Implications of the Global Financial Crisis on the Algerian Economy♦

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Abstract

The global financial crisis may affect the Algerian economy through the following channels: (1) increase of costs of firms' borrowing to finance their investment, (2) decline in oil prices, and (3) the lower world interest rates. This paper uses a small-open economy model with financial frictions (the financial accelerator) to examine the implications of the global financial crisis on the Algerian economy and evaluates the importance of the main transmission channels. Firms operating in Algeria borrow from domestic and foreign banks. The financing costs depend on firms' balance sheet positions and on external finance premiums charged by banks for higher risks they are facing. Main findings are that the global financial crisis has substantially and negatively affected the Algerian economy and all channels are important in the transmission of the financial shocks. Nevertheless, the implementation of expansionary monetary and government spending policies can successfully help the economy avoid recession and thus offset the negative implications of the global financial crisis.

Keywords: Algerian economy; Global financial crisis; Transmission channel; Oil prices.

JEL classification: E52; F3; F4; G10

1. INTRODUCTION

The ongoing global financial crisis, which was triggered by dysfunctional U.S. credit markets, broke out in 2007 when the subprime mortgage default rates rose sharply after the housing bubble burst in 2006. Starting in the beginning of 2000s, consecutive interest rate cuts and the flows of capital from the emerging and oil-exporting economies allowed the U.S. banks to extend their loans to low-income households without the need to exercise prudent control over the credit risks. In addition, with historical low interest rates,

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investors could easily obtain funds with high leverage for investments. Consequently, the housing crunch led to a chain of events: the value of houses (collateral for mortgages) fell and was followed by mounting default rates, which caused sharp declines in the values of the underlying securities and in turn the asset markets as a whole.

The slump in the values of the asset-backed securities led to a deterioration in the balance sheets of banks and firms, and sharp increase in the external finance premiums for firms. The deterioration of the balance sheets of banks and firms exacerbated the impacts of the financial crisis and led to credit contractions in the financial and real sectors. This resulted in deep recession worldwide. Thus, the failure to monitor the loans and the decline in the collateral values were two of the main causes of the global financial crisis.

The global financial crisis has affected the oil-exporting countries, such as Algeria, through four main channels. First, with tightening credit supply conditions, banks in developed countries have largely reduced their loans. Thus, capital flows to finance foreign direct investment in oil exporting countries have been seriously affected and costs of firms' borrowing abroad widely increased, which incites foreign firms to cut their direct investment in these countries. Second, with higher lending risks worldwide, domestic banks may tighten their credit supply and raise the external finance premium requested to compensate higher risks. Third, global financial crisis has induced substantial decline in oil prices. Oil prices have dropped from about $150 in the mid of July 2008 to about $50 in the mid of 2009. This rapid and persistent decline resulted from the fall of global oil demand. Consequently, revenues of oil exporting countries (from oil exports) have been largely declined, which is considered a major shock to their current accounts. Fourth, to stimulate their economies, developed countries cut their nominal interest rates. For example, the Federal Reserve Bank, cut the U.S. federal funds by 500 basic point, from 5.25% to 0-0.25%. Consequently, revenues of reserves, which oil exporting countries were accumulated during the boom, have dramatically fell leading to substantial deterioration of their current account position.

This paper aims to examine the implications of the global financial crisis on the Algeria economy and to analyze the role of the main previous four channels in the transmission of the financial crisis. It also evaluates the importance of expansionary monetary and government spending policies in offsetting negative impacts of the financial crisis. Thus, we develop a small open economy model with financial frictions and financial shocks. The model is a class of dynamic and stochastic general equilibrium (DSGE) models that have been developed for policy and macro-economics analyses.[1] The financial frictions are introduced using the financial accelerator mechanism à la Bernanke, Gertler and Gilchrist (1999) (BGG, hereafter), as used by Christensen and Dib (2008). This financial mechanism focuses on the role of corporate (firm) balance sheets in the amplification and propagation of the different shocks to the real economy.

In this framework, households save by deposits at banks (financial intermediaries). Using deposits, banks provide loans to entrepreneurs, who are subject to idiosyncratic productivity shocks, to finance parts of their investment. The presence of information asymmetry between banks and entrepreneurs creates financial frictions and makes entrepreneurial demand for capital depends on their financial position (leverage ratio), which implies the external finance premium.[2]

The model is calibrated to fit the main features of the Algerian economy, such as: (1) oil accounts for more than 95% of exports; (2) the country is a net creditor to the rest of the world and holds its reserves in the U.S. treasury bonds; and (3) its current accounts highly depends on oil prices. Thus, we assume that oil is the only exported good and total imports are invoiced in the U.S. dollar.

[1]Similar models are used by Cespedes, Chang and Velasco (2004) to examine impacts of the Asian financial crisis, by Dib, Mendicino and Zhang (2008) to evaluate effects of financial shocks on the Canadian economy, and by Bouakez, Rebei and Vencatachellum (2008) to examine the impacts of oil price shocks in Africa..

[2] The entrepreneurs' leverage ratio is defined as the ratio of debt to net worth (equity).

The model is solved numerically using Blanchard and Kahn (1980) procedure. Then, it is simulated using global financial, domestic financial, oil price, monetary, and government spending shocks. Main findings are that foreign financial shocks associated with the global financial crisis have substantial negative implications on the Algerian economy and the four transmission channels have large role in the propagation of global financial crisis. After a negative foreign financial shock that tights credit supply abroad, Algerian output and investment fall by more than 1% on impact, and these negative effects persist for longer period. Similarly, drops of oil price entails significant decline in output, consumption, and the current account position.

A fall of the world interest rates negatively reduces the returns on reserves held abroad and deteriorates the country's current account position. Nevertheless, a decline in world interest rate boosts the domestic aggregate demand and incites the home country to invest its reserves domestically. Interestingly, the implementation of expansionary monetary and government spending policies can successfully help the economy avoid recession and thus eliminate negative implications of the global financial crisis.

The paper is organized as follows. Section 2 describes the model. Section 3 discusses the calibration of the parameters. Section 4 analyzes the simulation results. Finally, section 5 concludes.

