Monetary Policy and Choice of Exchange Rate Regime for the Developing Countries: Case of Morocco
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Abstract: In this paper, a dynamic stochastic general equilibrium model is proposed to determine the optimal monetary rule for the conduct a price stability policy in Morocco, if the monetary authorities decide to adopt a flexible exchange rate. The results suggest that the standard Taylor rule and Taylor rule with a target exchange rate are better adapted to the Moroccan economy. Indeed, these two monetary rules allow a stabilization of the macroeconomic framework, able to conduct effectiveness monetary policy. However, the Taylor rule with a target exchange rate gives a more stable exchange rate. Thus, on the basis of these empirical results, it seems appropriate for Moroccan monetary authorities to conduct this rule in the context of an intermediate exchange rate regime, as a preliminary phase before the transition to a floating regime.

Keywords: Exchange rate regime, monetary policy, DSGE, developing country and pass-thought.

JEL Classification: C68, D44, E27, E52, E58.

1. Introduction

In a crisis, to ensure the sustainability of fixed exchange rate regime seems a difficult task for the Moroccan authorities. Several factors are driving the transition to a more flexible exchange rate regime: (i) a significant decrease in the level of foreign reserves in line with the decline in remittances from Moroccans living abroad, FDI and tourism receipts, (ii) a gradual opening and continuing capital account, (iii) render to a medium-term Casablanca the first financial city in the North of Africa and finally (iv) the interest of the Central Bank to adopt an inflation targeting regime to have more control over the transmission channels of monetary policy.

The IMF indicates for this purpose, in the context of the 2011 Article IV consultation with Morocco that “While the current pegged exchange rate regime has served Morocco well, the authorities maintain the medium-term objective of moving to a more flexible monetary and exchange rate regime. Looking forward, the timing for a shift in exchange rate policy may be more opportune. In particular, the prerequisites for a move to inflation targeting are largely in place; the risk of imported inflation is now much less; and balance sheets in the economy have little exposure to exchange rate movements. A more flexible regime would ease the economy’s adjustment to shocks, and could be implemented in a manner to minimize any increase in volatility in the economy. Paired with structural reforms, it could help address Morocco’s competitiveness challenges, likely boosting growth rates over the medium term.”

However, the choice of an optimal exchange rate regime constitutes an important determinant for the macroeconomic framework stability. Moreover, it became in the main of the international
macroeconomics since work of Friedman (1953) and Mundell (1961). Thus, two empirical approaches of the choice of optimal exchange rate regime are proposed in the literature: approaches based on the traditional macroeconomic theory and the macroeconomic models with microeconomic foundations.

In the first group, the exchange rate regime is apprehended through approximate variables which are used as dependent or independent variables. In the first work category (Papaioannou, 2003), Juhn and Mauro (2002) and Moosa (2005)) connects the dependent variables representing the selected exchange rate regime and the explanatory variables that to determine the choice of the exchange rate regime. The specification of the exchange rate regime can be either discrete (for example, zero for the peg exchange rate regime and one for the intermediate exchange rate regime), or continuous by taking values which relate to the degree of flexibility of the exchange rate regime. In addition, the choice of these values can be established on various classifications of the exchange rate regime. For this category of model, several approaches of modeling are used. These include the method of discriminates analysis, probit models and multinomial logit methods ordered or unordered. The second category (Broda (2001a), Edwards and Levy-Yeyati (2003) and Borensztein et al, 2001) aims to explain the effect of exchange rate regimes on macroeconomic performance, or more generally to study the effect of different exchange rate regimes on the dynamics of macroeconomic variables. the four macroeconomic indicators that are often used are: inflation, monetary growth, the real interest rate and the real growth rate.

The second group of models uses the dynamic stochastic general equilibrium (DSGE). The interest of these models is that they can incorporate several requirements relating to the conduct of monetary policy: a floating of nominal exchange rate at the hard peg, through an intermediate exchange rate regime. These models can be classified into two groups: the first is based on the criterion of the volatility of the key macroeconomic variables, particularly inflation and output to identify the exchange rate regime as appropriate, while the second investigates the optimality of exchange rate regimes through the maximization of the function of the welfare of the consumer, the producer or the central bank. In the first category are the work of Devereux and Engel (1999), Cúrdia and Finocchiaro (2005), and Daria Cúrdia (2007) and Devereux (2000). In the second category we find the work of Devereux et al (2004) and Kollmann (2001).

Most of these studies were interested in the case of developed and emerging countries. To our knowledge the case of developing countries has rarely been studied. In the same line as the work of Devereux et al (2004) and Devereux (2000), we propose a DSGE model to evaluate alternative monetary rules corresponding to different exchange rate regimes for the case of Morocco. This paper aims to define the various tradeoffs that may arise for monetary policy in Morocco if the authorities decide a flexible exchange rate regime. The interest is to assess the volatility of macroeconomic variables in response to changes in the exchange rate regime.

We treat the case of Morocco, which is considered a small economy with a partially closed capital account. In this work we distinguish between two budget constraints of households. The first relates to a fixed exchange rate regime with a closed capital account. The second is a flexible exchange rate regime with an open capital account in which the Moroccan households can lend or borrow abroad.
Similarly, the model is characterized by the presence of rigidities. According to Devereux (2006) price rigidity for a role for monetary policy and establish meaningful comparisons between different exchange rate regimes. By the same author, the degree of transmission of the variation in the exchange rate to prices is important in the assessment of monetary rules.

