Monetary policy through the pandemic loans instrument to address the effects of COVID-19: hybrid financial DSGE-SIR

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Référence
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**Abstract**

In our research, we employ an innovative hybrid model, merging a financial dynamic stochastic general equilibrium (DSGE) model with a conventional epidemiological model, to delve into the potential effectiveness of unconventional monetary policy in cushioning the impact of the COVID-19 pandemic on the Moroccan economy. While earlier illnesses have presented economic dangers, our work differentiates itself by incorporating epidemiology into macroeconomic theory, indicating a recent and essential breakthrough in the area. Our detailed research demonstrates that unorthodox monetary policy measures, such as the provision of "pandemic loans" by the Central Bank, may actually relieve some of the harmful implications of a pandemic crisis. However, our results also underline a fundamental limitation: these interventions are inadequate to totally erase the economic obstacles faced by a pandemic, underscoring the deep and varied character of such crises that demand a multimodal strategy for mitigation.

**Keywords:** Monetary Policy - COVID-19 - DSGE Model

**JEL Codes:** E52 - E32 - C32
Introduction

The COVID-19 pandemic is causing severe damage to the world's economies. Fiscal authorities have begun to draft and implement stabilization programs to help boost families' purchasing power and the activity of firms. Following these steps, monetary authorities were quick to respond, with central banks quickly reactivating their instruments during crises (for example, the 2008–09 financial crisis). Similarly, since the beginning of the health crisis, Bank Al-Maghrib (BAM) has initiated several actions to support households, firms, and the economy as a whole: Firstly, the reduction of the key rate from 2.25% to 2% (council meeting of March 17) and then from 2% to 1.5% (council meeting of June 16) to enable households and firms to finance themselves under better conditions; Second, Bank Al-Maghrib has strengthened its specific refinancing program for SMEs, which now includes operating credits in addition to investment credits; banks can also use the refinancing instruments available at Bank Al-Maghrib in both dirham and foreign currency. Finally, the establishment of specific accompanying measures for banks.

The COVID-19 pandemic revived research on the economic impact of the pandemic by integrating epidemiology into macroeconomic theory for the first time ever. This is not the case for microeconomics studies (Horan and Wolf, 2005). Recently, Eichenbaum et al. (2020a, b, and c) evaluated the potential economic impacts of COVID-19 on a macroeconomic scale by employing the SIR epidemiological model in line with the New Keynesian model. In addition, past articles have not focused on the effects of economic policies to remedy the economic cost of the COVID-19 pandemic.

Our study closely follows the methodology employed by Verónica Acurio Vásconez et al. (2021). We use a hybrid macroeconomic-epidemiological model that combines a financial DSGE, as in Gertler and Karadi (2011), with a susceptible-infected-recovered (SIR) epidemiological model to study the ability of monetary policy to remedy the effects of the COVID-19 crisis. To link the above SIR model with the DSGE model, we assume that the pandemic affects the economy through both the demand (we assume that the marginal utility of household consumption decreases with disease severity) and supply (we assume that the supply of labor is given by the quantity of healthy people and is driven exogenously by the Sir model) sides, as in Faria-e Castro (2020).
Our study assesses the impacts of non-conventional monetary measures, such as quantitative easing (QE) or loan policies, on the economy. We specifically examine the effects of "pandemic loans," which involve injecting liquidity into the real sector through central bank claims that bypass private banks. This approach can be seen as a lighter version of "helicopter money" (Friedman, 1969), wherein the injected liquidity directly reaches the real sector without the direct involvement of fiscal authorities or private banks. Overall, our findings align with existing empirical research, indicating that unconventional monetary policies cannot fully mitigate the negative economic consequences of the pandemic.

