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| **ARTICLE INFO** | Mustapha Ziky and Nabil El Hamidi (2023). The behavior of the Taylor rule in the presence of sovereign Sukuks based on the growth rate of the economy: An analysis by DSGE modelling. *Investment Management and Financial Innovations*, *20*(1), 304-316. doi:10.21511/imfi.20(1).2023.26 |
| **DOI** | http://dx.doi.org/10.21511/imfi.20(1).2023.26 |
| **RELEASED ON** | Monday, 27 March 2023 |
| **RECEIVED ON** | Saturday, 01 October 2022 |
| **ACCEPTED ON** | Thursday, 16 March 2023 |



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|---|---|
| **JOURNAL** | "Investment Management and Financial Innovations" |
| **ISSN PRINT** | 1810-4967 |
| **ISSN ONLINE** | 1812-9358 |
| **PUBLISHER** | LLC “Consulting Publishing Company “Business Perspectives” |
| **FOUNDER** | LLC “Consulting Publishing Company “Business Perspectives” |

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10,
Sumy, 40022, Ukraine
www.businessperspectives.org

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# THE BEHAVIOR OF THE TAYLOR RULE IN THE PRESENCE OF SOVEREIGN SUKUKS BASED ON THE GROWTH RATE OF THE ECONOMY: AN ANALYSIS BY DSGE MODELLING

**Received on:** 1st of October, 2022
**Accepted on:** 16th of March, 2023
**Published on:** 27th of March, 2023



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## Abstract

The aim of this paper is to study the behavior of the Taylor rule in the presence of Sukuks. The New Keynesian model of Gali (2008)/Chapter 3 is used, due to its simplicity and small size. Nevertheless, such a model is suitable for examining the implications of monetary policy in the presence of sovereign Sukuks. The growth rate is used as the rate of return on sovereign Sukuks, which is closest to the profit and loss sharing approach, and is compared to the Gali's baseline model. The results show that the introduction of sovereign Sukuks mitigates inflation and output gap shocks, but also limits the scope of the Taylor rule. Thus, an increase in the interest rate is offset by a flight of capital from sovereign Sukuks to treasury bonds, while a decrease in the interest rate leads to a flight from treasury bonds to sovereign Sukuks. In the extreme, if the preference for Sukuks is largely dominant, the Taylor rule tends to be obsolete, and vice versa.

**Keywords** Taylor rule, DSGE model, monetary policy, sovereign Sukuks, profit and loss sharing

**JEL Classification** E12, E52, E50

## INTRODUCTION

The conventional central bank leads its monetary policy through the transaction of treasury bonds, which allows it manage the money in circulation and finance the fiscal policy. The interest rate on treasury bonds is against the precepts of Islamic law (Sharia). The activity of Islamic central banks is not totally different from that of conventional central banks, nevertheless, monetary policy must use instruments other than the interest rate. In this sense, how can governments finance their budget deficits? This is the main issue facing purely Islamic monetary policy. The answer to this question lies in sovereign Sukuks. The monetary instruments of the conventional banking system are not suitable for the Islamic central banking in the control of liquidity, because the monetary instrument of the open market is not allowed. To initiate an Islamic monetary policy, conventional treasury bonds must be replaced by non-usurious open market operations, of which Musharakah-type sovereign Sukuks can be a substitute that links financial activity to the real economy.

Interest-free instruments should be developed for an Islamic monetary policy. The rate of profit sharing is used as a remuneration mechanism that replaces the interest rate. The profit-sharing rate affects the



**Conflict of interest statement:**
Author(s) reported no conflict of interest



http://dx.doi.org/10.21511/imfi.20(1).2023.26

supply and demand of money. Bidabad (2010) shows that the relationship between money supply and demand can create business cycles. Thus, fluctuations in the money market generate fluctuations in the real economy and not vice versa. The most important effect of eliminating the interest rate is to close the gap between investment and savings through the rate of return in the real economy. This topic is important for Islamic monetary policy with respect to stabilization policies and open market operations on paper and usury-free bonds. This paper tries to imagine a modality of remuneration of sovereign Sukuk more than developing monetary tools in accordance with the Islamic law. In this sense, the growth rate of the economy is considered in this paper as the yield of sovereign Sukuks. Thus, "the growth rate is the remuneration of the state's efforts, and the fiscal policy represents the spending that households contribute to through the purchase of sovereign Sukuks".

This paper presents a simple closed economy model used in the analysis of monetary policy in the presence of sovereign Sukuks. Therefore, when working with different versions of the basic model, namely a Gali DSGE model with some extensions, it allows to focus on specific assumptions and their economic consequences. Thus, this paper can be regarded as a benchmark for more sophisticated models for monetary policy analysis in the presence of Islamic monetary tools.

## 1. LITERATURE REVIEW

The variables of inflation, unemployment, aggregate savings, exchange rate and investment are widely cited in the literature as the main efficiency indicators of the outcomes of both conventional and Islamic monetary policies. The latest financial crises showed that the interest rate set in the monetary market, irrespective of the real economy, is not only incapable of addressing unemployment, but also high inflation, falling incomes, low levels of investment and savings, and low and volatile growth in the real economy (Ashraf et al., 2020). Islamic finance has proven itself to be a realistic and practicable substitute for mainstream finance (Lewis, 2008). Innovative Islamic banks have comparatively outperformed conventional ones in this respect, especially during the last financial crisis (Ashraf et al., 2020; Hasan and Dridi, 2010; Hussain et al., 2015). Economic research into monetary policies from an Islamic economics perspective is still scarce, though the focus of the International Monetary Fund (IMF) has generated some more recently insightful literature (Zaheer et al., 2013; Kammer et al., 2015; Ndiaye and Masih, 2017). While there is some empirical support for a stable money demand function in an economy with zero interest rates (Darrat, 1988), further work in this area is required. Meanwhile, some empirical work suggests monetary policy operates through an Islamic banking channel (Mohieldin, 2012), whereas others claim the monetary transmission mechanism doesn't run through Islamic banks (Sukmana and Kassim, 2010). Such mixed evidence comes as little wonder, as Islamic banking operates in a dual system in most Muslim countries, where the monetary developments are different. The focus should be more on the mutual impacts that monetary policies can have in a system where Islamic and conventional monetary instruments coexist. There are challenges not only from the Islamic finance principles, but also in the macroeconomic and monetary policy environment of countries where Islamic banks are operating.

