Modeling the Decisions on Determining the Interest Rate on Deposits in Iranian Banking System by Using Game Theory

Journal of Industrial Strategic Management
Year, 2022,
Volume 7 (Issue 1),
Pages: 29 - 41.

Mehdi Memarpour[a], Ashkan Hafezalkotob[b], Mohammad Khalilzadeh[a], Abbas Saghaei[a], Roya Soltani[c]*

a Department of Industrial Engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran.
b College of Industrial Engineering, South Tehran Branch, Islamic Azad University, Tehran, Iran.
c Department of Industrial Engineering, Faculty of Engineering, KHATAM University, Tehran, Iran.

Article history:
Received: 29/05/2021
Received in revised: 08/06/2022
Accepted: 27/06/2022

Abstract
In this paper, the optimal interest rate on bank deposits is calculated according to monetary policy in Iranian banking system. The interest rate on deposits is determined by using the Game theory and a Stackelberg Game approach. The Game leader is Central Bank of Islamic Republic of Iran, while the followers include three banks called A, B, and C. The leader of the Game regulates its monetary policies in the form of 3 scenarios and the variables of "legal deposit award rate", "legal deposit ratio", and "rate of bank commission received" from the followers- banking system. The follower players also determine the "interest rate on deposits" based on the strategy of the leader player. The overall results of this study indicated that in this Stackelberg Game, the optimal scenario of Central Bank involves "reducing the rate of commissions received" from the banking system and "increasing the legal deposit award rate" under conditions where the coefficient of the importance of the components of the utility function (social welfare) of this bank and the coefficient for facilities paid by this bank to the government, companies, banks, and governmental institutes are complete (equal to 1), and that the scenario of changing the percentage (ratio) of the legal deposit is not optimal. Meanwhile, optimal scenario of the follower players was reducing the interest rate on deposits in 2016. Also, the players of this Game will be more profitable than their current situation if they choose Stackelberg's Game.

Keywords: Stackelberg Game, Monetary policies, Interest rate on deposits, Iranian banking System.

1. Introduction

The development of different financial and non-bank financial institutes (NBFIs) has caused intense competition in Iranian banking system (Reza-Gharehbagh et al., 2020). Accordingly, the interest rate pricing on deposits may create short-term and long-term competitive advantages by fostering profitability and customer satisfaction. Pricing the banking interest rate on deposits has various direct and indirect effects on economic indicators. This rate is often defined and relied upon the government's monetary and fiscal policies. Meanwhile, the critical point is that there is always a controversy among the economists of the country about reducing the interest rate on banking deposits on the inflation rate and the precedence and antecedence of these two indicators. According to the investment theory, the proponents believe that as the interest rate on banking deposits decreases, both investment and national production grow. Upon gradual reduction of inflation, the grounds for employment are provided. In other words, they believe that high interest rate on banking facilities leads to increased investment costs and higher finished price of the commodities, thus reduce the competitive power of national products.

On the other hand, the opponents argue that by the reduction of the banking interest rate on deposits, when the country is in absolute inflation conditions, the banking resources are guided towards nonproductive and non-generative activities, thus setting the ground for increasing inflation and unemployment (Rubio, 2016).

Accordingly, “monetary and fiscal policies” are among the most critical government intervention forms for the macro economy. “Fiscal policy" refers to a policy based on which the government tries to achieve specific economic goals through different means such as changing the governmental costs and taxes. Indeed, "monetary policy" is

* Corresponding author Email address: a_hafez@azad.ac.ir

a policy by which Central Bank desires to achieve a specific economic goal through changing the structure and level of the "interest rate", changing and controlling the money volume, or other conditions of offering credit and financial facilities.

Hence, the monetary policy proceeds through changing the money volume, altering the growth of the money volume and interest rate, or offering financial facilities. The initiative of changing the money volume is mostly in the hands of "Central Bank". This bank changes the money volume by applying monetary policies such as altering the legal deposit ratio of banks, changing the rediscount rate, opening market operations, and determining the minimum and/or maximum interest rate plus commission received from the banks.