2. **THE MODEL**

We consider a small open economy populated by households, producers of final goods, a continuum of retailers and importers, producers of capital, entrepreneurs, and a central bank. The country's exports consist only of oil whose prices are set on the world markets and denominated in the U.S. dollar.

2.1. **Households**

Households derive utility from consumption, C_t, real cash money, m_t (holdings of money outside banks), and leisure 1-h_t, where h_t is hours worked. Their preferences are described by

$$U_0 = E_0 \sum_{t=0}^{\infty} \beta^t u(C_t, m_t, h_t), \quad (1)$$

where $0<\beta<1$ is the discount factor. The single-period utility function is

$$u(\cdot) = \log(C_t) + \upsilon \log(m_t) + \eta \log(1 - h_t), \quad (2)$$

where $\upsilon>0$ and $\eta>0$ denote the weights on money and leisure in the utility function, respectively. Total consumption depends on private consumption, c_t, and public consumption, g_t, so that

$$C_t = \left[a^{\frac{1}{\gamma}} c_t^{\frac{\gamma-1}{\gamma}} + (1-a)^{\frac{1}{\gamma}} g_t^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}, \quad (3)$$

where $\gamma>0$ is the constant elasticity of substitution between private and public consumption, and $0<a<1$ is the share of private consumption in total consumption. For $0<\gamma<1$, private and public consumption are complement.

Households enter period t with real cash money, m_{t-1}, real deposits at domestic banks, d_{t-1}, and real net foreign bonds, b^*_{t-1}, denominated in the U.S. dollar.[3] During period t, households may sell or purchase foreign bonds for prices that depend on the country-specific risk premium, κ_t, and the world interest rate, $R^*_t>1$. Furthermore, households receive revenues from exporting a fixed quantity of oil, y_o, for the oil price, p^*_{ot}. Households also earn real wages, w_t, from supplying labour services and receive dividend payments from the monopolistically competitive retailers and importers, $\Omega_{nt} + \Omega_{ft}$, as well as a lump-sum transfer, T_t, from the central bank. The single-period budget constraint of the representative household is given by:

$$c_t + m_t + \frac{d_t}{R_t} + \frac{s_t b^*_t}{\kappa_t R^*_t} \le \frac{d_{t-1}}{\pi_t} + \frac{s_t b^*_{t-1}}{\pi^*_t} + \frac{m_{t-1}}{\pi_t} + w_t h_t + s_t p^*_{ot} y_o + \Omega_{nt} + \Omega_{ft} + T_t, \quad (4)$$

[3] b^*_t is the stock of the real foreign debt if it is negative, i.e. $b^*_t < 0$.

where s_t is the real exchange rate, the price of one U.S. dollar in terms of the Algerian dinars, R_t>1 is the domestic nominal interest rate on holding deposits, and π_t^*>1 is the world inflation rate.

We assume that oil prices, p_{ot}^*, are given in the world markets in terms of the U.S. dollar and evolve according to an AR(1) process, while the oil supply, y_o, is a fixed endowment. The world nominal interest rate, R_t^*, and inflation, π_t^*, are assumed to evolve exogenously according to AR(1) processes. The country-specific risk premium, κ_t, which reflects departures from the uncovered interest rate parity, is decreasing in the foreign-asset-to-total-output ratio and given by:

$$\kappa_t = \exp\left(-\varphi \frac{s_t \tilde{b}_t^*}{y_t}\right), \tag{5}$$

where φ>0 is a parameter measuring the risk premium, $\tilde{b}_t^*$>0 is the average real stock of foreign assets held by the domestic households, and y_t denotes total output in the economy. The household chooses [c_t , m_t , h_t, d_t , b^*_t] to maximize the expectation of the discounted sum of its utility flows subject to equations (3) and (4). See Dib (2008) for further details about this optimization problem.

2.2. Firms

2.2.1. Final-good producer

The perfectly competitive final-good producer uses domestic goods, y_{nt}, and imported goods, y_{ft}, to produce a final good, z_t, according the following CES technology

$$z_t = \left[(1-\omega)^{\frac{1}{\nu}} y_{nt}^{\frac{\nu-1}{\nu}} + \omega^{\frac{1}{\nu}} y_{ft}^{\frac{\nu-1}{\nu}}\right]^{\frac{\nu}{\nu-1}}, \tag{6}$$

where ω>0 denotes the share of imports in the final good, and ν>0 is the elasticity of substitution between domestic and imported goods. Similarly, both inputs are produced using the CES technology

$$y_{nt} = \left(\int_0^1 [y_{nt}(j)]^{\frac{\theta-1}{\theta}} dj, \right)^{\frac{\theta}{\theta-1}} \text{ and } y_{ft} = \left(\int_0^1 [y_{ft}(j)]^{\frac{\theta-1}{\theta}} dj, \right)^{\frac{\theta}{\theta-1}}, \quad (7)$$

where θ >1 is the constant elasticity of substitution between intermediate goods in composite goods aggregation. The final-good producer chooses y_{nt} and y_{ft} to maximize its profit. Its maximization problem is

$$\max_{\{y_{nt}, y_{ft}\}} P_t z_t - P_{nt} y_{nt} - P_{ft} y_{ft},$$

subject to (6). This implies the following demand functions for domestic- and imported goods:

$$y_{nt} = (1-\omega)\left(\frac{P_{nt}}{P_t}\right)^{-\nu} z_t \text{ and } y_{ft} = \omega\left(\frac{P_{ft}}{P_t}\right)^{-\nu} z_t. \quad (8)$$

The zero-profit condition implies that the final-good price level, which is the consumer-price index (CPI), is linked to domestic- and imported-goods prices through:

$$P_t = \left[(1-\omega)P_{nt}^{1-\nu} + \omega P_{ft}^{1-\nu}\right]^{1/(1-\nu)}. \quad (9)$$

The final good is divided between private consumption, government spending, and investment, so that $z_t = c_t + g_t + i_t$.