Choudhry and Mirakhor (1997) suggested that equity-based government securities whose yield is derived from the budget surplus should be used in monetary control. However, since the mid-1990s, the field has lost its appeal and no major papers have been published on the theoretical aspects of monetary economics from an Islamic perspective. Hanif and Shaikh (2010) introduce growth-linked securities to finance government debt. To this end, a secondary market can be created by requiring banks to fulfil their institutional obligations by trading such securities. This will create a more developed money market, and the return on which such an instrument can be used as a reference for structuring and pricing other derivatives. Hanif and Shaikh (2010) advised using the nominal GDP growth rate as a reference rate. The advantage of using GDP, they argue, is that it can be used not only as a reference rate for the banking sector, but as well as for central bankers in the context of monetary policy affecting conventional and Islamic financial systems. The analysis conducted by the authors on a multi-country basis showed that there was no statistical discrepancy between the GDP growth rate and various benchmarks (e.g. the Treasury bill rate, the deposit rate, the discount rate, etc.) applied in the countries studied. Therefore, this instrument has the potential to be used to index Treasury financing and can also be an important alternative investment instrument for money market participants and an alternative to open market operations.

Incorporating Islamic banking into the framework of monetary policy is a complicated challenge, not only due to the need to comply with Islamic finance's underlying principles, but also due to the heterogeneous nature of financial systems and the monetary policy settings in each country where Islamic banks are present (Khatat, 2016). Anwar (1987) and Khan (1996) have attempted, using the mainstream ISLM framework, to build an economic model without interest. To conform to Islamic Monetary Law, emphasis must be placed on meeting the needs of economic agents, achieving full employment, a fair allocation of wealth, optimal growth and economic stability. In addition, the policy makers of an Islamic system may use profit sharing ratios and required reserves to bring about shifts in the monetary and credit stock (Khan and Mirakhor, 1994). Consequently, there have been some efforts to develop comparative models to determine whether the GDP growth rate or the real interest rate can more accurately identify and forecast monetary policy outcomes. For this purpose, Ali et al. (2018) found that Sukuks, as an instrument in line with Islamic law, have the potential to address liquidity management issues. Taylor rule does not have to be a reflection of central bank behavior but rather a reflection of the steady-state link between a nominal interest rate and the anticipated rate of inflation in a general equilibrium model (Taylor, 1999). This Taylor rule can reproduce the transmission of monetary pressure in a general equilibrium model with nominal rigidity and an exogenous money supply (Taylor, 1999). Nevertheless, if the Taylor rule is seen as a suitable way of describing the monetary policy, it allows replicating a number of codynamic movements of inflation and the nominal interest rate. While the Taylor rule has been used extensively within the framework of a conventional economic representation, to our knowledge, no studies to date have investigated the behavior of monetary policy under a Taylor rule in the presence of both interest rate and GDP growth rate based Sukuks.

The research literature suggests that the objectives of conventional and Islamic monetary policy are quite comparable, despite the absence of an interest rate in the Islamic economy, which makes it unique to the Islamic system (Biancone and Radwan, 2018, 2019). There are numerous instruments available in mainstream monetary policy that could be replicated easily in the Islamic system, except for the interest rate and other instruments related to it. However, to ensure sustainable economic growth, there is a need to explore other appropriate and feasible ways to conduct monetary policy in an environment that is compliant with Islamic law. As with conventional systems, there is a need to appropriately consider monetary policy in the context of an Islamic banking system. Nevertheless, the central bank's ability to affect conditions in the market is highly differentiated (Khatat, 2016). Although the interest rate is not permissible in the Islamic economy, a number of traditional instruments are at the disposal of the Islamic monetary policy: reserve requirement changes, selective and global control of credit flows and monetary base changes through money supply management. Equity-based instruments would be effective in an interest-free environment (Khan and Mirakhor, 1989). According to Khan and Mirakhor (1994), the primary aims of monetary policy are macroeconomic stability, including price stability and a sustainable position of the balance of payments. Regarding monetary policy, the authors conclude that the monetary policy in an Islamic system is carried out within a context in which all the traditional instruments normally used in a conventional system are at the monetary authority's disposal, except for the discount rate and the interest rate related policy instruments. Nevertheless, in the presence of several monetary transmission channels, particularly in dual systems, it may be desirable to take as many channels as available into consideration in assessing the overall monetary policy position, particularly channels that are closely linked to Islamic financial instruments, such as interbank Islamic money market rates and Sukuks. Taking this into consid-


http://dx.doi.org/10.21511/imfi.20(1).2023.26

eration, it is legitimate to ask how macroeconomic aggregates react to monetary instruments in an economy where both monetary policy modalities are conducted at the same time. In this respect, this paper aims to study the impact of a Taylor-style monetary policy in the presence of sovereign Sukuks.

# 2. METHODS (DSGE MODELLING)

## 2.1. Households

The household spends part of its disposable income on final goods and services at the beginning of each period. The rest of the income is spent on Treasury bonds and sovereign Sukuks. Money is returned to the household at the end of each period in the form of wages, interest income and profit sharing, which is consumed and saved. Representative households maximize the present value of utility by choosing the optimal consumption, labor and capital financing. The utility Ut of the representative household is given by:

$$Ut = E_0 \sum_{t=0}^{\infty} \beta^t \left[ \frac{C_t^{1-\chi}}{1-\chi} + \frac{D_t^{h^{1-\chi d}}}{1-\chi_d} + \frac{S_t^{h^{1-\chi s}}}{1-\chi_s} - N_t \right], \quad (1)$$

where $\beta^t$: the discount rate; $C_t$: the consumption in terms of final goods; $D_t^h$: investment in treasury bonds; $S_t$: investment in sovereign Sukuks; $N_t$: the amount of labor; $\chi_d$ and $\chi_s$ are the inverse of the elasticity of money holdings with respect to the interest rate and the profitability of Sukuks.

