Vol. 14, No. 55, 2025
مطالعات اقتصادی کاربردی ایران
Quarterly Journal of Applied Economics Studies, Iran (AESI)
Scientific Association of Regional Development Economics
OPEN ACCESS

Applied Economics Studies, Iran (AESI)
P. ISSN:2322-2530 & E. ISSN: 2322-472X - Journal Homepage: https://aes.basu.ac.ir/
Scientific Journal of Department of Economics, Faculty of Economic and Social Sciences, Bu-Ali Sina University, Hamadan, Iran. Owner & Publisher: Bu-Ali Sina University.

Bu-Ali Sin University

The Impact of Shadow Banking on the Transmission of Monetary Policy in Iran: A DSGE Model Approach

Mehran Zarei[1], Marziyeh Esfandiari[2], Seyed Hossein Mirjalili[3]

Type of Article: Research
https://doi.org/10.22084/aes.2025.30883.3788
Received: 2025.04.29; Revised: 2025.06.30; Accepted: 2025.17.11
Pp: 9-41

Abstract

Monetary policy is one of the most important tools for policymakers to influence macroeconomic variables including production. However, implementing this policy sometimes yields unintended consequences. Understanding monetary policy transmission mechanisms is therefore critical for effective implementation. Research following the 2008-2009 financial crisis indicates that the shadow banking activity can disrupt the monetary policy transmission and weaken its effectiveness. An analysis of Iran's financial system reveals increasing shadow banking activity. This paper therefore examines how shadow banking affects monetary policy transmission in Iran using a DSGE model that innovatively incorporates the shadow banking sector. We compare two scenarios: a financial system without shadow banking and one including shadow banking. The effects of two contractionary monetary policies—interest rate increase and reductions in money supply growth—on GDP, investment, and inflation were analyzed under each scenario. The findings indicate that shadow banking diminishes monetary policy's impact on all three variables by weakening the credit channel of monetary policy transmission. In the scenario without shadow banking, In the scenario without shadow banking, all three variables will decline in response to the monetary shock of decreasing money supply growth. However, in the scenario with shadow banking, investment levels are not declining but rising. The impact of monetary policy on output and inflation is diminished in the presence of shadow banking. In the case of interest rate shocks, the results also indicate a negative impact of shadow banking on the effectiveness of monetary policy.

Keywords: Shadow Banking, Monetary Policy, Output, DSGE Model, Iran's Economy.
JEL Classification: E42, E44, E51, E52, G20.

1. Ph.D. Student in Economics, Faculty of Economics and Administrative Sciences, University of Sistan and Baluchestan, Zahedan, Iran.
2. Associate Professor, Department of Economics, Faculty of Economics and Administrative Sciences, University of Sistan and Baluchestan, Zahedan, Iran (Corresponding Author). ***Email:*** m.esfandiari@eco.usb.ac.ir
3. Professor, Department of Economics, Faculty of Economics, Institute for Humanities and Cultural Studies, Tehran, Iran.

Citations: Zarei, M., Esfandiari, M. & Mirjalili, S. H., (2025). "The Impact of Shadow Banking on the Transmission of Monetary Policy in Iran: A DSGE Model Approach". *Journal of Applied Economics Studies in Iran,* 14(55): 9-41. https://doi.org/10.22084/aes.2025.30883.3788
Homepage of this Article: https://aes.basu.ac.ir/article_6147.html?lang=en

1. Introduction

Monetary policy is a crucial macroeconomic tool for influencing economic variables. Consequently, governments and monetary authorities have consistently employed this policy to achieve economic objectives, particularly since the 1960s. Although monetary policy is a powerful instrument, it sometimes yields unexpected or unwanted outcomes (Mishkin, 1995). Thus, the extent and direction of monetary policy effectiveness remain key concerns for monetary authorities, giving rise to the concept of "monetary policy transmission" in economic literature.

Monetary policy transmission refers to the process through which a monetary policy (changes in nominal interest rates or money supply) affects real economic variables such as employment and output. The mechanism of monetary policy transmission explains how monetary policy impact on real variables. Understanding these mechanisms is essential for effective policy implementation. Transmission mechanisms are broadly categorized into four channels: interest rate, exchange rate, other asset price effects, and credit channels (Arabian *et al.,* 2020). Some scholars also identify expectations as a fifth channel (e.g., Bajelan *et al.,* 2018).

Mishkin (2019) argues that the emergence of shadow banking can be traced back to the economic changes of the 1960s. Since the 1960s, individuals and financial institutions in financial markets have faced drastic changes in the economic environment. These changes included: 1- Inflation and interest rate fluctuations increased sharply and became more difficult to predict, a situation that changed the demand conditions in financial markets. 2- Vast advances in computer technologies transformed the supply conditions. 3- Financial regulations became stricter. Financial institutions found that in these conditions, many of the old methods in this market were no longer profitable. In response to these conditions, financial deregulation began in the 1970s. In this context, financial innovations rapidly expanded and new financial instruments were introduced. These changes led to the process from which shadow banking grew; the process of ‘securitization’.

Following financial deregulation in the United States during the 1970s, numerous financial intermediaries have emerged which intermediated between savers and borrowers through financial innovations. Although functioning as financial intermediaries, these entities were not categorized as banks and consequently not subject to rigorous central bank supervision. Many scholars argue that these non-bank intermediaries, —termed "shadow banks"—, played a major role in the 2007-2009 financial crisis (Yang *et al.,* 2019).

The expansion of non-bank financial intermediaries may undermine monetary policy effectiveness by weakening the credit channel of monetary policy transmission. Given that

these intermediaries connect firms, workers, and government policies, some researchers have examined shadow banking from a political economy perspective (e.g., Fisher & Bernardo, 2014; Ban & Gabor, 2016).

Over the past two decades, shadow banking activity in Iran, while modest compared to many countries, has increased significantly. Therefore, it is necessary to examine the impact of shadow banking on the economy, especially its impact on monetary policy transmission and macroeconomic variables. While a review of studies related to the Iranian economy shows that this issue has been neglected by researchers and policymakers. Therefore, the main question of the present article is whether shadow banking in Iran weakens the transmission of monetary policy in Iran? To answer this question, this paper addresses this gap using a DSGE model to analyze shadow banking's impact on monetary policy transmission in Iran.

The remainder of this paper is organized as follows. section 2 reviews the theoretical background; section 3 surveys relevant literature; section 4 details the model; section 5 presents empirical results; and section 6 concludes with policy recommendations.

2. Theoretical background

2-1. Monetary Policy and Its Transmission Mechanisms

Empirical studies confirm early finding of Friedman and Schwartz (1965) that monetary policy actions lead to changes in real output (Bernanke and Gertler, 1995). Therefore, most economists agree that monetary policy can influence real economic variables, at least in the short run. Over recent decades, there has been a growing consensus among economists and politicians that stabilization of output and inflation should be left to monetary policy. Since the 1960s, fiscal policy has lost some credibility and luster due to concerns about large budget deficits, because of doubts about the political system's ability to make sound and timely decisions about spending and taxes. Consequently, monetary policy has assumed greater prominence in macroeconomic policymaking (Mishkin, 1995). Nevertheless, monetary policy can occasionally yield unanticipated and unwanted consequences that adversely affect public welfare. Therefore, understanding the transmission mechanisms of monetary policy is crucial for the implementation of such policies.

Mishkin (1995; 1996) categorizes monetary policy transmission into four channels: the interest rate; the exchange rate; the other asset price, and credit. Each of these channels is explained below.

a) Interest Rate Channel

Interest rate transmission can be considered as the main mechanism of monetary policy transmission. The traditional Keynesian perspective of how monetary contraction is transmitted to the real variables of the economy can be shown schematically below:

The reduction of the money supply (a contractionary monetary policy) results in the rise of real interest rate which results in an increase in the cost of financing and; this, in turn, discourages investment. Subsequently, aggregate demand and aggregate output will both decline. Prior research suggested that the interest rate channel operated solely through the investment spending decisions of businesses. However, subsequent studies have demonstrated that interest rates also impact on the expenditure decisions of households, especially housing and durable goods. For example, an increase in real interest rates leads households to try to postpone consumption. Current consumption is reduced compared to future consumption. With sticky prices, a reduction in current aggregate demand reduces output (Walsh, 2017).

According to John Taylor, the interest rate is a crucial element in the transmission of monetary policy. In the Taylor model, contractionary monetary policy raises the short-term interest rates, and considering price rigidity and rational expectations the long-term interest rate also increases (Mishkin, 1996; Bajelan *et al.,* 2018). It diminishes the formation of fixed capital, reduces spending on durable goods, and raises the cost of housing for households; and consequently, the total output declines.

b) Exchange Rate Channel

With the advent of flexible exchange rates in the 1970s, monetary policy transmission via the effects of exchange rates on net exports attracted attention. Foreign currency deposits become less attractive than domestic deposits denominated in the national currency when domestic interest rates increase. Consequently, the domestic currency appreciates relative to foreign currencies. An appreciation of the domestic currency (foreign currency depreciation) leads to a higher price for domestic goods relative to foreign goods, thereby causing a contraction in exports and output (Mishkin, 1995 & 1996). The aforementioned effects are illustrated in the following diagram.

c) Other Asset Price Effects

In his critique of the Keynesian approach to the monetary policy transmission mechanism, Allan Meltzer highlights the narrow focus of this analysis, which is limited to the relative price of an asset, specifically the interest rate. When analyzing monetary policy

transmission mechanisms, monetarists contend that it is important to examine how this policy type affects the relative prices of assets and real wealth. The asset price channel, in addition to bond prices, also focuses on other asset prices, including stock prices and real estate prices (Li *et al.,* 2021). In this regard, two monetary policy transmission channels are highlighted: The Tobin's q theory on investment and the impact of wealth on consumption.

According to Tobin's theory, the 'q' is the ratio of firms' market value to the replacement cost of capital. When q is high, then firms' market value relative to the cost of capital replacement will be high. Additionally, the price of fixed capital and equipment will be lower than the market value of business firms. Firms can therefore issue shares at a relatively high price (compared to fixed capital) and generate substantial profits. As a result, their investment expenditures rise, as issuing a limited number of shares enables them to acquire a substantial quantity of capital goods. However, when the value of q is low, firms will be reluctant to acquire capital goods for the same reason.

