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## EVALUATING THE WELFARE ASPECTS OF THE SIMPLE MONETARY RULES FOR IRAN

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**ABSTRACT:** *This paper following a monetary growth rate rule aims to compare the properties of different monetary policy rules in Iran. In that regards, the paper draws on the New Keynesian Dynamic Stochastic General Equilibrium (DSGE) models. Within this framework, we rank the different policy rules based on the Impulse response Functions, the volatility of key macroeconomic variables and the welfare loss function. The paper concludes that the effects of alternative monetary rules depend on what shocks affect the economy, the exchange rate regime, and the choice*

*of inflation index. When the economy experiences productivity shocks, domestic inflation targeting is welfare-superior to other monetary rules. However, in the case of other shocks except productivity shock a managed exchange rate is the best policy rule. Finally, the results of welfare loss of alternative monetary policy rules allowed noticing the nature of the shocks affecting the economy dictate the implication and choice of the best monetary policy rule.*

**KEY WORDS:** *Welfare Loss, simple monetary rules, Small open economy*

**JEL CLASSIFICATION:** F41, E52, E58

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## **1. INTRODUCTION**

Over the last three decades, the Iranian economy has been subject to a number of major adverse shocks. Some of them are external, including the eight-year war with Iraq and volatility in global oil prices. However, major imbalances in the economy were also policy driven. Economic performance of the economy of Iran significantly depends on the efficiency of macroeconomic policies in general and the monetary policy in particular. The government of Iran attempts to reform economy within the framework of the Five Year Development Plans (FYDPs) since 1989. When looking at the ability to meet inflation and monetary targets set in the FYDPs, the performance of monetary policy has been less than satisfactory. Although the attainment of the inflation targets has improved somewhat recently, the gradual disinflation targets set in the FYDPs have not been achieved.

While there is a consensus on the need to reduce inflation and enhance economic growth, the main questions arise are How does the Central Bank of Iran (CBI) choose between alternative monetary policies? Is the current state of monetary policy satisfactory? On the other hand, are there problems that need to be fixed? The answer depends on the costs and the benefits associated with the current monetary policy status and the possible alternatives. This leads us to discuss the effectiveness and optimality of alternative monetary policy rules in terms of the welfare loss of them. In this paper, we analyse these questions for the open economy of Iran following a monetary growth rate rule in which the monetary base growth rate is determined according to output and the deviation of inflation from its target value.<sup>1</sup>

In this paper, using of the development of the last decade in Bayesian estimation, we employ an open-economy new-Keynesian model featuring oil production to assess different monetary policy rules for Iran. The small open

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<sup>1</sup> There are problems with applying the Taylor rule in Iran. Firstly, the weak micro-foundation of the rule; secondly, according to this rule, especially in the short run, instead of interest rate the policy variable is the growth rate of the monetary base; thirdly, according to Law for Usury (Interest) Free Banking of Iran, the objective of the central bank is not control of the interest rate. Instead, money growth rate is used as an instrument; and finally, according to Taylor (2000), in a situation of high inflation rate, the real interest rate is hard to measure, and risk premia can be high and variable.

economy model derived as a limiting case of a two-country dynamic stochastic general equilibrium framework. The model assumes no trade or financial frictions, that is, the law of one-price holds, asset markets is complete, and money is important because of the assumption of real balances in household's utility function. Then, we assume the quantity theory of money and the Fisher equation to hold true in a period-by-period fashion, something that leads us to exploit the identity between nominal interest rate and money growth and use such identity in the Investment-Saving (IS) equation. The model is then enriched with an oil sector and a loss function à la Galí-Monacelli is employed to evaluate four different money-growth rules.

A large number of New Keynesian models have developed a framework to analyse the properties of alternative monetary policy regimes in case of an open economy. The most significant contributions to the literature in this field have been made by Svensson (2000), Clarida, Galí and Gertler (2001), McCallum and Nelson (2000), Corsetti and Pesenti (2001, 2005), Benigno and Benigno (2003), and Galí and Monacelli (2002, 2005). There is a large volume of literature on optimal monetary policy in industrial, Latin American and Asian economies, but few of these studies are based on Iran. In Iran, the pioneering work in this area is by Khalili Araghi et al. (2009), while other attempts have been made by Dargahi and Sharbatoghli (2011), Bahrami and Ghoreishi (2011) and Shahmoradi and Sarem (2013).

A common limitation in previous studies of optimal monetary policy in Iran has been that monetary policy rules are evaluated in terms of an ad-hoc or non-structural loss function, usually constructed from variability in output gap and inflation. Furthermore, in all these studies little attention has been paid to the inclusion of exchange rate in setting monetary policy rules and a discussion of the optimal monetary policy for the open economy of Iran. Given the size and degree of openness of many emerging market countries, the exchange rate may play an important role in the transmission of foreign shocks into domestic economic conditions and in the transmission of policy actions. As such, there is an added incentive for the exchange rate to be included as one of the implications of monetary policy. Thus, of central importance in this paper is the role of the exchange rate in the construction of optimal monetary policy rules (MPRs) in the open economy of Iran.

The paper structured as follows. Section 2 develops the monetary policy rule in Iran. Section 3 describes the stylized facts of Iran Economy. Section 4 develops the standard DSGE model, while section 5 describes the monetary policy and the quadratic loss function. Section 6 investigates the model simulation and robustness checks. Finally, section 7 presents the conclusion.

## **2. MONETARY POLICY IN IRAN**

From the 1970s until the March 2002 unification, the exchange rate system of the Islamic republic of Iran was heavily controlled, featuring multiple exchange rate practices with associated exchange restrictions and import controls. The two remaining official exchange rates of the Iranian Rial were unified in March 2002, after which the authorities adopted a market-based managed floating exchange rate system. The current approach to monetary policy formulation gives the government a decisive influence in setting specific monetary targets. In particular, Five Year Development Plans (FYDP) set annual targets for monetary growth and inflation, which are approved by parliament and must be used as benchmark for formulating monetary programs by the central bank. In implementing monetary policy, the Central Bank can directly resort to its regulating power or affect money market conditions indirectly as issuer of high-powered money (notes and coins in circulation and deposits held with Central Bank). On this basis, two different monetary policy instruments are being utilized: direct instruments (with no reliance on market conditions) and indirect instruments (market-oriented).