The next sections of the paper are organized as follows: Section 1 offers an empirical analysis of the literature that underlines the role of monetary policy in resolving the issues provided by the COVID-19 situation. In Section 2, we go into the basic ideas underpinning the SIR (Susceptible-Infectious-Recovered) model while also illustrating the possible integration of this model with the financial DSGE (Dynamic Stochastic General Equilibrium) model. Additionally, Section 3 details the calibration approach applied to calculate parameters relevant to the Moroccan economy as well as provides the findings gained from numerical summations. Lastly, the study finishes with a final section summarizing the important results and implications.

1- Literature review

Carvalho et al. (2021) examined the impact of COVID-19 on emerging market economies (EMEs) and their monetary policy responses. The authors found that EMEs faced significant challenges due to the pandemic, including reduced capital inflows and a sharp decline in commodity prices. However, EMEs with more flexible exchange rate regimes and lower levels of external debt were able to respond more effectively to the crisis using a combination of monetary and fiscal policies. The authors argue that policymakers in EMEs need to continue to prioritize macroeconomic stability and financial resilience in the face of ongoing uncertainty. In addition to Carvalho et al. (2021), there have been several other studies examining the impact of COVID-19 on emerging market economies. Hasanov and Bulut (2021) analyzed the impact of the pandemic on macroeconomic variables in Turkey and found that the government's monetary policy response helped stabilize the economy. Similarly, Escaith and MacGregor (2021) examined the impact of the pandemic on Latin American economies and found that countries with more flexible exchange rates and stronger policy frameworks were better able to weather the crisis. These studies highlight the importance of
effective monetary policy in supporting economic stability in emerging market economies during the pandemic.

Belke et al. (2021) analyzed the impact of COVID-19 on inflation dynamics and monetary policy in the euro area. The authors found that the pandemic has led to a significant decline in inflation expectations and increased uncertainty about the inflation outlook. They argue that the ECB needs to adopt a more flexible approach to inflation targeting, including greater emphasis on forward guidance and more active use of unconventional policy tools such as asset purchases. The authors also note the importance of international policy coordination in responding to the challenges posed by the pandemic and supporting global economic recovery. In addition, Baumeister and Hamilton (2021) analyzed the impact of the pandemic on inflation expectations in the United States and found that they had declined significantly in the early months of the crisis. The authors argue that this decline was due in part to increased uncertainty about the economic outlook and the effectiveness of monetary policy in a highly unusual environment. Similarly, Osorio and Wong (2021) examined the impact of the pandemic on inflation in Latin America and found that it had declined significantly, posing challenges for policymakers in the region.

Several studies have used dynamic stochastic general equilibrium (DSGE) models to analyze the impact of monetary policy during the COVID-19 pandemic. Bauer and Rudebusch (2021) found that the Federal Reserve's policy responses were successful in stabilizing inflation and output but that there may be long-term costs associated with the use of unconventional policy tools such as asset purchases. Galesi and Sgherri (2021) found that the pandemic led to a significant decline in economic activity and inflation in the euro area and that the ECB's policy actions helped to mitigate the negative effects of the crisis. Lemoine and Lindé (2021) found that the pandemic led to a significant decline in economic activity and inflation in France and that the ECB's policy actions were effective in stabilizing financial markets and supporting the economy. These studies demonstrate the usefulness of DSGE models in analyzing the impact of monetary policy during the COVID-19 pandemic. They also highlight the complex challenges facing central banks and policymakers in responding to a crisis of this magnitude and the importance of evaluating the short- and long-term costs and benefits of different policy actions. Moreover, Collard and Hémet (2021) analyzed the effectiveness of the ECB's policy response using a DSGE model and found that it had been successful in stabilizing inflation and output. However, the authors also noted that the use of unconventional policy tools had increased the risk of financial instability in the long run.
Similarly, Coibion et al. (2021) used a DSGE model to analyze the impact of the pandemic on the U.S. economy and found that the Federal Reserve's policy response had been effective in stabilizing inflation and output. The authors also noted that the use of unconventional policy tools had been necessary in a crisis of this magnitude, but that there were risks associated with their long-term use.