2.2.2 Entrepreneurs

The entrepreneurs' behavior is modeled following BGG (1999). We assume that entrepreneurs manage firms that produce wholesale non-oil goods. Entrepreneurs are risk neutral and have a finite expected horizon for planning purposes. The probability that an entrepreneur will survive until the next period is τ, so the expected lifetime horizon is 1/(1-τ). This assumption ensures that entrepreneurs' net worth (the firm equity) is never sufficient to self-finance new capital acquisitions, so they issue debt contracts to finance their desired investment expenditures in excess of net worth.

At the end of each period, entrepreneurs purchase capital, k_{t+1}, that will be used in the next period at the real price q_t. Thus, the cost of the purchased capital is $q_t\ k_{t+1}$. The capital acquisition is financed partly by their net worth, n_t, and by borrowing $q_t\ k_{t+1} - n_t$

from domestic and foreign banks. We assume that entrepreneurs borrow a fraction α from domestic banks and (1-α) from foreign banks. Domestic banks obtain their funds from the households' deposits. Borrowing from foreign banks is denominated in foreign currency.

The entrepreneurs' demand for capital depends on the expected marginal return, r_{t+1}^{k}, and the expected marginal external financing cost at t+1, $E_t\, f_{t+1}$, which equals the real interest rate on external (borrowed) funds. Consequently, the optimal entrepreneurs' capital demand guarantees that

$$E_t\, f_{t+1} = E_t\left[\frac{r_{t+1}^{k} + (1-\delta)q_{t+1}}{q_t}\right], \qquad (10)$$

where δ is the capital depreciation rate. The expected marginal return of capital is given by the right-side terms of (10), in which r_{t+1}^{k} is the marginal productivity of capital, and q_{t+1} is the value of one unit of capital used in t+1.

BGG (1999) assume the existence of an agency problem that makes external finance more expensive than internal funds. The entrepreneurs observe their output costlessly, and output is subject to a random outcome. Banks incur an auditing cost to observe entrepreneurs' output. After observing their project outcome, entrepreneurs decide whether to repay their debt or to default. If they default, the banks audit the loan and recover the project outcome, less monitoring costs.

BGG solve a financial contract that maximizes the payoff to entrepreneurs, subject to the required rate of return of loans. BGG show that---given parameter values associated with costs of monitoring borrowers, characteristics of the distribution of entrepreneurial returns, and the expected life span of firms---the debt contract implies an external finance premium, $\Psi(\cdot)$, that depends on the entrepreneurs' leverage ratio. The underlying parameter values determine the elasticity of the external finance premium with respect to the firm's leverage ratio.

Accordingly, the marginal external financing costs is equal to the gross premium for external funds plus the real opportunity costs

that is equivalent to the risk-free interest rate. We assume that entrepreneurs borrow at the same time from domestic and foreign banks. They borrow a fraction α from domestic banks and (1-α) from foreign banks.[4] Loans from foreign banks are denominated in the foreign currency, so they are converted to Algerian currency by multiplying by the real exchange rate s_t. The marginal cost of borrowing from domestic banks is $E_t\left[\frac{R_t}{\pi_{t+1}}\Psi(\cdot)\right]\Gamma_t$ and that from foreign banks is $E_t\left[\frac{R_t^*}{\pi_{t+1}^*}\frac{s_{t+1}}{s_t}\Psi(\cdot)\right]\Gamma_t^*$. Thus, the total external financing cost is the sum of both marginal costs of borrowing, so that

$$E_t f_{t+1} = \alpha E_t\left[\frac{R_t}{\pi_{t+1}}\Psi(\cdot)\right]\Gamma_t + (1-\alpha)E_t\left[\frac{R_t^*}{\pi_{t+1}^*}\frac{s_{t+1}}{s_t}\Psi(\cdot)\right]\Gamma_t^*, \tag{11}$$

where Γ_t and Γ_t^* are domestic and foreign financial shocks, respectively.[5] Demand for capital should satisfy the following optimality condition (11). We assume that these financial shocks follow AR(1) processes, and the external finance premium is given by

$$\Psi(\cdot) = \Psi\left(\frac{q_t k_{t+1}}{n_t}\right)^{\psi}, \tag{12}$$

with ψ<0 is the elasticity of the external risk premium with respect to the entrepreneurs' leverage ratio, and $\Psi(1)=1$. This elasticity depends on the standard deviation of the distribution of the entrepreneurs idiosyncratic shocks, the agency cost and the entrepreneurs' default threshold. The external finance premium depends on the borrower's equity stake in a project (or, alternatively, the borrower's leverage ratio). As $q_t k_{t+1}/n_t$ increases, the borrower increasingly relies on uncollateralized borrowing (higher leverage) to

[4] The total entrepreneurs debt is ($q_t\ k_{t+1}$-n_t), so they borrow α ($q_t\ k_{t+1}$-n_t) from domestic banks and (1-α) ($q_t\ k_{t+1}$-n_t) from foreign banks.

[5] For further details, see Dib et al. (2008) that analyze the impacts of these shocks on the Canadian economy.

fund the project. Since this raises the incentive to misreport the outcome of the project, the loan becomes riskier, and the cost of borrowing rises.[6]

Aggregate entrepreneurial net worth evolves according to

$$n_t = \tau\left[f_t q_{t-1} k_t - E_{t-1} f_t (q_{t-1} k_t - n_{t-1})\right], \qquad (13)$$

where f_t is the ex-post real return on capital held at t, and $E_{t-1}f_t$ is the cost of borrowing (the real interest rate implied by the loan contract signed at t-1.)[7] In this formulation, borrowers sign debt contracts that specify nominal interest rates. The loan repayment (in real terms) will then depend on ex post real interest rates. Therefore, an unanticipated increase (decrease) in inflation will reduce (increase) the real cost of debt repayment and increase (decrease) the entrepreneurial net worth.