At the operational level, the Monetary and Credit Council (MCC) is the body responsible for day-to-day monetary policy decisions. Parliament and the government can also issue directives for credit allocation, which could have implications for monetary policy implementation. In practice, the targets for M2 and inflation fixed in FYDP are usually revised by the MCC in its annual monetary guidelines. Nevertheless, even these revised targets are often inconsistent with fiscal financing requirements and other important decisions, in particular those on the administrative set rates of return and other direct controls on banking system activities.

Against this background, the central bank has not been able to meet its intermediate target for M2 since the beginning of FYDPs; The range of

monetary policy instruments have evolved over time but still remain inadequate. During the early 1990s, direct administrative controls were predominant and policy decisions on credit ceilings and directed credits, as well as rates of return on loans and deposits, were often inconsistent with the stated objectives for M2 or inflation.

Since the mid-1990s, the authorities have gradually phased out direct controls and introduced some indirect instruments of monetary policy that were partially market-based. In particular, central bank participation paper (CBPP) was introduced in 2001 to mop up excess liquidity. However, their primary issuances are made at a fixed rate of return, secondary trading can only be done at par, and banks are not authorized to buy them in the primary market. These design features of CBPP have limited their effectiveness.

The 2002 exchange rate unification and establishment of a managed float exchange rate regime raised the issue of the appropriate nominal anchor, as well as the related supporting policies. While the central bank has increasingly focused monetary policy implementation on M2, such a policy has not yet achieved sufficient credibility to effectively anchor inflationary expectations. Indeed, in aftermath of the 2002 exchange rate unification, exchange rate considerations continued to be dominant, initially out of concern for the stability of the nominal rate, and subsequently to preserve competitiveness through a gradual nominal effective depreciation of the exchange rate to compensate for past inflation differentials. This dual-objective policy, however, became difficult to sustain in the face of increased supply of foreign exchange stemming from fiscal relaxation and FDI inflows. In the attempt to contain growth of monetary aggregates while continuing with nominal exchange rate depreciations, the central bank started to use CBPP to mop up excess liquidity at relatively attractive fixed rate of return, thereby bearing directly the cost of sterilization operations. With the rapid increase in the CBPP stock, these operations became costly and less effective in offsetting large injections of oil revenue into the system. As a result, the amount of unsterilized purchases became a function of exchange rate objectives, and the control over monetary aggregates has weakened.

### **3. STYLIZED FACTS OF IRAN ECONOMY**

The study of the stylized features of business cycles is the first step towards using the dynamic stochastic general equilibrium models (DSGE) in explaining business cycles.

Shahmoradi et al. (2011) studies the stylized facts of the business cycle features on the Iranian economy. In addition to the usual cyclical co-movement of macroeconomic variables, they paid especial attention to study the cyclical co-movement of oil prices with macroeconomic variables. The results, using both Hodrick- Prescott (HP) and Baxter-King (BK) filters, had been shown that imports, exports and investment were the most volatile components of the Iranian economy. Although government consumption was about two folds more volatile than private consumption, total consumption was the least volatile component. Even though monetary aggregates and price levels were more volatile in the Iranian economy than in G7 countries, the high volatility of oil prices can uniquely explain part of the volatility of Iranian business cycles. Except for monetary aggregates, the co-movements of the Iranian business cycles are similar to those of developed countries. The market exchange rate is procyclical with the monetary aggregate. Nominal monetary aggregates are negatively and weakly correlated with the real output. Moreover, consumer price index (CPI), wholesale price index (WPI), and GDP deflator positively correlated with monetary aggregates. These show that monetary policies alone account for the most part of the price level increases. Therefore, it seems that supply shocks play prominent roles in the business cycle of the Iranian economy. Based on the HP filter, real output does not have contemporaneous correlation with growth rates of money. On the other hand, the correlation between price levels, inflation rates, and interest rates with the growth rate of money are positive. WPI and GDP deflator are contemporaneously procyclical with oil prices. Furthermore, using the BK filter, CPI is procyclical with oil prices, too. The nominal money M1 is weakly procyclical with oil prices, whereas nominal money M2 is contemporaneously uncorrelated with them. Real output, overall, is contemporaneously uncorrelated with oil prices.

#### 4. THE SMALL OPEN ECONOMY MODEL

The New Keynesian Model (NKM) assumes a small open economy that consists of an infinitely lived representative household, final goods-producing firm, an oil-producing firm, and a monetary authority. The household makes savings decisions, consumes domestic- and foreign-differentiated final goods, and provides labour to both the final goods sector and the oil sector. Labour is perfectly mobile between the oil and non-oil sectors, and workers in both sectors are subject to the same competitive wages. The household owns all firms and receives profits from them. Additionally, we assume there is a continuum of final good firms each producing a specific variety. The final good variety-producing firms buy oil from the oil sector at a world-determined, exogenously given price. They coexist in an environment of monopolistic competition and set prices, as in Calvo (1983). The oil sector maximizes profits and satisfies domestic and foreign demand for domestic oil, and, finally, the model assumes that the monetary authority follows a money growth rule. The New Keynesian Model applied to Iran's economy consists of five general equilibrium equations and four stochastic shocks. All equations are log-linearized and the variables denoted by a wave are gap variables.