According to monetarists, when the money supply decreases, the public finds they have less money than they want and attempts to control it by reducing their spending. The stock market is where people can reduce their expenditures, as this decreases the demand for securities and, by extension, their prices. Given that a decrease in stock price (Pe) leads to lower 'q' and thereby investment costs (I), the monetary policy transmission mechanism can be conceptualized as follows from a monetarist standpoint:

A similar argument is also advanced in support of wealth effects, according to Modigliani's life cycle theory of consumption. A decline in stock prices leads to a corresponding reduction in individuals' financial wealth (W), which subsequently reduces their consumption (C). Aggregate demand and aggregate output will decline as a result of decreased consumption.

d) Credit Channel

Contrary to the monetary view that emphasizing money's exclusive role in transmission, the credit perspective focuses specifically on credit (De Bondt, 1999). Bernanke & Gertler (1995) argue that the credit channel augments traditional monetary transmission mechanisms (e.g., the interest rate channel) and therefore cannot be considered as an independent channel. However, this primarily applies to developed economies. Empirical evidence suggests that in emerging markets with imperfect financial systems, monetary policy transmission occurs predominantly through the credit channel—particularly the bank lending channel.

The credit channel perspective highlights how the agency problem in financial markets is formed by asymmetric information and costly contract enforcement. Two primary monetary policy transmission channels result from the agency problem in credit markets: the bank's lending channel and the balance sheet channel. The premise underlying the bank lending channel is that banks play a pivotal role within the financial system, particularly for small enterprises and households. Furthermore, it is assumed that bank loans and alternative funding sources are not complete substitutes, given that a considerable number of borrowers, particularly households and small and medium-sized businesses, lack the financial means to finance through bond issuance.

A contractionary monetary policy diminishes bank reserves and deposits (D), thereby diminishing banks' ability to lend (L). It diminishes both firms' and individuals' expenditures on investments and consumption. The figure below illustrates how this channel operates:

Following financial innovations since the 1970s, and the reducing role of banks in financial system, the balance sheet channel of monetary policy transmission gained greater prominence. This channel functions through commercial enterprises' net worth. Lower net worth means that lenders have less collateral for their lending, and thereby, losses attributable to financial intermediaries' adverse selection will be greater. As a result, financing for investment expenses of enterprises is diminished. A decline in business firms' net worth also exacerbates the problem of moral hazard, as proprietors will have less equity in their own company and will be more inclined to undertake risky investment endeavors. High-risk investment endeavors increase the likelihood of loan default; consequently, this results in reduced lending activity and decreased investment expenses.

Monetary policy can impact enterprises' balance sheets in numerous ways. The implementation of a contractionary monetary policy results in a decline in stock prices, which subsequently impacts the net assets of enterprises. The aforementioned discussions suggest that an increase in moral hazard and adverse selection will lead to a reduction in bank lending. Consequently, this will result in a decrease in companies' investment expenditures, ultimately causing a decline in aggregate output.

2-2. Shadow Banking and Monetary Policy Transmission

By the 1970s, conventional banks played a substantial role in the financial system. Central banks imposed stringent regulations on them while implementing monetary policy. Since then, however, the United States government has enacted extensive deregulations in the

financial sector, leading to the rapid expansion of so-called non-bank financial intermediaries. These non-bank financial institutions are known as “shadow banking”.

Paul McCulley coined the term “shadow banking system” to refer to “the whole alphabet soup of levered up non-bank investment conduits, vehicles, and structures”. Various definitions of shadow banking have been proposed, each serving a specific purpose. However, the definition put forth by the Financial Stability Board (FSB) is widely regarded as the most straightforward and conventional. According to this definition, shadow banking is “the system of credit intermediation that involves entities and activities outside the regular banking system” (Financial Stability Board, 2011). Insurance companies, pension funds, mutual investment Funds, hedge Funds, money market Funds, and investment banks are among the most significant of these entities. In addition, in some cases, especially under the strict central bank regulations, traditional banks provide off-balance sheet financing to escape central bank regulations. In the literature related to shadow banking, this type of activity by traditional banks is known as shadow banking, and it is especially intense in China. For example, Yang *et al.,* (2019), Huang (2018), and Chen *et al.,* (2018) considered off-balance sheet financing by traditional banks as a form of shadow banking in their research.

Due to the lack of strict supervision, the shadow banking system facilitates the circumvention of the regulatory frameworks (Schairer, 2024). Therefore, Shadow banking interferes with the lending role of traditional banks and may reduce the effectiveness of monetary policy (Cheng and Wang, 2022). As a result of the expansion of shadow banking, a larger part of the financial system is now not subject to tight central bank supervision; consequently, the central bank’s regulations have no bearing on their operations. Therefore, the lending channel of monetary policy transmission is weakened since the expansion of shadow banking undermines the assumption of the lending channel (that bank loans and alternative funding sources are not complete substitutes).

The amount of lending by commercial banks decreases in response to a tight credit policy enforced by the central bank. However, shadow banking, which operates outside the purview of central bank supervision, does not follow these regulations. As a result, some businesses and households denied loans from conventional financial institutions resort to shadow banking as an alternative method of borrowing. Based on this, and assuming the incomplete substitution of bank loans with other credit supply channels, the decrease in bank loans is compensated by shadow lending (Gong *et al.,* 2021). Therefore, as the proportion of shadow banking expands and the share of conventional banks diminishes, monetary policies affect only a small part of the financing system and their effectiveness

will decrease. Conversely, when expansionary monetary policy is implemented, the money supply increases and interest rates decrease. In this situation, conventional lending channels (traditional banks) replace shadow banking (substitution effects), which slows down the growth of this type of banking or even makes its growth negative.

2-3. Shadow Banking in Iran

Research on shadow banking in Iran remains limited. Arbab Afzali *et al.,* (2015) estimated the size of shadow banking in Iran for the first time in their research. According to their estimates, the value of shadow bank assets in Iran has increased from less than 50 trillion rials in 2009 to more than 400 trillion rials in 2013. Also, the ratio of the value of shadow banking assets to GDP in Iran has increased from 4% in 2009 to 76% in 2013, which indicates the strong growth of this type of banking activity during the years under review. Makipour *et al.,* (2023) in their article estimated the size of shadow banking assets in Iran during the years 2009 to 2020. According to the estimates of this article, the value of shadow banking assets in Iran in 2020 was more than 400,000 trillion Tomans (4000,000 trillion rials).

In this study, to quantifies Iran's shadow banking activity, we examined the assets of intermediaries introduced by the Financial Stability Board as shadow banking. Three different indexes have been used to examine the trend of shadow banking activity in Iran over the past years: 1) total value of shadow banking assets, 2) the ratio of the value of shadow banking assets to the total assets of the banking system (traditional and shadow), and 3) ratio of the value of shadow banking assets to GDP. In Iran, Non-bank credit institutions, insurance companies, investment funds, pension funds, and leasing companies are examples of these intermediaries. The asset value of shadow banking in Iran from 2011 to 2022 is depicted in figure 1.

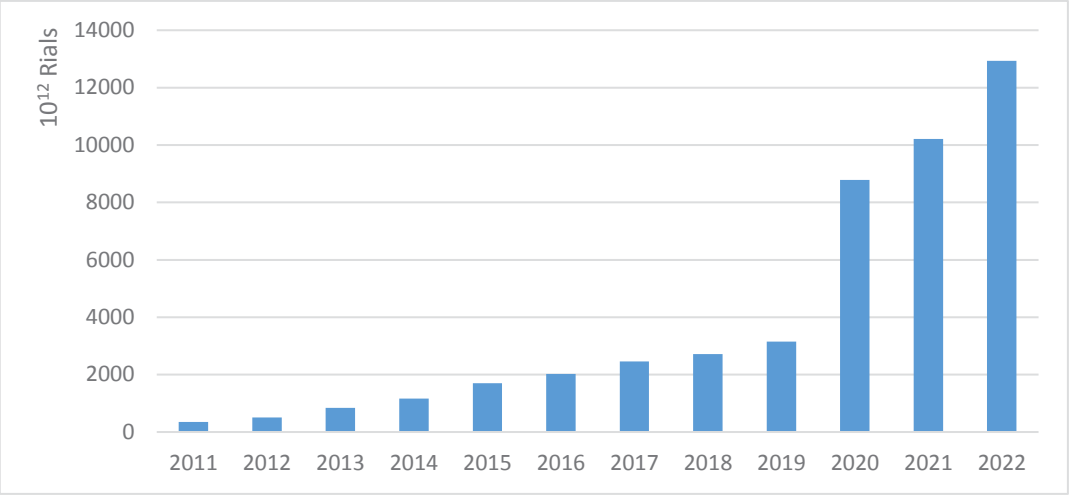

Fig. 1: Value of shadow banking assets in Iran (thousand billion Rials). Source: Kodal and Rahvard Novin

Figure 1 illustrates that the value of shadow banking has risen steadily over the period, from approximately 351 thousand billion Rials in 2011 to 12,936 thousand billion Rials in 2022, representing an annual growth rate of 38.8%. The asset value of these intermediaries witnessed its most substantial annual increase, approximately 178% in 2020.

To provide a clearer illustration of shadow banking in Iran, Figures 2 and 3 illustrate the ratio of shadow banking's value to the banking system's total value and to the GDP as a whole. It is evident from figure 2 that the ratio of shadow banking's value to that of all banks has exhibited a consistent upward trend until 2020, increasing from an estimated 10.9% to 28.5%. However, subsequent to that period, and in light of the liquidation of certain non-banking financial institutions, this ratio declined to 23.1% in 2022.

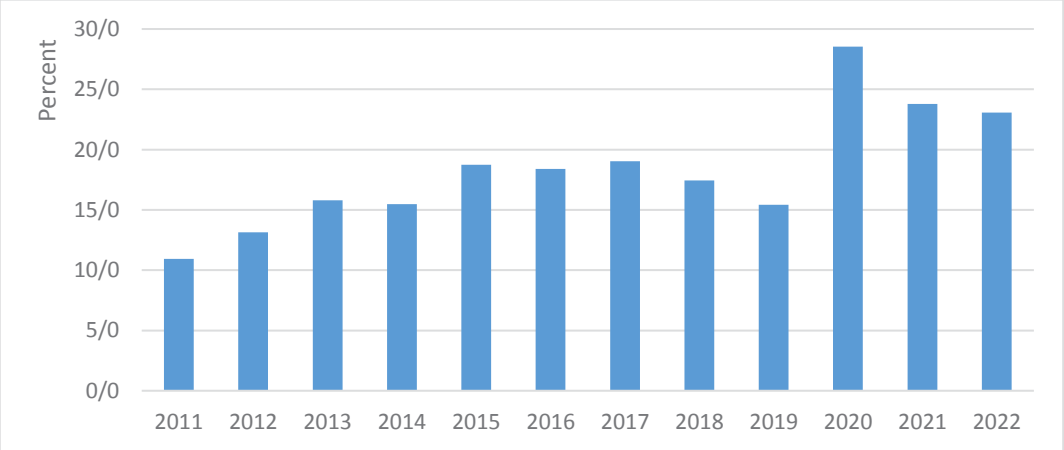

Fig. 2: The ratio of shadow banking assets to the total assets of the banking system (shadow and traditional) (percent) Source: Kodal and Rahvard Novin

The ratio of shadow banking value to GDP value is also displayed in Figures 3.