The representative household's utility is assumed to have a preference for treasury bonds because of the uncertain nature of Sukuks income. The budget constraint is the second restriction. At the start of all periods, the representative household has three sources of income, namely labor income and income from Treasury bonds and government Sukuks from the previous period. The budget constraint of the household can be formulated in the following way:

$$P_t C_t + D_t^h + S_t^h = (1+i_{t-1}^h) D_{t-1} + +(1+s_{t-1}^h) S_{t-1} + W_t N_t + G_t, \quad (2)$$

$$F_t^h = D_t^h + S_t^h, \quad (3)$$

$$D_t^h = (1-\varepsilon) F_t^h, \quad S_t = \varepsilon F_t^h, \quad 0 \le \varepsilon \le 1, \quad (4)$$

$$\chi_d < \chi_s, \quad (5)$$

where $P_t$: the price index; $i_{t-1}^h$: the interest rate on treasury bonds; $s_{t-1}^h$: the rate of return on sovereign Sukuks; $W_t$: wages; $G_t$: government expenditure; and $F_t^h$: total savings.

Households are more elastic to the interest rate than to the profitability of Sukuks. The first order conditions with respect to $C_t$, $N_t(j)$ and $\lambda_t$ are:

$$C(j)_t^{-\chi} = P_t \lambda_t, \quad (6)$$

$$W_t = \frac{1}{\lambda_t}, \quad (7)$$

$$\beta^t \left[ -\lambda_t + \beta \lambda_{t+1} \left( (1-\varepsilon)(1+i_{t-1}^h) + +\varepsilon(1+s_{t-1}^h) \right) \right] = 0, \quad (8)$$

where $\lambda_t$ is a Lagrange multiplier.

By combining the second and third first order conditions, the definition of the real wage is:

$$\frac{W_t}{P_t} = C_t^{-\chi}. \quad (9)$$

Combining the first and third first-order conditions, the Euler equation defining intertemporal consumption substitution is obtained:

$$\frac{1}{\beta} E_t \left( \frac{Y_t}{Y_{t+1}} \right)^{-\chi} \Pi_{t+1} = = E_t \left[ (1-\varepsilon)(1+i_t^h) + \varepsilon(1+s_t^h) \right], \quad (10)$$

This is equivalent to:

$$\frac{1}{\beta} E_t \left( \frac{Y_t}{Y_{t+1}} \right)^{-\chi} \Pi_{t+1} = = E_t \left[ (1-\varepsilon)(1+i_t^h)(F_{t+1}^{h(\chi_s-\chi_d)} + 1) \right], \quad (11)$$

where $\Pi_t = \frac{P_t}{P_{t-1}}$,

By using the log-linearization:

$$\overbrace{-\eta}^{\log\frac{1}{\beta}} E_t\left(\overbrace{y_t}^{\log Y_t} - y_{t+1}\right)^{-\chi} + \overbrace{\pi_{t+1}}^{\log \Pi_{t+1}} = \\ = Et\left[-\varepsilon + i_t^h + (\chi_s - \chi_d)\overbrace{f_{t+1}}^{\log F_{t+1}}\right], \quad (12)$$

Thus:

$$-\eta - \chi\left(y_t - y_{t+1}\right) + \pi_{t+1} = \\ = -\varepsilon + i_t^h + (\chi_s - \chi_d) f_{t+1}. \quad (13)$$

This gives :

$$y_t - y_t^n = E_t\left\{y_{t+1} - y_{t+1}^n\right\} + \\ + \frac{1}{\chi}\left(-\pi_{t+1} + \eta + i_t^h + \left\{-\varepsilon + (\chi_s - \chi_d) f_{t+1}\right\}\right), \quad (14)$$

where $y_t^n$ is the natural output, so the IS curve is given as follows:

$$\tilde{y}_t = E_t\tilde{y}_{t+1} + \frac{1}{\chi}E_t\left(-\pi_{t+1} + \eta + i_t^h + \\ + \left\{-\varepsilon + (\chi_s - \chi_d) f_{t+1}\right\}\right), \quad (15)$$

where $\tilde{y}_t$ is the output gap.

The above IS curve differs from the traditional IS curve in that, the IS curve no longer depends only on the interest rate, but also on the interest rate elasticities of money holdings and the profitability of government Sukuks.

## 2.2. Firms

### 2.2.1. *Final good producers*

The final good is obtained by using a Cobb-Douglas function:

$$Y_t = A_t M_t^{\alpha} N_t^{1-\alpha}. \quad (16)$$

The market for final goods is competitive where the quantities of intermediate goods produced are continuous indexed by $f \in [0, 1]$, are aggregated through a CES function as:

$$Y_t = \left(\int_0^1 y_t(f)^{1-\varepsilon} df\right)^{\frac{\varepsilon}{\varepsilon-1}}, \quad (17)$$

where $\varepsilon > 1$ represents the elasticity of substitution of the demand for intermediate goods.

The final firm resells its final goods at $P_t$ and purchases its intermediate goods at $P(f)$. The intermediate demand is set by profit maximization of the final goods producers according to the following equation:

$$\max \pi = P_t Y_t \int_0^1 p_t(f) y_t(f) df, \quad (18)$$

Therefore:

$$\max \pi = P_t\left(\int_0^1 y_t(f)^{1-\varepsilon} df\right)^{\frac{\varepsilon}{\varepsilon-1}} - \\ - \int_0^1 p_t(f) y_t(f) df. \quad (19)$$

The solution to the problem gives the demand for final goods:

$$y_t(f) = \left(\frac{p_t(f)}{P_t}\right)^{-\varepsilon} Y_t, \quad (20)$$

where

$$P_t = \left(\int_0^1 p_t(f)^{\varepsilon-1} df\right)^{\frac{1}{\varepsilon-1}}. \quad (21)$$

### 2.2.2. *Intermediate good producers*

The economy is made up of a continuous number of intermediate goods producers indexed by $f \in [0, 1]$, in a monopolistically competitive market. Intermediate goods firms use labor and capital to produce. Producers adjust their prices according to the Calvo process. The producers operate according to a Cobb-Douglas production function as follows:

$$Y_t = A_t M_t(f)^{\alpha} N_t(f)^{1-\alpha}, \quad (22)$$

where $A_t$ is a productivity shock, $M_t(f)$ et $N_t(f)$ are the capital and labor inputs. The technology shock is the result of a AR (1) process:



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$$\log A_t = \rho_A \log A_{t-1} + \varepsilon_t^A,$$
$$\varepsilon_t^A \sim i.i.d.N(0,\sigma_A^2), \quad |\rho_A|<1. \tag{23}$$