To produce output y_{nt}, the entrepreneurs use k_t units of capital and h_t units of labor following a constant-returns-to-scale technology:

$$y_{nt} = A_t k_t^{\alpha_n} h_t^{1-\alpha_n}, \qquad (14)$$

where $\alpha_n \in (0,1)$ is the share of capital in the non-oil output production and A_t is a technology shock common to all entrepreneurs. A_t is assumed to follow a stationary AR(1) process.

Each entrepreneur sells its output to retail firms in a perfectly competitive market for a price that equals its nominal marginal cost. The entrepreneur maximizes profits by choosing k_t and h_t subject to the production function (14). See Dib et al. (2008) for further details.

2.2.3 Capital producers

Capital producers use a linear technology to produce capital goods sold at the end of period t. They use a fraction of final goods

[6] When the risk of loans increases, the agency costs rise and the lender's expected losses increase. A higher external finance premium paid by successful entrepreneurs offsets these higher losses.

[7] The cost of borrowing from domestic and foreign banks is

$$E_{t-1} f_t = E_{t-1}\left[\alpha \frac{R_{t-1}}{\pi_t}\left(\frac{q_{t-1}k_t}{n_{t-1}}\right)^{\psi} \Gamma_{t-1} + (1-\alpha)\frac{R^*_{t-1}}{\pi^*_t}\frac{s_t}{s_{t-1}}\left(\frac{q_{t-1}k_t}{n_{t-1}}\right)^{\psi} \Gamma^*_{t-1}\right].$$

purchased from retailers as investment goods i_t and the existing capital stock to produce new capital goods. The new capital goods replace depreciated capital and add to the capital stock. Capital producers are also subject to quadratic investment adjustment costs that are specified as $0.5\chi(i_t / i_{t-1} - 1)^2 i_t$, where χ>1 is the investment adjustment cost parameter.

The capital producers' optimization problem consists of choosing the quantity of investment to maximize their profits. The optimal condition is

$$1/q_t = 1 - \chi(i_t / i_{t-1} - 1) + \beta\chi E_t(i_{t+1} / i_t - 1), \qquad (15)$$

which is the standard Tobin's *Q* equation that relates the price of capital to the marginal adjustment costs. Note that, in the absence of investment adjustment costs, capital price q_t is equal to 1. We introduce investment adjustment costs in the model to allow capital price variability, which contributes to volatility of entrepreneurial net worth.

The quantity and price of capital are determined in the capital market. The intersection of the demand and supply curves gives the market-clearing quantity and price of capital. Capital adjustment costs slow down the response of investment to different shocks, which directly affects the price of capital. Furthermore, the aggregate capital stock evolves according to $k_{t+1} = (1-\delta)\, k_t + i_t$.

2.2.4 Retail firms

Retail firms are used to incorporate nominal price rigidity into the economy. They purchase the wholesale goods from entrepreneurs at a price that equals the nominal marginal cost and diversify them at no cost. Then, they sell their goods in a monopolistically competitive market. Following Calvo (1983) and Yun (1996), we assume that each retailer cannot reoptimize its selling price, unless it receives a random signal. The constant probability of receiving such a signal is $(1-\phi)$; and, with probability ϕ, the retailer *j* must charge the same price of the preceding period, indexed to the steady-state gross rate of CPI inflation, π.

If the retailer *j* receives the signal to reoptimize, it chooses a price that maximizes its discounted, expected real total profits for *l*

periods, when it will not be allowed to reoptimize. The retailer's optimization problem implies the following New Phillips curve:

$$\hat{\pi}_{nt} = \beta E_t \hat{\pi}_{nt+1} + \frac{(1-\beta\phi)(1-\phi)}{\phi}\hat{\xi}_t, \qquad (16)$$

where π_{nt} is the gross inflation rate in the non-oil sector, $\hat{\hat{\xi}}_t$ is the real marginal cost, and variables with hats are log deviations from the steady-state values.

2.2.5. Importers

There is a continuum of monopolistically competitive importers indexed by $j \in [0,1]$ that import a homogeneous good produced abroad. Importers can only change their prices when they receive a random signal. The probability of receiving such a signal is $(1-\phi)$. Also, if an importer is not allowed to optimize its prices, it fully indexes them to the steady-state CPI inflation rate. The presence of price rigidity implies that the response of the imported goods price to exogenous shocks is gradual. Thus, there is incomplete pass-through of exchange rate changes to the levels of prices.

If importer *j* is allowed to change its price, it sets the price that maximizes its weighted expected profits, given the real exchange rate, s_t. The maximization problem implies the following New-Phillips curve.

$$\hat{\pi}_{ft} = \beta E_t \hat{\pi}_{ft+1} + \frac{(1-\beta\phi)(1-\phi)}{\phi}\hat{s}_t, \qquad (17)$$

where π_{ft} is the gross inflation rate in the import sector.

2.3. Monetary authority

We assume that the monetary authority follows a Taylor-type monetary policy rule. According to this rule, the central bank endogenously adjusts the short-term nominal interest rate, R_t, to response to changes in the CPI inflation rate, π_t. Thus,

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_r}\left(\frac{\pi_t}{\pi}\right)^{\rho_\pi}\exp(\varepsilon_{rt}), \qquad (18)$$

where ρ_r is a smoothing-term parameter, ρ_π, is a policy coefficient measuring the central bank's response to deviations of inflation from its steady-state level. The serially uncorrelated monetary policy shock, ε_{rt}, is normally distributed with zero mean and standard deviation σ_r.

We also assume that the government consumes a fraction of the final goods and runs a balanced-budget financed with lump-sum taxes: $g_t = T_t$, where g_t follows an AR(1) process.

2.4. Shock processes

A part from monetary policy shock, ε_{rt}, other structural shocks follow AR(1) processes:

$\log(x_t) = (1-\rho_x)\log(x) + \rho_x \log(x_{t-1}) + \varepsilon_{xt}$,

where $x_t = \{A_t, g_t, \Gamma_t, \Gamma_t^*, p_{ot}^*, R_t^*, \pi_t^*\}$, $x > 0$ is the steady-state value of x_t, $\rho_x \in (-1,1)$, and ε_{xt} is normally distributed with zero mean and standard deviation σ_x.