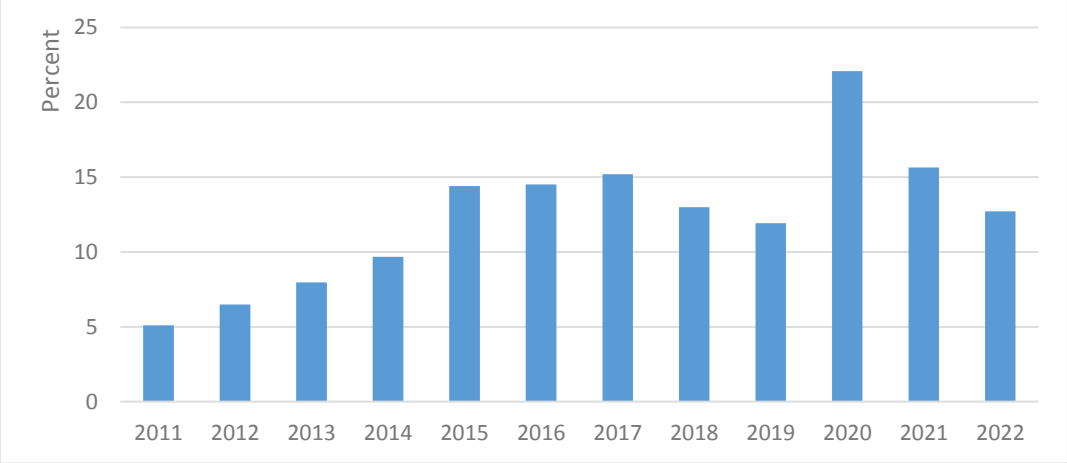

Fig. 3: Ratio of shadow banking assets to GDP value (percent). Source: Central Bank, Kodal and Rahvard Novin

3. Literature Review

Shadow banking concept appeared in the economic literature subsequent to the financial crisis of 2007-2009, therefore, research pertaining to it, such as its impact on the transmission of monetary policy, lacks an extensive historical background. Generally, the research pertaining to shadow banking is structured into two categories: theoretical and experimental. Some studies have examined shadow banking and its role in the economy from a theoretical view and have tried to provide a framework for its analysis. However, experimental investigations into its impact on economic variables have been conducted by others. Following is a review of some of the most important related studies.

Tobias Adrian, one of the theoretical pioneers of shadow banking, has provided a theoretical explanation for its existence in the economy. According to Adrian & Shin (2008), monetary policy transmission is centered on financial intermediaries, and the balance sheets of market-based financial intermediaries provide a window through which monetary policy transmission can go through capital market conditions. They argue that the 2007-2009 financial crisis is unique among previous crises in that it is the first financial crisis after securitization. Additionally, Adrian & Shin (2009) examined the origins and the contribution of shadow banking to the 2008 financial crisis and indicated that shadow banking emerged as a consequence of asset securitization and the banking system's integration with capital market developments. Initially perceived as a method to credit risk transfer, securitization ultimately intensified the vulnerability of the entire financial system

due to the fact that banks and other financial intermediaries could purchase each other's securities to increase their banking leverage.

Funke *et al.,* (2015) examined the impact of liberalization of interest rate on monetary policy transmission and the dynamics of the shadow banking using a DSGE model including shadow banking. They indicated that a rise in lending of shadow banking results from the tight interest rate policy implemented by traditional banks. As anticipated, their findings indicate that raising the policy interest rate leads to a decrease in investment, output, and inflation. However, the effects of this policy are lessened when the interest rate is liberalized.

Mazelis (2015) investigates the heterogeneous effects of monetary policy shocks on financial intermediaries focusing on the differentiation between shadow banking and commercial banking. As banks' credits endogenously responds to economy-wide productivity, the bank's response to shocks corresponds to the balance sheet channel. The lending channel provides the most adequate explanation for shadow banking behavior, given their constrained financial resources. The findings of this article indicate that shadow banking operations undermines the effectiveness of monetary policy due to the inverse relationship between the trajectory of shadow banking loans and traditional bank loans in the aftermath of monetary policy shocks.

In their article, Chen *et al.,* (2018) provided a theoretical examination of the relationship between shadow banking and monetary policy in China and defined shadow banking as the off-balance sheet activities of banks. The contractionary monetary policy that diminishes the lending capacity of shadow banking, as indicated by their research, motivates these banks to allocate funds towards risky non-loan assets to avoid central bank regulations.

Using the DSGE model, Yang *et al.,* (2019) examined the impact of shadow banking on economic activities and the effectiveness of monetary policy in China. Their findings indicate that shadow banking can reduce the effectiveness of macro prudential policy and disturb the transmission of monetary policy. Shadow banking will enhance welfare in the face of technology shocks, bank net asset shocks, and loan quota shocks; and conversely, welfare is diminished in the face of monetary policy shocks. Their findings also indicate that regulatory regulation aimed at improving financial stability could have a negative effect on the economy. Highlighting that regulations aim to strike a balance between the costs and benefits of policy intervention, they propose coordination between monetary policy and leverage ratio regulation to stabilize the economy and decrease shadow banking.

In the context of the CC-LM model, Zhang *et al.,* (2020) examined the effect of shadow banking on the prospective effectiveness of monetary policy. Their model shows that

shadow banking has the potential to influence the rate of money creation, causing it to increase during times of expansion and decrease during times of contraction. The introduction of shadow banking to the CC-LM model induces a transfer of the CC and LM curves, which ultimately culminates in an increase in equilibrium production.

Gong *et al.,* (2021) using a DSGE model, examined the effects of shadow banking on monetary policy. The results indicate that the shadow banking in China exhibits countercyclical attributes. The model's numerical analyses indicate that increases in interest rates that are positive shocks in nature stimulate the shadow banking growth and augment its credit leverage, while concurrently diminishing the credit leverage of commercial banks. These findings indicate that although shadow banking has partially addressed the problem of credit resource misallocation, it weakens the effectiveness of monetary policy through the credit channel and worsens financial instability, as indicated by these findings. They assert that to enhance the effectiveness of monetary policy, the process of liberalization of interest rate must be accelerated and supervision of the shadow banking need to be strengthened.

Agarwal *et al.,* (2022) examine the transmission of monetary policy through shadow banking in the mortgage market, with a specific focus on the role of mortgage servicing in the creation of non-deposit funds for lending. They argue that housing mortgage loan services mitigate the impact of monetary policy on shadow banking mortgage loans and serve as a natural hedge against interest rate shocks. The estimations presented in this article suggest that as the proportion of shadow banking in mortgage services rises, the transmission of monetary policy to the overall mortgage loan market is weakened.

Le *et al.,* (2022), in their study examines how regulatory arbitrage and shadow banking activities in China have impacted the effectiveness of monetary policy focusing on the influence of regulatory arbitrage. The authors argue that regulatory arbitrage is a persuasive explanation for the rapid growth of credits in the shadow banking sector. For instance, the implementation of a loan-to-deposit ratio (LDR) cap of 75% between 2009 and 2015 incentivized conventional banks to lend to SMEs via shadow banking in order to circumvent regulations and thereby contribute to the shadow banking credit growth. The outcome of this policy is that shadow bank lending responds to monetary policy shocks in the opposite direction of commercial bank lending and as a result reduces the effectiveness of monetary policy. They show that under normal conditions, regular bank credit and shadow bank credit changes pro-cyclically with monetary policy, but when the LDR cap is imposed varies contra-cyclically.

Enkhbold (2024) examined how monetary policy, through the mortgage market concentration channel, transmitted mortgage rates for traditional and shadow banks in the United States from 2009 to 2019. His results show that, on average, shadow and traditional banks have only a small difference in the transmission of monetary shocks to mortgage rates. However, in highly concentrated markets, shadow banks transmit monetary shocks more than traditional banks because they rely on investor funds that react quickly to changes in monetary policy.

Huang (2024) investigated how commercial and shadow banks adjust their mortgage interest rates in response to changes in long-term interest rates. The results of this paper show that both types of banks respond similarly to changes in short-term rates. But shadow banks are significantly more responsive to long-term interest rates than commercial banks. He argues that this difference could be due to the distinct asset sensitivities associated with each type of bank.

Jiang and Fu (2025) examined the differential impact of monetary policy on investment between state-owned enterprises (SOEs) and non-SOEs in China, with respect to the growth of shadow banking. They concluded that policymakers should consider developments in the financial system when assessing the effectiveness of monetary policy. According to their findings, contractionary monetary policy has a significant negative impact on investment by state-owned companies, as these companies rely more on traditional bank loans and are therefore more sensitive to monetary tightening, while non-state-owned companies are largely dependent on the shadow banking sector, which reduces the impact of monetary contraction on them.

A number of research in Iran has examined the mechanisms and determinants of monetary policy transmission. Notable contributions in this area include those of Komeijani & Alinejad Mehrabani (2012), Bajelan *et al.,* (2018), Kazerooni *et al.,* (2018), and Raei *et al.,* (2018). Zarei *et al.,* (2021a) examined the role of shadow banking in the transmission of monetary policy using cross-country data from 2002 to 2018 and the quantile regression and GMM models. Their results show that an increase in the shadow banking index diminishes the effectiveness of monetary policy. Also, Zarei *et al.,* (2021b) examined the impact of shadow banking on the financial stability using data from 14 countries of the G20 during the 2002-2018. They use quantile regression method and divided countries into four groups according to the level of shadow banking activity. Their results indicated that shadow banking has a negative impact on financial stability. Furthermore, an examination of Iran's monetary policy was conducted by Makipour *et al.,* (2023), who utilized the DSGE approach and the model proposed by Mazelis (2015) to

account for shadow banking. Their results show that the presence of shadow banking in the economy reduces the effect of this policy in the case of contractionary monetary policy and promotes its effect in the case of expansionary monetary policy.

