepreneurs is given by

$$P_t L_t^j R_t = R_{t+1}^L P_t L_t^j \int_{\overline{\omega}_{t+1}^j}^{\infty} f(\omega^j) d\omega^j + (1-\mu) R_{t+1}^K P_t Q_t K_t^j \int_0^{\overline{\omega}_{t+1}^j} \omega^j f(\omega^j) d\omega^j . \quad (12)$$

This equation shows that in expectation level the entrepreneurial sector supports all costs related with bankruptcy via the loan rate. That is, it supports a very high-interest rate which covers also the bankruptcy costs of the bank.

Rannenberg (2016) demonstrates that all entrepreneurs choose the same leverage $\varphi_t^e = Q_t N_t K_t$, implying that ω_{t+1}^{j} is the same across all firms as well[3]. Up to first order, these equations give rise to a relationship between E_t R_{t+1}^{K} and E_t R_{t+1}^{b} as follow: $E_t\hat{R}_{t+1}^K - E_t\hat{R}_{t+1}^b = \chi'(\hat{K}_t + \hat{Q}_t - \hat{N}_t)$

[3] Refer to Rannenberg (2016), Appendix A.4 for more details on the entrepreneur's maximization program.

Where $\chi' \geq 0$. Higher entrepreneurial leverage increases the probability of bankruptcy and thus expected marginal bankruptcy costs, which requires an increase in the entrepreneurial quasi-profit margin, $E_t\hat{R}^K_{t+1}/E_t\hat{R}^b_{t+1}$.
Finally, the total entrepreneurial net worth at the end of period t consists of that part of entrepreneurial equity V_t not consumed by dying entrepreneurs and a transfer from households to entrepreneurs W^e., $N_t = \gamma V_t + W^e$

2. Monetary Policy measure

The central bank determines the risk-free (nominal) interest rate following the interest feedback rule of the form:

$$R_t - 1 = (1-\rho_i) + [\psi_\pi \log\left(\frac{\log(\pi_t}{\pi}\right)] + [\psi_y \log\left(\frac{((Y_t)}{(\bar{Y}_t)}\right)] \rho_i(R_{t-1}-1)\, e_t^r \quad (9)$$

where, ρ_i is the policy interest rate smoothing , $\psi_\pi$and ψ_y are the coefficient associated to the deviation of the inflation from its target and to the output gap, respectively. e_t^r is serially correlated shock follows AR(1) process.

7. Market equilibrium:

Our model presents these equilibrium equations:

$$S_t = (1-\xi^p)\left(\frac{\Pi_t}{\Pi_t^*}\right)^{\varepsilon} + \xi^p\left(\frac{\Pi_t}{\Pi_{t-1}^{\gamma_p}}\right)^{\epsilon} S_{t-1}$$

$$C_t^p = C_t + C_t^e + C_t^b$$

$$Y_t = S_t\left(I_t + C_t + \frac{R_t^k}{\Pi_t} Q_{t-1}K_{t-1}\mu\int_0^{\varpi_t} \omega f(\omega)d\omega\right)$$

$$GDP_t = I_t + C_t + G_t$$

8. Exogenous shocks process:

In our article, we focus on three shocks: COVID shock, productivity shock, and financial shocks. For each shock, we will consider stochastic processes.
For our first shock, the coronavirus shock denoted indices $covid\ shock_t$ is modelled as an autoregressive process of the ratio of world uncertainty index (WUI) from 2000 Q1-2021 Q3. For Tunisia, the estimation of the autoregressive coefficient ρ_{covid} is 0,85 with a standard deviation ε_{covid} equal to 0,8. For the South Africa, the autoregressive coefficient equal to 0.85 with a standard deviation of 0.7. The Volatility in the both countries is low the persistant is very important , which reflects the low resistance of these two countries to the shock.

$$a_t = \rho_a a_{t-1} + \varepsilon_t^a \qquad \varepsilon_t^a \sim i.i.d\ N(0.1)$$

Our third shock denoted Z_t like a financial choc, specially chock of bank asset growth rate. The autoregressive coefficient of this shock ρ_Z is equal to 0,7 with a standard deviation σ_Z equal to 5%. The volatility of the atmospheric temperature has a slowly increasing because Tunisia is a Mediterranean country.

$$Z_t = \rho_Z Z_{t-1} + \varepsilon_t^Z \qquad \varepsilon_t^Z \sim i.i.d\ N(0.1)$$

9. Calibration of the DSGE model

The DSGE model which are exposed in detail by Rannenberg (2016) and we add the covid shock of Can and al (2021). The parameters of this model are calibrated in this section using Dynare 4.4.2 developed by Adjemian et al. (2012) and MATLAB R2016a. We calibrate the model's parameters to broadly match the real data of the Tunisian economy at the quarterly frequency, from 2000 Q1 to 2020 Q1. All series are referred to as the Central bank of Tunisia (CBT) and from the national statistics institute of Tunisia (INS).