3. PARAMITRIZATION

We calibrate the model's structural parameters using the conventional procedures. Some parameters are resorted to calibrated values based on previous studies [particularly, Dib (2008) that develops a model for Algeria], while others are set to match the model's steady-state ratios to those observed in the data.[8] See Table 1 and 2. To calibrate the parameters in the financial sector, we set the elasticity of the external finance premium, ψ, and the firms' leverage ratio, n/k, at 0.05 and 0.5, respectively. The probability of entrepreneurs' survival to the next period, τ, is set at 0.983. These values are commonly used in the studies that use DSGE models with the financial accelerator à la BGG (1999). The investment adjustment cost parameter, χ, is set at 10.

The discount factor β is set at 0.992, implying an annual steady-state real interest rate on external debt of about 4%. The parameter η, denoting the weight put on leisure in the utility

[8] For example, Christiano et al. (2009) and Dib (2008).

function, is set at 1.47, so that households spend roughly one third of their time in market activities. The elasticity of substitution between private and public consumption, γ, is set at 0.5, implying that private and public consumption goods are complement. The share of private consumption in total consumption, *a*, is 0.65 to match the observed ratio in the data. The parameter υ, which determines the steady-state money velocity, is set at 0.021.

The shares of capital in the non-oil production and the capital depreciation rate, α_n and δ are assigned values of 0.27 and 0.025, respectively. These values are commonly used in open economy literature. The parameter θ that measures monopoly power in domestic- and imported-intermediate-goods markets is set at 6, implying a steady-state markup of price over marginal costs equal to 20%. The parameter ϕ, determining the degree of nominal price rigidity in retail and import sectors, is set at 0.66. Thus, on average the domestic and imported goods prices remain unchanged for 3 quarters. The parameter *v*, measuring the elasticity of substitution between domestic and imported goods in the final output, is set equal to 0.5. Thus, domestically produced goods are only slightly substitutable for imported goods. This reflects the nature of Algerian imports that consist of a large share of investment goods. The fraction of imported goods in the final goods, ω, is set at 0.22.

Table 1 also reports the calibration of the stochastic process coefficients. We assume that both financial shocks are highly persistent, but moderately volatile. Therefore, we set the autoregressive coefficients, ρ_{Γ} and ρ_{Γ^*}, at 0.9 and their standard deviations, σ_{Γ} and σ_{Γ^*}, at 0.002. The oil-price shocks are persistent and largely volatile. We set their autoregressive coefficient, ρ_{p^*}, and the standard deviation, σ_{p^*}, at 0.81 and 0.097, respectively. These values are larger than those assigned for forcing stochastic processes in the model. The stochastic processes of government spending, the world interest rate, and world inflation are persistent, with the autoregressive parameters above 0.5 and standard deviations are ranging from 0.006 to 0.12.

The steady-state of the gross inflation and nominal rates, π, π_t^*, *R*, and R_t^*, are set equal to 1.0125, 1.007, 1.02, and 1.0156,

respectively. The parameter in the country-specific risk premium, φ, is set equal to 0.0046 implying an annual risk premium of 1% (100 basis points). This value implies a steady-state foreign-asset-to-GDP ratio of 25%. Monetary policy coefficients are calibrated as in Dib (2008), so ρ_r, ρ_π, and σ_r are set at 0.86, 0.17, and 0.015, respectively. Table 2 displays the steady-state ratios of key macro variables generated by the model.

4. SIMULATION RESULTS

To examine the implications of the global financial crisis, we simulate the dynamic response of the Algerian economy to foreign financial, domestic financial, world interest rate, and oil price shocks. We also examine the responses of the central bank and government to financial shocks by adopting expansionary monetary and government spending policies. Therefore, we perform the impulse responses of the non-oil production, consumption, investment, employment, imports, the domestic interest rate, CPI inflation, the real exchange rate, the currant account, firms' net worth, and the external finance premiums. Each response is expressed as the percentage deviation of the variable from its steady-state level.

4.1. Responses to global financial shocks

Figure 1 displays the implications of the global financial shocks on the Algerian economy. It plots the impulse responses of key macro variables to a 1% global financial shock: an exogenous increase in the external finance premium when of loans contracted with foreign banks (an increase in Γ_t^*). This negative shock reflects tightening conditions of credit supply in the international financial markets due to the decrease in the confidence level of foreign banks' with respect to the risks and the health of the economy worldwide. Following this negative shocks, foreign banks reduce their credit supply and increase their requested external finance premium when lending to entrepreneurs. With a higher risk premium, entrepreneurs are facing a higher external finance costs, so they reduce their demand of loans and therefore investment declines.

Figure 1 shows that the foreign financial shock negatively affects the entrepreneurs' net worth, which drops by about 15% on the impact and persists for few quarters. The decline of net worth deteriorates firms' balance sheets and triggers an increase in the external finance premium paid to foreign banks. Therefore, the external finance costs increase, associated with a drop of firms values (equities), leads to sharp decreases in investment and output and thus entailing a recession of the Algerian economy. The instantaneous impacts of this shock on investment and output are very substantial: Investment and output fall by 1.5% and 1%, respectively, on the impact and remain below their steady-state levels for many quarters. Interestingly, the impulse responses also show that after this shock, the domestic external finance premium is lower few quarters after the shock, implying substitution of borrowing from domestic banks for those from abroad.

We note that a foreign financial shock negatively affects labour and imports. It also leads to the appreciation of the domestic currency vis-à-vis the U.S. dollar and to moderate improvement of the country's current account in the short-term. This current account improvement reflects the decline in both entrepreneurs' borrowing from abroad and imports, resulting from the drop of investment. Finally, the simulation results show that the global financial shocks push down both the inflation and interest rates. This allows the central bank to adopt expansionary monetary policy (quantitative monetary easing) to offset the negative impacts of the global financial crisis.

4.2. Responses to domestic financial shocks

To examine the implications of domestic financial shocks, we plot, in Figure 2, the impulse responses to a 1% increase in Γ_t. The qualitative responses of macro variables to this shock are similar to those of a global financial shock. Nevertheless, the magnitudes of the responses to domestic financial shocks are much lower than those to global financial shocks. The instantaneous impacts of this shock on output, investment, and net worth are about the half of those generated following a global financial shock.