Our paper connects two streams of literature by integrating two popular models. Firstly, we build upon the widely used method of modeling epidemics, which is based on the seminal contribution of Kermack and McKendrick (1927) and its extension to include asymptomatic infected individuals (Prem et al. 2020). Secondly, we incorporate this modified SEIR model into a financial New Keynesian business cycle framework, similar to the one developed by Gertler and Karadi (2011). Our complete framework is most similar to the approach taken by Eichenbaum, Rebelo, and Trabandt (2020a), who demonstrate that a DSGE model with an SIR component can effectively capture macroeconomic processes during an epidemic.

2- The model
2.1 Epidemiological Model

The COVID-19 pandemic has highlighted the importance of epidemiological mathematical models in shaping health and political decision-making. The susceptible-infected-removed (SIR) model, which was developed in the early 20th century, is a widely used model in epidemiology for modeling the spread of infectious diseases. It has been extensively studied by researchers such as Anderson (1991), Kermack, and McKendrick (1927). The SIR model, which stands for susceptible-infected-recovered model, is made up of three distinct components that relate to the spread and recovery from a disease. These components include:

- The number of susceptible individuals, denoted as St, who are currently healthy but are at risk of contracting the disease;
- The number of infected individuals, denoted as it, who have contracted the disease and can spread it to susceptible individuals;
- The number of recovered individuals, denoted as Rt, who have contracted and recovered from the disease and are now immune to future infections;

As its name suggests, the SIR model is named after these three components. To simplify the
analysis, we normalize the total population size to 1, which allows us to interpret \( S_t, I_t, \) and \( R_t \) as shares or proportions of the overall population in each respective class.

Additionally, we limit our analysis to the transmission of the disease within a specific location or a closed economy. The conventional SIR model assumes that there are no births or deaths and that there is no migration into or out of the location. As a result, the population size \( N_t \) remains constant over time. Therefore, at any given time \( t \), we have:

\[
S_t + I_t + R_t = \alpha_p N_t
\]

One usually normalize the population number to 1, and we have the following equation:

\[
S_t + I_t + R_t = 1
\]

As in Eichenbaum, Rebelo, and Trabandt (2021), we suppose there are three ways susceptible individuals might get infected: by buying consumer products, working, and through random interactions unrelated to economic activity. The transmission function reveals the frequency of newly infected individuals:

\[
\tau_t = \pi_1(S_t C_t^c)(I_t C_t^l) + \pi_2(S_t L_t^c)(I_t L_t^l) + \pi_3 S_t I_t
\]

We can write the dynamic of the pandemic over time as:

\[
S_{t+1} = S_t - T_t
\]

\[
I_{t+1} = I_t + T_t - (\pi_r + \pi_d) I_t
\]

Here, \( \pi_r \) is the rate at which infected people recover from the infection and \( \pi_d \) is the probability that an infected person deaths.

\[
R_{t+1} = R_t + \pi_r I_t
\]

\[
D_{t+1} = D_t + \pi_d I_t
\]

### 2.2 Households

To link the DSGE model with the SIR modeling of COVID-19, our research operates under the assumption that the disease can impact the economy through both the demand and supply sides, as outlined in Faria-e-Castro's (2020) work. Specifically, we consider an
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The economy that is composed of infinitely many identical households. The representative household has the following expected lifetime utility:

\[ U = E_t \sum_{t=0}^{\infty} \beta_t \left\{ \text{Health} \left( \frac{c_{t-\sigma}}{1-\sigma} - \frac{L_t^{1+\varphi}}{1+\varphi} \right) \right\} \]

Where \( \beta \) is a discount factor. \( c_t \) and \( L_t \) are consumption and labor supply at time \( t \), respectively. The key difference between our model and the literature lies in the introduction of term \( \text{Health} \) is related variable that affects consumption and labor supply. With the health variable including the variables of the SIR model.

\[ \text{Health}_t = \{ S_t, I_t, R_t \} \]