The first equation is the dynamic IS equation. Following Gali (2008) and according to study of Shahmoradi and Sarem (2013)<sup>2</sup>, after solving the consumer problem and simplifying the Euler equation; the dynamic IS equation in the case of Iran is given as:

$$\tilde{y}_t = E_t \{ \tilde{y}_{t+1} \} - \frac{1}{\sigma_\alpha} (m_t - E_t \{ \pi_{t+1} \} - \rho) - \frac{\alpha \Theta}{\sigma} E_t \Delta s_{t+1} \quad (2.1)$$

Where;  $\Theta = w - 1 = \sigma\gamma + (1 - \alpha)(\sigma\eta - 1) - 1 > 0$  and  $\tilde{y}_t$  is the output gap. We examined output gap by HP filter method for Iran by using annual data. At first because of Iran is oil exporting country then we used non-oil GDP rather than

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<sup>2</sup> According to Shahmoradi and Sarem (2013), inflation in Iran is a monetary phenomenon. Thus, we can say in Iran the inflation equal to money growth rate, furthermore, when inflation is greater than nominal interest rate; one can use inflation for discounting the future.

GDP. Second, we used a logarithmic transformation on GDP to obtain a more homogeneous variance of a series and avoid numerical instability. Third, we used unit root test on the logarithm of GDP in order to resolve spurious regression and other problems with non-stationary time series. Furthermore,  $m_t$  is the money growth rate,  $E_t \{ \pi_{t+1} \}$  is the expected inflation in the next period,  $\rho = -\ln \beta$ ,  $E_t \{ \tilde{y}_{t+1} \}$  represents the expected output gap in the next period,  $E_t \Delta s_{t+1}$  terms of trade variation that linking domestic output to the international environment, and finally the parameter  $\sigma$  is the coefficient of risk aversion in utility function.

The second equation is the linearized equilibrium dynamics for the small open economy in terms of output gap and domestic inflation that is called the New Keynesian Phillips curve (NKPC) as:

$$\pi_t = \beta E_t \{ \pi_{t+1} \} + k \tilde{y}_t \quad (2.2)$$

Where;  $\pi_t$  is inflation,  $\beta$  is the household discount factor and  $k = \lambda(\varphi + \sigma)$  is the output gap elasticity of inflation,  $\varphi$  is the elasticity of labor supply.

The third equation is production function consisting of oil  $O_t$  and labor  $N_t$  as inputs.<sup>3</sup>

$$Y_t(j) = A_t N_t(j)^\alpha O_t(j)^{1-\alpha} \quad (2.3)$$

Where  $Y_t(j)$  is the output produced by firm in period t,  $A_t$  is the economy-wide technology level, that is assumed to follow an AR (1) process. We assume that firms set prices in a staggered fashion, as in Calvo (1983). A firm in each

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<sup>3</sup> The capital stock is treated as fixed and investment is set to zero in the short run. These two specifications follow McCallum and Nelson (1999), who argued that capital do not play a major role in most monetary policy and business cycle analyses.

period with probability  $1-\theta$  changes the price of its product and with probability  $\theta$  keeps it unchanged<sup>4</sup>.

The fourth equation is labor demand for the oil sector firm as<sup>5</sup>:

$$\nu Z_t P_t^O N_t^{O\nu-1} = W_t \quad (2.4)$$

The oil-producing firm maximizes profits by taking prices  $P_t^O$  and  $W_t$  as given, and determines total oil supply  $O_t^S$  in the economy. The volume of oil  $O_t^S$  is determined by the amount of labor  $N_t^O$  used. The parameter  $0 < \nu < 1$ ; reflects the diminishing returns to labor in the production technology of oil. A factor  $Z_t$  determines the performance of oil producing firm.

The fifth equation is the foreign demand for domestic oil, which given by:

$$O_{H,t}^* = \gamma_O^* \left( \frac{P_t^{*O}}{P_{F,t}^*} \right)^{-\theta_O^*} O_t^* \quad (2.5)$$

Where  $P_t^{*O}$  is the price of oil in terms of foreign currency (i.e., the international price of oil) and  $O_t^*$  is the foreign oil demand<sup>6</sup>; furthermore, we assume a symmetric structure for the foreign sector. Also, the model assumes that the home good has the same price in both the domestic and foreign markets so that the law of one price for domestic goods sold abroad holds. We denote  $e_t$  the nominal exchange rate; then, the real exchange rate,  $q_t$  defined as  $q_t = e_t \frac{p_t^*}{p_t}$ ; where  $p_t^*$  is foreign CPI index.

The last four equations represent stochastic shocks that follow an AR (1) processes.

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<sup>4</sup> For more information, see Gali (2008).

<sup>5</sup> For more information, see Romero (2008).

<sup>6</sup> For more information, see Medina and Soto (2005).

$$a_t = \rho_a \alpha_{t-1} + \varepsilon_{a,t} \quad \text{Technology shock} \quad (2.6)$$

$$o_t^* = \rho_{o^*} o_{t-1}^* + \varepsilon_{o^*,t} \quad \text{Oil demand shock} \quad (2.7)$$

$$p_t^o - p_t = \rho_{p^o} (p_{t-1}^o - p_{t-1}) + \varepsilon_{p^o,t} \quad \text{Oil price shock} \quad (2.8)$$

$$v_t = \rho_v v_{t-1} + \varepsilon_{v,t} \quad \text{Monetary policy shock} \quad (2.9)$$

#### 4.1. Calibration and Estimation of Parameters

After set up the theoretical model, we calibrate the structural parameters such that capture the salient features of the Iran business cycle. Table 1 depicts the calibrated values for the parameters considering the economy of Iran. This calibration is based on the quarterly data of economy during 1990-2013. There are different ways of calibrating parameters of the linearized DSGE model. Some of the parameters taken from previous studies on Iran’s economy, in addition, using econometric models and Bayesian methods in the Dynare software calculate others. Table 1 and 2 report the calibration and estimation of main parameters, respectively.

**Table 1:** Calibrated Parameters

Parameters	Value	Source
$\eta$ substitutability between domestic and foreign goods	3.4	Jafari Samimi et al. (2014)
$\beta$ discount factor	0.964	Tavakolian & Komijani (2012)
$\nu$ share of labor in oil production	0.035	Authors’ calculation
$\sigma$ coefficient of risk aversion	1.52	Tavakolian & Komijani (2012)
$\phi_{\pi}^{CPI}$ sensitivity of the central bank to CPI inflation	$[0,-1]^7$	Authors’ calculation

<sup>7</sup> From negative relationship between interest rate and money growth rate, (in contrast to the Taylor rule) the coefficients of inflation and output in monetary growth rule must be negative.