In this case, an exogenous increase in Γ_t deteriorates credit supply conditions by domestic banks. This is a result of the deterioration of the domestic banks' confidence level and the banks' risk perception:

Domestic banks negatively perceive changes in creditworthiness of entrepreneurs. Therefore, a tightening domestic financial shock increases the external finance premium requested by banks to be compensated for the increase in risks of providing loans. A higher finance premium raises external finance costs of borrowing to finance investment, leading to a decline in entrepreneurs' net worth and significant drops of investment and output. Furthermore, following this domestic financial shock, employment, imports, inflation, and the nominal interest rate jump below their long run equilibrium values, while on the impact the country's current account slightly improves and the real exchange rate persistently appreciates.

4.3. Responses to oil price shocks

The global financial crisis has negatively affected the oil prices, which is the consequence of drops in oil demand caused by to the recession worldwide. The fall of oil prices is one of the main channels through which the financial crisis is transmitted to the oil exporting economies, such as Algeria. Therefore, we investigate macroeconomic effects of negative oil price shocks, p_{ot}^{*} that reduce oil exporting revenues.

Figure 3 plots the impulse responses to a 1% negative oil-price shock (a decrease in the oil price by 1%). A negative oil-price shock implies an instantaneous and substantial deterioration of the current account and very persistent and significant depreciation of the domestic currency. Imports negatively, but gradually, react to this shock. Therefore, a fall in the oil price, which entails an instantaneous decline in the Algerian export revenues, implies a deficit in country's current account.

In addition, following a negative oil price shock, the entrepreneurs' net worth decreases. This triggers increases in both domestic and foreign external finance premiums. So the costs of borrowing substantially rise, which incites entrepreneurs to cut

further their investment. This makes output, employment, and imports declining. The oil-exporting country is not richer after a negative oil price shock (negative wealth effect), what in turn reduces households' consumption. On the other hand, the depreciation of the domestic currency offsets the effects of the decreases in domestically-produced goods price on CPI inflation and leads to a slight increase in inflation and the nominal interest rate for longer periods.

4.4. Responses to world interest rate shocks

The drop of the world interest rate during the crisis period is one of transmission channel through which the global financial crisis affects oil exporting countries. These economies had accumulated large reserves during the boom period that had preceded the financial crisis. The accumulated reserves are invested in foreign assets and mostly in the U.S. treasury bonds. The rate of returns of foreign assets largely depends on the U.S short-term rates. Therefore, a fall in the U.S. short term rates lowers the returns of foreign assets held by the exporting economies. This has direct effects on the current account position and may lead to its deterioration.

Figure 4 displays the implications of a 100 basic points drop in the world interest rate. Following this shock, the country's current account falls by about 0.75%, reflecting the decline in the returns of invested reserves in foreign countries. Therefore, the country reduces its stock of foreign assets by selling a fraction of which in the international financial markets and uses obtained funds domestically. Therefore, the aggregate demand rises substantially and the country's currency appreciates.

Entrepreneurial net worth is positively affected by the drop of the world interest rates. First, a lower world interest rate means a decline in costs of borrowing abroad for entrepreneurs. Second, the increase in the aggregate demand boosts firms' net worth that lowers the entrepreneurial leverage ratios and thus reduces external finance premiums paid for borrowing funds. (See Figure 4).

4.5. Responses to expansionary monetary policy shocks

We now return to investigate whether the monetary authority is able to reduce the impacts of shocks associated with the global financial crisis using an expansionary monetary policy. Sine prices are sticky, monetary policy is not neutral in the short terms. Thus, the central bank can neutralize the effects of exogenous shocks by facilitating the reallocation of the resources in the economy.

Figure 5 plots the impulse responses of the Algerian economy to a 1% expansionary monetary policy shock (a 1% decrease in ε_{rt}). This shock stimulates domestic aggregate demand and reduces the external cost of borrowing from domestic banks. After this shock, the nominal interest rate, falls, while output, consumption, investment, employment, imports rise sharply on impact. Moreover, this shock entails a deterioration of the current account, because the country reduces its foreign assets holdings to finance the increase of imports that are boosted by positive effects on aggregate demand (consumption and investment). The deficit of the current account leads to the depreciation of the country's real exchange rate, which facilitates the increase in the inflation rate.

Also, this expansionary shock has a positive impact on entrepreneurial net worth, as it rises by about 2% on impact, while domestic and foreign external finance premiums slightly increase, reflecting the rise in the entrepreneurs' leverage ratio to finance the expansion of their investment. Therefore, adopting an expansionary monetary policy that reduces the short-term interest rate will increase the domestic aggregate demand, particularly investment, and thus helps in offsetting negative impacts of different shocks implied by the global financial crisis.

4.6. Responses to expansionary government spending shocks

Here we examine the effects of a 1% positive shock to government spending (an increase in government expenditure by 1%). Figure 6 displays the impulse responses of the Algerian economy to this expansionary shock. The effects of this shock are evident, the implementation of government spending can successfully help the economy avoid recessions. Output increases by 0.2%, while consumption, employment, and imports rise by about

0.1%. Nevertheless, the increase in investment is marginal. This is explained by the crowding-out effect of government spending on the interest rate that has increased after the shock. The current account position declines because of the increase in imports caused by a higher aggregate demand.

We also note that entrepreneurial net worth is positively affected by this expansionary shock, so firms' balance sheets are enhanced. With a lower leverage ratio, the external finance premiums fall, which reduces costs of borrowing from banks to finance capital purchases.

5. CONCLUSION

The ongoing global financial crisis was triggered by dysfunctional U.S. credit market and spread to the most of countries through different transmission channel. The financial crisis has affected the Algerian economy through the following channels: (1) increase of costs of firms' borrowing to finance their investment, (2) decline in oil prices, and (3) the lower world interest rates. The paper uses a small open economy model with financial friction à la BGG (1999), price rigidity, and financial shocks to examine the implications of the financial crisis and the importance of the transmission channels.