Five rules for monetary policy are simulated: (i) a Taylor rule which aims to stabilize the volatility of inflation and output gap, (ii) a Taylor rule with a target of nominal exchange rate, (iii) a Taylor rule aimed at stabilizing the rate of increase in the CPI, (vi) a Taylor rule aimed at stabilizing the rate of increase in the prices of non-tradable. These four rules are often conducted in flexible exchange rate regimes with inflation targeting policy (strict or flexible), and finally (v) a rule of stability in the exchange rate associated with a peg exchange rate regime.

The rest of this paper is structured as follows: at first we present the DSGE model adopted in this paper. Next, a model calibration is performed with a presentation of the results obtained. Then we examine the responses of the economy to various shocks simulated under the different monetary rules. Finally, a comparison of the volatility of key macroeconomic variables under the different monetary rules is set to conclude at the choice of optimal exchange rate regime for the case of Morocco.

2. Presentation of the Model

The DSGE model proposed for the case of Morocco, to assess the choice of optimal exchange rate regime, is composed of four agents: households, firms, entrepreneur and the central bank. Added to this, the rest of the world where the prices of exported and imported goods are determined. Moreover, the economy consists of two sectors producing two types of goods: tradable and non-tradable. This distinction allows a better characterization of the Moroccan economic conditions. Households consume domestic non-tradable goods and imported foreign goods. Firms in both sectors hire charge the household labor and the labor and capital over the entrepreneur and sell consumer goods to household residents and foreign importers. Competitive firms using capital and investment to produce intermediate capital goods which are sold by entrepreneurs. In addition, importing firms buy foreign goods imported and sold in the domestic market. Entrepreneurs are transforming the capital and intermediate sectors sell back finished goods. Finally, the central bank uses the nominal interest rate as an instrument of monetary policy. Two nominal rigidities are also included in the model: (i) the costs of price adjustment firms of non-tradable sectors and (ii) an incomplete pass-through of the exchange rate to import prices (figure 1).

Nominal rigidities are introduced to explain the role of monetary policy. There are several studies that confirm the existence of a transmission delay variations in the exchange rate to consumer prices. Moreover, it is established by Engel (1999) that deviations from the law of one price are major factors in determining the real exchange rate.

2.1 Consumers

The economy is constituted by a continuum of consumers which expected inter-temporal utility at the date t=0:
\[
\text{MAX}(U_{\sigma, H, \psi}) = \mathbb{E}_0 \sum_{i=1}^{\infty} \beta^i \left( \frac{C_i^{1-\sigma}}{1-\sigma} - \eta \frac{H^{1+\psi}}{1+\psi} \right)
\]

(2.1)

With \( \beta \in [0.1] \) is a discount factor, \( C_i \) is an index of consumption, \( \sigma > 0 \) is the elasticity of inter-temporal substitution, \( H \) is the supply of labor and \( \psi \) is the elasticity of demand of labor. The total consumption of the households is made up of the consumption of the non-tradable \( C_{Ni} \) and the tradable goods \( C_{Mt} \):

\[
C_i = (a^\frac{1}{\rho} C_{Ni}^{1-\frac{1}{\rho}} + (1-a)^\frac{1}{\rho} C_{Mt}^{1-\frac{1}{\rho}})^{\frac{1}{\rho}}
\]

(2.2)

Where \( \rho > 0 \) the elasticity of substitution between the tradable and non-tradable goods, \( 0 < a < 1 \) is the share of the tradable and non-tradable goods in the consumer price index. This last has the following form:

\[
P_i = (a P_{Ni}^{1-\rho} + (1-a) P_{Mt}^{1-\rho})^{\frac{1}{\rho}}
\]

(2.3)

To introduce nominal rigidities in the non-tradable sectors we need a form of power pricing. We assume that the non-tradable sectors are imperfectly competitive. The function of consumption of non-tradable differentiated can be presented as follows:

\[
C_{i_t}^N = \left[ \int C_{i_t}^N (Z)^{\frac{\rho-1}{\sigma}} dZ \right]^{\frac{1}{\rho}}
\]

(2.4)

With the elasticity of substitution between the different varieties of goods \( Z \) is equal to \( \theta > 1 \). Given the current restrictions on the movement of capital account, the Moroccan households cannot use the international financial market to borrow or invest. Under these conditions, the Moroccan households can consume in value \((P_i * C_i)\), investment in tradable and non-tradable sectors \((I_{NT}, I_{XT})\), to finance their placement \( B_t \) for the current period and hold real balances they want to consume \( M_t \) in the current period. The income which the households perceive comes from the number of labor hours that they offer to the firms of the two sectors against wages \( W_t \). The profits of the companies of the sectors of the non-tradable goods \( \pi_t \), the output of the supply of capital lent to the firms of the two sectors against a rate of profitability \( R_{Ni} \) and \( R_{Xt} \) and balance them monetary last \( M_{t-1} \) as well as the interest charged on the placements \( B_t (1+i_t) \) an real balance. Ultimately, the budgetary constraint under the conditions of a closed capital account is as follows:

\[
B_t + P_t (I_{Ni} + I_{Xt}) + M_t + P_tC_i = W_tL_t + \Pi_t + B_t (1+i_t) + M_{t-1} + P_t R_{Xt} K_{Xt} + P_t R_{Ni} K_{Ni}
\]