Therefore, the utility function become:

\[ U = E_t \sum_{t=0}^{\infty} \beta_t \left\{ s_t \left( \frac{c_{t-\sigma}}{1-\sigma} - \frac{L_{t,s}^{1+\varphi}}{1+\varphi} \right) + i_t \left( \frac{c_{t,i-\sigma}}{1-\sigma} - \frac{L_{t,i}^{1+\varphi}}{1+\varphi} \right) + r_t \left( \frac{c_{t,r-\sigma}}{1-\sigma} - \frac{L_{t,r}^{1+\varphi}}{1+\varphi} \right) \right\} \]

The budget constraint faced by the household is:

\[ P_t C_{H,t} + B_{t+1} \leq b_t i_t L_{t,i} + W_t (s_t L_{t,s} + r_t L_{t,r}) + R_t B_t + T_t + P_t D_t \]

The variables \( C_{H,t} \) and \( L_{t,s}, L_{t,i}, L_{t,r} \) means the consumption and hours worked of susceptible, infected and recovered households, respectively.

The variables \( B_t, D_t, W_t, b_t \) and \( P_t \) means government bond held by the household, dividends earned by the household, wages paid by firms, unemployment compensation received by infected people, and the aggregate price level, respectively.

The law of motion for the stock of capital is:

\[ K_{t+1} = Inv_t + (1-\delta)K_t \]

The first-order conditions for \( C_{t,s}, C_{t,i}, \) et \( C_{t,r} \) are:

\[ C_{t,s}^{-\sigma} = \lambda_t b_t P_t - \lambda_t \pi_1 (l_t c_t^i) \]

\[ C_{t,i}^{-\sigma} = \lambda_t b_t P_t \]
\[ C_{t,r}^r = \lambda_t^b P_t \]

Here, \( \lambda_t^b \) is the Lagrange multiplier on the household budget constraint. The first-order conditions for \( L_{t,s} \), \( L_{t,i} \) and \( L_{t,r} \) are:

\[ L_{t,s}^\phi = \lambda_t^b W_t + \lambda_t^r \pi_2 (l_t N_t^i) \]
\[ L_{t,i}^\phi = \lambda_t^b b_t \]
\[ L_{t,r}^\phi = \lambda_t^b W_t \]

The first-order condition for \( K_{t+1} \) is:

\[ \lambda_t^b P_t = \beta \lambda_{t+1}^b [p_{t+1}^k + P_{t+1} (1 - \delta)] \]

2.3 Firms and Calvo pricing

The model distinguishes two types of firms: intermediate non-financial firms and retailers. The first type of firm produces a continuum of differentiated goods, thus operating in an imperfectly competitive market. The second type of firm produces final goods and is characterized by a representative firm that aggregates the production of a continuum of intermediate firms \( j \in [0,1] \). The Dixit-Stiglitz-type aggregation function is defined by:

\[ Y_t = \left( \int_0^1 Y_{i,t} \frac{1}{P_{i,t} Y_{i,t}} di \right)^\gamma, \gamma > 1 \]

Where \( \gamma \) is the elasticity of substitution between the differentiated goods. This representative firm maximizes its profit according to the following equation:

\[ \text{Prof}_t = P_t Y_t - \int_0^1 P_{i,t} Y_{i,t} di = P_t \left( \int_0^1 Y_{i,t} \frac{1}{P_{i,t} Y_{i,t}} di \right)^\gamma - \int_0^1 P_{i,t} Y_{i,t} di \]

Profit maximization implies the following demand schedule for intermediate products:

\[ Y_{i,t} = \left( \frac{P_{i,t}}{P_t} \right)^{-\frac{\gamma}{\gamma-1}} Y_t. \]

Here, \( P_{i,t} \) denote the price of intermediate input i in unit of the final good.
The price of output is given by:

\[ P_t = \left( \int_0^1 P_{i,t} \frac{1}{P_{i,t}^\gamma} di \right)^{-(\gamma-1)} \]

For **intermediate non-financial firms**: The production function of intermediate good firm i is Cobb-Douglas as follows:

\[ Y_{i,t} = AK_{i,t}^{1-\alpha}L_{i,t}^\alpha \]

where \( L_{i,t} \) and \( K_{i,t} \) are the capital and labor employed by firm i, respectively. A is the total factor productivity (TFP) level of the economy, which is shared by all the intermediate good firms and is assumed to be constant.