$\phi_{\pi}^{DPI}$	sensitivity of the central bank to domestic inflation	[0,-3]	Authors' calculation
$\phi_y$	sensitivity of the central bank to output gap	[0,-3]	Authors' calculation
$\phi_e$	sensitivity of the central bank to exchange rate	[0,1.75]	Authors' calculation
$\frac{O_H^*}{X}$	oil export to total export ratio	0.83	Authors' calculation
$\frac{O_H^*}{O^*}$	oil export to total oil production ratio	0.48	Authors' calculation

Source: Authors' calculation

**Table 2:** Estimated Parameters

	Parameters	Prior mean	Prior p.d.f	Posterior mean
$\rho_a$	persistence of the technology shock	0.810	beta	0.924
$\rho_o$	persistence of oil demand shock	0.7310	beta	0.866
$\rho_m$	persistence of monetary policy shock	0.4420	beta	0.389
$\rho_{po}$	persistence of oil price shock	0.890	beta	0.852
$\alpha$	degree of openness	0.470	beta	0.514
$\varphi$	elasticity of labor supply	2.500	gamma	3.038
$\theta$	measure of price stickiness	0.73	beta	0.8867
$\varepsilon$	elasticity of substitution	6	normal	6.014

Source: Authors' calculation

## 5. MONETARY POLICY

### 5.1. Monetary Policy rules

The choice between a policy rule with the interest rate as the instrument and a policy rule with the money base (or some other monetary aggregate) as the instrument is essentially the same choice originally pointed out by Poole (1970). In earlier work on policy rule evaluation with an inflation target, such as Taylor (1979) the money supply use as the instrument. McCallum (1988) has stressed the advantages of policy rules with a monetary aggregate as the instrument, and of course, the famous Friedman constant growth rate rule had a monetary aggregate as the instrument. If there is too much uncertainty in measuring the real interest rate or if there are relatively big shocks to investment or net exports, then a monetary aggregate is the preferred instrument; the same is true if it is difficult to measure the equilibrium real interest rate (Taylor 2000).

In this setting, using a money growth rate rule in which monetary base growth rate is determined according to output and inflation deviations from their target values; the alternative monetary policy rules for monetary authority in Iran are examined. To be more consistent with the CBI behavior, we use money supply as a monetary policy instrument rather than the commonly used interest rate. Hence, we assume that the CBI follows the CPI inflation-based money growth rate rule (CIMR) of the form  $m_t = \rho + \phi_{\pi}^{CPI} \cdot \pi_t$ ; where  $\phi_{\pi}^{CPI}$  is the relative weight on the CPI inflation. This equation implies that CBI changes the money growth rate only if the CPI inflation deviates from its targeting level.

In order to compare the CIMR performance to the other alternative monetary rules, we specify three different simple monetary rules: the domestic inflation-based money growth rate rule (DIMR), simple money growth rate rule (MR) and managed exchange rate (MER). Under DIMR monetary policy regime, CBI objects at stabilization of domestic prices, which expressed as  $m_t = \rho + \phi_{\pi}^{DPI} \cdot \pi_{H,t}$  where  $\phi_{\pi}^{DPI}$  is the relative weight on the domestic price inflation.

The simple money growth rate rule (MR) is specified as  $m_t = \rho + \phi_{\pi}^{CPI} \cdot \pi_t + \phi_y \cdot \tilde{y}_t$ , where  $\phi_y$  is the relative weight on the output gap. The Money growth rule tells that central bank concerns both on the output gap and on the deviation of an

inflation from the target. However, parameter  $\phi_{\pi}^{CPI}$  should be higher than  $\phi_y$  because the main goal of CBI is the still price stability.

Managed exchange rate rule (MER) specified as  $m_t = \rho + \phi_{\pi}^{CPI} \cdot \pi_t + \phi_y \cdot \tilde{y}_t + \phi_e \cdot e_t$ , where, including the term  $\phi_e \in (0, \infty)$  in the policy rule helps to reproduce the behavior of nominal exchange rates. This rule implies the type of exchange regime chosen by the country, depending on the degree of control that the central bank exercises over the nominal exchange rate (the value of  $\phi_e$ ). If  $\phi_e = 0$ , the central bank does not care about deviations of the nominal exchange rate, that is, the economy reproduces a flexible exchange rate behavior. On the other hand, if  $\phi_e \in (0, \infty)$  the central bank acts in response to the deviation of the nominal exchange rate from its current target or steady-state value. This case corresponds to a managed exchange rate and, in the limit as  $\phi_e$  goes to infinity, to a fixed exchange rate.

## 5.2. The Welfare Loss Function

In a micro-founded model, welfare and the policymaker's objective function can be precisely derived from households' utility. The analysis of welfare evaluation to the alternative monetary policy rules has become an important field of study since firstly introduced by Taylor (1999). The main idea of welfare evaluation concerns the importance for policy makers to have a set of tools that allow them to compare alternative policy rules. Under the special parameters configuration and following Gali and Monacelli (2005), a second-order approximation to the utility losses of the domestic representative consumer, this expressed as a fraction of steady state consumption

$$w = -\frac{(1-\alpha)}{2} \left[ \frac{\varepsilon}{\lambda} \sum_{t=0}^{\infty} \beta_H^t \pi_{H,t}^2 + (1+\varphi) \sum_{t=0}^{\infty} \beta_H^t \tilde{y}_t^2 \right] \quad (3.1)$$

The expected period welfare losses of any policy that deviates from strict inflation targeting can be written as:

$$L = -\frac{(1-\alpha)}{2} \left[ \frac{\varepsilon}{\lambda} \text{var}(\pi_{H,t}) + (1+\varphi) \text{var}(\tilde{y}_t) \right] \quad (3.2)$$