(2.5)

The households maximize their utility (2.1) under the budgetary constraint (2.5). The inter-temporal optimum of the households can be characterized by the following conditions:

\[
\frac{1}{1 + i_{t+1}} = \beta \mathbb{E}_t \left\{ \frac{C_{i_t}^\sigma P_t}{C_{i_{t+1}}^\sigma P_{t+1}} \right\}
\]

(2.6)
The equation (2.6) represents the equation of Euler and the equation (2.7) represents the supply of labor.

If Morocco switches to a flexible exchange rate regime which will be accompanied by a more important opening of the capital account, the Moroccan households could in this case resort to the international financial market to lend or borrow an amount $F_t$ in foreign currency from a foreign interest rate $I_t$. The interest rate with which the households are borrowed from abroad is an increasing function of the stock of the foreign debt $S_t$. The padding of the external debt at the last period at an exchange rate $S_t$. In this configuration, the budgetary rule of the consumer can take the following form:

$$B_t + P_t (I_{N_t} + I_{X_t}) + M_t + P_t C_t + (1+i_t^c) S_t D_t = W_t L_t + \Pi_t + B_t (1+i_t) + M_{t-1} + P_t R X_t K_{X_t} + P_t R N_t K_{N_t} + S_t D_{t+1}$$

(2.8)

The Households are the owners of all firms. Tradable sector firms operating in an environment of perfect competition do not influence the pricing of their goods (price equals marginal cost), while firms in non-tradable sectors may vary the price since, they use market power (Mark-up). The optimal inter-temporal household budget constraint with open capital account (2.8) can be characterized by the following conditions:

$$\frac{1}{1 + i_t^*} \left[ 1 - \frac{\psi D_t}{S_t} (D_{t+1} - D_t) \right] = \beta E_t \left\{ \frac{C_t^\sigma P_t}{C_{t+1}^\sigma P_{t+1}} \frac{S_{t+1}}{S_t} \right\}$$

(2.9)

$$\frac{1}{1 + i_t^*} = \beta E_t \left\{ \frac{C_t^\sigma P_t}{C_{t+1}^\sigma P_{t+1}} \right\}$$

(2.10)

$$W_t = \eta H_t^\prime P_t C_t^\sigma$$

(2.11)

The equation (2.9) and (2.10) represent Euler equation. The equation (2.11) represents the supply of labor. The combination of the equations (2.9) and (2.10) gives the relation of the interest rate parity.

The households choose the level of consumption of the imported goods and the not exported goods which enable them to minimize the consumer expenditure. The functions of request of the two consumer goods are written as follows:

$$C_{N_t} = a (\frac{P_{N_t}}{P_t})^{-\sigma} C_t$$

(2.12)

$$C_{M_t} = (1-a) (\frac{P_{M_t}}{P_t})^{-\sigma} C_t$$

(2.13)
2.2 Production Firms

Two types of firms produce the final goods: the firms in the tradable and non-tradable goods. Both goods are produced by combining labor and capital. These two types of firms use different technology levels. Like Devereux, Lane and al. (2001), the labor comes from households and entrepreneurs. Labor input factor of firm in the non-tradable sector is defined as follows:

\[ L_{nt}(i) = H_{nt}(i)^{\Omega} H_{nt}^\varepsilon(i)^{1-\Omega} \]  \hspace{1cm} (2.14)

With \( H_{nt}(i) \) the household’s supply of labor, \( H_{nt}^\varepsilon \) is the entrepreneur’s labor supply and \( \Omega \) represents the share of the household’s supply of labor in the labor factor. The aggregate output of non-tradable sectors is given by the following form:

\[ Y_{nt}(i) = A_N K_{nt}(i)^{\alpha} L_{nt}(i)^{1-\alpha} \]  \hspace{1cm} (2.15)

With \( A_N \) is the parameter of the productivity and \( \alpha \) is the share of the capital in non-tradable sector. The production function of exporting firms is:

\[ Y_{xt}(i) = A_X K_{xt}(i)^{\gamma} L_{xt}(i)^{1-\gamma} \]  \hspace{1cm} (2.16)

With \( A_X \) is the parameter of the productivity and \( \gamma \) is the share of the capital in non-tradable sector. The firms of the two manufacturing sectors use labor and capital of the consumers and the entrepreneurs, and sell their production to the consumers and to the entrepreneurs. The optimization of the behavior of the firms of the two sectors generates the first order condition following:

\[ R_{xt} = P_{xt} Y_{xt} \frac{Y_{xt}^{\gamma}}{K_{xt}} \]  \hspace{1cm} (2.17)

\[ R_{nt} = MC_N \alpha Y_{nt} \frac{Y_{nt}^{\alpha}}{K_{nt}} \]  \hspace{1cm} (2.18)

\[ W_i = MC_N (1-\alpha) \Omega Y_{ni} \frac{Y_{ni}}{H_{ni}} \]  \hspace{1cm} (2.19)