A literature review indicates that the importance of shadow banking in Iran's economy and its impact on the effectiveness of monetary policy has been neglected. The only study in this field is the article by Makipour *et al.,* (2023) which used the DSGE method. As mentioned in Section 2, the estimated value of shadow banking assets in their study is very different from the present study. In terms of DSGE modeling, the paper by Makipour *et al.,* (2023) used the Mazelis (2015) model, which itself is a modified version of the Gertler and Karady (2011) model. In fact, the paper by Gertler and Karady (2011) is about Unconventional monetary policy and does not address the issue of shadow banking. However, due to the type of model used, Mazelis (2015) modified this model to examine shadow banking and its relationship with monetary policy. Makipour *et al.,* (2023) used the Mazelis (2015) model in their paper. While in the present paper, the Gertler and Karadi model has been directly modified by the authors in an innovative way based on the conditions of the Iranian economy. The traditional and shadow banking sector in this paper entered into the model by introducing variables and parameters that are different from the article by Makipour *et al.,* (2023). Also, in this article, in addition to the monetary shock of the change in the money growth rate, the nominal interest rate shock is also examined and the effects of this shock on macroeconomic variables are examined. While in the article by Makipour *et al.,* (2023) the interest rate shock is not considered. The results of the present paper are also different from the aforementioned article, which is described in Section 5. Therefore, our study complements Makipour *et al.,* (2023) study and helps to understand how shadow banking affects monetary policy transmission in Iran.

4. Method

In order to investigate the shadow banking effects on the transmission of monetary policy, this article employs the monetary DSGE model under the New Keynesian school that nominal rigidity exists (Mirjalili, 2015). The conceptual framework for this model was established by Gertler & Karadi (2011). A model was developed by Gertler & Karadi (2011) with the purpose of examining unconventional monetary policy. When traditional channels of monetary policy transmission are weakened, ineffective, or inadequate to accomplish the central bank's objectives, unconventional monetary policy may be implemented (Mirjalili, 2017). As the argument posited in the theoretical foundations suggests that shadow banking has the potential to undermine the implementation of

monetary policy, shadow banking is in some way associated with unconventional monetary policy. The model proposed by Gertler & Karadi (2011) is utilized in this article with qualification to examine the effects of shadow banking in Iran. In pursuit of this objective, the financial intermediation sector is partitioned into two distinct sectors: conventional banking and shadow banking.

The DSGE model under consideration comprises six agents: 1. Households; 2. Financial intermediaries, comprising two sectors—traditional banking (which is regulated) and shadow banking; 3. Producers of intermediate goods; 4. Producers of capital goods; 5. Retailers; and 6. The government and monetary authority (central bank). The characterizing equations are log-linearized around the steady state and therefore, the shocks to the model and the deviations from the steady state can be interpreted as percentage changes. To presentational purposes, the equations expressed in linear form.

4-1. Households

Continuum of identical households (with identical utility function), in addition to providing labor, households consume products and services and save surplus funds. The surplus funds of households are deposited in either conventional or shadow banking. Every household consists of two individuals: the worker and the banker. Workers are compensated for their labor. Bankers oversee financial intermediaries and distribute their proceeds to households. Therefore, households are owners of financial intermediaries.

At any given time, 1-f of the household members are workers and f of households are bankers. One may shift from worker to banker over the course of their lifetime. A banker during this period will maintain that occupation for the subsequent period with a θ percent probability. Consequently, the average survival for a banker is 1/(1-θ). Hence, during each period, (1-θ) f of bankers move into the worker. A similar number of workers are also become bankers in a random manner, maintaining a constant ratio of their numbers. The household maximizes the utility function (1):

$$\max E_t \sum_{(i=0)}^{\infty} \{\beta^i [\ln(C_{(t+i)}-hC_{(t+i-1)})-\chi^ /(1+\varphi) \{L_{(t+i)}\}^{(1+\varphi)}]\} \quad (1)$$

Where C denotes consumption and L denotes labor supply. The equation incorporates parameters β and h to discount factor and habits, respectively. These parameters have values ranging from zero to one. The parameter φ represents the inverse Frisch labor supply elasticity and χ is the relative utility weight of labor, whose value is greater than zero.

From period t-1 to t, both traditional (conventional) and shadow banking institutions pay interest to their deposits (B). Hence, for the purpose of optimizing their utility, households are constrained by the budget constraint represented by Equation 2:

C_t=w_t L_t+Π_t-T_t+R_t^b B_t^b+R_t^sb B_t^sb-B_(t+1)^ (2)

Where T denotes tax, W represents wage rate, and Π denotes profits to the household from both financial firms (traditional and shadow banks) and non-financial firms. B represents the aggregate amount of household savings held as deposits with both conventional and shadow banking institutions. B_ ^b denotes the savings held by households with conventional banks, while B_ ^sb represents their savings with shadow banking. Additionally, R_ ^b and R_ ^sb denote gross interest rate paid on deposits in conventional and shadow banks, respectively. Consequently, the sum of the household's savings will be B_t^T=B_t^b+B_t^sb. The average interest rate of conventional and shadow banks, denoted as R^w, can be expressed as follows:

R_t^b B_t^b+R_t^sb B_t^sb=R_t^wB_t^T (3)

The marginal utility of consumption ϱ_t, denoted as dU/〖dC〗_t, can be obtained by constructing the Lagrange function and implementing the first order condition:

〖ϱ_t=(C_t-hC_(t-1))〗^(-1)-βhE_t (C_(t+1)-hC_t)^(-1) (4)

1=βE_t Λ_(t,t+1) R_(t+1)^w Λ_(t,t+1)=(〖ϱ_(t+1)^ 〗_ ^)/(ϱ_t^) (5)

W_t=χ 〖L_t〗^φ/ϱ_t (6)

4-2. Financial Intermediaries

a) Traditional Banks

The funds collected from households are lent by banks to non-financial businesses. In period t, the wealth (net worth) of bank j is denoted as N_jt. If B_(jt+1) represents household deposits with bank j, and S_j represents the bank's portfolio of lending, the resulting balance sheet for bank j would be as follows:

Q_t S_jt=N_jt+B_(jt+1) (7)

Where the price of each unit of loan portfolio is denoted by Q_t. As previously stated, banks earn return R_(tk+1) from lending and pay gross return R_(t+1) on deposits during period t+1. The net worth of a bank consequently evolves according to Equation 8.

N_(jt+1)=R_(kt+1) Q_t S_jt-R_(t+1) B_(jt+1)=(R_(kt+1)-R_(t+1)) Q_t S_jt+ 〖R_(t+1) N〗_jt (8)

Hence, the interest spread (difference between the interest rate paid and received (R_(kt+1)-R_(t+1))) determines the growth of equity.

The banker maximizes their expected terminal net worth V_t and distributes all accumulated profits to their household prior to exit the industry. This is achieved through Equation 9:

$$V_{jt}=〖\max_{f_0}\ E〗_t\ \sum_{(i=0)}^{\infty}〖(1-\theta)\ \theta^i\ \beta^{(i+1)}\ \Lambda_{(t,t+1+i)}\ 〗\ N_{(jt+1+i)}=〖\max_{f_0}\ E〗_t\ \sum_{(i=0)}^{\infty}〖(1-\theta)\ \theta^i\ \beta^{(i+1)}\ \Lambda_{(t,t+1+i)}\ 〗\ [(R_{(kt+1)}-R_{(t+1)}\ )\ Q_t\ S_{jt}+〖R_{(t+1)}\ N〗_{jt}\ ] \quad (9)$$

So far as the return on loans (R_(kt+1)) exceeds the interest paid to deposits (R_(t+1)), banks have a propensity to increase their asset base through more borrowing from households and further lending. In order to curtail this capability, the central bank implements lending restrictions, including the capital adequacy ratio. It is postulated that every period the banker diverts the fraction λ of loan portfolio from the project and then transfer them back to the household and the bank's depositors are not able to recover; consequently, they are authorized to lend 1-λ of the deposits. Failure to adhere to this regulation may result in the banker incurring a penalty from the central bank or potentially facing insolvency. Thus, the subsequent equation needs to be established prior to depositors being inclined to deposit in bank j:

$$V_t \geq \lambda Q_t S_{jt} \quad (10)$$

Rewriting Equation 9 as follows is possible by implementing this restriction:

$$V_{jt}=v_t\ Q_t\ S_{jt}+\eta_t\ N_{jt} \quad (11)$$

$$v_t=E_t\ [(1-\theta)\beta\Lambda_{(t,t+1)}\ (R_{(kt+1)}-R_{(t+1)}\ )+\beta\Lambda_{(t,t+1)}\ \theta x_{(t,t+1)}\ v_{(t+1)}\ ] \quad (12)$$

$$\eta_t=E_t\ [(1-\theta)+\beta\Lambda_{(t,t+1)}\ z_{(t,t+1)}\ \theta\eta_{(t+1)}\ ] \quad (13)$$

Where η_t represents the expected discounted value of an additional unit of N_j, while v_t signifies the expected discounted value of expanding assets. In addition, the gross growth rate of net worth of bank j is denoted by z_(t,t+1) and the gross asset growth rate (loan portfolio value) is represented by x_(t,t+1) using the following equations:

$$x_{(t,t+1)}=(Q_{(t+1)}\ S_{(jt+1)})/(Q_t\ S_{jt}\ ) \quad (14)$$

$$z_{(t,t+1)}=N_{(jt+1)}/N_{jt} \quad (15)$$

Consequently, we can rewrite Equation 10 as follows:

$$v_t\ Q_t\ S_{jt}+\eta_t\ N_{jt} \geq \lambda Q_t\ S_{jt} \quad (16)$$

If this restriction is upheld, then the assets the bankers can acquire depends positively to their equity capital.

$$Q_t\ S_{jt}=\eta_t/(\lambda_t-v_t\ )\ N_{jt}=\phi_t N_{jt} \quad (17)$$

The (private) leverage ratio, denoted by ϕ in this equation, represents the private assets to equity ratio. Equation 18 provides an expression for the progression of the banker's net worth.