Intermediate good firm maximize profits:

\[ \pi_{i,t} = P_{i,t}Y_{i,t} - mc_tY_{i,t} \]

The firm maximization problem gives the following FOCs for \( K_t \) and \( L_t \):

\[ \frac{\alpha Y_{i}(i)}{K_{i}(i)} mc_t = r_{K,t} \]

\[ (1 - \alpha) \frac{Y_{i}(i)}{K_{i}(i)} mc_t = w_t \]

**Calvo pricing**: Nominal price rigidity is imposed in the manner of Calvo (1983) style price-setting frictions. With probability \( 1 - \zeta \) the firm reoptimizes \( \bar{P}_t \). With probability \( \zeta \), \( P_{t,t} = P_{t,t+1} \). The firm chooses its optimal price at time t, \( \bar{P}_t \) to maximize:

\[
\max_{P_t} \sum_{j=0}^{\infty} (\xi \beta)^j \lambda_{t+j}^p (\bar{P}_t Y_{i,t+j} - P_{t+j}mc_{t+j}Y_{i,t+j})
\]

subject to the demand function.

\[ Y_{i,t} = \left( \frac{P_{i,t}}{P_t} \right)^{-\frac{1}{\gamma-1}} Y_t \]
Here, $mc_t$ denotes the real marginal cost at time t:

$$mc_t = \frac{W_t^\alpha (R_t^k)^{1-\alpha}}{P_t A \alpha^\alpha (1 - \alpha)^{1-\alpha}}$$

The optimal price is given by:

$$\tilde{p}_t = \left(1 - \xi \right) \left[ \frac{1 - \xi \pi_t^{\gamma-1}}{1 - \xi} \right]^\gamma + \frac{\xi \pi_t^{\gamma-1}}{\tilde{p}_{t-1}}$$

### 2.4 Financial Intermediaries, Central Bank and Public Loans

For these blocks, we adopt the methodology used in Gertler et al. (2011). For more detail, see Gertler et al. (2011) and the Appendix for a detailed derivation of this publication.

### 2.5 Government and Monetary policy

In our analysis of the government block, we make the assumption that government consumption of final goods remains constant. This is based on the idea that transfers are adjusted automatically at each date and that all expenditures (including final good consumption, expenditures to non-financial intermediaries, and unemployment benefits) are matched by revenue (including lump sum taxes and interest from debt). Under these conditions, the government faces the following budget constraints:

$$G_t + \tau \psi_t Q_t K_{t+1} + b_t (1 - L_t) + \psi_t Q_t Z_t = T_t + (R_{k,t} - R_t) B_{g,t} + B_{g,t+1}$$

The unconventional monetary policy, denoted as $\psi_t$, is determined using the following procedure:

$$\psi_t = \tilde{\psi}_t + \omega \mathbb{E}_t \left[ (\log R_{k,t+1} - \log R_{t+1}) - (\log R_k - \log R) \right]$$

where $\tilde{\psi}_t$ is defined as our pandemic loans, $\omega > 0$ is the Central Bank credit feedback parameter, and $(\log R_k - \log R)$ is the steady state risk-premium.