\[ W_{ni} = MC_N (1-\alpha)(1-\Omega) Y_{ni} \frac{Y_{ni}}{H_{ni}} \]  \hspace{1cm} (2.20)

\[ W_i = P_X (1-\gamma) \Omega Y_{xi} \frac{Y_{xi}}{H_{xi}} \]  \hspace{1cm} (2.21)

\[ W_{xi} = P_X (1-\gamma)(1-\Omega) Y_{xi} \frac{Y_{xi}}{H_{xi}} \]  \hspace{1cm} (2.22)
The equations (2.19) and (2.20) describe the optimal alternative of the labor supply of the households and the entrepreneurs in non-tradable sector, with $MC_{N_t}$ the marginal cost in this sector. The equations (2.21) and (2.22) characterize the optimal alternative of the labor supply of the households and the entrepreneurs in the sectors of the tradable goods. Let us note that the price of the tradable goods is $P_{X_t}$. Under the assumption that the sectors of the tradable goods are in perfect competition, $P_{X_t}$ represents the unit costs of production. The trends of prices to the importation $P_{X_t}$ represent the fluctuations of the terms of trade for a small economy. Finally the equations (2.17) and (2.18) represent the choice of the optimal capital in the sectors of the goods tradable and non-tradable.

The stock of capital in the sectors of the goods tradable and non-tradable is given by the following form:

$$K_{N_t+1} = \left[ \frac{I_{N_t}}{K_{N_t}} - \frac{\psi}{2} \left( \frac{I_{N_t}}{K_{N_t}} - \delta \right)^2 \right] K_{N_t} + (1 - \delta) K_{N_t}$$

(2.23)

$$K_{N_t+1} = \left[ \frac{I_{N_t}}{K_{N_t}} - \frac{\psi}{2} \left( \frac{I_{N_t}}{K_{N_t}} - \delta \right)^2 \right] K_{N_t} + (1 - \delta) K_{N_t}$$

(2.24)

With $\delta$ is the quarterly rate of the capital depreciation. The investment in a new capital requires tradable and non-tradable goods as it is the case of the basket of household consumption. The nominal price of a unit of investment, in each sector is $P_t$, the competing firms produce the intermediate goods in capital and sell them to the entrepreneurs.

### 2.3 Inside Prices Setting

Firms in the non-tradable sectors set their prices in an environment of monopolistic competition. As Devereux (2001), it is assumed that firms in this sector bear the costs of price adjustment. However, the adjustment of prices occurs gradually in response to demand shocks and marginal cost.

Households own domestic firms in the non-tradable sector. Firms maximize their profits by using the discount rate as follows:

$$\Gamma_{t+1} = \beta \frac{P_t C_t^\sigma}{P_{t-1} C_{t-1}^\sigma}$$

(2.25)

Thus, we can define the objective function of the firms of non-tradable sector:

$$E_0 \sum_{i=1}^{\infty} \Gamma_i \left[ P_{N_t}(i) Y_{N_t}(i) - MC_{N_t} Y_{N_t}(i) - P_t \frac{\psi}{2} \frac{P_{N_t}(i) - P_{N_t-1}(i)}{P_{N_t}(i)}^2 \right]$$

(2.26)

With $Y_{N_t}(i)$ and $MC_{N_t}$ represents the total output and marginal cost of firms in non-tradable sectors.
respectively. The third expression of the equation describes the adjustment cost of the prices. The firm selected its price to maximize the equation (2.13). We describe the following equation of the optimal pricing:

$$P_{Nt} = \frac{\lambda}{\lambda - 1} \frac{MC}{Nt} - \frac{\psi}{\lambda - 1} \frac{P_{Nt} - P_{Nt-1}}{P_{Nt-1}} - \frac{\psi}{\lambda - 1} \frac{E_t}{\Gamma_{t+1}} \left[ \frac{P_{Nt+1} - P_{Nt}}{P_{Nt}} \right]$$

(2.27)

### 2.4 Outside Prices Setting

We assume that the tradable goods must evolve according to the law of one price as:

$$P_{Xt} = S_t P_{Xt}^*$$

(2.28)

With $S_t = P_{Xt} / P_{Xt}^*$ is a nominal foreign exchange rate and $P_{Xt}^*$ is price abroad of the exported goods. The prices of the imported goods are adjusted only with one delay compared to the variations of foreign exchange rate. The importers, in the same way, face the costs of adjustment of the prices that those of the firms of the non-tradable goods. The price index of the imported goods evolves as follows:

$$P_{Mt} = \frac{\lambda}{\lambda - 1} S_t P_{Mt}^* - \frac{\psi}{\lambda - 1} \frac{P_{Mt} - P_{Mt-1}}{P_{Mt-1}} - \frac{\psi}{\lambda - 1} \frac{E_t}{\Gamma_{t+1}} \left[ \frac{P_{Mt+1} - P_{Mt}}{P_{Mt}} \right]$$

(2.29)

$T_{Mt}$ indicate the total of demand of imported goods and $\lambda$ represents the elasticity of substitution between the imported goods and the not exported goods. Following the paper of Devereux (2004), we use the parameter $\psi_{\nu_t}$ as the degree of transmission of the variations of foreign exchange rate at the prices (the pass-through).

