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Rim Arem[1] Mahmoud Sami Nabi[2] and Houda Boubaker[3]

South Mediterranean University (SMU)-Mediterranean School of Business (MSB)

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1. Introduction

The 2007-2008 financial crisis abruptly ended a long period of economic stability, prompting economists to reconsider the role of the financial sector and to reassess its macroeconomic impact. On one hand, this crisis was caused by “credit boom” triggered by household expectations of rising housing prices, and by “housing bubble” generated by the sharp rise in housing prices by investors due to an increase in demand, on the other hand. Different approaches have been developed in the literature to address the crisis issues and to investigate the potential reasons. Most of these researches have focused on the financial accelerator effect.

The term financial accelerator is used to reflect the amplification of economic shocks and their propagation mechanism. It aims to explain how relatively small economic shocks can have large and persistent effects on the aggregate economic activity due to the financial market imperfections (Bruno, 2011). The different modeling approaches of the financial accelerator reflect the variety of the asymmetric information problems between borrowers and lenders. They reflect the various participants' attitudes toward whether they can overcome the problem of asymmetric information or not. The financial accelerator effect has been used to explain the bank lending channel as well.

The approach developed by Bernanke et al. (1999) relies on the interplay between economic agents’ net worth and the external finance premium that arises because of the asymmetric

[1] Rim Arem: SMU-MSB, assistant professor, 1053 Les Berges du Lac II Walkway, Tunis, « LEGI Laboratory» (+216) 71194444, rim.arem@msb.tn

[2] Mahmoud Sami Nabi

[3] Houda Boubaker: SMU-MSB, assistant professor, 1053 Les Berges du Lac II Walkway, Tunis, MASE Laboratory ,(+216) 71194444, houda.boubaker@smu.tn

information between lenders and borrowers. Which is widely adopted by other researchers. This model provides explanation from the supply side of credit to firms.

Another approach, from a demand side of credit, suggested by Gertler and Karadi (2011) in that the financial accelerator effect emerges due to an asymmetric information problem that constrains the ability of banks to obtain funds from depositors as well as in wholesale ("inter-bank") financial markets. They established, also, the information-based financial market imperfections as a channel through which monetary policy measures influence aggregate economic activity.

In this paper, we attempt to investigate a combined model where the two types of financial frictions are coupled to provide a comprehensive investigation of monetary policy conduct in Tunisia.

The challenge for the Tunisian economy, which is our main contribution, is to develop a model that rationalizes the four stylized facts, that are: (1) Households' reluctance to save their money in the bank, (2) the entrepreneurs borrowing cost depends on their leverage, (3) 40% of the banks' loans cover the government budgetary deficit, and (4) The banks capacity to grant credits is constrained by a new macro-prudential measure (the credit/deposit ratio) introduced in 2018 by the CBT.

The aim of this paper is to explore the impacts of the monetary policy changes on credit demand and supply and their implications in the Tunisian context using a DSGE model by exploring financial accelerator effects. Our main contribution is to fill the gap in the Arab countries by exploring the role of financial frictions from the supply and demand side.

The final paper will be organized as follows. Section 2 will present the financial frictions in the of Tunisian economy. The literature about the DSGE models in Tunisia and emerging countries characteristics will be reviewed in section 3. In section 4 we will describe our model the methodology and data used in this study. The results of the DSGE model analysis will be given on section 5. In the last section, we will deal with conclusion and policy implications.

2. The importance of the financial accelerator

The term financial accelerator is used to reflect the amplification of economic shocks and their propagation mechanism. It aims to explain how relatively small economic shocks can have large and persistent effects on the aggregate economic activity due to the financial market imperfections (Bruno, 2011). The different modeling approaches of the financial accelerator reflect the variety of asymmetric information problems between borrowers and lenders. They also reflect the various participants' attitudes (that try to overcome the problem of asymmetric information), as well as the different types of borrowers' economic activities (that can be affected by the financial markets imperfections). Recently, the financial accelerator effect has been used to explain the bank lending channel as well. In fact, the monetary policy can influence the aggregate economic activity through changes in loan supply. For example, the tightening of monetary policy reduces the banks' capacity of lending, which causes a decline in loan supply, a credit crunch that negatively impacts the overall economic activity.