The simulation results show that foreign financial shocks associated with the global financial crisis have substantial negative implications on the Algerian economy and the four transmission channels have large role in the propagation of global financial crisis. Nevertheless, the implementation of expansionary monetary and government spending policies can successfully help the economy avoid recession and thus eliminate negative implications of the global financial crisis.

Future work consists of developing a large scale small open economy model for Algeria by incorporating optimizing bank sector using the microfounded framework developed by Dib (2009) to model the supply-side of the credit market.

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Table 1: Calibration of the model's parameters

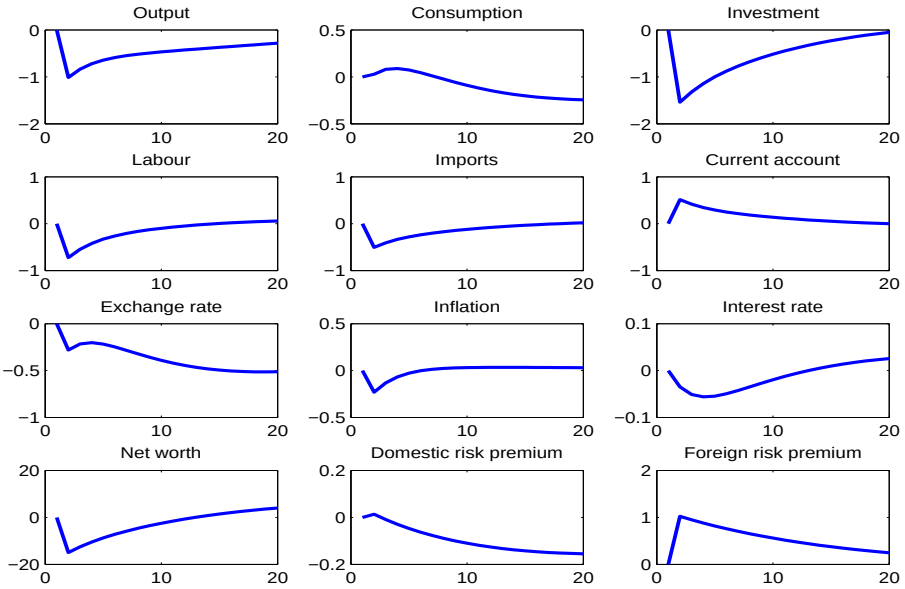
Parameters	Definition	Values
ψ	Elasticity of external risk premium	0.05
τ	Probability of survival	0.983
n/k	Firm's leverage ratio	0.5
β	Discount factor	0.992
ρ_r	Smoothing coefficient in the monetary	0.90
ρ_π	policy	0.17
σ_r	Inflation coefficient in the monetary	0.005
ν	policy	0. 5
γ	Standard deviation of monetary policy	0.5
a	shocks	0.8
ϕ	Elasticity of substitution between home	0.66
θ	and imported goods	6
χ	Elasticity of substitution between	10
ω	private and public consumption	0.27
α_n	Share of private consumption in total	0.25
δ	consumption	0.025
φ	Price rigidity parameter	0.0046
η	Elasticity of substitution between	1.47
υ	intermediate goods	0.021
ρ_{Γ^*}	Capital adjustment cost parameter	0.9
ρ_Γ	Share of capital in non-oil production	0.9
ρ_{p^*}	Share of imports in GDP	0.81
ρ_A	Capital depreciation rate in the oil	0.76
ρ_g	sector	0.95
ρ_{R^*}	Country-specific risk premium	0.83
ρ_{π^*}	parameter	0.5
σ_{Γ^*}	Weight of leisure in utility	0.002
σ_Γ	Weight of cash money in utility	0.002
σ_{p^*}	Autocorrelation of global financial	0.097
σ_A	shocks	0.012
σ_g	Autocorrelation of domestic financial	0.01
σ_{R^*}	shocks	0.006
σ_{π^*}	Autocorrelation of oil price shocks	0.007
	Autocorrelation of technology shocks	
	Autocorrelation of government	

spending shocks	
Autocorrelation of world interest shocks	
Autocorrelation of world inflation shocks	
Standard deviation of global financial shocks	
Standard deviation of domestic financial shocks	
Standard deviation of oil price shocks	
Standard deviation of technology shocks	
Standard deviation of government spending shock	
Standard deviation of world interest shocks	
Standard deviation of world inflation shocks	

Table 2: The model's steady-state ratios to GDP

External reserve	0.25	Consumption	0.74
Total exports	0.34	Investment	0.11
Total imports	0.24	Government spending	0.20
Non-oil output	0.71	Total money stock	0.64

Figure 1: Effects of a 1% increase in the foreign external finance premium



(Γ^*_t)

Figure 2: Effects of a 1% increase in domestic external finance premium (Γ_t)

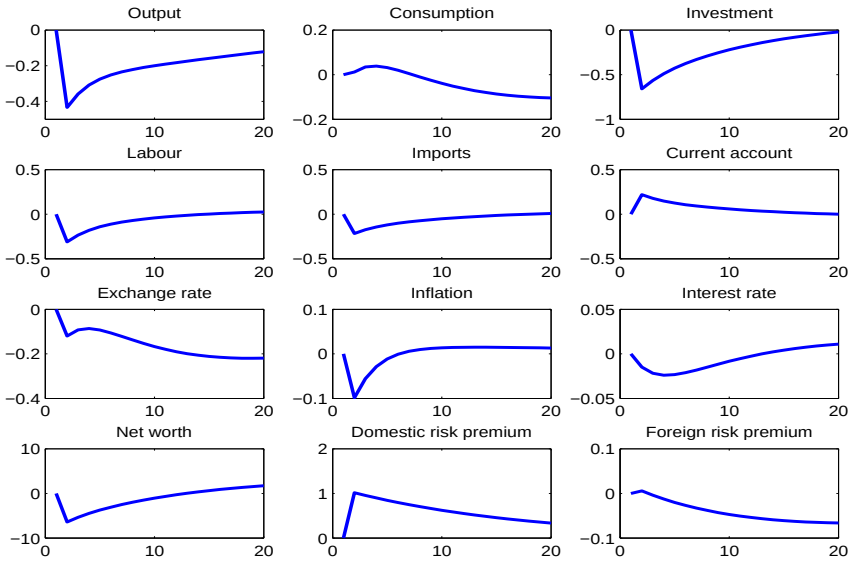


Figure 3: Effects of a 1% decrease in the oil price (p_{ot}^{*})