The producer of intermediate goods does not have the freedom to adjust its prices in each period. According to Calvo (1983), the firm faces a constant randomness (1-$\theta$) in adjusting its price. The intermediate goods firm will minimize its costs independently from the good's price. The problem can be broken down into two components. The firms are price-takers in the input markets, confronted with the nominal wage. Therefore, the cost minimization problem is given by:

$$CF_t = P_t M_t(f) + W_t N_t(f). \tag{24}$$

Under the constraint

$$Y_t(f) = A_t M_t(f)^\alpha N_t(f)^{1-\alpha} = = \left[\frac{P_t(f)}{P_t}\right]^{-\varepsilon} Y_t, \tag{25}$$

The Lagrangian is given by:

$$L = -P_t M_t(f) - W_t N_t(f) + +\lambda\left[A_t M_t(f)^\alpha N_t(f)^{1-\alpha} - \left[\frac{P_t(f)}{P_t}\right]^{-\varepsilon} Y_t\right]. \tag{26}$$

The first order conditions are:

$$\frac{dL}{dM_t(f)} = 0 \rightarrow P_t = = \lambda\alpha A_t M_t(f)^{\alpha-1} N_t(f)^{1-\alpha}, \tag{27}$$

$$\frac{dL}{dN_t(f)} = 0 \rightarrow W_t = = \lambda(1-\alpha) A_t M_t(f)^\alpha N_t(f)^{-\alpha}. \tag{28}$$

These conditions equalize the real prices of factors with the real marginal cost multiplied by the marginal products. By combining the two conditions, the following expression can be derived:

$$\frac{P_t}{W} = \frac{\lambda\alpha A_t M_t(f)^{\alpha-1} N_t(f)^{1-\alpha}}{\lambda(1-\alpha) A_t M_t(f)^\alpha N_t(f)^{-\alpha}}. \tag{29}$$

The capital-labor ratio will be equal in all firms, which in turn will be equal to the aggregate ratio with respect to the right-hand terms of the previous equation that do not depend on f. Thus, firms use capital and labor in the same ratio and the marginal cost is the same in all firms and is given as follows:

$$MC_t = A_t^{-1}\left(\frac{M}{\alpha}\right)^\alpha \left[\frac{Wt}{1-\alpha}\right]^{1-\alpha}. \tag{30}$$

From this point, the natural production level $Y_t^n$ is obtained given by:

$$MC_t = A_t^{-\left(\frac{1}{1-\alpha}\right)} (Y_t^n)^{\chi+\left(\frac{\alpha}{1-\alpha}\right)}. \tag{31}$$

Having dealt with the demand factor, attention is now turned to the problem of pricing. The firm will choose the price that maximizes the present value of profits. Profit $Pr_t$ is given by:

$$\Pr_{t+k} = E_0 \sum_{t=0}^{\infty} \psi^t \omega^t \left[P_t^* Y_t(f)_{t+s} - -CF_t(Y_t(f))\right]. \tag{32}$$

Assuming that $P_t^*$ is the no-friction pricing, the firm's objective is to minimize the loss function:

$$L(P_t) = \Pr_{t+k} - \Pr_{t+k}^* = [P_t - P_{t+k}^*]Y_{t+k}. \tag{33}$$

It can be shown that the NKPC is given as:

$$\pi_t = \beta E_t \pi_{t+1} + \vartheta\frac{(1-\theta)(1-\theta\beta)}{\theta}\tilde{y}_t, \tag{34}$$

where $\theta$ represents the unchanged fraction of prices and $p_t = \ln P_t$.

#### 2.2.3. Government and monetary authority

The government conducts fiscal and monetary policy. The government's real budget constraint is given by the following equation:

$$F_t = (1+i_{t-1})B_{t-1} + (1+s_{t-1})S_{t-1} + G_t, \tag{35}$$

where $G_t$ is the government's real expenditure.

The government conducts monetary policy to close output and inflation gaps. In this paper, the monetary policy instrument is the Taylor rule. The Taylor rule is used in the form:

$$(1+i_{t-1}^h) = \frac{1}{\beta}\Pi_t^{\phi_\pi}\tilde{Y}_t^{\phi_y}e^{v_t}, \tag{36}$$

with:

$$\nu_t = \rho_\nu \nu_{t-1} + \varepsilon_t^\nu,$$
$$\varepsilon_t^\nu \sim i.i.d. N(0, \sigma_\nu^2), \quad |\rho_\nu| < 1. \tag{37}$$

where $\varphi_\pi$: the influence of the inflation rate in the interest rate rule; $\varphi_y$: the influence of the output gap in the interest rate rule.

The log-linearized version of the growth of the quantity of money in circulation is given by the following equation:

$$mn_t = \pi_t + y_t - y_{t-1} + \tau(i_t - i_{t-1}). \tag{38}$$

#### 2.2.4. *Model calibration*

In the steady state, the disturbances tend to disappear and have no longer any impact on the parameters, so there is no effect on the steady state variables. In this way, the focus will be on the parameters that determine long-term trends. The parameters are mainly taken from the basic New Keynesian model of Gali (2008), chapter 3. The parameters are presented in Table 1:

**Table 1.** Calibration of the model parameters

Source: Gali (2008) and the authors of this article themselves.

| Parameters | Values | Meaning |
|---|---|---|
| χ | 1 | Relative risk aversion |
| $1-\alpha$ | 2/3 | Elasticity of production with respect to work |
| σ | 6 | Elasticity of substitution between goods |
| β | 0.99 | Discount factor |
| $\phi_y$ | 0.5/4 | Influence of the output gap in the interest rate rule |
| $\phi_\pi$ | 1.5 | Influence of the inflation rate in the interest rate rule |
| $\chi_S$ | **1** | The elasticity of money holdings with respect to the profitability of Sukuks |
| $\chi_S$ | **1,5** | The elasticity of money holdings with respect to the interest rate |
| $\rho_v$ | 0.5 | Persistence of the monetary policy shock |
| $\rho_A$ | 0.9 | Persistence of the technology shock |
| θ | 2/3 | Probability of keeping the old price |

For the study of the dynamic properties of the model, the parameter values were defined following Gali (2008) in addition to some parameters specific to this study.