Moreover, it is extremely complicated to build a model that includes all the possible aspects in which the asymmetric information problems may arise as sources of the financial accelerator effect. Hence, the strategy adopted by researchers is to use one particular aspect of asymmetric information problems. As a result, various models adopted different formulations of the financial accelerator. Generally, there are four major types of modeling approaches used by researchers to include the financial accelerator effect into general equilibrium models. The first approach established by Greenwald and Stiglitz (1993) considers asymmetric information on equity markets and managers' risk aversion as the cause of this effect. This formulation does not depend on the existence of the external financial premium. It still produces amplification of aggregate economic fluctuations due to asymmetric information and the procyclicality of firms' net worth. The second approach is proposed by Bernanke and Gertler (1989), which constructs a general equilibrium model with incomplete financial markets. The model relies on the interplay between economic agents' net worth and the external finance premium that arises due to asymmetric information between lenders and borrowers. This approach is widely adopted by other researchers (e.g. Bernanke et al, 1999; Aoki et al, 2004; Gertler et al, 2007; Christiansen and Dib, 2008; Portes and Ozenbas, 2009; and Freedman et al, 2010). The third approach is suggested by Kiyotaki and Moor (1997) which considers informational asymmetry on credit markets as the cause of the financial accelerator effect. A modified version of this approach is adopted by Bernanke and Gertler (1989) who considers that lenders are not able to enforce debt repayment by any means. This version is adopted and further developed by Kiyotaki (1998), Iacoviello (2005), Monacelli (2009) and Martin and Ventura (2010). The last approach is developed by Gertler and Kiyotaki (2010) which proposes a general equilibrium model in which the financial accelerator effect emerges due to an asymmetric information problem that constrains the ability of banks to obtain funds from depositors as well as in the wholesale ("inter-bank") financial markets. According to this approach, the information-based financial market imperfections is the channel through which monetary policy influences the aggregate economic activity (e.g. Adrian and Shin, 2011; Gertler and Karadi, 2011).

In our study we build on Gerlter and Karadi (2011)'s model and adapt it to the Tunisian context. Therefore, we propose a quantitative monetary DSGE model with financial intermediaries that face regulatory constraints by the central bank as well as enforcement problems of the defaulting loans.

III. Review of the DSGE modelling literature applied to the Tunisian monetary policy

There are few studies analyzing the Tunisian monetary policy using a DSGE model. Nevertheless, in our knowledge none of these papers has explicitly introduced the financial intermediaries in their models. For example, Ben Aissa and Rebei, (2012)'s model evaluates the implementation of inflation targeting. It analyzes the welfare-improving monetary policy reaction functions in the context of a New Keynesian economy model with sticky prices, where fiscal authorities subsidize some of the consumption goods and services. They explore what would be the optimal parametrization of an implementable interest rate rule where the central bank smooths out interest rates, stabilizes inflation measures, and reduces the output gap. Abdelli and Belhadj (2015) analyzes the monetary transmission mechanisms and evaluates the success of the adoption of inflation targeting regime. It also evaluates the effects of the economic shocks and the inflation targeting transmission into the Tunisian economy. To do so the authors use a DSGE model of a closed economy and estimate it by using Bayesian techniques and includes four types of shocks. Alimi et al (2017) explores the factors that hinders the achievement of the objective of price stability. To do this, the authors use a DSGE model of a small open economy, estimate it by using Bayesian techniques and include three different types of structural shocks. Their main conclusion is that the output gap is less sensitive to interest rates, which reduces the impact of the real effects of the monetary policy shocks on aggregate demand. In Ben Romdhane (2020) the role of financial frictions and their importance in the transmission of shocks to the Tunisian Economy is highlighted. Using Bayesian method, it estimates an open economy DSGE model with Bernanke et al. (1999) type of financial accelerator, enriched with imperfect exchange rate passes through and wage rigidities. The existing asymmetric information between entrepreneurs and lenders creates financial frictions that make the demand of capital depending on their financial position.

3. The models:

The DSGE models provide a coherent framework for analyzing policies. Basically, identify structural changes, and sources of fluctuations, forecast and predict the policy changes' effects, and present counterfactual experiments. Also, they highlight the link between structural features of the economy and parameters, something that many macroeconomic models could not easily provide. Note that, as with any new tool, DSGE models need to fit the data and confirm their utility as policy tools.

A DSGE model is dynamic in the sense that it explains how the economy evolves over time. It is stochastic because agents know only the distribution of future shocks thereafter their expected value is zero. Thus, only when these models are linearized to the first order do agents behave as if future shocks are equal to zero, which is the certainty equivalence property. Finally, it is based on a general equilibrium framework as it depicts the macroeconomy as the sum of individual choices and decisions made by firms, households, the government, and the central bank, according to their own preferences and views about the future.