Our analysis incorporates both conventional and unconventional monetary policy measures. The conventional policy is based on a Taylor rule, which links the nominal interest rate $\hat{R}_t$ to
its past value $\hat{R}_{t-1}$, as well as the nominal inflation rate $\hat{\pi}_t$ and the output gap $(\hat{Y}_t - \hat{Y}_{t-1})$. Additionally, we consider the use of unconventional monetary policy measures.

$$\hat{R}_t = \rho \hat{R}_{t-1} + (1 - \rho) \rho_\pi \hat{\pi}_t + (1 - \rho) \rho_y (\hat{Y}_t - \hat{Y}_{t-1})$$

In addition to conventional and unconventional monetary policy measures, our analysis also considers a Fisher relation that connects the nominal interest rates set by the central bank to the gross real interest rate fixed by the market.

$$1 + i_t = R_{t+1} \mathbb{E}_t \Pi_{t+1}$$

Lastly, our analysis incorporates market clearing conditions that determine how production is allocated among consumption, net investment, government expenditures on goods, and government financial interventions.

$$Y_t = C_t + I_{n,t} + f \left( \frac{I_{n,t}}{I_{n,t-1}} \right) I_{n,t} + G + \tau \psi_t Q_t K_{t+1}$$

3- Calibration and monetary policy to reduce the effects of Covid-19

3.1 Calibration

In this section, we outline the approach used to calibrate the parameters of the model to fit the Moroccan context. To calibrate the epidemiological model, we refer to recent literature concerning COVID-19. The computation of mortality rates is based on direct standardization, which allows us to account for disparities caused by factors influencing the mortality rate. In the case of Morocco, the calibration indicates an average mortality rate of approximately 0.4. Furthermore, we assume that an infected individual remains contagious for 15 days, considering our calibration is performed on a weekly basis. This implies that the per-period probability of dying if infected, denoted as $\pi_d$, is equal to 0.004*7/15, while the recovery probability, denoted as $\pi_r$, is equal to 7/15.

Following the approach adopted by Jones, Philippon, and Venkateswaran (2021) and consistent with the findings reported in Ferguson et al. (2020), we assume that both labor and consuming activities contribute equally to transmission, with each accounting for 1/4 of total transmissions.

We begin with the pandemic module, where we calibrate the parameters that govern the
spread of the disease through consumption, labor, and other activities. To accomplish this, we follow the methodology of Eichenbaum, Rebelo, and Trabandt (2020c) and set the parameters such that, in the absence of containment measures, each of the two economic channels accounts for one-sixth of the transmission and approximately two-thirds of the population becomes infected before the pandemic subsides. The final proportion of the population that either recovers or succumbs to the disease is consistent with the herd immunity levels estimated to be between 60 and 70%, as suggested by standard models. These models have been discussed in studies such as Gomes et al. (2020) or Prem et al. (2020).

Similar to Atkeson (2020), we assume that it takes 18 days (equivalent to 7/18 periods in our weekly model) to recover from or succumb to the disease, which is consistent with more recent estimates reported by Zhou et al. (2020). By combining this with the infection fatality rate of 0.6 percent suggested by cross-country and meta-studies (Ioannidis 2020; O’Driscol et al. 2020), we arrive at our calibrated value for the basic death probability. The share of symptomatic individuals in all infected cases is set at 0.6, representing a compromise between a wide range of estimates found in the COVID-19 medical literature (Oran and Topol 2020; Wells et al. 2020; Yanes-Lane et al. 2020). The relative infectiousness of asymptomatic cases is also subject to considerable uncertainty, so we use a value of 0.5, consistent with a meta-study by Byambasuren et al. (2020), which has been adjusted upward based on recent evidence from Bi et al. (2020). The relative productivity of infected individuals is assumed to be 0.8. Lastly, following the approach taken by Ferguson et al. (2020) and Wilde et al. (2021), we assume that mortality doubles when the number of infected cases exceeds 1% of the population.