# 3. RESULTS

## 3.1. Results of the monetary policy shock

The objective is to compare the standard Gali model with the author's model, which includes some extensions reflecting the introduction of sovereign Sukuks. Thus, the changes in the values of the variables responding to a transient rise in the Taylor rule's stochastic component are examined for both models. All the variables are given as a percentage deviation from their steady state values. The variations in the variables are only temporary, as each variable is stationary. Therefore, all variables return to their long-run values after about three years. The appearance of the shock to monetary policy in our model reflects the Taylor rule specification. An increase of 0.25% in the stochastic component reflects the effect of an expansionary monetary policy on real and nominal variables.

According to Gali and Gertler (2007), the transmission of monetary policy is determined by producers' response to the anticipated monetary policy. The nominal interest rate increases by 1% due to the shock. This implies that the decline in the nominal interest rate is more important. The monetary authority will intervene to decrease the nominal interest rate, but this increases inflation. The monetary authority must therefore reduce the money supply. This negative short-term movement in the money supply and the nominal interest rate in response to an exogenous monetary policy shock causes what is known as a liquidity effect.

The money supply must decrease to increase the nominal rate in response to output and prices. Thus, the decline in the latter caused by monetary shocks, combined with the induced decline in the nominal rate, causes a countercyclical movement in the money supply. Our results show that the monetary policy shock generates an increase in the real rate and a decrease in inflation and output. Nevertheless, in our model, the increase in the interest rate creates a substitution of households from sovereign Sukuks to Treasury bonds, which has a smaller impact on prices and thus on inflation and output than in the standard case.



http://dx.doi.org/10.21511/imfi.20(1).2023.26

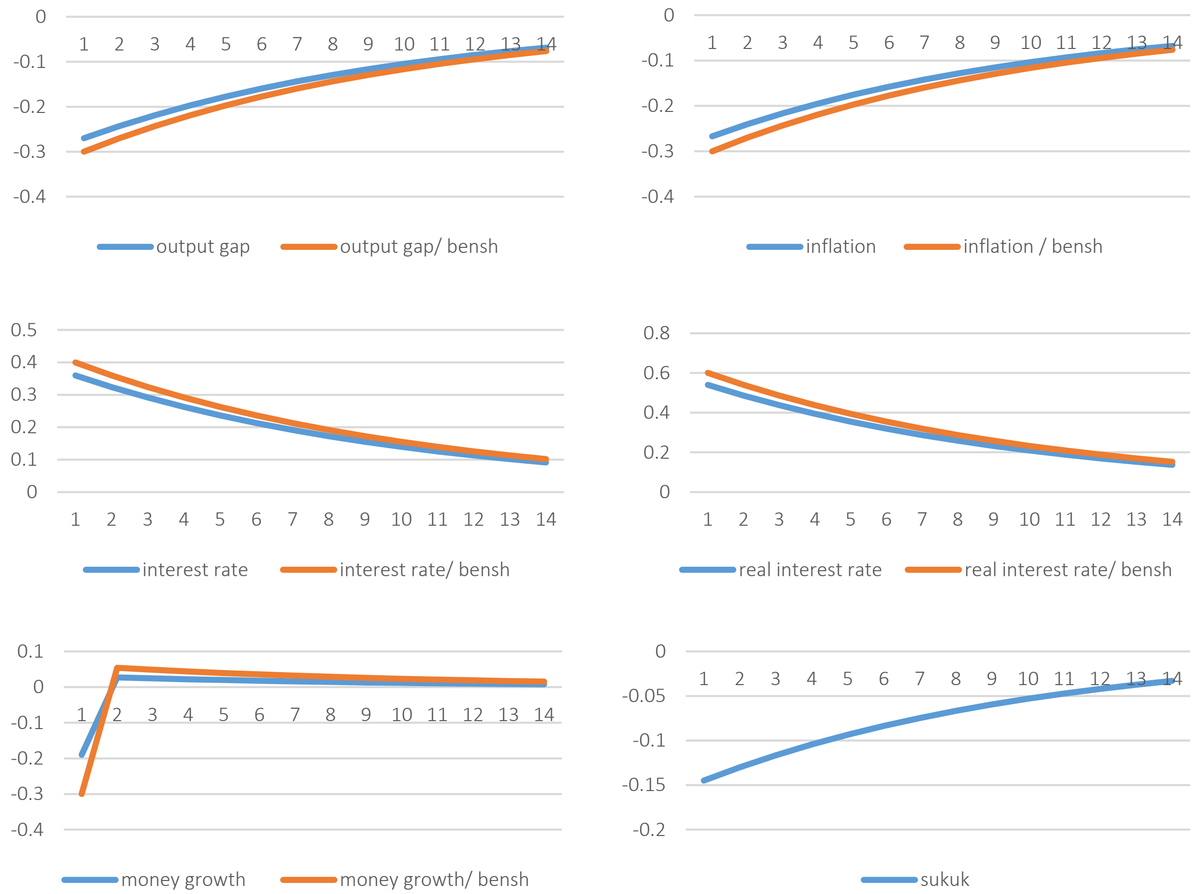


**Figure 1.** Effects of a monetary policy shock

The real interest rate reacts more strongly than the nominal interest rate because expected inflation is lower than in the baseline model. Note that in the baseline calibration, the nominal interest rate rises, although to a lesser extent than its exogenous component, due to the downward adjustment induced by lower inflation and the output gap. This is confirmed in the Sukuk model, but to a lesser extent. The central bank must therefore reduce the money supply. The model with Sukuks thus shows a liquidity effect that is less important than in the standard model. Note also that the reaction of the real interest rate is more important than that of the nominal interest rate, since both models expect inflation to fall. Nevertheless, it can be seen that the introduction of government Sukuks based on the real activity of the economy acts as a shock absorber.

Price rigidity means that nominal interest rate changes do not correspond to one-to-one expected inflation changes, as implied by the New Keynesian Phillips curve, which is identical in our model and in the reference model. Therefore, the reaction of the real interest rate differs from that of the nominal interest rate. The response of the nominal rate is positive and stronger in both models, but less so in the model with Sukuks. The real rate changes influence the behavior of both investment and consumption, which in turn affects the responses of employment and output. Thus, it can be seen that in the short run monetary policy has an effect on real variables, but as our graph shows, the response is less significant in the presence of government Sukuks.