Our model Consists of medium-scale New Keynesian model, with traded consumption of Firm goods and Households. The preferences in consumption and hours are the same as Smets and Wouters (2007). We have a Cobb-Douglas production. The Price and wage stickiness are in the form of staggered Calvo-type price setting. The nominal interest rate is set by the Central Bank in the form of a simple Taylor rule.

In order to introduce the concept of banking, some sort of heterogeneity in the households was needed, so there are two types of household: workers and bankers. The fraction 1 - f of the household members is workers and the fraction f is bankers. Workers supply labor and transfer the wages they earn to the household. Each banker manages a bank and similarly transfers their earnings back to the household. The bank is owned by the household and the bankers manage it. It is important to note that bankers do not own the deposit.

Following Jaimovich and Rebello (2008) we consider the utility function (1) because the Smets and Wouters (2007)'s utility function is less flexible in that it can only target one steady state outcome. However, the Jaimovich and Rebello (2008)'s utility function can target labor supply elasticity and (as we shall see) wealth effect.

$$U_t^j = \frac{\left(C_t^j - k(H_t^j)^{\theta} X_t\right)^{1-\sigma_c} - 1}{1-\sigma_c} \quad \text{with} \quad k \in [0,1] \; \sigma_c > 0 \tag{1}$$

We have $X_t = C_t^j X_{t-1}$ represents the dynamic of agents' consumption path. Its presence as a multiplicative variable with the worked hours, makes preferences non-time-separable in consumption (C_t^j) and the worked hours (H_t^j). These preferences represent special cases of the two classes of utility functions which are most widely used in the business cycle literature. It is clear that U_t^j converges to $\log\left(C_t^j - k{H_t}^{\theta} X_t\right)$ as $\sigma_c \to 1$.

The parameter σ_c is referred to by Smets and Wouters (2007) as the labor supply elasticity. For the log-utility case σ_c is the Frish parameter. SW assume a prior mean of 2 for σ_c. Following Gerlter and Karadi (2011), in a symmetric equilibrium, the household first-order conditions, in relation to the consumption, the stochastic discount factor, and the labor supply are given by :

$1 = E_t\ [\Lambda_{t,t+1} R_{t+1}\ ]$

$\Lambda_{t,t+1} = \beta \frac{\lambda_{t+1}}{\lambda_t}$ with $\lambda_t = U_{C,t} - \gamma \mu_t \frac{X_t}{C_t}$ and $\mu_t = - U_{X,t} + \beta(1\text{-}\gamma) E_t(\frac{\mu_{t+1}\, X_{t+1}}{X_t})$

$\frac{U_{H,t}}{\lambda_t} = - W_t$

When $\gamma = 1$ we obtain the preferences class discussed in King, Plosser, and Rebelo (1988), which we refer to as KPR. When $\gamma = 0$ we obtain the preferences proposed by Greenwood, Hercowitz, and Hu§man (1988), which we refer to as GHH[4]. In line with Jaimovich and Rebello (2008), we assume that $0 < \beta < 1$, $\theta > 1$, H> 0, and $\sigma_c > 0$.

Sticky Prices

First we introduce a retail sector producing differentiated good under monopolistic competition. This sector converts an homogenous output produced by a competitive wholesale sector. The aggregate prices in the two sectors are respectively given by P_t and P_t^W respectively and $P_t > P_t^W$ from the mark-up under the monopolistic competition. The real marginal cost of producing each differentiated good $MC_t \equiv \frac{P_t^W}{P_t}$. In the NK model, retailers are locked into price-contracts and cannot change their prices each period. Hence, their marginal costs vary accordingly. In periods of high demand they simply increase output until they become able to change prices. The retail

[4] Jaimovich and Rebello (2008).

sector uses a homogeneous wholesale good to produce a basket of differentiated goods which contributes to the aggregate consumption of the household as following:

$$C_t = \left[\int_0^1 C_t\,(\mathrm{m})^{\frac{\zeta-1}{\zeta}}\mathrm{dm}\right]^{\zeta/(\zeta-1)} \tag{2}$$

Where ζ >1 is the elasticity of substitution between the retail goods. For each m, the consumer chooses the quantity C_t(m) to consume/purchase at a price P_t(m) to maximize its utility (1) given its total expenditure $\int_0^1 P_t(\mathrm{m})\ C_t$(m)dm. This results in a set of consumption demand equations for each differentiated good (m) with price P_t(m) of the form :

$$C_t(\mathrm{m}) = (\left[\frac{P_t(\mathrm{m})}{P_t}\right]^{-\zeta} C_t \tag{3}$$