The parameters associated with the New Keynesian model are primarily based on the extensive DSGE literature, with some parameters calibrated to reflect characteristics specific to the Moroccan economy. The discount factor is chosen to represent an annual real interest rate of 3%, which corresponds to a discount factor of approximately 0.97. The elasticity of substitution between goods is set at $\theta = 6$, and the subsidy parameter $\zeta$ is adjusted to ensure that the steady-state markup is equal to one. The inflation target and the steady-state real interest rate are both set at 2% annually, which translates to a weekly gross rate of Parameters related to monetary policy and the Taylor rule are calibrated in accordance with working papers published by the research department of the Moroccan central bank. The monetary authority responds to deviations in inflation and the output gap from the target with
coefficients $\rho_\pi = 1.5$ and $\rho_\pi = \frac{0.5}{52}$ respectively. Both the intertemporal elasticity of substitution, denoted as $\frac{1}{\delta}$, and the Frisch elasticity of labor supply, denoted as $\phi$, are set to $1/2$, which are standard values commonly used in the monetary policy literature.

Finally, the different steps of solving and simulating the model were implemented using Matlab and Dynare software version 4.6.4, as documented in Adjemian et al., 2021.

### 3.2 Monetary policy during a pandemic

In this research, we concentrate our analysis on financial parameters only, specifically focusing on three policy instruments: leverage ratio ($\emptyset$), feedback parameter ($\omega$) and Finally, we analyze the application of “pandemic loans” to reduce the impacts of the pandemic. This takes the form of an exogenous shock of publicly intermediated assets ($\bar{\psi}$).

In our comprehensive study, we delve into the impact of the leverage ratio on private banks. The leverage ratio $\emptyset$, a crucial financial indicator, signifies the total loans a private bank can issue in comparison to its net worth. Our analysis reveals that an increased leverage ratio culminates in a significant surge in the injection of funds, denoted by the quantity of financial claims ($\psi$), into the economy by the Central Bank. This occurrence is linked to the amplified probability of banks divesting claims in a state typified by a higher leverage ratio. As banks divest an increased number of claims, it results in an expansion in the spread of interest rates. This subsequently prompts the Central Bank to escalate its fund injections. As a consequence, there is a steep drop in GDP before it reverts to equilibrium levels. Moreover, there is an upsurge in the inflation rate due to an increase in money creation. This observation aligns with existing theoretical and empirical literature, thereby reinforcing the established correlation between monetary policy and inflation.

Our findings are substantiated by several empirical studies. A study conducted by Stefano Corradin et al. (2023) discusses the implications of Basel III regulations, which include the leverage ratio, on banks’ behavior in Eurosystem monetary policy operations. The paper suggests that the introduction of these ratios could have significant effects on banks’ recourse to Eurosystem monetary policy operations. Jatin Dhingra and others (2022) examine how the leverage ratio is affected by adverse financial scenarios, which provides valuable insights into how changes in the leverage ratio might influence banks’ behavior and the broader financial system. Another study by Luisa Carpinelli and Matteo Crosignani (2017) on the effect of
central bank liquidity injections on bank credit supply found that banks increased their credit supply to low-leverage firms following liquidity injections. This suggests a positive transmission of central bank liquidity, which aligns with our finding that a higher leverage ratio leads to a greater injection of funds into the economy by the central bank.

*Fig1: responses of variables to the shocks of Leverage ratio (∅).*

In our subsequent analysis, we investigate the sensitivity of Bank Al-Maghrib to changes in the spread through the feedback parameter (ω). Our findings reveal that Bank Al-Maghrib exhibits a more pronounced response to changes in the spread, resulting in a higher injection of funds into the economy during the initial stages of the pandemic, when the spread difference is at its peak. The Central Bank employs a range of instruments to achieve this objective, including a reduction in the key interest rate from 2.25% to 2% during the March 17 Council meeting, followed by a further decrease to 1.5% at the June 16 Council meeting.
These measures were implemented to improve financing conditions for households and businesses. Additionally, the Central Bank enhanced its specific refinancing program for SMEs, expanding it to cover operating credits in addition to investment credits. It also broadened banks' access to all refinancing instruments in dirham and other currencies, introducing accompanying measures for the banks. Our analysis does not indicate any significant impact on GDP losses. However, we observe that when the central bank reacts more assertively to changes in the spread, the reductions in consumption are smaller compared to the previous scenario. Similarly, the inflation rate reaches the same level as in the first scenario.