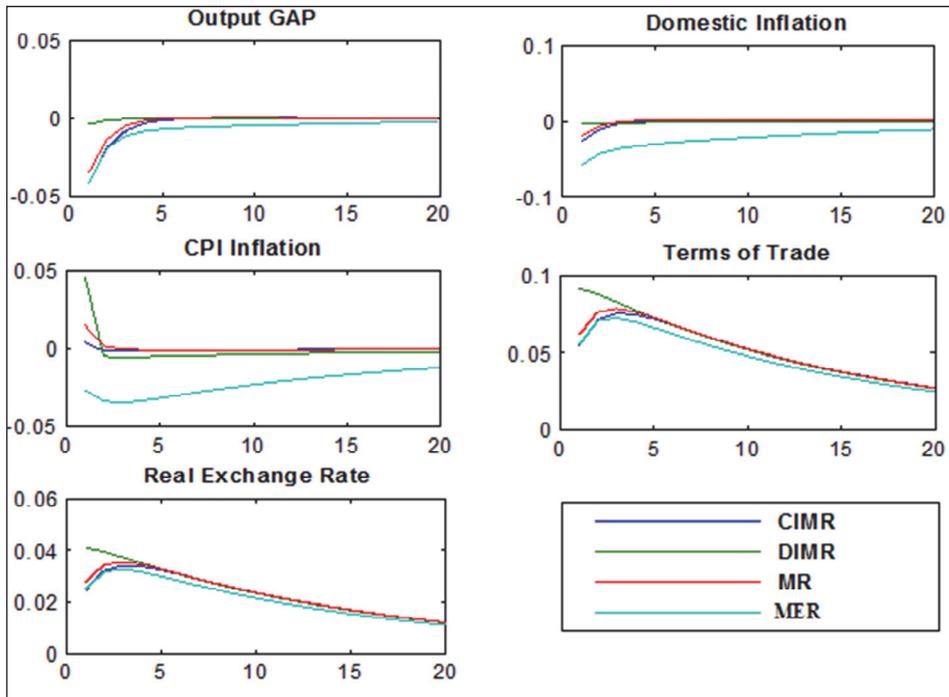
By using this welfare loss function, we evaluate and rank alternative monetary policies.

## **6. MODEL SIMULATION**

### **6.1. Impulse Response Analysis**

The impulse responses analysis can give the useful information about the dynamic behavior of the economy in response to the various shocks and the reaction of the monetary authority.

The responses of output gap, inflation, exchange rate and terms of trade following a technology shock under CIMR, DIMR, MR and MER regimes have showed in Figure 1. A positive productivity shock decreases domestic inflation, causing both the real exchange rate and terms of trade to increase. Furthermore, decreasing inflation lead to decreasing marginal cost for firms and increases their output, thus the output gap decreases. From Figure 1, the MER regime creates the highest volatility in output gap, domestic inflation, and CPI inflation relative to the other rules, and creates the lowest volatility in real exchange rate and terms of trade. The CIMR produces greater volatility in output gap and domestic inflation relative to DIMR and MR regimes. However, it generates lower fluctuation in exchange rate and terms of trade. A monetary authority that follows the DIMR and MR lowers money growth rate to stabilize the domestic price and output gap changes, respectively. From the point of view of the domestic economy, a lower domestic price level raises terms of trade, which means that the competitiveness of domestic products advances in the rest of the world; increasing terms of trade cause the CPI price level to inflate and the real exchange rate to depreciate.

**Figure 1.** Impulse Response to Productivity Shock

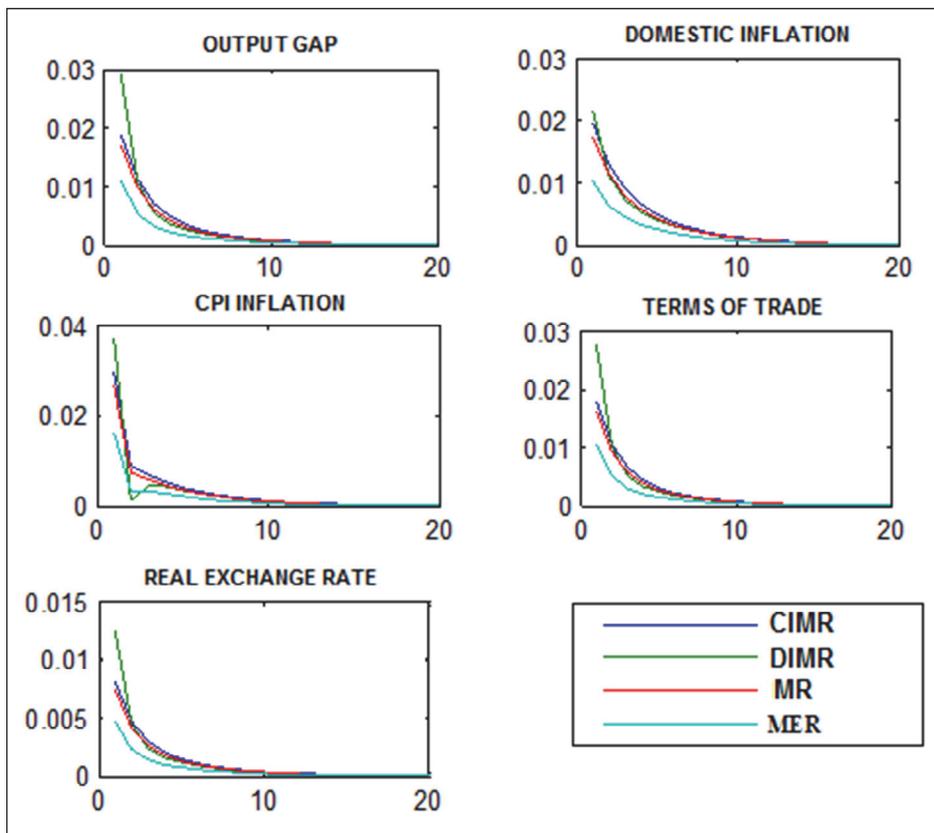
Source: Authors' calculation

The impulse responses of output gap, inflation, exchange rate and terms of trade following an oil price shock have showed in Figure 2. Bjørnland (2000), showed that the expected effects of an oil price shock (that increases oil price) on the other macroeconomic variables in oil-producing countries were an instant appreciation of the real exchange rate, an increase in output that quickly dies out, and a gradual increase in inflation. Farzanegan and Markwardt (2009) indicated that, in the case of Iran, positive oil price shocks increase the real effective exchange rate and appreciate domestic currency in mid run, which is one of the syndromes of Dutch disease.<sup>8</sup> A change in oil price might be a medium to long-term change in terms-of-trade (Frankel, 2011); where for an