Where P_t = $[\int_0^1 P_t^{1-\zeta}(m)\mathrm{dm}]^{\frac{1}{1-\zeta}}$ represents the aggregate price index. Note that C_t and P_t are Dixit-Stiglitz aggregators (Dixit and Stiglitz, 1977). The demand for investment and government services takes similar aggregated form so that the revenue of the producer of the differentiated good (m) is given by:

$$Y_t(\mathrm{m}) = \left[\frac{P_t(\mathrm{m})}{P_t}\right]^{-\zeta}\ Y_t \tag{4}$$

Following Calvo(1983), we now assume that there is a probability of 1-ζ_p at each period that the price of each retail good (m) is set optimally to P_t^0(m). if the price is not re-optimized, then it is held fixed5. For each retail producer (m), given its real marginal cost $\mathrm{M}C_t \equiv \frac{P_t^W}{P_t}$, its objective at time (t) is to determine $\{P_t^0$(m)} that maximizes its discounted real profits

$$E_t \sum_{k=0}^{\infty} \zeta_p^k \frac{\Lambda_{\mathrm{t,t+k}}}{P_{t+k}} Y_{t+k}(\mathrm{m})\ [P_t^0(\mathrm{m})\}\text{-}\ P_{t+k}\ \mathrm{M}C_{t+k}\ ] \tag{5}$$

Given that $Y_{t+k}(\mathrm{m}) = \left[\frac{P_t^0(\mathrm{m})}{P_{t+k}}\right]^{-\zeta} Y_{t+k}$ (6)

Where $\Lambda_{\mathrm{t,t+k}} \equiv \beta^k \frac{U_{C,t+k}}{U_{C,t}}$ is the (non-stationaraized) stochastic discount factor over the interval [t,t+k]. Following (….), the solution to this optimization problem is given by :

$$E_t \sum_{k=0}^{\infty} \xi_p^k \frac{\Lambda_{\mathrm{t,t+k}}}{P_{t+k}} Y_{t+k}(\mathrm{m})\ [P_t^0(\mathrm{m})\}\ \text{-}\ \frac{1}{(1-{}^1/_\zeta)} P_{t+k}\ \mathrm{M}C_{t+k}\ ]=0 \tag{7}$$

Using (6) and rearranging (7) we obtain

$$P_t^0 = \frac{1}{(1-{}^1/_\zeta)} \frac{E_t \sum_{k=0}^{\infty} \xi_p^k \frac{\Lambda_{\mathrm{t,t+k}}}{P_{t+k}} Y_{t+k}(\,P_{t+k}\,)^\zeta \mathrm{M}C_{t+k}}{E_t \sum_{k=0}^{\infty} \xi_p^k \frac{\Lambda_{\mathrm{t,t+k}}}{P_{t+k}} Y_{t+k}(\,P_{t+k}\,)^\zeta} \tag{8}$$

[5] Thus, we can interpret $\frac{1}{1-\zeta_p}$ as the average duration for which prices are left unchanged.

Where the (m) index is dropped as all firms face the same marginal cost so the right-hand side of the equation is independent of the firm size and of the price history. By the law of large numbers, the evolution of the price index is given by

$$P_t^{1-\zeta} = \zeta_p\, P_{t-1}^{1-\zeta} + (1-\zeta_p)(\,P_t^0)^{1-\zeta} \qquad (9)$$

Now, let's define the k-periods-ahead inflation as $\Pi_{t,t+k} \equiv \frac{P_{t+k}}{P_t}$. To simplify the notation in what follows, we denote $\Pi_t = \Pi_{t-1,t}$ and $\Pi_{t+1} = \Pi_{t,t+1}$. We can now write the fraction (8)

$$\frac{P_t^0}{P_t} = \frac{1}{(1-{}^1/_{\zeta})} \frac{E_t \sum_{k=0}^{\infty} \xi_p^k \Lambda_{\mathrm{t,t+k}}\ Y_{t+k}(\,\Pi_{t,t+k}\,)^{\zeta} \mathrm{M}C_{t+k}}{E_t \sum_{k=0}^{\infty} \xi_p^k\, \Lambda_{\mathrm{t,t+k}}\, Y_{t+k}(\,\Pi_{t,t+k}\,)^{\zeta-1}} \qquad (10)$$

And (9) as

$$1 = \zeta_p\,(\,\Pi_t\,)^{1-\zeta} + (1-\zeta_p)\,(\frac{P_t^0}{P_t})^{1-\zeta} \qquad (11)$$