The legal deposit ratio is one of the indirect means of monetary policy for Central Bank. Banks have to keep a share of their debts- the sums received from people known as a deposit- in Central Bank. Indeed, the Central Bank receives this deposit to fulfill people's security, control liquidity and inflation, and support the banks when facing possible bankruptcy or needing blocked liquidity. C-Legal deposit award: the legal sum of the banks invested in Central Bank receive a low interest rate by Central Bank, called legal deposit award, since the deposit kept Central Bank should be based on the debt and practically no investment occurs by the banks in this area, the interest rate paid to legal reserves or deposits is always controversial worldwide). D- rediscount rate: it is the interest rate set by Central Bank discounts and long-term documents-promissory notes and bills of exchange- of commercial banks, based on loans given to the banks, E-Quantitative and qualitative control of credits: this refers to determining and regulating the credits into proper production route to apply the guidance policy of the government, F-Participation in open market operations: by adopting this policy, Central Bank can affect the supply and demand of money and hence economic activity through purchasing or selling open market securities, determining the minimum and maximum interest rate, commission received, and bank payments.

Based on all these explanations, after reviewing the studies on monetary policy and macroeconomic indicators and monetary policy tools and monetary policies in the form of Game theory in different countries, the rest of this paper is structured as follows. Section 2 presents the methodology of the study. The variables and indicators of the research are introduced in Section 3. The data are analyzed in Section 4. Finally, last section concludes the paper and offers some recommendations regarding the research subject.

2. Literature review

The Literature review is presented in two parts. The first part is devoted to the studies related to monetary policies and tools and the relationship between these policies and macroeconomic indicators. The second part addresses the studies conducted on Game theory and monetary policies.

Khanizad & Montazer, (2018) indicated that the profit of the banks is higher with coalition Game than acting alone in the market, and it would continue with the increasing demand and the presence of more banks. Mahmoudinia et al. (2018) found that the value of social welfare was higher when the government and Central Bank behaved in the framework of cooperative than non-cooperative Game. In their study, Mahmoudinia et al. (2016) concluded that in Stackelberg Game between the government and Central Bank, in the cooperative Game between the government and Central Bank, more profit will be given to the players and more welfare will be given to the society. Engwerda et al., (2016) addressed how monetary and fiscal policies stabilize government debt levels by using Game theory in Iran.

Memarpour et al., (2021) studied the monetary policies of Central Bank to determine the interest rate on deposits in the interaction with Iranian banking system in the form of Stackelberg (leader- follower) and Nash equilibrium (competitive) games. They concluded that in the studied year (2019), the strategy of the players of this Game including the leader and followers has been mostly Nash (more competitive) rather than cooperative and If the players of this game had chosen cooperative strategy, they would have achieved greater profit.

2.1. Research Gap/Contribution

As seen in previous studies, various studies have been conducted on the importance and necessity of monetary policy and the relationship between monetary policy and economic variables (both micro and macro). In most of these researches, correlation and regression methods have been used. Also, the most important monetary policy tool in previous studies is the interest rate or interest rate on deposits. But, none of the previous studies has examined monetary policy and its tools as a game by the presence of Central Bank and the banking network. In fact, except for the study of Memarpour et al., (2021) in which the Game of determining the interest rate on deposits between Central Bank and the banking network has been examined in two ways called leader-follower and competitive, and selected the optimal game, not modelled this game. On the other hand, in the above study, the current and real situation of the banking network players has not been examined in determining the interest rate on deposits. But, in the present study, the leader-follower scenario is compared with the real and current state of the system and selected optimal approach.

3. Material and methods

Game theory and dynamic decision process are considered as the methods used in this study. The Game in question is a leader-follower Game (Stackleberg) consisting of a leading player and three follower players. So, a "quantitative method" is used to develop the model and solve it. Quantitative research methods seek to test a scientific hypothesis in a statistical sample/population.

Table1. The interest rate on deposits across Iranian banking system in 2010-2017

No.	Bank name	The interest rate of timed deposits within 2010-2017(%)							
		2010	2011	2012	2013	2014	2015	2016	2017
1	A	2.1	2	12.8	13.65	16.05	16.64	15.30	14.14
2	B	10.67	9.94	11.68	10.97	15.20	15.63	15.70	13.55
3	C	7.53	8.05	11.61	14.87	16.47	17.66	16.38	19

Table2. Descriptions of the symbols of modeling the pricing Game of the interest rate on deposits across the Iranian banking system