$$N_{jt+1}=[(R_{kt+1}-R_{t+1})\phi_t+R_{t+1}]N_{jt} \quad (18)$$

The values of $x_{t,t+1}$ and $z_{t,t+1}$ are thereby reformulated according to the subsequent equations:

$$z_{t,t+1}=N_{jt+1}/N_{jt}=〖(R〗_{kt+1}〖-R〗_{t+1})\phi_t+R_{t+1} \quad (19)$$

$$x_{t,t+1}=(Q_{t+1}S_{t+1})/(Q_t S_t)=(\phi_{t+1}N_{jt+1})/〖\phi_t N〗_t=\phi_{t+1}/〖\phi_t〗_ z_{t,t+1} \quad (20)$$

Since the constituents of ϕ_t are not contingent upon the particular attributes of the firm, the following individual demands can be added together to ascertain the total demand for bank assets:

$$〖Q_t S〗_t=\phi_t N_t \quad (21)$$

A fraction $f(1-\theta)$ of bankers exit and allocate the accumulated profits among their households during each period. A similar process occurs whereby bankers are appointed to workers at random, ensuring that the proportion of bankers remains constant. The following outcome will result from denoting the net worth of new banks as N_{nt} and the net worth of existing banks as N_{et}:

$$N_t=N_{et}+N_{nt} \quad (22)$$

The households transfer the ratio $\omega(1-\theta)$ of their asset values to new banks during each period. Therefore, the net asset value of new banks compared to existing banks is ascertained by Equations 23 and 24:

$$N_{et}=〖\theta[〖(R〗_{kt}〖-R〗_t)\phi_{t-1}+R_t]〖-N〗_{t-1)〗_ \quad (23)$$

$$N_{nt}=\omega Q_t S_{t-1} \quad (24)$$

Where ω is the parameter used to determine the steady state ϕ.

b) Shadow Banking

As stated in the preceding section, this model divides the financial intermediations into two distinct sections: conventional banking and shadow banking. To clarify, the aggregate amount of lending in the financial system ($Q_t S_t$) is calculated by adding the following: traditional banking lending ($Q_t S_t^b$) and shadow lending ($Q_t S_t^{sb}$):

$$Q_t S_t^=Q_t S_t^b+Q_t S_t^{sb} \quad (25)$$

In contrast to conventional banking institutions, which are subject to limitations on lending, shadow banking operates without such constraints and are not face with tight central bank regulations, such as the capital adequacy ratio.

It is assumed that shadow banking accounts for ψ_t percent of financial intermediation (lending) during period t. Therefore, Equation 25 can be expressed as follows:

$$Q_t S_t^ =\phi_t N_t+\psi_t Q_t S_t^ =\phi_{ct} N_t \quad (26)$$

Where the leverage ratio of traditional banks is denoted by ϕ_t, while the leverage ratio of all financial intermediaries (both shadow and traditional) is represented by ϕ_ct. The equation can be expressed as follows:

$$\phi_{ct}=1/(1-\psi_t)\ \phi_t \quad (27)$$

Gertler & Karadi (2011) state that the variable ψ_t is determined using Equation 28:

$$\psi_t=\psi_ +\nu E_t [〖(logR〗 _(kt+1) 〖-logR〗 _(t+1))- 〖(logR〗 _k 〖-logR)_] \quad (28)$$

Where ψ is the percentage of shadow intermediation in the steady state.

4-3. Intermediate goods firms

A producer of intermediate goods is a non-financial firm that sells intermediate goods to retailers and operates under perfect competition. The firm grants capital K_(t+1) at the end of period t for utilization in the production process of the subsequent period. The firm is permitted to sell its capital in the market at the of period t+1. As there are no adjustment costs, capital choice problem of the firm remains static. Firm's capital is provided by borrowing from financial intermediaries, including both shadow and traditional banking. Due to the fact that the return of financial sector operations is distributed as profit to shareholders, the firm's profit is zero. Thus, the total capital of firms is equivalent to the aggregate amount of lending by both traditional and shadow banking institutions.

$$Q_t K_{t+1}= 〖Q_t S_t〗 _ \quad (29)$$

The firm produces output Y in each period by utilizing labor L and capital K. Equation 30 provides the output when total factor productivity (technology factor) is denoted by A, the rate of capital utilization is denoted by U, and the quality of capital is denoted by ξ (so ξK is effective capital utilization):

$$Y_t=A_t (〖U_t \xi_t K〗 _t)^\alpha L_t^{1-\alpha} \quad (30)$$

P_mt denotes the price of intermediate goods produced by the firm. Also, the replacement price of capital utilized in each unit remains constant. Firms encounter the constraint of funds provided by financial intermediaries (capital) for manufacturing purposes. Thus, the firm maximizes its profits using Equation 31:

$$K(K_{(t+1)},L_t) \left[=\beta \max\right] \left[E_t \sum_{(i=0)}^{\infty} \left[\beta^i \Lambda_{(t,t+1)}\right] \left[P_{mt} Y_t+(Q_t-\delta) U_t \xi_t K_t-W_t L_t-R_{kt} K_t Q_{(t-1)}\right]\right] \quad (31)$$

While there is no profit for the firm, it pays capital return to the banks. Given $E_t \beta\Lambda_{(t+1)}$ by Ψ ($E_t \beta\Lambda_{(t+1)}=\Psi$) and according to equation 30, we can solve the first-order condition as below:

$$(dK(K_{(t+1)},L_t))/(dK_t)=\Psi P_{(mt+1)} \alpha A_{(t+1)} \xi_{(t+1)} \left[U_{(t+1)} (U_{(t+1)} \xi_{(t+1)} K_{(t+1)})\right]^{(\alpha-1)} \left[L_{(t+1)}\right]^{(1-\alpha)}+\Psi(Q_t-\delta) U_t \xi_{(t+1)}-\Psi R_{(kt+1)} Q_t=0 \quad (32)$$

$$R_{(kt+1)} Q_t=P_{(mt+1)} \alpha Y_{(t+1)}/K_{(t+1)} +(Q_{(t+1)}-\delta)U_{(t+1)} \xi_{(t+1)} \quad (33)$$

To determine $R_{(kt+1)}$, we can rewrite equation 33 as equation 34:

$$R_{(kt+1)}=([P_{(mt+1)} \alpha Y_{(t+1)}/ \left[\xi_t K\right]_{(t+1)} +(Q_{(t+1)}-\delta)U_{(t+1)}] \xi_{(t+1)})/Q_t \quad (34)$$

With optimization and consideration of capital constraints, the capital utilization rate and labor demand of the firms during period t can be stated as Equations 35 and 36 respectively:

$$P_{mt} \alpha Y_t/U_t =\delta'(U_t)\xi_t K_t \quad (35)$$

$$P_{mt} (1-\alpha)Y_t/L_t =W_t \quad (36)$$

The residual capital stock is quantified as $Q_{(t+1)}-\delta(U_{(t+1)}) \xi_{(t+1)} K_{(t+1)}$. The $\xi_{(t+1)}$ shock provides the source of volatility in capital returns. Furthermore, the current value of the asset is typically depending on the expected future path of $\xi_{(t+1)}$.

4-4. Capital Producers

At the end of period t, capital producing firms purchases capital from producers of intermediate goods and proceeds to manufacture and build new capital goods subsequent to repairs and renovations. The replacement cost of capital that has been depreciated is equal to 1. the cost of new capital is Q_t. No adjustment costs are associated with refurbishing capital, whereas the production of new capital incurs an adjustment cost. Assumptions underlying the model posit that households hold ownership of the capital and are entitled to accrue interest on it.

The net capital created can be expressed as Equation 37, where I_t represents the gross capital produced:

$$I_{nt}=I_{(t)}-\delta(U_t) \left[\xi_t K\right]_t \quad (37)$$

When I_{ss} denotes the steady state of investment, the discounted profit of the capital goods producer is derived by maximizing Equation 38 subject to Equation 39:

〖I_nt=〗 〖max E_t ∑_(τ=t)^∞ 〖β^(τ-t) Λ_(t,τ)〗 [(Q_τ-1) I_nτ-f((I_nτ+I_ss)/(I_(nτ-1)+I_ss))(I_nτ+I_ss)]〗 (38)

〖s.t. I〗 _nt=I_(t)-δ(U_t) 〖ξ_t K〗 _t (39)

Where f(1)=f′(1)=0 and f″(1)>0. I_nt denote specific shocks, I_ss denotes the steady state of investment and δ(U_t) ξ_t K_t shows the value of capital replacement. The first-order condition for the price Q_t is given by the derivative of 38 equations with respect to I_nt (see Gertler and Karadi, 2011). To solve it, we can expand equation 38 as follows:

〖I_nt=〗 〖max E_t [(Q_t-1) I_nt-f((I_nt+I_ss)/(I_(nt-1)+I_ss))(I_nt+I_ss)]+E_t β^ Λ_(t,t+1) [(Q_(t+1)-1) I_nt-f((I_(nt+1)+I_ss)/(I_nt+I_ss))(I_(nt+1)+I_ss)]+⋯〗 (40)

Since the third and subsequent sentences do not include the term I_nt, then their derivative is zero with respect to this variable. Denoting f((I_nτ+I_ss)/(I_(nτ-1)+I_ss)) by f(.) and E_t βΛ_(t+1) by Ψ the first order condition is:

Q_t-1-f′(.) 1/(I_(nt-1)+I_ss) (I_nt+I_ss)-f(.)-Ψf′(.) ((I_(nt+1)+I_ss)/(I_nt+I_ss))^2=0 (41)

Q_tis obtained by solving this equation:

It produces the subsequent relationship for Q_t:

Q_t=1+f(.)+(I_nt+I_ss)/(I_(nt-1)+I_ss) f^' (.)-E_t β^ Λ_(t,t+1) 〖((I_nt+I_ss)/(I_nt+I_ss))〗 ^2 f^' (.) (42)

4-5. Retailers

These firms buy intermediate goods from the producer at the price of P_mt and produce final goods. The final good Y_t is a CES combination of differentiated retail firms, that using intermediate goods (as the input), produce the final good by Equation 43:

Y_t=[∫_0^1 〖Y_ft^((ε-1)/ε) df〗]^(ε/(ε-1)) (43)

Where Y_ft is the produced goods by firm f. The parameter ε is the elasticity of substitution between goods. By minimizing the cost by consumer of the final product Equations 44 and 45 are as follows:

Y_ft=(P_ft/P_t)^(-ε) Y_t (44)

P_t=[∫_0^1 〖P_ft^(1-ε) df〗]^(1/(1-ε)) (45)