<sup>8</sup> An appreciation of the real exchange rate may shrink manufacturing exports and reduce firms' willingness to invest if it leads to higher uncertainty regarding future economic conditions. Hence, the government may not be able to carry out effective and sound macroeconomic, social and industrial policies (Akanni 2007).

oil-exporting country the increase in oil prices entails an improvement in the terms of trade. According to Figure 2, under the oil price shock the MER performs best in lower standard deviations of the variables relative to other rules, while the DIMR has the worst performance in higher standard deviations of the variables relative to other policy rules. Furthermore, output gap and real exchange rate tend to be lower under CIMR than the MR. In addition, the MR performs very well in domestic and CPI inflation and gap, but it works defectively in volatilities of output gap and terms of trade. Korhonen and Jurikkala (2009) stress that oil is one of the main sources of export revenues for most oil-producing countries, and that oil might therefore affect terms of trade and the real exchange rate.

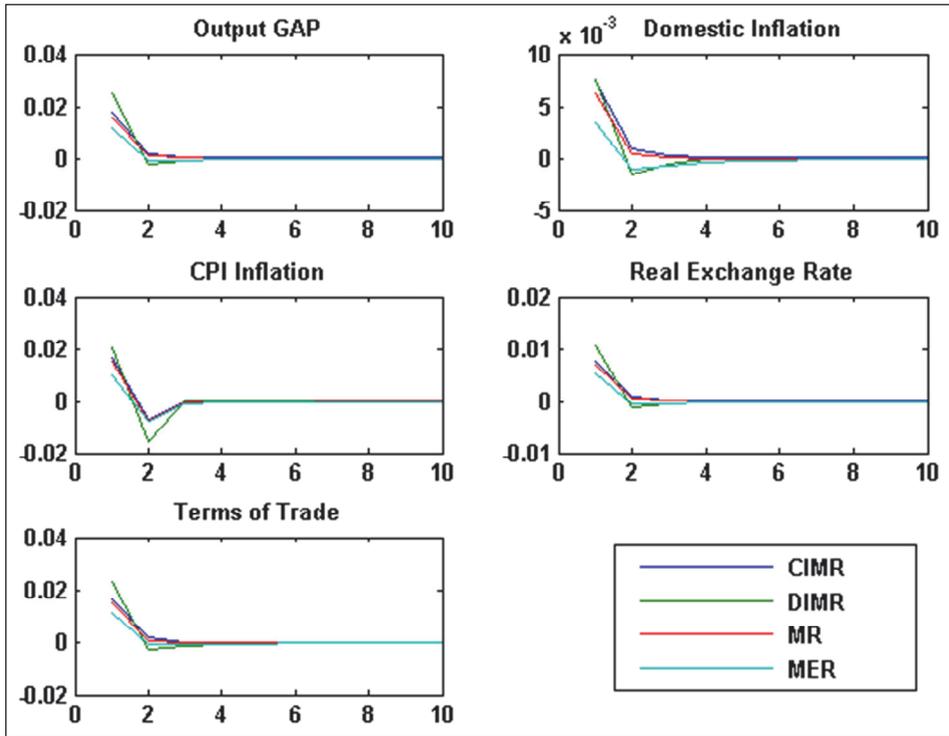
**Figure 2.** Impulse Response to Oil Price Shock



Source: Authors' calculation

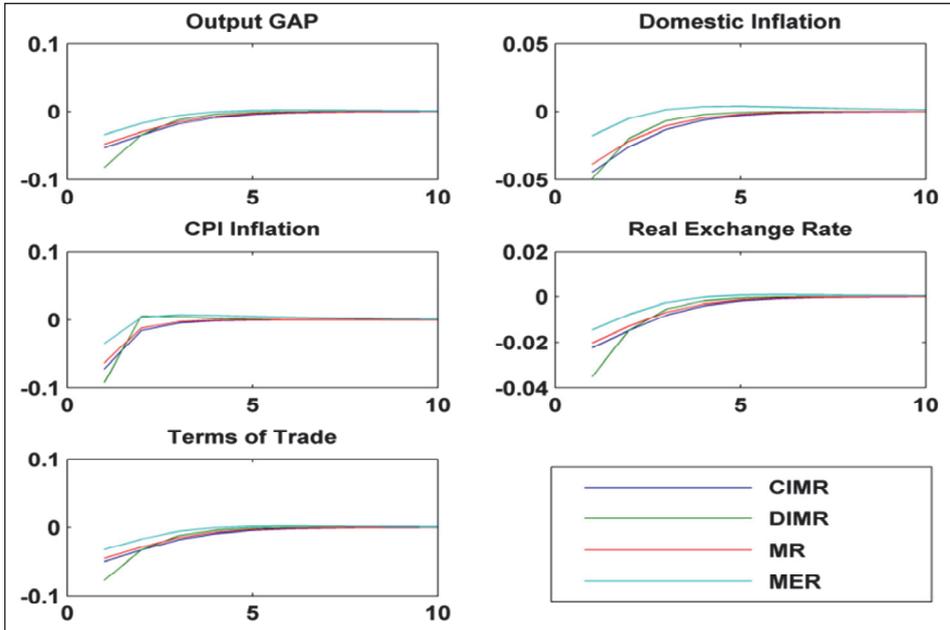
We performed other impulse responses (for instance, monetary policy shock and oil demand shock), presented in Figures 3 and 4, which show that a managed exchange rate generates the lowest welfare losses and more able to replicate the optimal solution than other rules.