Sticky Wages

To introduce wage stickiness, we now assume that each household supplies homogeneous labor at a nominal wage rate $W_{h,t}$ to a monopolistic trade-union who differentiates the labor and sells type H_t(j) at a nominal wage $W_{n,t}\,(j)$ > $W_{h,t}$ to a labor packer in a sequence of Calvo ( ) staggered nominal wage contracts. The real wage is then defined as $W_t \equiv \frac{W_{n,t}}{P_t}$. We now have to distinguish between price inflation (with the notation ${\Pi_t}^p \equiv \frac{P_t}{P_{t-1}}$) and wage inflation, $\Pi_t^w \equiv \frac{W_{n,t}}{W_{n,t-1}}$ = $\frac{W_t\,\Pi_t^P}{W_{t-1}}$. As for the price contract, we employ Dixit-Stiglitz quantity and price aggregators. Calvo ( ) probabilities are now ζ_p and ζ_w for price and wage contract respectively. The competitive labor packer forms a composite labour service according to H_t= ($\int_0^1 H_t(j)^{(\mu-1)/\mu} dj)^{\mu/(\mu-1)}$ and sells onto the intermediate firm. Here, μ >1 represents the elasticity of substitution between the labors types. For each j, the labour packer chooses H_t(j) at a wage $W_{n,t}$(j) to maximize H_t given total expenditure $\int_0^1 W_{n,t}(\mathrm{j}) H_t(j)dj$. This results in a set of labor demand equations for each differentiated labour type j with wage $W_{n,t}$(j) of the form

$$H_t(\mathrm{j}) = \left(\frac{W_{n,t}(\mathrm{j})}{W_{n,t}}\right)^{-\mu} H_t \tag{12}$$

Where $W_{n,t} = [\int_0^1 W_{n,t}(j)^{1-\mu} dj]^{\frac{1}{1-\mu}}$ is the aggregate nominal wage index. H_t

Monetary Rule, Output equilibrium and shocks

The nominal interest rate is given by one of the following Taylor-type rules :

$$\mathrm{Log}\left(\frac{R_{n,t}}{R_n}\right) = \rho_r \log\left(\frac{R_{n,t-1}}{R_n}\right) + (1-\rho_r)\left[\theta_\pi \log\left(\frac{\Pi_t}{\Pi}\right) + \theta_y \log\left(\frac{\mathrm{Y}_t}{\mathrm{Y}}\right) + \theta_{dy} \log\left(\frac{\mathrm{Y}_t}{Y_{t-1}}\right)\right] + \varepsilon_{MPS,t} \tag{13}$$

$$\mathrm{Log}\left(\frac{R_{n,t}}{R_n}\right) = \rho_r \log\left(\frac{R_{n,t-1}}{R_n}\right) + (1-\rho_r)\left[\theta_\pi \log\left(\frac{\Pi_t}{\Pi}\right) + \theta_y \log\left(\frac{\mathrm{Y}_t}{\mathrm{Y}_t^F}\right) + \theta_{dy} \log\left(\frac{\mathrm{Y}_t/Y_t^F}{Y_{t-1}/Y_{t-1}^F}\right)\right] + \varepsilon_{MPS,t} \tag{14}$$

Where Y_t^F *is* the flexi-price level of output and $\varepsilon_{MPS,t}$ is a monetary policy shock process. Also it is an ‘implementable’ form of the Taylor rule which stabilizes output about its steady state. Then θ_π and θ_y are the long-run elasticities of the inflation and output respectively with respect to the interest rate. The output equilibrium is given by:

$$Y_t = C_t + G_t + I_t \tag{15}$$

Finally, the model is closed with seven exogenous AR1 shock processes to technology, government spending, the real marginal cost (the latter being interpreted as a mark-up shock), the marginal rate of substitution, an investment shock, a risk premium shock and a shock to monetary policy.

A. Friction between the bank and depositors (the GK model)

Banks get $D_t$deposits then they lend to firms and entrepreneurs: L_t= L_t^{WC} +L_t^K = D_t +N_t

The accumulated wealth in t + 1: N_{t+1} = $R_t^{l,WC}$ L_t^{WC} + $R_{t+1}^{l,K}$ L_t^K- R_t D_t

The Banks have finite lifetimes with survival rate ω and maximize expected final wealth (V_t).

Our Moral hazard problem here is from the supply side: the bankers can steal fraction μ (exogenous and stochastic) of assets and declare bankruptcy. Thus, our constraint is V_t ≥ μL_t .

The Banks' problem can be written as:

$$\max \ V_t = \rho_t^{L,WC} \ L_t^{WC} + \rho_t^{L,K} \ L_t^K + \rho_t^N \ N_t.$$

$$\text{s.t} \quad V_t \geq \ (L_t^{WC} \ + L_{t\ t}^K) \ \ \forall \text{t}.$$

C. Frictions between banks and borrowers (the BGG model)

The entrepreneurs' Balance Sheets: Q_t K_t= L_t^K + N_t^e.