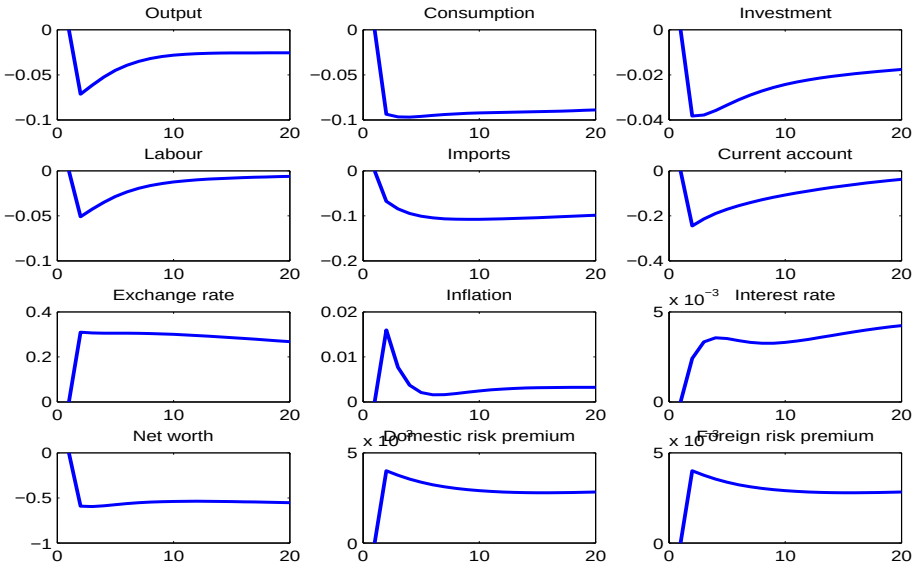


Figure 4: Effects of a 1% decrease in the world interest rate (R_t^{*})

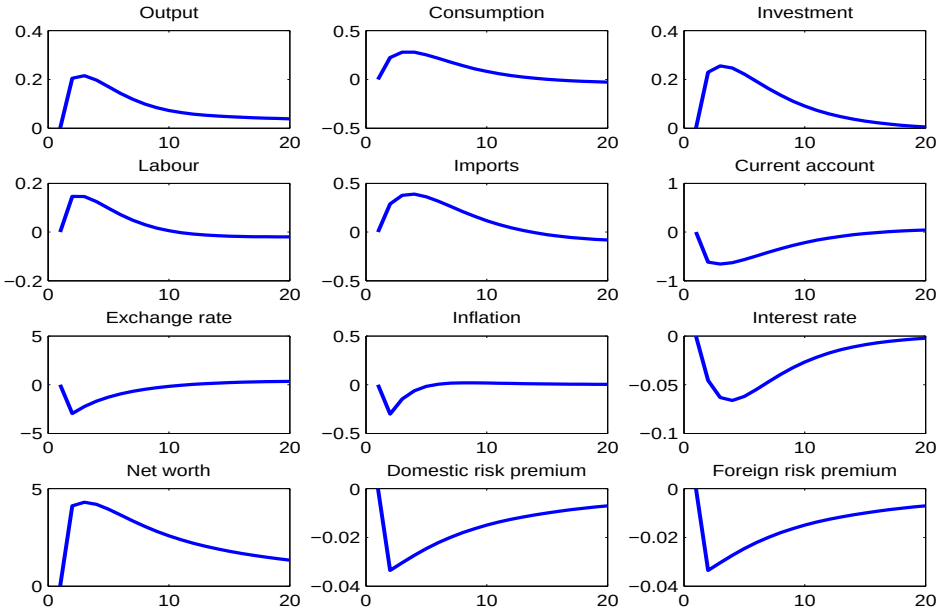


Figure 5: Effects of a 1% decrease in the domestic interest rate (ε_{rt})

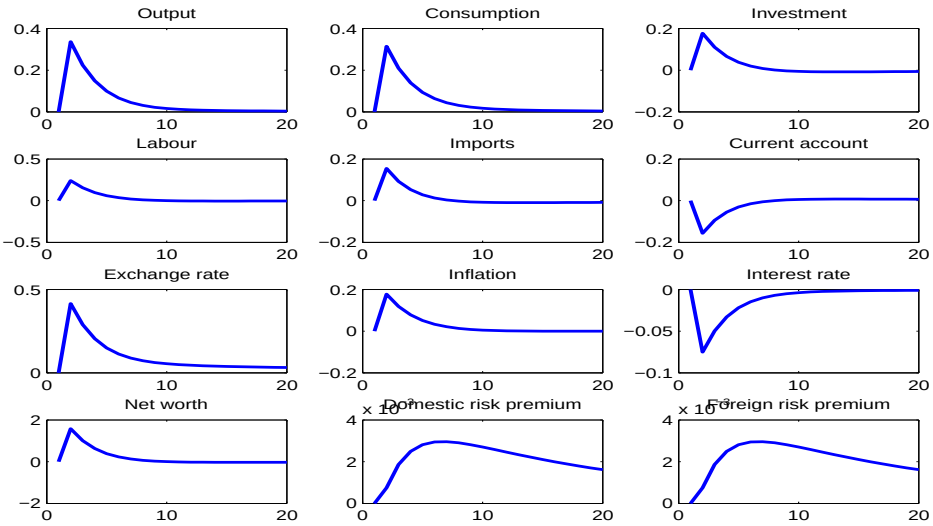


Figure 6: Effects of a 1% increase in government spending (g_t)