### 2.5. Entrepreneurs

Intermediate goods are produced by entrepreneurs and sold to firms in both sectors. They borrow to finance their investments and put in their capital lease end for both firms and finished goods for firms that produce intermediate goods through capital investment and use of existing capital. The real return on investment capital can be described as the ratio between the total of the nominal rate of return generated by the finished goods firms, firms of intermediate capital goods and the value of the depreciation of capital stock multiplied by the capital initial on the initial price of capital. This can be formulated as follows:

$$R_{KNt+1} = \frac{1}{Q_{Nt}} \left( R_{Nt+1} \left[ 1 - \delta + \psi_T \left( \frac{I_{Nt+1}}{K_{Nt+1}} - \delta \right) \right] \left( \frac{I_{Nt+1}}{K_{Nt+1}} - \delta \right)^2 Q_{Nt+1} \right)$$

(2.30)

$$R_{KXt+1} = \frac{1}{Q_{Xt}} \left( R_{Xt+1} \left[ 1 - \delta + \psi_T \left( \frac{I_{Xt+1}}{K_{Xt+1}} - \delta \right) \right] \left( \frac{I_{Xt+1}}{K_{Xt+1}} - \delta \right)^2 Q_{Xt+1} \right)$$

(2.31)

With $\psi_T$ is the cost of adjustment of the investment.
2.6 Current Account Dynamics and the Real Exchange Rate

Like Ferrero, Gertler, and Svensson (2008) we assume that the real value of net exports is as follows:

$$NX_t = \frac{P_{Mt}Y_{Mt} - P_{Mt}C_{Mt}}{P_t}$$  \hspace{1cm} (2.32)

With $C_{Mt}$ the consumption of the tradable goods, $Y_{Mt}$ production of the tradable goods and $P_{Mt}$ the price of the tradable goods.

Finally, we define real foreign exchange rate as:

$$TCER_t = \frac{S_t^*P_t^*}{P_t}$$  \hspace{1cm} (2.33)

2.7. Monetary Policy

The model assumes that the central bank uses the interest rate on short-term as an instrument of monetary policy. The general form of rule interest rate chosen allows a variety of monetary rule on whether the exchange rate regime is fixed or flexible. It is as follows:

$$\left(d^{h}_{t,s}\right)^{-1} = \left(\frac{P_{Mt}}{P_{Mt-1}} \frac{1 + \pi_n}{1 + \pi_n}\right)^{\mu_m} \left(\frac{P_t}{P_{t-1}} \frac{1 + \pi_y}{1 + \pi_y}\right)^{\mu_y} \left(\frac{Y_t}{\overline{Y}}\right)^{\mu_y} \left(\frac{S_t}{\overline{S}}\right)^{\mu_y} (1 + \hat{\iota}) \exp(\mu)$$  \hspace{1cm} (2.34)

$\mu_m$ and $\mu_y$ represent the extent to which the central bank target to restrict the fluctuations of the rate of increase in the prices of the not exported goods and of the rate of inflation (measured by the CPI) around the target rates $\overline{\pi}_n$ and $\overline{\pi}$ respectively. $\mu_y$ and $\mu_s$ represent the extent to which the central bank target to restrict the fluctuations of the aggregate output and foreign exchange rate around the target rates $\overline{Y}$ and $\overline{S}$ respectively.

According to the classification of de facto exchange rate regimes and monetary policies associated with IMF (2010) Moroccan monetary authorities conduct a conventional fixed exchange rate regime with exchange rate anchor as monetary policy framework. Note that, at present, the monetary policy focuses on price stability. According to de facto classification of IMF, we assume that the central bank conducts its monetary rule as a targeting exchange rate. Thus, the pegged exchange rate is defined as $\mu_y \rightarrow \infty$ and $\mu_m = \mu = \mu_y = 0$.

We propose four alternative rules of monetary policy which are defined as follows:

1. The central bank aims only the stability of the inflation of the non-tradable goods if $\mu = \mu_y = \mu_s = 0$ and $\mu_m \rightarrow \infty$; This rule is justified in the situation where the adjustment of the instruments of the monetary authorities to limit the strong deviations of the inflation of the non-
tradable goods, limiting or reduces the need for the producers of the non-tradable goods to adjust their prices compared to the trend of the prices of the tradable goods (Balassa-Samuelson effect). According to Devereux (2004) this policy makes it possible to reproduce real answers in an economy with a flexibility foreign exchange rate regime in absence of other nominal rigidities.

2. The central bank follows a rule of Taylor form according to which interest rate reacts follows to the variations of the rate of the inflation and the variation of the production if $\mu_{m} = \mu_{s} = 0$; This rule supposes that the monetary authorities pursue a policy of flexible targeting of inflation. In the same way, this rule is often led in a flexible exchange rate regime.