In fact, the firm producing the final product needs a unit of intermediary goods to produce a unit of output. Therefore, the final cost of these firms is equal to the relative price of the intermediate good P_mt. The nominal rigidity of prices is included in the model in such a way that in each period the firm can adjust prices with a probability of γ-1. These firms determine the optimal price P_t^* by solving the following equation:

$$\max \; \int_0 \left[E_t \sum_{t=0}^{\infty} \left[\gamma^i \beta^i \Lambda_{t,t+1} \right] \left[(P_t^*)/(P_{t+i}^{\;}) \prod_{k=1}^{i} (1+\pi_{t+k-1})^{\gamma_p} - P_{mt+i} \right] Y_{ft+i} \right] \quad (46)$$

Where π_t is the inflation rate of period t-1 to period t. The first order condition gives the Equation 47.

$$\sum_{i=0}^{\infty} \left[\gamma^i \beta^i \Lambda_{t,t+1} \right] \left[(P_t^*)/(P_{t+i}^{\;}) \prod_{k=1}^{i} (1+\pi_{t+k-1})^{\gamma_p} - \mu P_{mt+i} \right] Y_{ft+i}=0 \quad (47)$$

In this regard, the μ parameter is equal to:

$$\mu=\varepsilon/(\varepsilon-1) \quad (48)$$

Using the law of large numbers, equation (49) is obtained to determine the change in the price level:

$$P_t=[(1-\gamma)(P_t^*)^{(1-\epsilon)}+\gamma(\Pi_{t-1}^{\gamma_p} P_{t-1})^{(1-\epsilon)}]^{(1/(1-\epsilon))} \quad (49)$$

4-6. Government and Monetary Authority

It is assumed based on the findings of Keshavarz's (2018) that the government finances its expenditures by oil export revenues, money creation, and taxation., Therefore, the government budget constraint is as follows:

$$G_t=O_t+T_t+(M_t-M_{t-1})/P_t \quad (50)$$

Where G_t and O_t follow the AR(1) process:

$$G_t=(1-\rho_g)G_{t-1}+\rho_g G_{ss}+\varepsilon_t^g$$

$$O_t=\rho_o O_{t-1}+\varepsilon_t^o$$

Monetary policy is typically established in DSGE models by the Taylor rule. However, in the majority of domestic studies that have applied the DSGE model to Iran's economy, this rule has been deemed invalid in light of the circumstances governing Iran's economy and the mandatory interest rate determination. As a result, alternative methods have been utilized for the monetary policy rule. Typically, the money growth rate is incorporated as a policy variable in such analyses.

The framework for targeting inflation, which the Central Bank of Iran implemented by June 2020, places emphasis on the market's role in determining the exchange rate. In pursuit of this objective, the central bank has implemented open market operations as its primary mechanism, with interbank market interest rates serving as one of the instruments to accomplish this.

In light of this and in accordance with the Central Bank of Iran's new guidelines, the monetary policy rule in the current model is regarded as a straightforward Taylor rule. Although some studies (like: Chenarani *et al.,* 2023) have used Taylor rule for Iran's economy. But so as to be more compatible with Iranian economic conditions, as stated in Farzinvash *et al.,* (2014), parameters related to the dependence of interest rates to output-

inflation gap being considered as below normal level. Because the interest rate in Iran is largely determined mandatory and has less dependence on the output-inflation gap (as stated in the Taylor rule). Therefore, the monetary policy rule is mathematically expressed as Equation 51:

$$i_t= i_{(t-1)}^{\rho} ((1/\beta\ \pi_t^{(\kappa_\pi)}) ((1/P)/\mu)^{(\kappa_y)})^{(1-\rho)} e_i \quad (51)$$

Where e_i denotes the interest rate shock. Moreover, given Iran's economy, it seems that, the money growth rate be considered as a policy rule. Alternatively, monetary policy can be implemented through the regulation of the nominal growth rate of money. The money supply growth rate is determined by an AR (1) process:

$$\dot{M}_t=\rho_m \ 〖\dot{M}_{(t-1)}+(1-\rho_m)(\dot{M}_t)\bar{}+\rho_m \varepsilon_t^m〗 \quad (52)$$

Fisher's equation is defined as follows:

$$1+i_t=R_{(t+1)} E_t (〖1+\pi〗_{(t+1)}) \quad (53)$$

The market clear condition is ultimately illustrated as follows:

$$Y_t=C_t+I_t+G_t \quad (54)$$

5. Model Analysis and Results

Most of the structural parameters utilized in this study are taken from Gertler & Karadi (2011). The value of some parameters has been adjusted based on the structure of Iran's economy. For example, the steady state ratio of government spending to GDP is considered to be 0.12 instead of 0.2 based on research calculations. The values of the parameters are presented in Table 1.

Table 1. Model parameters

Symbol	Value	Description	Source
Households			
β	0.990	Discount rate	GK (2011)
h	0.815	Habit	GK (2011)
χ^{HH}	3.409	Relative utility weight of labor	GK (2011)
φ	0.276	Inverse Frisch elasticity of labor supply	GK (2011)
Banks			
λ	0.381	Fraction of bank assets that can be diverted	GK (2011)
ω	0.002	Proportional transfer to the incoming banks	GK (2011)
θ	0.972	Survival rate of a banker	GK (2011)
v	400	The leverage ratio parameter for shadow banks	Model calibration

Symbol	Value	Description	Source
Goods Producers			
α	0.330	Effective capital share	GK (2011)
δ	0.025	Depreciation rate	GK (2011)
ϵ	4.167	Elasticity of substitution	GK (2011)
γ	0.779	Probability of keeping prices fixed	GK (2011)
γ_p	0.241	Price indexation	GK (2011)
η	1.728	Elasticity of investment adjustment cost	GK (2011)
Government			
$G/_Y$	0.12	Steady state proportion of government expenditures	Research calculations
κ_π	1.1	Inflation coefficient of Taylor rule	Model calibration
κ_y	0.1	Output gap coefficient of Taylor rule	Model calibration
ρ_i	0.8	Smoothing parameter of the Taylor rule	GK (2011)

To assess the impact of shadow banking on monetary policy effectiveness, we analyzed two distinct scenarios: one without shadow banking and another incorporating shadow banking. These scenarios were used to evaluate how policy shocks—specifically changes in interest rates and money growth—affect key real variables (investment and output) as well as the inflation rate. The results are presented in Figures 4 and 5. Since the model is log-linearized, both the shocks and the deviations from the steady state can be interpreted as percentage changes.

5-1. Negative Money Growth Rate Shock

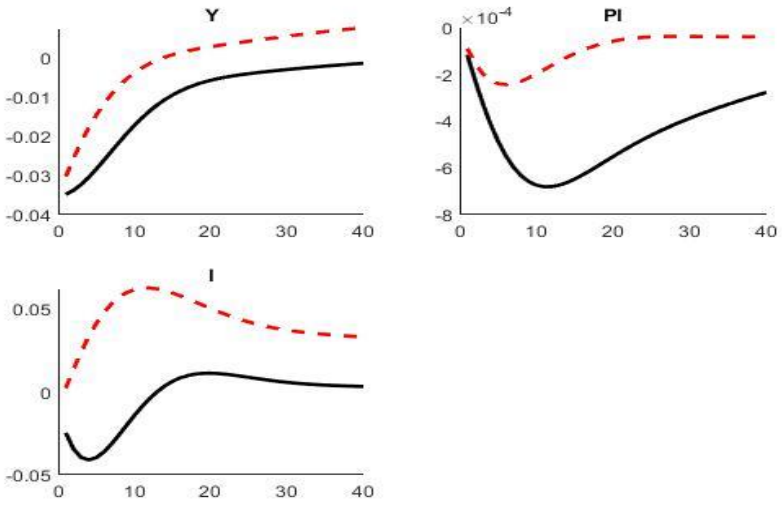

Fig. 4: Macroeconomic variables responses to a negative money growth rate shock.

Figure 4 illustrates the dynamic responses of output, investment, and inflation to a 5% contractionary money growth rate shock, comparing two scenarios: one without shadow banking (solid black curve) and another with shadow banking (dotted red curve).

5-1-1. Baseline Scenario (Without Shadow Banking)

As expected, the contractionary policy (decreasing money supply growth) leading to declines in investment, aggregate demand, and output. Because this policy reduces bank lending capacity, thereby reducing the investment expenditures of enterprises and household consumption costs via the credit channel. As aggregate demand declines, the output will also decrease. With a five percent negative shock to money supply growth:

Output drops by 0.035% from its steady state, persisting for 40 periods. Investment initially falls by 0.045% but fully recovers after 19 periods. Inflation declines steadily until the 10th period, remaining below the steady state thereafter. These results align with conventional monetary transmission theories, where reduced credit availability suppresses economic activity.

5-1-2. Shadow Banking Scenario

When shadow banking is introduced, the model results reveal significant deviations from the baseline due to the unregulated nature of shadow credit intermediation. Unlike in the baseline, investment rises by 0.07% (peaking at the 10th period) before gradually declining—yet never fully reverting to steady-state levels. This reflects credit substitution: as traditional bank lending contracts, firms and households turn to shadow banks for financing, offsetting part of the credit reduction. Indeed, when the lending capacity of traditional banks decreases, households and small and medium-sized enterprise (SMEs) are unable to secure financing through alternative means (e.g., issuing shares or bonds), they resort to the riskier practice of shadow banking. In this way, a portion of the credit reduction in conventional banks is offset.

In this scenario output still falls, but the decline is smaller than in the baseline, and the effect dissipates after just 11 periods (versus 40 in Baseline Scenario). The attenuation stems from partial credit replacement by shadow banks, though reduced government spending and consumption still weigh on aggregate demand. Inflation drops by only 2% (versus 7% in the baseline), with effects vanishing almost immediately. This suggests shadow banking dampens monetary policy's price-stabilizing effectiveness, as unregulated credit softens demand-side pressures.

This finding supports Mazelis (2015) and Le *et al.,* (2022), highlighting the divergent lending behaviors of shadow and traditional banks under monetary shocks.

5-2. Positive Interest Rate Shock

The response of economic variables to a contractionary policy involving a positive interest rate shock is depicted in figure 5.