**Figure 3.** Impulse Response to Oil Demand Shock



Source: Authors' calculation

**Figure 4.** Impulse Response to Negative Monetary Shock



Source: Authors' calculation

## 6.2. Welfare Analysis of Alternative Regimes

The standard deviations of the main macro variables and welfare losses under the alternative regimes have reported in Tables 3 and 4. In this section, we consider the welfare losses of the alternative rules. The welfare losses result from a decrease in output gap and domestic inflation volatility deviating from alternative monetary policy regimes, and they are expressed as a fraction of steady state consumption.

**Table 3.** Welfare Loss of Alternative Policy Rules under Oil Price Shock

Variable	CIMR	DIMR	MR	MER
Output Gap	0.024	0.032	0.028	0.021
Domestic Inflation	0.026	0.027	0.024	0.018
CPI Inflation	0.034	0.038	0.033	0.024
Real Exchange Rate	0.011	0.014	0.012	0.009
Terms of Trade	0.013	0.031	0.027	0.011
Var (domestic inflation)	<b>0.0008</b>	<b>0.001</b>	<b>0.0005</b>	<b>0.0003</b>
Var (output gap)	<b>0.0006</b>	<b>0.0007</b>	<b>0.0008</b>	<b>0.0004</b>
Welfare loss	-0.015	-0.018	-0.01	-0.006

Source: Authors' calculation

From the Table 3, we can conclude that the MER is the best monetary policy regime in terms of welfare loss under oil price shock, with MR ranking second, CIMR third, and DIMR fourth.

**Table 4.** Welfare Loss of Alternative Policy Rules under Productivity Shock

Variable	CIMR	DIMR	MR	MER
Output Gap	0.043	0.004	0.039	0.045
Domestic Inflation	0.027	0.005	0.023	0.034
CPI Inflation	0.004	0.047	0.001	0.011
Real Exchange Rate	0.045	0.054	0.047	0.043
Terms of Trade	0.102	0.121	0.104	0.088
Var (domestic inflation)	<b>0.0007</b>	<b>0.00002</b>	<b>0.0005</b>	<b>0.0012</b>
Var (output gap)	<b>0.0019</b>	<b>0.00001</b>	<b>0.0015</b>	<b>0.0021</b>
Welfare loss	-0.015	-0.000001	-0.01	-0.024

Source: Authors' calculation

The results of Table 4 show that the DIMR is the optimal monetary policy rule in terms of welfare loss relative to the other three money growth rules. However, from Table 4, the MER gives the worst performance in terms of welfare loss under the productivity shocks. In addition, the welfare losses of CIMR and MR exhibit a similar result.

**Table 5.** Ranking of MR and MER under different coefficients of monetary rules

$\phi_{\pi}^{DPI} = \phi_y$				
	Productivity shock	Oil price shock	Oil demand shock	Monetary shock
MER	0.016	0.0005	0.0002	0.014
MR	0.005	0.006	0.0005	0.011
$\phi_{\pi}^{DPI} > \phi_y$				
MER	0.035	0.001	0.0007	0.008
MR	0.009	0.008	0.0009	0.024
$\phi_{\pi}^{DPI} < \phi_y$				
MER	0.011	0.00003	0.0001	0.002
MR	0.004	0.005	0.0004	0.013

Source: Authors' calculation

The standard deviations of macro-economic variables under different shocks and the performance of the money growth rule and managed exchange rate regime under different coefficients of output gap and inflation have reported in Table 5. The results imply that, regardless of coefficients of inflation and output gap in MR and MER, the MER is optimal, and welfare superior to the MR in terms of welfare loss under different shocks, except for productivity shock. These results imply that the CBI should consider not only inflation but also output gap.

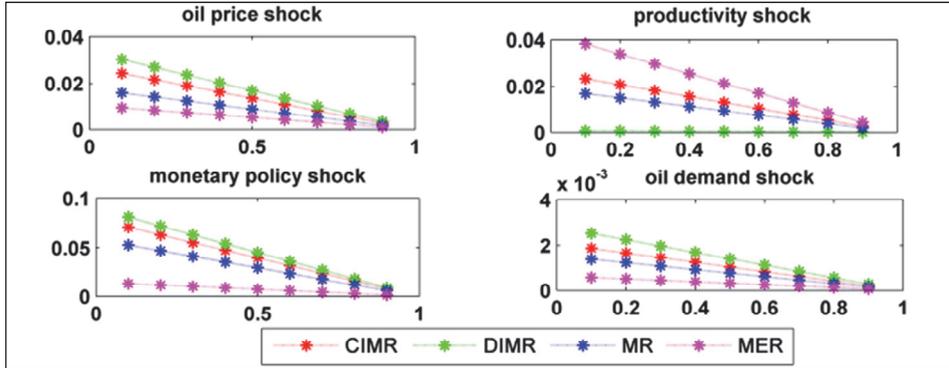
The standard deviations of the selected variables in Table 5 show that the larger the coefficient of inflation in monetary rules, the larger the welfare loss of monetary rules under different shocks. In addition, for larger coefficients of output gap relative to inflation, the welfare loss of monetary rules decreases.

### 6.3. Robustness Checks

In this section we study how robust the ranking of different monetary policy rules is to change in the value of key parameters. A robustness check is performed over the parameters of welfare loss function: degree of openness ( $\alpha$ ), elasticity of substitution between different variety of goods ( $\epsilon$ ), and elasticity of labour supply in the CES utility function ( $\varphi$ ). We only change the value of one

parameter while the others are kept at their baseline calibration. The calibration of monetary rules and key parameters are shown in Tables 1 and 2.