Notations	Definitions
i_i	Interest rate on the deposits absorbed by the i_{th} bank
i_j	Interest rate on the deposits absorbed by the competitor bank
r_i	Interest rate on the facilities offered by i_{th} bank
$\Delta i=r_i-i_i$	Margin of interest rate on banking deposits (the difference between the interest rate on facilities and the interest rate on deposits). It should be positive.
r'_i	Interest rate on the investments by i_{th} bank
X_i	Deposits of i_{th} bank or the entire capital collected from the society by i_{th} bank
α_β	Legal deposit rate in Central Bank (annual) (based on article 14 of the monetary and banking law ($0.1 \leq \alpha_\beta \leq 0.3$)
$Z = \alpha_B * X_i$	Entire legal reserve/deposit in Central Bank
k	Facility coefficient ($0.6 \leq k \leq 0.7$)
$S_i=k* Xi$	Percentage of the entire capital (resources) collected from society (X_i) offered by the banks as facilities (loan) to the society
$F_i= X_i-\alpha_B X_i-S_i$	Level of free resources (all the resources subtracted from legal deposit subtracted from facilities paid subtracted from the cash (funds) and ATM
r_B	Legal deposit award rate of Central Bank
X_e	Level of overdraft from Central Bank resources or reserves (borrowing)
r_p	Type of penalty for an overdraft from the reserves of Central Bank (borrowing) paid by each bank to Central Bank in case of the physical resources (r_p=0.34)
U(B)	Central Bank utility
y_0	Revenues of the government, including (oil sales, taxes, selling bonds, etc.)
$y_1 = Z + y_0$	Level of facilities paid by Central Bank to the government, state companies, as well as governmental institutes, and banks
t_B	Rate of commissions received by Central Bank from the followers (banking system)
R_i	Revenues of i_{th} bank
C_i	Costs of i_{th} bank
β_i	Coefficient (line slope) of the deposits absorbed by each bank
a_i	Intercept (constant value) of the deposits absorbed by each bank
γ_j	Coefficient (line slope) of the deposits absorbed by the competitor bank(s)
π_i	Profit of i_{th} bank obtained through subtracting the costs from the bank revenues
Ω	Coefficient of the importance of the components of the utility function (social welfare) of Central Bank including social and economic sectors ($0< \Omega \leq 1$)
Φ_B	Facilities coefficient paid by Central Bank to the government, state companies, as well as governmental institutes and banks ($0< \varphi_B \leq 1$)

This is done by investigating a model based on concepts and their relationship in a statistical sample. The model components (i.e., concepts) should be measured with suitable measures that are relevant, complete, and straightforward.

4. Results

The study population

The Game of pricing the interest rate of deposits across Iranian banking system includes three main players as follows:

1. Central Bank of Islamic Republic of Iran (the Game leader)
2. Private bank C (follower player)
3. Bank C's competitors in the banking network include banks A and B (follower players)

Table1 reports the interest rate on deposits across Iranian banking system based on the financial statements of these banks in 2010-2017.

Table2 provides the specifications of indices and symbols of the modelling of the pricing game of the interest rate on deposits across Iranian banking system.

4.1. Data analysis

In this section, the data are analyzed and the research model is introduced. Accordingly, the Game of pricing the interest rate on banking deposits between the leader player (Central Bank in Islamic Republic of Iran) and selected followers (banks A, B, and C) is examined. This Game is modeled as three scenarios: the tools and variables of the Game leader according to the research literature, including "legal deposit award rate", "legal deposit ratio", and "commissions received" by Central Bank from the follower banks. The tools and variables of the follower players include "the interest rate on banking deposits". To determine the relationship between the interest rate on deposits and the deposits absorbed in the follower banks, Minitab software has been used based on the data volume in the financial statements of the banks during 2010–2017. Accordingly, in each of the scenarios, using MATLAB software and over a specified period during the year 2016, both values of the follower players' variable (interest rate on deposits) and the objective functions of the two players are described while determining the value of the leader player variable.

4.2.Introducing the scenarios of the leader player against the follower players

Based on the review of the theoretical literature, Central Bank of the Islamic Republic of Iran and economic responsibilities and monetary policies also have social responsibilities and is in charge of creating "social welfare" across the country. Indeed, Central Bank has both economic and social responsibilities. Accordingly, as the leader of the Game of pricing the interest rates on deposits across Iranian banks through determining monetary policies, this bank can regulate and modify this rate using the following 3 variables. Also, the follower banks can determine this rate by considering the policies announced by Central Bank regarding the determination of the interest rate on deposits as well as indicators and financial leverages to equip and allocate their resources:

A: legal deposit award rate
B: legal deposit ratio
C: commission rate received from the banks