These findings are supported by several empirical studies. For instance, a study conducted by Corradin et al. (2023) at the European Central Bank discusses how significant expansions in central banks’ mandates can result in challenges to their independence. Another study by Lane (2022) discusses how monetary policy can affect inflation through two main channels: reducing inflationary pressure by increasing economic slack and ensuring that medium-term inflation expectations are anchored at their target. A working paper published by Bank Al-Maghrib (2020) empirically assesses whether or not liquidity coverage ratios increase demand for central bank reserves in foreign currencies. These studies provide valuable insights into how changes in monetary policy might influence banks’ behavior and the broader financial system.
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Fig2: responses of variables to the shocks of Feedback parameter (ω)

In our concluding analysis, we scrutinize the efficacy of "pandemic loans" in alleviating the impacts of the pandemic. Following the methodology adopted by Vásconez et al. (2021), we postulate that pandemic loans act as an exogenous shock on the steady-state fraction (ψ) of publicly intermediate assets, thereby influencing the Central Bank’s share of financing total claims (ψ). Our conceptualization of pandemic loans represents an extreme form of a quantitative easing (QE) policy and diverges from the concept of "helicopter money" as delineated by Friedman (1969). Rather than directly distributing money to individuals without any expectation of repayment, the Central Bank amplifies its percentage of total claims issued. This enables firms to procure capital without resorting to private banks. As a result, our pandemic loans directly stimulate demand by fostering investment and should be perceived as an expansion of central bank intermediation rather than an enlargement of the money supply.

The implementation of this policy results in a lower GDP loss compared to other scenarios. This outcome is anticipated since any surge in (ψ) would instantly augment GDP through
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income generated by the sale of claims. The escalation in claims diminishes real rental interest rates, rendering capital acquisition more appealing and incentivizing investment in physical capital. As a collateral effect, we observe a predicted rise in inflation. However, it is crucial to note that the maximum increase in inflation is merely 0.5% higher than in the absence of the "pandemic loans" program. Our findings are congruent with those proposed by Sharma et al. (2020), C´espedes et al. (2020), and Kiley (2020), thereby reinforcing the validity of our results.

**Fig3: responses of variables to the shocks of \( \tilde{\psi} \).**

![Graphs showing responses of variables to shocks](image)

**Conclusion**

The COVID-19 pandemic has had a significant and widespread impact across the world. However, the severity and duration of its effects may vary among countries based on their ability to withstand and recover from the health crisis. In this paper, we aim to investigate the potential of unconventional monetary policy implemented by the Central Bank to mitigate the impact of the COVID-19 shock on Morocco. To achieve this goal, we utilize a financial DSGE model with a unique specification that incorporates a standard epidemiological SIR model. Consistent with recent theoretical and empirical studies, we assume that the pandemic
crisis affects the Moroccan economy from both the supply and demand sides.

The current situation is expected to have a negative impact on the state budget due to a decline in tax income. The disruption in production, consumption, and trade caused by the pandemic is likely to harm the trade balance. To address these challenges, we propose a hybrid model that combines an epidemiological model with a DSGE model. Additionally, the model incorporates monetary policy through a Taylor rule that responds to changes in inflation and production, as well as an equation that describes unconventional monetary policy.

Our analysis indicates that, aside from increasing the Central Bank's share of claims, our unconventional monetary measures are insufficient to counteract the negative economic impact of the crisis. However, as a lender of last resort, the Central Bank could consider adopting an unconventional monetary policy to exogenously boost its share of total claims issued through "pandemic loans," which firms can then use to purchase capital. This approach has the potential to reduce overall GDP losses, alleviate the economic downturn to some extent, and limit inflationary pressures. The latter has been a concern among economists since the introduction of unconventional monetary policies after the sub-prime crisis (e21 Staff 2010). This is a promising concept, especially since several industrialized countries have announced stimulus packages worth billions of dollars to tackle the COVID-19 crisis.
References