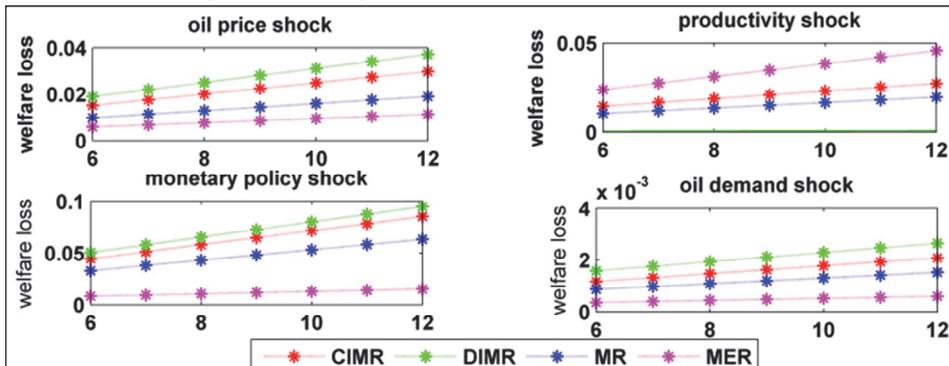
**Figure 5.** Ranking of Monetary Rules for Different Values of ( $\alpha$ )



Source: Authors' calculation

The degree of openness determines the weights of all the variables in the loss function. The more open the economy is, the greater the weight of imported goods in the consumption basket, and hence the more the domestic consumer is concerned about import prices. Figure 5 shows the performance of different policy rules for different values of openness. Independent of the degree of openness, the managed exchange rate is always a better rule under supply and demand shocks. Moreover, the more open the economy is, the progressively lower losses it generates.

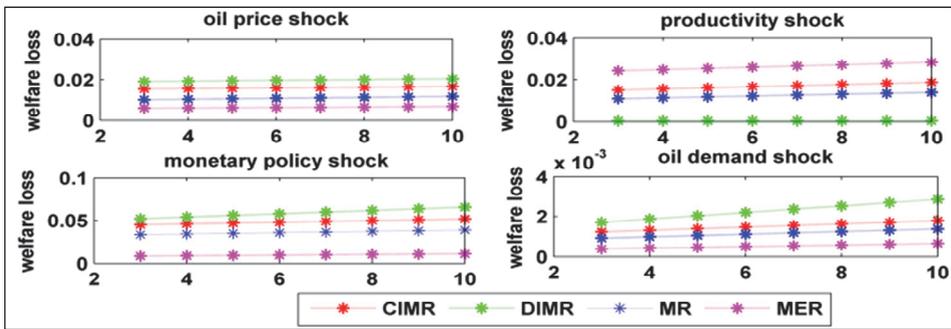
**Figure 6.** Ranking of Monetary Rules for Different Values of ( $\varepsilon$ )



Source: Authors' calculation

The performance of different policy rules for different values of substitution elasticity has showed in Figure 6. The substitution elasticity determines the weights on domestic inflation volatilities in the loss function. The higher  $\epsilon$  is, the more domestic inflation should be penalized. Though  $\epsilon$  changes the weights in the loss function it does not change the ranking of the different rules. Note that for high values of  $\epsilon$  welfare losses are higher. The intuition is as follows: the higher the substitution elasticity is between different varieties of goods, the greater are the losses experienced by the household, because of undesired price dispersion across the goods that are close substitutes for each other.

**Figure 7.** Ranking of Monetary Rules for Different Values of ( $\varphi$ )



Source: Authors' calculation

The elasticity of labour supply determines the weights on output gap volatilities in the loss function. The higher the  $\varphi$  is, the more output gap and inflation should be penalized. Figure 9 shows the performance of different policy rules for different values of labour supply elasticity. Although  $\varphi$  changes the weights in the loss function it does not change the ranking of different rules. Note that for high values of  $\varphi$ , welfare losses are greater. The intuition is as follows: the higher the weights on output gap the more losses the household experiences, but in contrast to higher weights on inflation, the welfare loss rises with greater intensity.

## 7. SUMMARY AND CONCLUSION

The paper uses a New Keynesian small open economy model to analyze the welfare implications of different monetary policy rules. It examines the

responses of output gap, inflation, exchange rate and terms of trade following a different shocks under CIMR, DIMR, MR and MER regimes. We assume the central bank uses the money stock as its policy instrument. This obliges us to get money into the model; we do this by introducing money into the utility function (as opposed to analyzing monetary policy without money `a la Woodford, 2003). We analyzed four different types of monetary policy reaction function. Under CIMR, money growth responds to CPI inflation only, under DIMR, money growth responds only to domestic price inflation, under MR, the central bank responds to CPI inflation and to the output gap and finally under MER, the central bank responds to the CPI inflation, the output gap, and the exchange rate.

The paper concludes that when the economy experiences only productivity shocks, the DIMR is welfare-superior to other three money rules. Furthermore, in the presence of other shocks the MER is the best policy rule. Our experiments with alternative monetary policy rules show that the welfare implications depend substantially on the chosen monetary policy rule and different shocks that hit the economy. Finally, and somewhat predictably, results showed flexible inflation targeting is superior to strict inflation targeting in the case of Iran.

The main conclusion of this paper is that the nature of the shock affecting the economy dictates the choice of the policy rule to be implemented. However, although the proposed model for Iran has good characteristics and the results are promising, it should be noted that both model and results have some limitations. First, we are dealing with simulation results that are obtained by making some assumptions and simplifications. The conclusions regarding policy dominance, ranking of alternative monetary rules, and welfare consequences depend on a specific parameterization and should not be taken as general propositions. We chose parameters that fit the Iranian economy, so the conclusions should have some empirical relevance. The second limitation has to do with those aspects that the model omits. The proposed model incorporates elements of the Iranian economy and its findings are in accordance with its characteristics: However, further research is still needed. One direction for further research is to overcome the assumptions and simplifications that are the limitations of the model. In practice, however, it may be difficult for the policymaker to identify the source of the shock affecting the economy. This begs

for a simple policy rule that is both optimal and independent of the nature of the shocks affecting the economy. Thus the other area for future research is to design such a robust rule in a more realistic and complicated model.

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