When the entrepreneurs buy K_t units of capital they obtain w_{t+1}^e R_{t+1}^K+K_t in t + 1, where

- w_t^e has a distribution F(w_t^e; $\sigma_{w,t-1}$) with E(w_t^e)= 1 and $\sigma_{w,t-1}$ describes cross-sectional dispersion (risk shock; CMR, 2014).
- The $R_{t+1}^K$is the aggregate return on capital.

The source of the financial friction here is the asymmetric information and costly-state-verification problem. the banks observe w_t^e ex-post against a monitoring cost.

The optimal debt contract specifies an interest rate on the loan $R_t^{L,e}$ with $w_{t+1}^{\sim e}$ as a limit.

- Entrepreneurs with $w_{t+1}^e < w_{t+1}^{\sim e}$ default, the bank pays the monitoring cost and seizes the defaulting entrepreneurs' assets.
- Entrepreneurs with $w_{t+1}^e > w_{t+1}^{\sim e}$ pay the established interest rate ($R_t^{L,e} L_t^K \leq \; w_{t+1}^{\sim e} \; R_{t+1}^K K_t$) and keep the difference.

The optimal debt contract is calculated by maximizing over $lev\,_t^e$, $w_{t+1}^{\sim e}$ and $R_t^{L,e}$ the expected return to entrepreneurs, subject to $L_t^K R_{t+1}^{L,K} \leq$ g($w_{t+1}^{\sim e}$; $\sigma_{w,t}$) $R_{t+1}^{L,K}$ K_t where g($w_{t+1}^{\sim e}$; $\sigma_{w,t}$) is the income that the bank can obtain given the distribution of entrepreneurs.

4. THE METHODDOLOGY

We developed a Dynamic Stochastic General Equilibrium (DSGE) model, combining the approaches of Gertler and Karadi (2011) (GK) and Bernanke, Gertler, and Gilchrist (1999) (BGG). Thus, we detect the most fraction possible in one model combining both the effect of two types of frictions from the demand side and supply side of credits. A similar strategy has been implemented by previous studies, Rannenberg (2016) and Garsia-Cicco and Kirchner(2016).

However, we derive from that literature by identifying the impact of combining the two financial frictions above on the conduct of Tunisian monetary policy. Especially, with the introduction of the "Loans/Deposits" ratio by the central bank of Tunisia in 2018, and the role of the latter in facilitating the financing of the State budget deficit through loans drawn from the financial system.

4.1 Data:2000-2018

The data covers the period from 2000 to 2018. The variables are growth in output, consumption, investment, real wage; hours worked, inflation, and nominal interest. All variables are expressed as growth rates and were made stationary using the Hodrick-Prescott (HP) filter. The data comes from the Database (Datastream) and are performed by the most recent data from the Central Bank of Tunisia (BCT). The results were obtained using the Dynare 4.6.2 software Matlab 2018 a.

4.2 The estimation method:

We chose the Bayesian time series methods to estimate our DSGE model because of the increasing computational power available to evaluate medium scale.

The Non-financial parameters and steady state values of $\Pi = 1.01$, g=0.005 and h=0.33 are calibrated as in the benchmark NK model. Standard values for the labour share, price elasticity, the discount and depreciation rates and the inverse of the intertemporal elasticity of substitution are α = 0.7, ζ= 7, μ= 3, β = 0.99, δ = 0.025 and α_c = 2. Government spending as a proportion of GDP is set at gy = 0.2. Calvo parameters, indexing, habit and investment adjustment parameters drive the dynamics and should be estimated, but here we choose the following fairly arbitrary values, ζ_p = ζ_w = 0.75, γ_p = γ_w = 0.5, X= 0.7 and ϕ_x = 2.

The parameters of the banking sector are calibrated in the following way. Following GK, we choose the value of σ_B so that the bankers survive 8 years (32 quarters) on average. Then with our quarterly model, 1/(1-σ_B) = 32. The values of Q and σ_B are computed to hit an economy wide leverage ratio of four and to have an average credit spread of 100 basis points per year. Then in our quarterly model σ_B = 0.9688, ϕ = 4 and R_k- R =0.04.