However, if parameters cannot be available from data their value is calibrated from similar model mechanisms. Hence, the choice of parameter values that we will use for our quantitative analysis consists of two sets. The first set contains those that are often used in the relevant literature and are considered conventional values. The second set, on the other hand, is those that are meant to capture the economic features of the Tunisian economy during the tested period.

We set the discount factor of households, β, at 0,983. for the retail sector, we fix, $\xi_p$equal to 0,75, which is amply classic in the DSGE literature. This signifies an average time of four quarters. The monitoring cost,μ, is set to respect the bankruptcy costs estimated by Carlstrom and Fuerst (1997). Finally, we assume that retailers have to wholly pre-finance their capital and labor costs via working capital loans, thus $\psi_k$and ψ_l=1.

The capital elasticity of output (α), the depreciation rate of capital, δ, and the elasticity of work disutility,φ,are fixed at 0.35, and 0.025 and 0.25 respectively as cited by Belhadj and Abdeli (2015).

parameter	***description***	***value***
φ	The elasticity of work disutility	0.25
β	Subjective discount factor	0.985
μ	Monitoring cost	0.298
α	The capital elasticity of output	0.35
ξ_p	Calvo parameters	0.75
δ	Capital depreciation rate	0.025
γ_p	Degree of price indexation	0.3
ψ_l	share of wage bill that retailers finance by loan	1
ψ_k	share of capital bill that retailers finance by loan	1
$R^L - R$	The spread of the loan rate to the nominal risk-free rate	1.40%
$(1-\theta)$	The probability of bankruptcy	0.1%
	Banks leverage ratio	1/0.125
$\frac{N^b}{L}$	Bank capital ratio, percent	**5.694%**

Some of the parameters relating to the various frictions in the banking and entrepreneurial sector are calibrated such that the steady-state values of the key financial variables in the model match their averages in the real data. This methodology is also applied by Renbergenn (2016), Christiano and al (2010), Meh and Moran (2010), and Bernanke, et al. (1999), the standard deviation of an idiosyncratic productivity shock, σ, is equal to 0.35, according to Ranbergen (2016).

The leverage ratio by which Tunisian banks were subject since 1999 is set at 8%.The spread $R^L - R$ is calibrated such that the quarterly interest rate margin is equal to 1.40%[4]. This percentage is attached to that estimated by Levin, Natalucci, and Zakrajsek (2006) for 796 and over the period 1997Q1–2004Q4.The target $\frac{N^b}{L}$is calculated according to the Basel I agreement, which represents the average ratio between tangible common equity (TCE) and the total credit granted to the economy. Since the banking sector is supported by the Tunisian central bank, so, we set the probability of bank death $1 - \theta$ to 0.01%.

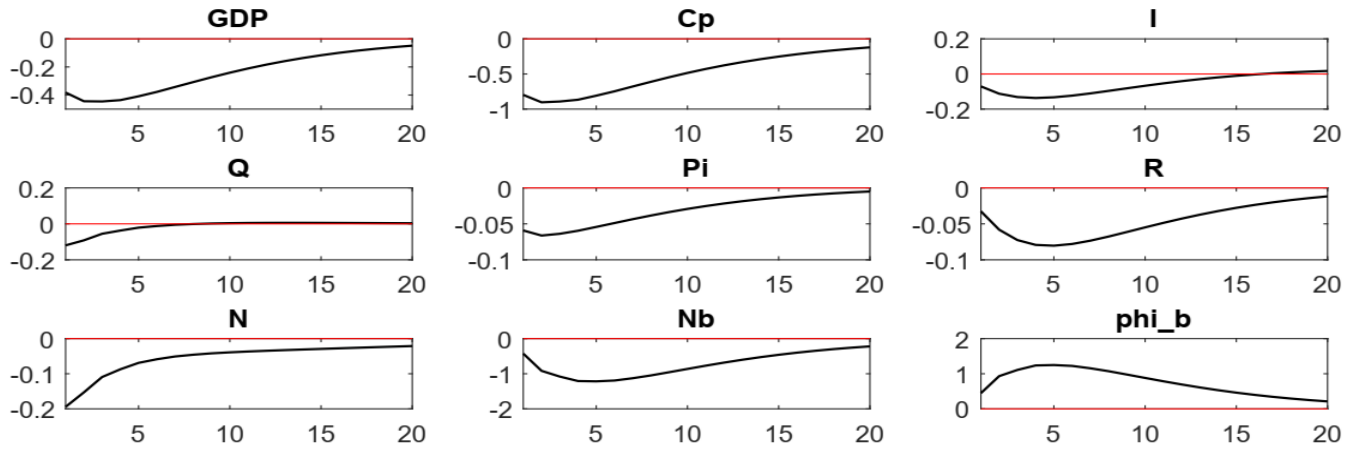
It is concretely supposed that firms have a higher default probability than banks, that is why we set the steady-state probability of firms failure, $1 - \gamma$ at 10%, Jouni and Rebei (2013). The share of assets delivered to the new banks,W^b, is set to 0.0001[5]. We calculate, on the same sample period, the bank capital ratio, $\frac{N^b}{L}$, with noted the average ratio between the bank net worth, available in the dataStream database, and the total debts. To correspond to the data this ratio is set to 5.694%.