## 3.2. Technology shock results

This paper analyses the changes in the values of the variables following a temporary increase in aggregate productivity. As the shock strikes the system, aggregate productivity changes from 1 to 1.01. The impulse responses are shown in Figure 2. The natural output response is positive because,

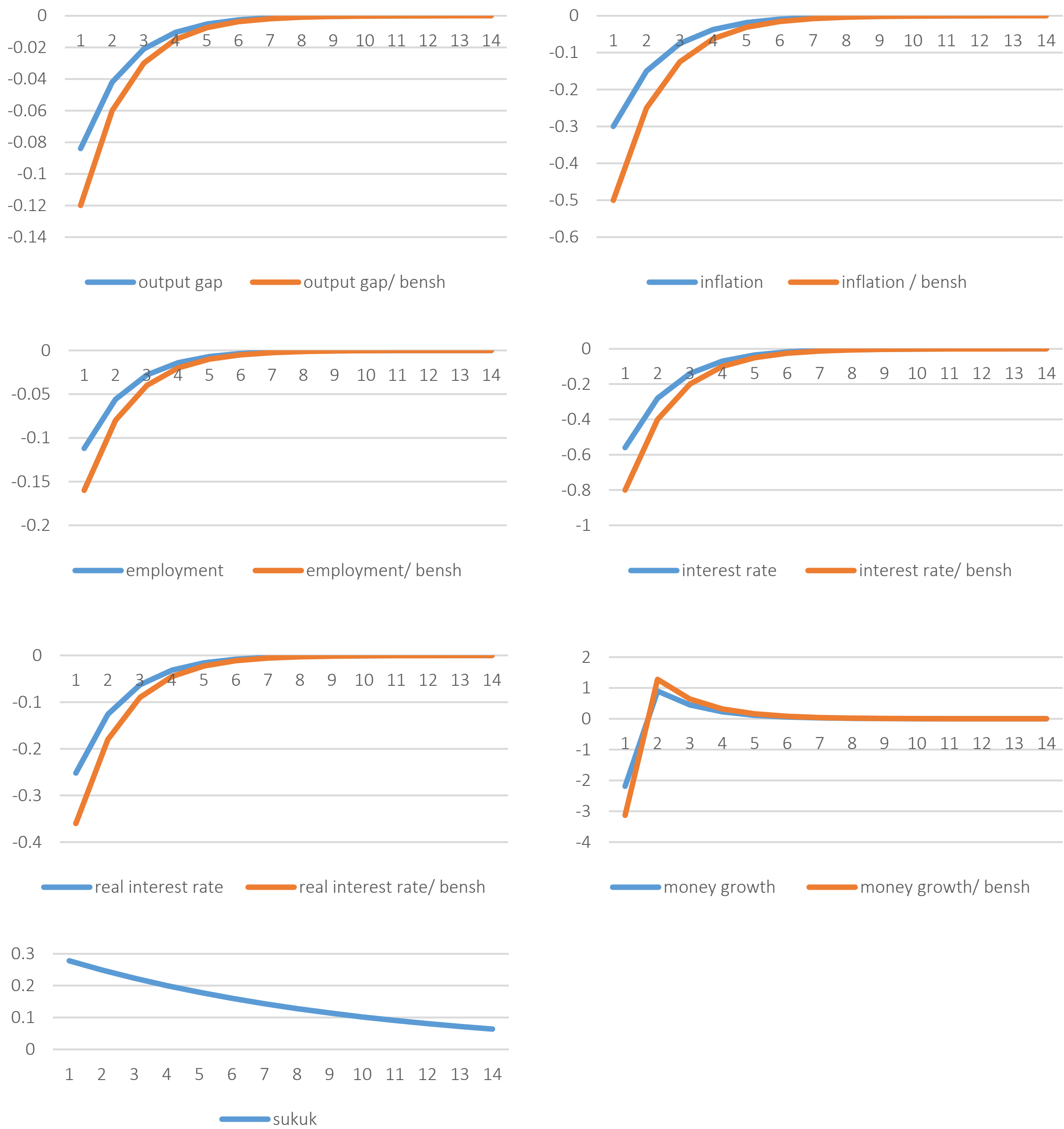


**Figure 2.** Effects of a technology shock

with flexible prices, marginal real costs remain unchanged and do not affect the output response. Also, according to the impulse responses, the level of natural output follows the same trend as the technology shock. However, the impulse responses of employment and output have different signs, depending on the values of the parameters in the model. For example, the response of output can be negative or positive, depending on the size of the fall in marginal costs. These parameters are set so that the marginal cost response is not too large and therefore does not cause a negative output response. The positive output response is less than the technological shock, which causes a reduction in employment with respect to the production function.

Figure 2 illustrates the central bank's response to the technology shock. Using the Taylor rule, the central bank can adjust the interest rate according to the output gap and inflation. In this way, the central bank will lower the nominal interest rate, which will cause the real interest rate to fall and thus increase the money supply. But this is not enough to close the negative output gap, which is caused by the fact that the increase in output does not fill its natural coun-



http://dx.doi.org/10.21511/imfi.20(1).2023.26

terpart. This leads to a fall in inflation according to the Phillips curve mechanism.

Under the Taylor rule, the monetary authority adjusts the interest rate to the output gap and inflation. So, the monetary authority lowers the interest rate. This induces households to substitute government bonds with Sukuks, whose profitability becomes more attractive. This policy increases the money supply. This is not enough to close the negative output gap, even though it is partly absorbed by the demand for Sukuks. According to the Phillips curve, which is identical in both models, this leads to lower inflation.

The results are similar under an identical interest rate rule in both cases. The output gap and thus inflation show a negative response to improved technology because output does not increase as much as its natural level for our model and the basic Keynesian model.

In the case of exogenous money, the gap between output and its natural level is smaller in the author's model than in the basic Keynesian model, which also explains the smaller decline in employment. This is due to the IS curve of our model, which is different from the standard Keynesian model, making the output gap less dependent on the interest rate.

## 4. DISCUSSION

The purpose of the analysis above was to contrast the Gali standard model against the authors' model, which has some extensions to reflect the implementation of sovereign Sukuks. The findings suggest that the shock to the monetary policy generates a rise in the real interest rate and a decline in both inflation and output. However, an increase in the interest rate in the authors' model causes households to replace sovereign Sukuks with government bonds, resulting in a smaller price effect and therefore a smaller impact on both inflation and output compared to the benchmark scenario. It should be noted that the nominal interest rate rises in the benchmark model, but by less than the amount of its exogenous component, as a result of the adjustment induced by the fall in both inflation and the output gap. This effect is repeated in the Sukuk model, but by a smaller amount. The Sukuk model therefore has a smaller liquidity effect compared to the baseline model. Furthermore, it is important to note that the response of real interest rates is more significant than the response of nominal interest rates, since both scenarios forecast a decline in inflation. However, the introduction of government Sukuks based on real economic activity does act like a shock absorber.