For the function Θ (x_t) we choose

$\Theta = \Theta (x_t) = \theta_{FF}(1+ \epsilon x_t + k_{FF} x_t^2/2)$. Then these parameters are calibrated θ_{FF}=0.4274 , k_{FF}= 13.333, ξ_t= 0.0023 ϱ=0.8529 $and\ \epsilon$=-2

Parameters	Definitions	Calibrated

Π	Inflation	1.01 (1.06)
G	Growth	0.005
H	hours	0.33
A	labour share	0.7
Z	price elasticity	7
B	depreciation rates	0.99
Δ	the inverse of the intertemporal elasticity of substitution	0.025
Gy	Government spending as a proportion of GDP	0.2
$\zeta_p = \zeta_w$	Calvo parameters	0.75
$\gamma_p = \gamma_w$	Indexing	0.5
ϕ_x	Habit	
X	Investment adjustment parameters	0.7
σ_B	banking sector parameters	0.9688
ϕ	banking sector parameters	4
R_k- R	average credit spread	0.04
θ_{FF}	function Θ parameter	0.4274
k_{FF}	function Θ parameter	13.333
ξ_t	function Θ parameter	0.0023
ϱ	function Θ parameter	0.8529
ϵ	function Θ parameter	-2

Estimated parameters

Using the biasing estimation, we will get the estimation of the other parameters

parameters

	prior mean	post. mean	90% HPD interval		prior	pstdev
sigma_c	1.500	1.3712	1.2308	1.5274	norm	0.3750
psi	2.000	4.8124	3.9538	5.6634	norm	0.7500
chi	0.500	0.2419	0.1869	0.2860	beta	0.1000
phiX	2.000	0.1316	0.0886	0.1717	norm	0.7500
xip	0.500	0.6610	0.6118	0.7226	beta	0.1000
xiw	0.500	0.1626	0.0988	0.2234	beta	0.1000
gammap	0.500	0.3541	0.1709	0.5237	beta	0.1000
gammaw	0.500	0.4705	0.3121	0.6273	beta	0.1000
rho_r	0.750	0.4023	0.3192	0.4807	beta	0.1000
theta_pie	1.500	2.0418	1.8070	2.3103	norm	0.2500
theta_y	0.120	0.0494	0.0271	0.0738	norm	0.0500
theta_dy	0.120	0.1710	0.1005	0.2411	norm	0.0500
rhoA	0.500	0.9902	0.9855	0.9953	beta	0.2000
rhoG	0.500	0.9757	0.9685	0.9830	beta	0.2000
rhoMCS	0.500	0.9374	0.9187	0.9560	beta	0.2000
rhoMRSS	0.500	0.9841	0.9719	0.9962	beta	0.2000
rhoMPS	0.500	0.3224	0.2423	0.4138	beta	0.2000
rhoRPS	0.500	0.7324	0.6808	0.7829	beta	0.2000
rhoIS	0.500	0.9725	0.9636	0.9829	beta	0.2000

Figure1 Parameters

4.3 Impulse Responses

We examine now the response of the three variants of the model described in previous Section to the monetary policy shock and the productivity shock. The model developed in this paper is referred to as the “full model,” while the BGG model, the Gertler–Karadi model, and the model without financial frictions are labeled “BGG,” “GK,” and “NK” respectively. All results presented below are based on a first-order approximation of the models’ equilibrium conditions.

The response of the four models to a contractionary one-standard-deviation monetary policy shock is displayed in Figures 2 (a) , 2(b) , 2(c). The decline in GDP is much stronger in the full model than in the BGG model and the GK model, which display similar on-impact responses, while the GDP response is weakest in the NK model. However, the GDP decline in the GK model is more persistent than in both the BGG and in the full model. The differences in the GDP paths across the four models are mainly caused by differences in the decline in investment. The following discussion of the economic intuition for the GDP effect of the shock in the models should be read in conjunctions with the respective flow chart displayed in Figures 2(a) , 2(b) , 2(c) which illustrates the key mechanisms.