3. The central bank strictly aims the stability of the inflation measured by the CPI if $\mu_{m} = \mu_{s} = \mu_{y}$ $= \mu_{s} = 0$ and $\mu_{s} \rightarrow \infty$; The choice of this rule is justified by the fact that the consumer price index total is used the most by the central banks which pursue a monetary strategy of inflation targeting. According to Devereux (2004), with a degree of pass-through of the variations of foreign exchange rate at the very important price, a rule of price stability is similar that is in mode of a fixed or flexible exchange. However, with an incomplete pass-through and which are delayed in time, it is more convenient to lead a rule of targeting of the inflation of the prices of the non-tradable goods

4. The central bank leads a Taylor rule form in which interest rate reacts to the variations of inflation, the variation of production and with an objective of foreign exchange rate if $\mu_{s} = 1$.This rule is adopted by the countries which passed to the flexible Exchange rate regime, but which always keep a control on foreign exchange rate (the fear of floating).

To determine the optimal monetary rule, it is to consider the implications of different monetary rules on the volatility of key macroeconomic variables such as inflation, economic growth and exchange rates. The optimal monetary rule is that minimizes the volatility of macroeconomic variables.

3. Equilibrium

In each period the balance between demand and supply of non-tradable is provided by the following equation:

$$Y_{Nt} = a \left( \frac{P_{Nt}}{P_t} \right)^{-\rho} \left( C_t + I_{Nt} + I_{xt} \right) \quad (3.1)$$

The evolution of the debt of the economy is described as follows:

$$S_{t}D_{t+1} = S_{t}D_{t}(1 + i_t^*) - P_{xt}Y_{xt} + (1 - a) \left( \frac{P_{xt}}{P_t} \right)^{-\rho} \left( C_t + I_{Nt} + I_{xt} \right) \quad (3.2)$$

In the same way, equilibrium in the market labor is given by the equality of the supply and demand of labor:
\[ H_t = H_{N_t} + H_{X_t} \]  

(3.4)

Finally, the inflation of the prices of the tradable and non-tradable goods is defined as follows:

\[ \pi_{N_t} = P_{N_t} - P_{N_{t-1}} \]  

(3.5)

\[ \pi_{X_t} = P_{X_t} - P_{X_{t-1}} \]  

(3.6)

4. Calibration and Validation of the Models

The calibration of the DSGE model becomes more difficult as we distinguish between two sectors of the economy: sectors of tradable and non-tradable. The values of some parameters are derived directly from empirical studies, others are determined on the basis of the stylized facts of the Moroccan economy. The model is calibrated under a fixed exchange rate.

As Devereux (2001), we assume that the inter-temporal elasticity of substitution in consumption is 0.5. Also, following the same author, we assume that the elasticity of substitution between imported goods and non-tradable goods stood at the unit. As Christiano, Eichenbaum and Evans (1997) we assume that the elasticity of substitution of labor supply is equal to unity.

In addition, the elasticity of substitution between consumption goods determines the profit margins of producers (mark-up) in the tradable sector and non-tradable. Given the absence of an estimate on the profit margins of entrepreneurs in Morocco, we refer to empirical studies that assume that the margin percentage in the two sectors totaled.

In another, the foreign interest rate chosen is the medium-term averages treasury bonds of the ECB's establishing at 6% in the period 1998-2010. The discount rate in quarterly value is equal to 0.985. This value is identical to that used by Devereux (2004) and most paper use DSGE models (Smets and Wouters, 1997).

The parameters of the production factors are important for the dynamics of the model. In the short term, we assume that labor is mobile in both sectors. Similarly we assume that the impact of interest rate shocks and terms of trade on economic activity depends on the intensity factor of production in both sectors. In this context, Devereux (2001) estimated that non-tradable sectors are more intensive in labor compared with the non-tradable sectors.

The contribution of tradable and non-tradable sectors in total added value in Morocco is different. Indeed, most of the growth is generated largely by three non-tradable sectors near the outside. These construction public, services and financial activities. The contribution of these sectors in economic growth averaged 65% during the period 1998-2010 and that of the tradable sectors is 35%.

However, estimates of the contribution of factors of production in Morocco, namely capital and labor in global economic growth may differ from one study to another. According to the study of HCP (1992), the contribution of capital to growth is 78% over the period 1960-2002. In this
regard and as Devereux (2004) we assume that the total share capital and labor in the economy represents 70% and 30%. Similarly, we assume that the contribution of the two factors of production is the same in both sectors.

As for the parameter "a", we believe that the share of non-tradable goods in the basket of the consumer prices index is around 0.5. This value is similar to that used by Devereux (2001).

The cost of price adjustment is introduced in the model as nominal rigidities. These costs of price adjustment correspond to degrees of transmission of changes in exchange rates to prices. Bases on the estimates of pass-through for the case of Morocco, the value of adjustment costs in the prices of tradable goods is 0.32 while the price of non-tradable rises to 0.20. The parameters used in the model are summarizing in Table 2.

In order to validate the microeconomic specifications adopted during the development of five DSGE models suggested for the evaluation of the optimal exchange regime in Morocco, two techniques were planned. The first uses the analysis of the theoretical and empirical moments and the second suggests the use of the stylized facts of the Moroccan economy. However, an alternative method consists with the examination of the impulse responses which will be treated in the following point.

The analysis of the theoretical and empirical moments confirms the validity of the calibration of the models. Indeed, the relative standard deviations are weak what ensures an agreement between the moments generated by the theoretical model and the characteristics of the macroeconomic variables (figure 2).