There is a positive response of the nominal interest rate in the two models, although to a lesser extent in the one with Sukuks. Real interest rate changes affect investment and consumption behavior, which affects employment and output responses. Hence, in the short run, it can be seen that monetary policy influences real variables, though less significantly in the presence of sovereign Sukuks. In accordance with the Taylor rule, the central bank adapts the interest rate in response to the output gap and inflation. Therefore, the monetary authorities will lower the interest rate. This encourages households to substitute government bonds with Sukuks, which become more appealing. However, the negative output gap is not closed, even though it is absorbed in part through the demand for Sukuks. This leads to lower inflation in line with the Phillips curve, which is similar in the two models. In the authors' model and in the basic Keynesian model, the production gap, and therefore inflation, is negatively sensitive to technological improvement, since production fails to rise to its natural level. With exogenous money, the output gap in the authors' model is smaller relatively to its natural level than in the basic Keynesian model, which also explains the lesser decline in employment. This results from the fact that the IS curve in the authors' model is constructed differently from the standard Keynesian model allowing for less dependence of the output gap on the policy rate.

## CONCLUSION

In the context of the above, this paper has tried to analyze the behavior of the Taylor rule in a small closed economy where Treasury bonds and Sukuks coexist. A basic New Keynesian model was used for its relative simplicity, with some extensions that support growth rate-based Sukuks, and the results were compared to the basic model. in this way, the previous simulations served several purposes. First, they illustrated how the New Keynesian model works in the presence of government Sukuks and how the model can be used to answer specific questions about the behavior of the economy under this assumption. Second, in the context of a plausible calibration, the simulations of monetary and technology shocks show similarities and differences between our model and the basic Keynesian model.

The introduction of government Sukuks absorbs the inflation and output gap shocks, but at the same time limits the scope of the Taylor rule. The part of the money supply used in government Sukuks limits the scope of the Taylor rule and at the same time reduces the distortions in addition to the difference in the IS curve of our model, which makes the output gap less sensitive to the interest rate. In this sense, an increase in the interest rate leads to a flight of capital from government Sukuks to Treasury bonds, while a decrease in the interest rate leads to a flight from Treasury bonds to government Sukuks. Ultimately, if there is a strong preference for Sukuks, Taylor's rule would become obsolete and inversely.

## AUTHOR CONTRIBUTIONS

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## REFERENCES


1. Ali, Q., Maamor, S., Yaacob, H., & Gill, M. U. T. (2018). Impact of Macroeconomic Variables on Islamic Banks Profitability. *International Journal of Business Ethics and Governance, 1*(2), 20-35. https://doi.org/10.51325/ijbeg.v1i2.14
2. Anwar, M. (1987). *Modelling Interest-Free Economy: A Study in Macroeconomics and Development (No. 4).* International Institute of Islamic Thought (IIIT). Retrieved from https://books.google.co.ma/books?hl=fr&lr=&id=yvoRCgAAQBAJ&oi=fnd&pg=PP1&dq=2.%09Anwar,+M.+(1987).+Modeling+Interest+Free+Economy:+A+Study+in+Macroeconomics+and+Development.+The+International+Institute+of+Islamic+Thought,+Herndon,+VA,+USA.&ots=QLg5lhPqGF&sig=eBom3G2aB531LIqm7CysvBSNMBM&redir_esc=y#v=onepage&q&f=false
3. Biancone, P. P., & Radwan, M. (2018). Sharia-compliant financing for public utility infrastructure. *Utilities Policy, 52,* 88-94. https://doi.org/10.1016/j.jup.2018.03.006
4. Biancone, P. P., & Radwan, M. (2019). Social Finance and Unconventional Financing Alternatives: An Overview. *European Journal of Islamic Finance, 10,* 1-6. https://doi.org/10.13135/2421-2172/2818
5. Bidabad, B. (2010). *Stabilizing business cycles by PLS banking and ethic economics.* Retrieved from http://www.bidabad.ir/doc/pls-business-cycles-en.pdf
6. Calvo, G. A. (1983). Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics, 12*(3), 383-398. https://doi.org/10.1016/0304-3932(83)90060-0
7. Chapra, M. U. (1985). *Toward Just a Monetary System.* The Islamic Foundation. Retrieved from https://kgsmiqbal.files.wordpress.com/2013/02/a1-towards-a-just-monetary-system.pdf
8. Chapra, M. U. (1996). Monetary Management in an Islamic Economy. *Islamic Economic Studies, 4*(1). Retrieved from https://ssrn.com/abstract=3165360
9. Choudhry, N. N., & Mirakhor, A. (1997). Indirect instruments of monetary control in an Islamic Financial system. *Islamic Economic Studies, 4*(2), 27-66. Retrieved from https://EconPapers.repec.org/RePEc:ris:isecst:0097



http://dx.doi.org/10.21511/imfi.20(1).2023.26

10. Darrat, A. F. (1988). The Islamic interest-free banking system: some empirical evidence. *Applied Economics, 20*(3), 417-425. https://doi.org/10.1080/00036848800000054

11. Gali, J. (2008). *Monetary Policy, Inflation, and the Business Cycle. An introduction to the New Keynesian Framework*. Princeton University Press, Princeton. Retrieved from https://perhuaman.files.wordpress.com/2014/06/gali_polc3adtica_monetaria.pdf

12. Gali, J., & Gertler, M. (2007). Macroeconomic modeling for monetary policy evaluation. *Journal of economic perspectives, 21*(4), 25-45. Retrieved from https://www.aeaweb.org/articles?id=10.1257/jep.21.4.25

13. Hanif, M. N., & Shaikh, S. (2010). Central banking and monetary management in Islamic finance environment. *Journal of Independent Studies and Research, 8*(2). Retrieved from https://mpra.ub.uni-muenchen.de/id/eprint/23548

14. Hasan, M., & Dridi, J. (2011). The effects of the global crisis on Islamic and conventional banks: A comparative study. *Journal of International Commerce, Economics and Policy, 2*(02), 163-200. https://doi.org/10.1142/S1793993311000270