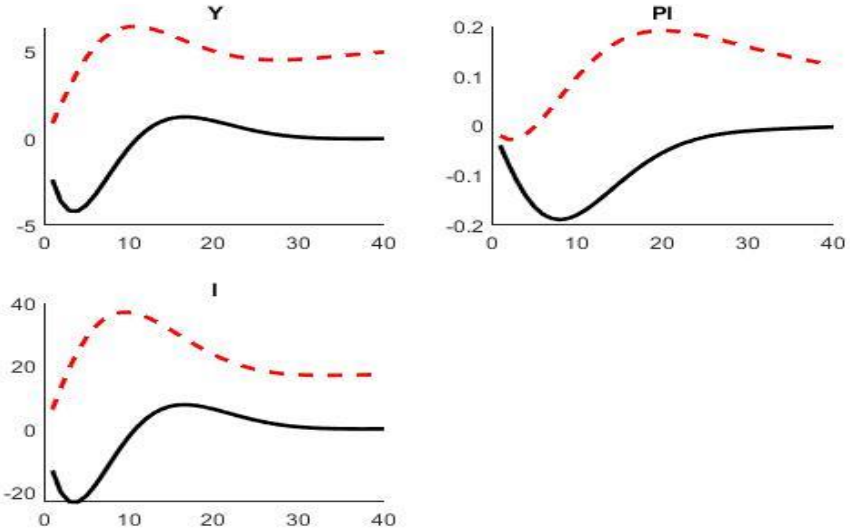

Fig. 5: Macroeconomic variables responses to a positive interest rate shock

5-2-1. Baseline Scenario (Without Shadow Banking)

According to these findings, in the first scenario (without shadow banking), the response of investment and output to an interest rate shock is consistent with expectations. Consistent with standard economic theory, a 5% positive interest rate shock leads to output Decline. As a result of this policy output falls immediately, reaching 5% below steady state within 2 periods, and recovers after 20 periods. The response of investment to this shock is stronger than that of output. Investment declines sharply by 20% below steady state (also within 2 periods), reflecting higher sensitivity to borrowing costs. Inflation decreases by 0.2% with a 9-period lag, aligning with conventional monetary policy transmission. These results confirm that higher interest rates suppress economic activity by raising borrowing costs, reducing demand, and dampening price pressures—a typical channel of monetary tightening.

5-2-2. Shadow Banking Scenario

When shadow banking is introduced, the dynamics deviate sharply from expectations. In case of contractionary policy of raising interest rate, instead of declining, both output and investment increase in response to rising interest rates. Shadow banks—unconstrained by regulatory or interest rate policies—expand lending to offset the contraction in traditional bank credit. Their ability to outpace the decline in conventional lending creates a net increase in available credit.

In response to the interest rate shock, output immediately begins to increase and reaches a maximum after 11 periods (7% increase from the steady state). This increase is persistent and never returns to the steady state level. The impact of this shock on investment is greater than on output, with an increase of 40% after 10 periods.

Inflation rises by 0.2% indefinitely, contrasting with the disinflationary effect in the baseline model. This suggests shadow banking counteracts central bank tightening, as easier credit access sustains demand-side price pressures.

The findings of this study provide support for the hypothesis that shadow banking mitigates the impact of monetary policy on macroeconomic variables. These findings underscore the need for policymakers to account for shadow banking's growing role in credit markets when designing and implementing monetary measures.

6. Conclusion

This study examined the impact of shadow banking on monetary policy transmission in Iran using a DSGE framework. By analyzing two scenarios—one excluding and another incorporating shadow banking—we assessed how monetary policy shocks (a reduction in money supply growth and an increase in interest rates) affect key macroeconomic variables: output, investment, and inflation. Our findings reveal that shadow banking significantly diminishes the effectiveness of monetary policy, altering both the magnitude and direction of policy impacts.

With a money supply contraction, in the scenario without shadow banking, a reduction in money supply growth led to declines in investment, output, and inflation, consistent with conventional monetary theory. With shadow banking scenario, Investment paradoxically increased, as shadow banks compensated for—and even surpassed—the reduction in traditional bank lending. Also, the effects on output and inflation were weaker, with smaller deviations from steady-state levels compared to the baseline scenario.

In the case of positive interest rate shock, in the absence of shadow banking, higher interest rates reduced output and investment, with inflation declining as expected. In this

case, the output and investment variables experience a negative deviation from their steady state values and subsequently decline. Additionally, the effects of this stimulus diminish after approximately 10 periods, and they revert back to their steady state value.

However, shadow banking not only undermine the impacts of this policy but also adversely effects on investment and output in comparison to the traditional banks. Investment and output rose in response to the interest rate shock, as unregulated shadow credit offset the contraction in traditional lending. Inflation increased permanently, contradicting the disinflationary outcome of the baseline model.

The results demonstrate that shadow banking undermines monetary policy transmission by: 1- Blunting investment and output responses through alternative credit channels; 2- Shortening the duration of policy effects; 3- Reducing inflation control efficacy, complicating central banks' stabilization efforts.

These results highlight a critical challenge for Iranian policymakers:

Shadow banking undermines monetary control by blunting or reversing policy transmission mechanisms.

Stricter regulations on traditional banks could inadvertently expand shadow banking activity, further eroding policy efficacy.

Policymakers must account for non-bank intermediation when designing measures, as ignoring its role risks unintended consequences.

Acknowledgments

The authors extend their sincere gratitude to the anonymous peer reviewers for their insightful critiques and constructive suggestions, which significantly enhanced the clarity and scholarly rigor of this manuscript.

Authors' contributions

This research is derived from the first author's doctoral dissertation. The primary data collection, encompassing all observational and analytical components, was conducted by the first author under the direct supervision and mentorship of the second and third authors.

Conflicts of interest

The authors declare no conflict of interest. This study received no financial support from any organization.

References

- Adrian, T. & Shin, H. S., (2008). *Financial intermediaries, financial stability, and monetary policy.* FRB of New York staff report, (346). https://doi.org/10.2139/ssrn.1266714

- Adrian, T. & Shin, H. S., (2009). *The shadow banking system: implications for financial regulation*. FRB of New York Staff Report, (382). https://doi.org/10.2139/ssrn.1441324

- Agarwal, I., Hu, M. & Zheng, K., (2022). "Lending by Servicing: How Shadow Banks Dampen Monetary Policy Transmission". *Available at SSRN*. https://doi.org/10.21799/frbp.wp.2023.14

- Arabian Mahdi, A., Khosravinejad, A. A., Pedram, M., Nazarian, R. & Mohammadi, T., (2020). "Assessment of Credit Channel on Output During Recession and Boom Period in Iran's Economy". *Journal of Applied Economics Studies in Iran,* 9(33): 31-55. https://doi.org/10.22084/aes.2019.18333.2815 (In Persian).

- Arbab Afzali, M., Shahchera, M. & Taheri, M., (2015). *Macro-mapping of the Shadow banking in Iran. Monetary and Banking Research Institue*, Central Bank of the Islamic Republic of Iran, Report MBRI-PN-94022. (In Persian).

- Bajelan, A. A., Bayat, R. & Ansari Samani, H., (2018). "The Role of Financial Development in the Effectiveness of Monetary Policy during Business Cycles: An Application of Markov-Switching Model", *Economic Research and Perspectives,* 18(4): https://ecor.modares.ac.ir/article_13417.html?lang=en (In Persian).

- Ban, C. & Gabor, D., (2016). "The political economy of shadow banking". *Review of international political economy,* 23(6): 901-914. https://doi.org/10.1080/09692290.2016.1264442

- Bernanke, B. S. & Gertler, M., (1995). "Inside the black box: the credit channel of monetary policy transmission". *Journal of Economic perspectives,* 9(4): 27-48. https://doi.org/10.1257/jep.9.4.27

- Chen, K., Ren, J. & Zha, T., (2018). "The nexus of monetary policy and shadow banking in China". *American Economic Review,* 108(12): 3891-3936. https://doi.org/10.1257/aer.20170133

- Chenarani, H., Yavari, K., Heydari, H. & Sharifzadeh, M., (2023). "The Effect of Banking Crises on Macroeconomic Variables Within the DSGE Models Framework". *Journal of Applied Economics Studies in Iran,* 12(46): 9-38. https://doi.org/10.22084/aes.2021.25066.3359 (In Persian).

- Cheng, X. & Wang, Y., (2022). "Shadow banking and the bank lending channel of monetary policy in China". *Journal of International Money and Finance,* 128, 102710. https://doi.org/10.1016/j.jimonfin.2022.102710

- De Bondt, G. J., (1999). *Financial structure and monetary transmission in Europe: a cross-country study*. PhD thesis, University of Amsterdam, Faculty of Economics and Business. https://doi.org/10.4337/9781782542759

- Enkhbold, A., (2024). *Monetary policy transmission through shadow and traditional banks*. Bank of Canada Staff Working Paper, (No. 2024-8).

- Fisher, E. A. & Bernardo, J., (2014). "The political economy of shadow banking: Debt, finance, and distributive politics under a Kalecki-Goodwin-Minsky SFC framework". *Levy Economics Institute of Bard College Working Paper,* (801). https://dx.doi.org/10.2139/ssrn.2439884

- Farzin Vash, A., Ehsani, M. A. & Keshavarz, H., (2014). "Financial Shocks and Labour Market Fluctuations with Financial Frictions". *Iranian Journal of Economic Research,* 19(59): 1-37. https://ijer.atu.ac.ir/article_1402.html?lang=en (In Persian).

- Financial Stability Board, F.S.B., (2011). *Shadow banking: Scoping the issues. A background note of the financial stability board*, 12 April.

- Friedman, M. & Schwartz, A. J., (1965). "Money and business cycles". *In The state of monetary economics*: 32-78. https://www.nber.org/system/files/chapters/c5179/c5179.pdf

- Funke, M., Mihaylovski, P. & Zhu, H., (2015). *Monetary policy transmission in China: A DSGE model with parallel shadow banking and interest rate control*. Hong Kong Institute for Monetary and Financial Research (HKIMR) Research Paper WP No. 12/2015. http://dx.doi.org/10.2139/ssrn.2605304

- Gertler, M. & Karadi, P., (2011). "A model of unconventional monetary policy". *Journal of monetary Economics*, 58(1): 17-34. https://doi.org/10.1016/j.jmoneco.2010.10.004

- Gong, X. L., Xiong, X. & Zhang, W., (2021). "Shadow banking, monetary policy and systemic risk". *Applied Economics,* 53(14): 1672-1693. https://doi.org/10.1080/00036846.2020.1841088

- Huang, J., (2018). "Banking and shadow banking". *Journal of Economic Theory*, 178: 124-152. https://doi.org/10.1016/j.jet.2018.09.003

- Huang, H., (2024). "The Shadow Banking Channel of Long-Term Interest Rate Transmission". *Available at SSRN* 5043960. https://dx.doi.org/10.2139/ssrn.5043960

- Jiang, B. & Fu, L., (2025). "Corporate investment and shadow banking channel of monetary policy". *Emerging Markets Review,* 67: 101291. https://doi.org/10.1016/j.ememar.2025.101291

- Kazerooni, A., Salahesh, T. & Asgharpur, H., (2018). "Banks' role in Monetary Policy Transmission Mechanism (Emphasis on Balance-Sheet and Financial Health Characteristics of Banks)". *Journal of Economic Research,* 53(1): 69-92. https://doi.org/10.22059/jte.2017.232209.1007571 (In Persian).