In addition, the study of the stylized facts of macroeconomic variables reproduces the inertia that often found in their dynamics. Thus, we confirm that all macroeconomic aggregates exhibit autocorrelation coefficients acceptable (figure 3).

5. Simulation Results

The objective of this point is to study the dynamics of DSGE model suggested by analyzing the impact of the shocks of economic policies on the macroeconomic variables. This analysis is led under the five alternative monetary rules. However, the study of the dynamics of the model will be limited to the simulation of three economic shocks. The two first relate to external shocks with Moroccan economy: shock of the term of trade and shock of foreign interest rate. The third is a domestic shock relative to a variation of nominal interest rate (monetary policy shock).

We suppose that the three shocks follow a process AR (1) with a persistence of about 0.46, 0.54 and 0.77 respectively, for foreign interest rate, the term of trade and domestic interest rate.

Lastly, we distinguish in the analysis from the impulse responses between two categories of variables: real variables (total production, the commercial balance and real foreign exchange rate) and nominal variables (total inflation, nominal foreign exchange rate and nominal interest rate). The dynamics of the model is studied in the context of an incomplete pass-through. We put thus for the parameter of price adjustment of the tradable (\( \psi_{T} \)) and non-tradable (\( \psi_{NT} \)) goods of the
values about 0.32 and 0.24 respectively.

5.1 Shock of Foreign Interest Rate

Figure 4 presents the reaction of the Moroccan economy to an increase in foreign interest rate. From its definition, the fixed rule of foreign exchange rate is not concerned with the impact of such a shock.

Following economic theory, an increase in interest rates abroad results in lower two components of domestic demand i.e. final consumption and private investment. Indeed, an increase in interest rates results in a growth in the cost of foreign debt. Also, the depreciation of the exchange rate increases the burden of external debt of entrepreneurs. The combination of these two factors leads to a lower level of investment, intermediate and final consumption. These two factors are likely to lower the level of domestic production. This would result ultimately in improved trade balance, a depreciation of the real exchange rate and a reallocation of production factors of tradable and non-tradable sectors (Devereux, 2004).

It is thus clear from Figure 4 that following a shock in interest rates abroad, the components of demand and aggregate supply decrease, however, the exchange rate depreciates and the trade balance improves. This result was observed under the different monetary rules. For the analysis by sector of activity, this increase in interest rates abroad results in a decrease in demand and production of non-tradable. However, the production of exportable goods increases and the surplus in the trade balance improves.

On another level, Figure 4 shows that the impact of the shock of foreign interest rate on the macroeconomic variables significantly depends on monetary rules pipes. To this end, there is no denying that consumption, investment and output fall significantly under the rule of inflation targeting. Note also that this rule leads to a large depreciation of the nominal exchange rate. This result in a greater increase in inflation compared to other monetary rules.

Moreover, the degree of transmission of exchange rate changes to price an important implication on the comparison of alternative monetary policy rules. By studying the case of emerging countries, Devereux (2001) suggests that in the case of a full pass-through of changes in exchange rates to prices, the makers of monetary policy can stabilize inflation without controlling the exchange rate exchange. However, the adoption of a policy of strict inflation targeting in a context of incomplete pass-through may be able to effectively cope with the shock of the foreign interest rate. In the case of the Moroccan economy is characterized by an incomplete pass-through, a rule of inflation targeting could lead to volatility in the exchange rate and therefore make it difficult to achieve the objective of stability price (figure 4).

5.2 Shock of the Term of Trade

As the economic analysis suggests it, a fast depreciation of nominal foreign exchange rate degrades the current balance. Then, reaction of real foreign exchange rate to the adjustment of the nominal foreign exchange rate led to an improvement of the competitiveness of the economy. This phenomenon is known under the name of the curve in J.
Figure 5 illustrates the effect of the shock to the fall of 1% of the terms of trade. Since this shock is equivalent to a negative shock of productivity in the sector of the tradable, it follows a deterioration of the trade balance caused by an increase in the imports in final and intermediate consumer goods. In fine, this effect led to an increase of inflation and a fall in the production.

In addition, the impact of the shock of the term of trade on the economy depends on the adopted monetary rules. Thus, under a rule of Taylor with an objective of foreign exchange rate, a negative shock of the term of trade generates a deterioration of the commercial balance and a fall of the more marked production and investment compared to the other alternative rules. To note, that the rule of stability of inflation leads to a more important depreciation of nominal foreign exchange rate. As is the case for the shock of interest rate abroad, the rule of stabilization of inflation generates with a more important depreciation of foreign exchange rate and consequently of inflation (figure 5).

5.3 Shock of Domestic Interest Rate

Figure 6 presents the effect of the shock of local interest rate on the macroeconomic variables. In a closed economy, an increase in real interest rate leads to a reduction in consumption because of the inter-temporal substitution effect. However, in an open economy a higher real interest rate results not only by the reduction of consumption, but also in an appreciation of real foreign exchange rate and an improvement of the terms of trade. The combination of these the last two factors tend to increase consumption by a substitution effect of the expenditure between the national and imported products. In other words, an increase in domestic interest rate leads to a fall of consumption and investment. This decrease in the total demand is accompanied by a fall by the total activity. The increase in domestic interest rate causes finally a fall of inflation.