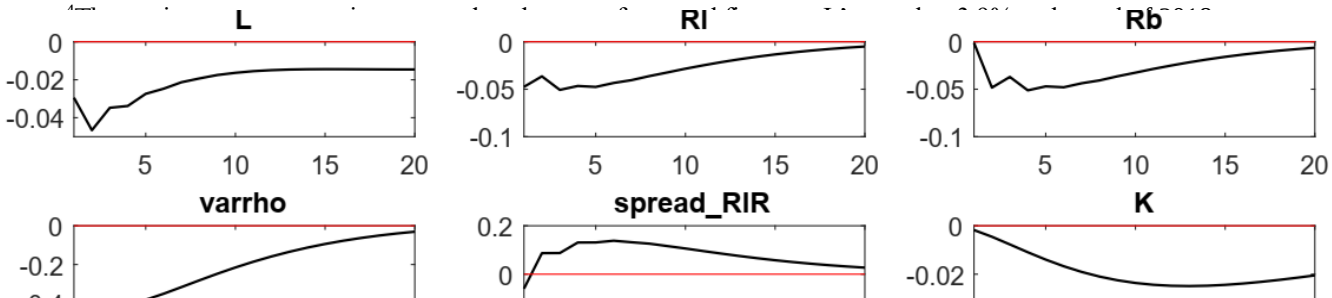
For the policy rule, we following the same parameters used by Alimi and al. (2017). We set the inflation coefficient,ψ_π, equal to 1.53, the output gap coefficient,ψ_y, equal to 0.48, and the smoothing parameters, ρ_i, equal to 0.3.

6. The interpretation of results

Economy reaction following the Coronavirus shock

Our objective is to analyze the effectiveness of monetary and macroprudential policies in the framework of coronavirus pandemic shock. Among over 40 endogenous variables in the model, simulations will be conducted on selected ones. The relevant subset will include real and financial variables, chosen according to their ability to trace the impacts of Covid-19 on these two spheres. The chosen endogenous variables are production, GDP, general consumption ,Cp , investment I, capital price, Q, inflation,PI, policy interest rate, R, entrepreneur and bank net worth, N and Nb respectively. Bank leverage ratio phi_b, total loan, L, return to assets and return to capital , RI and Rb, marginal utility of consumption varrho, credit spread, spread RIR, physical capital, K, Coronavirus pandemic, covid and the probability of default function, omega_bar_prime.





7. Conclusion and Policy recommendation : COVID-19 crisis call for a radical change in monetary and macroprudential policy:

Compared to past crisis episodes, there are two main reasons why the covid-19 is not like the others. First, after the financial crisis, the banking system has paled different roles to manage the damage of both crises. in terms of capital and liquidity, the banking sector in many countries around the world was much better prepared than it was before the great financial crisis. This was not least due to the progress made over the past decade in strengthening the regulatory standards for banks and moving towards bank technologies.

Second, credit provision during the pandemic has been aided by decisive government support measures, such as public loan guarantees and direct and indirect support to firms, and by relief measures taken by micro-and macroprudential authorities. Specifically, for Tunisia, the BCT organizes the first joint event with financial inclusion (AFI) on strengthening agent networks for digital financial services. the governor of the CBT announce that the promotion of innovation in the financial sector is crucial to achieving financial inclusion, and that is why the CBT conceived a whole strategy to act as a facilitator for innovative actors. So, there is a key challenge for the future African macroprudential policy after the COVID-19 pandemic.

The decision-makers take many analysis to attenuate and limit the damage of covid: we can regroup these analyses in three big points which are relevant for Tunisia and South Africa and which approach with their financial market structure and their nature of the monetary policy.

First, the creation of macroprudential space should be capital-neutral. In other words, it should be achieved by amending or rebalancing certain existing buffer requirements rather than by creating additional buffer requirements for banks. ... Second, the additional macroprudential space created in this way needs to have strong governance in order to ensure that capital buffers are released in a consistent and predictable way across countries when facing severe, system-wide economic stress. ..

Third, considerations to create macroprudential space should focus on options that ensure continued compliance with applicable international standards set by the Basel Committee. The capital conservation buffer would be a natural candidate for creating macroprudential space if it was made releasable in a context where these principles were adhered to. Specifically, the possible release of the capital conservation buffer in a system-wide crisis should be centrally

governed in both countries and could be combined with dividend restrictions in order to maintain equivalence with international standards.

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