15. Hassan, M. K., Chowdhury, M. I. H., Balli, F., & Hasan, R. (2022). A note on COVID-19 instigated maximum drawdown in Islamic markets versus conventional counterparts. *Finance Research Letters, 46*, 102426. https://doi.org/10.1016/j.frl.2021.102426

16. Hussain, M. M., Shahmoradi, A., & Turk, R. (2015). *An Overview of Islamic Finance* (Working Paper No. 2015/120). International Monetary Fund. Retrieved from https://www.imf.org/en/Publications/WP/Issues/2016/12/31/An-Overview-of-Islamic-Finance-42976

17. Kammer, M. A., Norat, M. M., Pinon, M. M., Prasad, A., Towe, M. C. M., & Zeidane, M. Z. (2015). *Islamic Finance: Opportunities, Challenges, and Policy Options* (Staff Discussion Notes No. 2015/005). International Monetary Fund. Retrieved from http://www.imf.org/external/pubs/cat/longres.aspx?sk=42816

18. Khan, M. A. (1982). Inflation and the Islamic Economy: AClosed Economy Model. In M. Ariff (Ed.), *Monetary and Fiscal Economics of Islam* (pp. 237-269). Jeddah: International Centre for Research in Islamic Economics. Retrieved from https://iei.kau.edu.sa/Files/121/Files/152672_14-MonetaryFiscalCover.pdf

19. Khan, M. F. (1996). A Simple Model of Income Determination, Growth and Economic Development in the Perspective of an Interest-Free Economy. In M. A. Mannan (Ed.), *Financing Development in Islam* (pp. 79-108). Jeddah: IRTI, IDB. Retrieved from https://www.iefpedia.com/english/wp-content/uploads/2009/12/financing-Development-in-Islam.pdf#page=73

20. Khan, M. S., & Mirakhor, A. (1989). The financial system and monetary policy in an Islamic economy. *Journal of King Abdulaziz University: Islamic Economics, 1*(1), 39-57. Retrieved from https://ssrn.com/abstract=3076332

21. Khan, M. S., & Mirakhor, A. (1994). Monetary management in an Islamic economy. *Islamic Economics, 6*(1), 3-22. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3075074

22. Khatat, M. E. H. (2016). Monetary policy in the presence of Islamic banking. International Monetary Fund. Retrieved from https://books.google.co.ma/books?hl=frandlr=andid=D1kZEAAAQBAJandoi=fndandpg=PA5anddq=Khatat,+2016andots=wkWvVTqkBxandsig=BeHMl8XRu59nVO-kLFcKJ3NRU60andredir_esc=y#v=onepageandq=Khatat%2C%202016andf=false

23. Khurshid, A. (1980). *Studies in Islamic Economics*. Leicester, UK: The Islamic Foundation.

24. Lewis, M. K. (2008). In What Ways Does Islamic Banking Differ from Conventional Finance? *Journal of Islamic Economics, Banking and Finance, 4*(3), 9-24. Retrieved from https://www.ibtra.com/pdf/journal/v4_n3_article1.pdf

25. Mazarei, A. (1996). The Iranian Economy Under the Islamic Republic: Institutional Change and Macroeconomic Performance (1979–1990). *Cambridge Journal of Economics, 20*(3), 289-314. Retrieved from https://www.jstor.org/stable/23600252

26. Medina, J. P., & Soto, C. (2006). *Model for Analysis and Simulations: A Small Open Economy DSGE for Chile* (Research Department Working Paper). Central Bank of Chile.

27. Mohieldin, M. (2012). *Realizing the Potential of Islamic Finance*. The World Bank, Washington DC. Retrieved from https://openknowledge.worldbank.org/server/api/core/bitstreams/2f6e35a0-e02e-5e86-b2ec-cfb65fc370a5/content

28. Ndiaye, N. D., & Masih, M. (2017). *Is Inflation Targeting the Proper Monetary Policy Regime in a Dual Banking System? New Evidence from ARDL Bounds Test* (MPRA Paper No. 79420). https://dx.doi.org/10.13140/RG.2.2.24930.02240

29. Siddiqi, M. N. (1982) Islamic Approaches to Money, Banking and Monetary Policy: A Review. In M. Ariff (Ed.), *Monetary and Fiscal Economics of Islam* (pp. 25-42). Jeddah: International Centre for Research in Islamic Economics. Retrieved from https://iei.kau.edu.sa/Files/121/Files/152672_14-MonetaryFiscalCover.pdf

30. Sole, J. (2007). *Introducing Islamic Banks into Conventional Banking System* (IMF Working Paper No. 07/175). IMF, Washington, DC. Retrieved from https://www.imf.org/external/pubs/ft/wp/2007/wp07175.pdf

31. Sukmana, R., & Kassim, S. H. (2010). Roles of the Islamic banks in the monetary transmission process in Malaysia. *International Journal of Islamic and Middle Eastern Finance and Management, 3*(1), 7-19. https://doi.org/10.1108/17538391011033834

32. Taylor, J. B. (1999). A historical analysis of monetary policy rules. In Monetary policy rules (pp. 319-348). University of Chicago Press. Retrieved from https://www.nber.org/system/files/chapters/c7419/c7419.pdf

33. Villa, S., & Yang, J. (2011). *Financial Intermediaries in an Estimated DSGE Model for the United Kingdom* (Working Papers No. 431). Bank of England. http://dx.doi.org/10.2139/ssrn.2026956

34. Walsh, C. E. (2010). *Monetary Theory and Policy* (3rd ed.). London: The MIT Press. Retrieved from http://students.aiu.edu/submissions/profiles/resources/onlineBook/N6v4L3_walsh.pdf

35. Wilson, R. (2008). Innovative in the Structuring of Islamic sukuk securities. *Humanomics, 24*(3), 170-181. https://doi.org/10.1108/08288660810899340

36. Zaheer, S., Ongena, S., & Van Wijnbergen, S. (2013). *The transmission of monetary policy through conventional and Islamic banks* (European Banking Center Discussion Paper No. 2011-018). http://dx.doi.org/10.2139/ssrn.1888345

37. Zamir, I. (1997). Islamic Financial Systems. *Finance and Development, 43,* 42-45. Retrieved from https://www.imf.org/external/pubs/ft/fandd/1997/06/pdf/iqbal.pdf




http://dx.doi.org/10.21511/imfi.20(1).2023.26