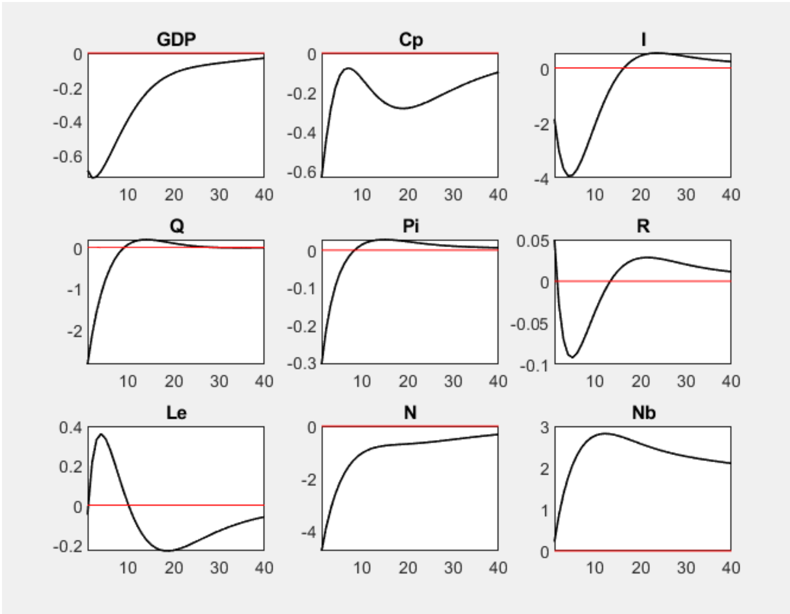

Figure 2(a) the Full Model

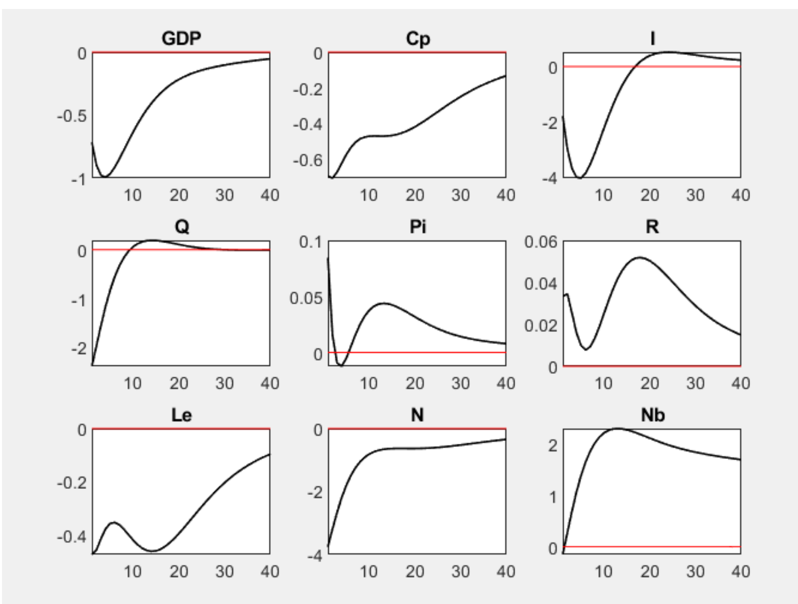

Figure 2(b) The full model

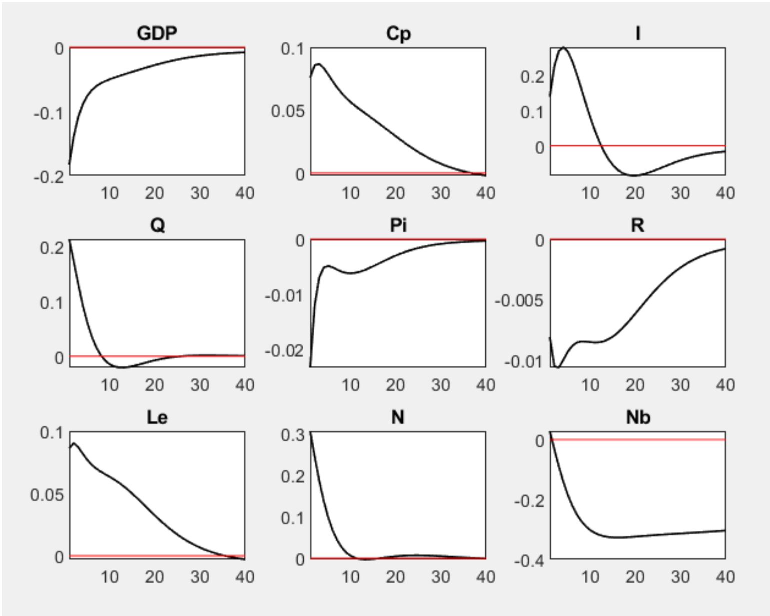

Figure 2(c) The full model

5 Policy Implications:

- Our model will serve as a guidance for the Central Bank of Tunisia by including financial frictions that may help to improve the conduct of monetary policy as the full model yields a better fit to the data.
- The full model is expected to produce a more realistic investigation of the financial sector into the central bank monetary policy.
- Credit frictions are important for the conduct of monetary policy in the measure they amplify the response of the cost of external finance and overall economy to shocks. Moreover, the frictions may have
- asymmetric effects that trigger uncertainty about the transmission mechanisms of the monetary policy.

6 A short bibliography

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