The simulation of the shock suggests that when the monetary authorities decide on an increase in the interest rate of 100 basis points, the components of the request decrease and lead to a contraction of the production. This results in a fall of inflation and an improvement of the commercial balance.

The degree of reaction of the macroeconomic variables differs according to the monetary rules. Thus, it is noted that the rule of Taylor with an objective of foreign exchange rate, amply minimizes the investment, the total production as well as that of the two sectors (tradable and non-tradable). In the same way, the answers formulated by this rule in term of inflation and commercial balance seem more convincing (figure 6).

6. Evaluation of the Monetary Rules

The results of simulations of the five monetary rules are presented in figure 5. The analysis of the degree of volatility simulated of the macroeconomic variables under the various monetary rules confirms the conclusions deduced from the analysis of the impulse responses.

It comes out from it thus that, the rule of stability of inflation generates a strong volatility of the real exchange rate and the rate of inflation. In the same way, the traditional rule of Taylor and the rule of Taylor with an objective of foreign exchange rate have levels of volatility of the macroeconomic aggregates weakest. However, the dynamics of foreign exchange rate is
characterized by a more important volatility under the traditional rule of Taylor compared to the rule of Taylor with an objective of foreign exchange rate.

Ultimately, under the assumption that macro-economic equilibrium remain unchanged at the time of the passage to a flexible exchange regime, simulations of the model suggest that the adoption of a rule of Taylor with an objective of foreign exchange rate seems more suitable for the Moroccan monetary authorities. Indeed, this rule could guarantee less volatility of the macroeconomic variables. Often adopted within the framework of an intermediate exchange rate regime, this rule makes it possible the monetary authorities to stabilize the volatility of inflation and the growth on the one hand and on the other hand to reduce the excessive variations of foreign exchange rate. Ultimately, these results suggest that the adoption of an intermediate regime before the passage a floating exchange rate regime is recommended (figure 7).

7. Summary and conclusion

Contributing to the debates on the floating of the exchange rate regime in Morocco, this work proposes an optimal monetary rule associated with a flexible exchange rate regime, which will allow a better macroeconomic stability. The criterion of the choice of the optimal exchange rate regime is based on the examination of the volatility of the macroeconomic variables under the various alternative monetary rules.

It comes out from it thus that the traditional rule of Taylor and the rule of Taylor with an objective of foreign exchange rate have lower levels in term of volatility of the macroeconomic aggregates. However, the dynamics of foreign exchange rate is characterized by a more important volatility under the traditional rule of Taylor compared to the rule of Taylor with an objective of foreign exchange rate.

Simulations indicate that an intermediate exchange rate regime seems convenient like a first stage before passing to total flexibility. As suggests the benchmark of the emerging countries (Chile, Poland, etc.), an intermediate exchange rate regime constitutes a gradual stage for the transition to a floating regime. Indeed, during this phase public authorities carry out a process of learning and correction of misalignment of the exchange rate from its equilibrium path.

Endnotes

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1. The variation of interest rate consists of an increase of 100 basis point of i*. 
2. The term of trade is defined as the price ratio in export compared to the import prices. It makes it possible to indicate on the number of units of imported goods which can be exchanged against a unit of exported goods.

3. An increase in domestic interest rate corresponds to an increase of 100 basis points.

References


Daria, F. and Curdia, V. 2007 “Monetary Regime Change and Business Cycles” Federal Reserve Bank of New York Staff Reports no. 29.


Figure 1: Structure of the model
Figure 2: relative standard deviation of the various monetary rules

![Bar chart showing relative standard deviation of various monetary rules.](image)

Figure 3: Autocorrelations of the several monetary rules

![Bar chart showing autocorrelations of several monetary rules.](image)
Figure 4: Shocks of foreign interest rate for various monetary rules
Figure 5: Shocks of the terms of trade for various monetary rules

![Graphs showing the terms of trade shocks for several rules](image-url)
Figure 6: Shocks of local interest rate for various monetary rules
Figure 7: Volatility of the macroeconomic variables under the various monetary rules
Table 1: characteristics of the monetary rules

<table>
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<tr>
<th>Monetary rules</th>
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<th>$\mu_{\pi c}$</th>
<th>$\mu_{i}$</th>
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Table 2: calibration of the model parameters

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<th>Value</th>
<th>Description</th>
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<td>$\alpha$</td>
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<td>Share of capital in the non-tradable</td>
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<td>$\beta$</td>
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<td>Discount rate (quarterly)</td>
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<td>$\gamma$</td>
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<td>Share of capital in the tradable sectors</td>
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<td>$\delta$</td>
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<td>Quarterly rate of depreciation of the capital (the same one for the two sectors)</td>
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<td>$\epsilon$</td>
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<td>Inverse of the elasticity of real balances</td>
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<td>$\eta$</td>
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<td>Coefficient of labor in the utility function</td>
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<td>$\lambda$</td>
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<td>Elasticity of substitution between imported goods and not exported goods</td>
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<td>$\rho$</td>
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<td>Elasticity of substitution between tradable and non-tradable consumer goods</td>
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<td>Inverse of the elasticity of substitution of consumption</td>
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<td>$\psi$</td>
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<td>inverse of the elasticity of labor demand</td>
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