- Keshavarz, h., (2018). "Monetary policy in a financial accelerator models with sticky price and wage". *Journal of applied economics studies in Iran*, 7(25): 227-247. https://aes.basu.ac.ir/article_2255.html (In Persian).

- Komijani, A. & Alinejad-Mehrabani, F. (2012). "Evaluating the Effectiveness of Monetary Transmission Channels on Production and Inflation besides Analyzing their Relative Importance in Iran's Economy". *Journal of Planning and Budgeting*. 17(2): 39-63. https://eprj.ir/article-1-609-fa.html (In Persian).

- Le, V. P. M., Matthews, K., Meenagh, D., Minford, P. & Xiao, Z., (2022). "Regulatory arbitrage, shadow banking and monetary policy in China". *Journal of International Financial Markets, Institutions and Money*, 80: 101640. https://doi.org/10.1016/j.intfin.2022.101640

- Li, H., Ni, J., Xu, Y. & Zhan, M., (2021). "Monetary policy and its transmission channels: Evidence from China". *Pacific-Basin Finance Journal*, 68: 101621. https://doi.org/10.1016/j.pacfin.2021.101621

- Makipour, A., Salahmanesh, A. & Anvari, E., (2023). "Analysis the effects of monetary policy in Iran's economy with the existence of shadow banking, using dynamic stochastic general equilibrium method". *Stable Economy Journal*, 4(2): 174-206. https://doi.org/10.22111/sedj.2023.45577.1341 (In Persian).

- Mazelis, F., (2015). "*The role of shadow banking in the monetary transmission mechanism and the business cycle*". (No. 2015-040). SFB 649 Discussion Paper.

- Mirjalili, S. H., (2015). *Schools of economic thought.* Institute for Humanities and Cultural Studies. Press Tehran: 433-465 (In Persian).

- Mirjalili, S. H., (2017). "Conventional vs. unconventional monetary policy: A comparative study". *Journal of Iranian Economic Issues*, 3(2): 111-125. https://economics.ihcs.ac.ir/article_2679.html?lang=fa (In Persian).

- Mishkin, F. S., (1995). "Symposium on the monetary transmission mechanism". *Journal of Economic perspectives*, 9(4): 3-10. https://doi.org/10.1257/jep.9.4.3

- Mishkin, F. S., (1996). "The channels of monetary transmission: Lessons for monetary policy". *National Bureau of Economic Research*. Working paper 5464. https://doi.org/10.3386/w5464

- Mishkin, F. S., (2019). *The economics of money, banking, and financial markets*. Twelfth Edition. Pearson education.

- Raei, R., Iravani, M. J. & ahmadi, T., (2018). "Monetary Shocks and Monetary Transmission Mechanism in The Iranian Economy: With Emphasis on Exchange Rates, Housing Prices and Credits". *Economic Growth and Development Research*, 8(31): 29-44. https://egdr.journals.pnu.ac.ir/article_4342.html?lang=fa (In Persian).

- Schairer, S., (2024). "The contradictions of unconventional monetary policy as a post-2008 thwarting mechanism: financial dominance, shadow banking, and inequality". *Review of Evolutionary Political Economy*, 5(1): 1-29. https://doi.org/10.1007/s43253-024-00115-3

- Walsh, C.E., (2017). *Monetary Theory and Policy*. MIT Press Books, Fourth Edition. ISBN 9780262035811.

- Yang, L., van Wijnbergen, S., Qi, X. & Yi, Y., (2019). "Chinese shadow banking, financial regulation and effectiveness of monetary policy". *Pacific-Basin Finance Journal,* 57: 101169. https://doi.org/10.1016/j.pacfin.2019.06.016

- Zhang, H., Skolnik, R., Han, Y. & Wu, J., (2020). "The Impacts of China's Shadow Banking Credit Creation on the Effectiveness of Monetary Policy". *International Journal of Finance & Banking Studies*, 9(4): 33-46. https://doi.org/10.20525/ijfbs.v9i4.899

- Zarei, M., Esfandiary, M. & Mirjalili, S. H., (2021a). "The Impact of Shadow Banking on the Effectiveness of Monetary Policy: Evidence from G20 Countries". *Journal of Monetary & Banking Research,* 13(46): 237-252. https://doi.org/10.52547/jme.16.2.237 (In Persian).

- Zarei, M., Esfandiary, M. & Mirjalili, S. H., (2021b). "The Impact of Shadow Banking on the Financial Stability: Evidence from G20 Countries". *Journal of Money and Economy,* 16(2): 237-252. https://doi.org/10.52547/jme 16.2.237

مطالعات اقتصادی کاربردی ایران
Quarterly Journal of Applied Economics Studies, Iran (AESI)
سال ۱۴، شمارهٔ ۵۵، ۱۴۰۴

فصلنامهٔ علمی مطالعات اقتصادیِ کاربردی ایران
شاپای چاپی: ۲۵۳۰-۲۳۲۲؛ شاپای الکترونیکی: X۴۷۲-۲۳۲۲ - وب‌سایت نشریه: https://aes.basu.ac.ir
نشریهٔ گروه اقتصاد، دانشکدهٔ علوم اقتصادی و علوم اجتماعی، دانشگاه بوعلی‌سینا، همدان، ایران.

بررسی تأثیر بانکداری سایه بر انتقال سیاست پولی در ایران با استفاده از رویکرد DSGE

مهران زارعی[۱]، مرضیه اسفندیاری[۲]، سید حسین میرجلیلی[۳]

نوع مقاله: پژوهشی
شناسهٔ دیجیتال: https://doi.org/10.22084/aes.2025.30883.3788
تاریخ دریافت: ۱۴۰۴/۰۲/۰۹، تاریخ بازنگری: ۱۴۰۴/۰۴/۰۹، تاریخ پذیرش: ۱۴۰۴/۰۴/۲۰
صص: ۴۱-۹

چکیده

شناخت دقیق مکانیزم‌های انتقال سیاست پولی و عوامل مؤثر بر آن، به‌منظور اجرای موفق یک سیاست پولی امری ضروری است. فعالیت بانک‌داری سایه به‌دلیل تداخل در نقش وام‌دهی بانک‌ها، می‌تواند کانال اعتباری انتقال سیاست پولی را تضعیف کند. بر این‌اساس و با توجه به افزایش فعالیت بانک‌داری سایه در نظام مالی ایران طی سال‌های اخیر، پرسش اصلی این است که بانک‌داری سایه چه تأثیری بر انتقال (اثربخشی) سیاست پولی در ایران دارد؟ هدف پژوهش حاضر بررسی تأثیر بانک‌داری سایه بر انتقال سیاست پولی در ایران است. برای این‌منظور از مدل تعادل عمومی پویای تصادفی استفاده شده است که در آن، دو سناریوی اقتصاد بدون بانک‌داری سایه و اقتصاد با بانک‌داری سایه درنظر گرفته شده است. در هر سناریو، تأثیر شوک دو سیاست پولی تغییر نرخ رشد عرضهٔ پول و تغییر نرخ سود (بهره) بر متغیرهای تولید، سرمایه‌گذاری و تورم بررسی شده است. نتایج این پژوهش نشان می‌دهد که وجود بانک‌داری سایه در اقتصاد، باعث تضعیف کانال اعتباری انتقال سیاست پولی شده و تأثیر سیاست پولی بر هر سه متغیر را کاهش می‌دهد. این یافته‌ها نشان می‌دهد هنگامی که بانک‌داری سایه وارد مدل می‌شود، به‌دلیل این‌که بانک‌های سایه تابع مقررات سخت‌گیرانهٔ بانک مرکزی نیستند، کاهش وام‌دهی بانک‌های تجاری (سنتی) درنتیجهٔ اعمال سیاست پولی انقباضی را تا حدی جبران می‌کنند. این موضوع باعث می‌شود سرمایه‌گذاری در واکنش به شوک منفی نرخ رشد پول افزایش یابد. با اعمال شوک مثبت نرخ بهره نیز واکنش متغیرهای تولید و سرمایه‌گذاری در سناریوی با بانک‌داری سایه نسبت به سناریوی بدون بانک‌داری سایه معکوس می‌گردد.

کلیدواژگان: بانک‌داری سایه، انتقال سیاست پولی، مدل DSGE، اقتصاد ایران.
طبقه‌بندی JEL: E42, E44, E51, E52, G20.

۱. دانشجوی دکتری اقتصاد، گروه اقتصاد، دانشکدهٔ اقتصاد و علوم اداری، دانشگاه سیستان و بلوچستان، زاهدان، ایران.
Email: mehr.zarei114@gmail.com
۲. دانشیار گروه اقتصاد، دانشکدهٔ اقتصاد و علوم اداری، دانشگاه سیستان و بلوچستان، زاهدان، ایران (نویسندهٔ مسئول).
Email: m.esfandiari@eco.usb.ac.ir
۳. استاد گروه اقتصاد، پژوهشکدهٔ اقتصاد، پژوهشگاه علوم انسانی و مطالعات فرهنگی، تهران، ایران.
Email: h.jalili@ihcs.ac.ir

ارجاع به مقاله: زارعی، مهران؛ اسفندیاری، مرضیه؛ و میرجلیلی، سیدحسین، (۱۴۰۴). «بررسی تأثیر بانکداری سایه بر انتقال سیاست پولی در ایران با استفاده از رویکرد DSGE». مطالعات اقتصادی کاربردی ایران، ۱۴(۵۵): ۹-۴۱. https://doi.org/10.22084/aes.2025.30883.3788
صفحهٔ اصلی مقاله در سامانهٔ نشریه: https://aes.basu.ac.ir/article_6147.html?lang=fa