4.3.Introducing the objective functions of the leader and follower players

To determine the optimal model of the leader-follower Game (Stackelberg) for pricing the interest rate on deposits between Central Bank and three selected banks firstly, the objective functions of both players are introduced:
To determine the objective function of the three selected banks "A", "B", and "C" as the Game followers, the following variables are then introduced based on the symbols shown in Table 2:

$$X_i = a_i + \beta_i i_i - \sum_{j\neq i} \gamma_j i_j \quad (1)$$

$$Z = \sum\nolimits_{-}(i = 1)\hat{}(i = n)\text{▒}Zi = \alpha_B * Xi \quad (2)$$

$$R_i = r_i(X_i - Z_i)S_i + r_i^{'}(X_i - Z_i)(1 - S_i) + \alpha_\beta X_i r_B \quad (3)$$

$$C_i = X_i i_i + t_B\left(X_i - \alpha_\beta X_i - S_i\right) + r_p X_e \quad (4)$$

$$\pi_i = R_i - C_i = \left(r_i S_i - r_i S_i \alpha_\beta + r_i^{'} - r_i^{'} S_i - r_i^{'}\alpha_\beta + r_i^{'}\alpha_\beta S_i + \alpha_\beta r_B - i_i - t_B + \alpha_\beta t_B\right)\left(a_i + \beta_i i_i - \sum_{j\neq i}\gamma_j i_j\right) + t_B S_i - r_P X_e \quad (5)$$

$$r_i S_i\beta_i - r_i S_i\beta_i\alpha_\beta + \beta_i r_i^{'} - r_i^{'}\beta_i S_i - r_i^{'}\alpha_\beta\beta_i + r_i^{'}\alpha_\beta S_i\beta_i + \alpha_\beta r_B\beta_i - a_i - 2\beta_i i_i + \sum_{j\neq i}\gamma_j i_j - \beta_i t_B + \alpha_\beta t_B\beta_i = 0 \quad (6)$$

Based on the equation (6), the value of i_i will be equal to equation (7):

$$i_i = \frac{r_i S_i\beta_i - r_i S_i\beta_i\alpha_\beta + r_i^{'}\beta_i - r_i^{'}\beta_i S_i - r_i^{'}\alpha_\beta\beta_i + r_i^{'}\alpha_\beta S_i\beta_i + \alpha_\beta r_B\beta_i - a_i + \sum_{j\neq i}\gamma_j i_j - \beta_i t_B + \alpha_\beta t_B\beta_i}{2\beta_i} \quad (7)$$

In order to determine the objective function of Central Bank as the leader of the game, in addition to equations (1) and (2) and considering the parameters presented in Table 3, objective function of Central Bank as the leader of the Game is considered as equation (8):

$$U(B) = (1-\Omega)\left[\sum_{i=1}^{n} X_i + y_1\right] + \Omega\left[\sum_{i=1}^{n} t_B\left(X_i - \alpha_\beta X_i - S_i\right) + \sum_{i=1}^{n} r_p X_e + \varphi_B y_1 - r_B\sum_{i=1}^{n} Z_i\right] \quad (8)$$

As seen in Table 3, by incorporating y_1, S_i, x_i, and equation (2) into $\sum_{i=1}^{n} Z_i$, eventually, the utility function of the Game leader is changed into equation (9) as follows. (see equation 9)

In the next stage, the equation (7) is incorporated into the equation (9), i.e., the leader equation, instead of variable i_i (the variable of the follower player). In order to determine the policies of the leading player and examine the response of follower players, in three main scenarios of the monetary policy of the leading player, the values of variables of leader and follower players are calculated:

first scenario: Applying the monetary policy considering the legal deposit award rate variable (r_B):

By incorporating Eq. (7) into Eq. (9), and by deriving from U (B) function in relation to the variability of the leading player, which in this scenario is the standard deposit award rate (r_B), and by setting the resulting equation to zero, Eq. (10) can be obtained as follows. (see equation 10)

Considering the equations (7) and (10), and assuming the values of α_β. t_B, β_i, r_i, r'_i, S_i, a_i, γ_j, Ω, φ_B during the year 2016, in order to determine the values of the leader and follower variables including legal deposit award rate r_B, the interest rate on deposits for the bank A (i_1), the interest rate on deposits for the bank B (i_2), and the interest rate on

$$\begin{aligned}\sum_{i=1}^{n} a_i + \sum_{i=1}^{n} \beta_i i_i - \sum_{i=1}^{n}\sum_{j\neq i} \gamma_j i_j + \alpha_\beta \sum_{i=1}^{n} a_i + \alpha_\beta \sum_{i=1}^{n} \beta_i i_i - \alpha_\beta \sum_{i=1}^{n}\sum_{j\neq i} \gamma_j i_j - \Omega \sum_{i=1}^{n} a_i - \Omega \sum_{i=1}^{n} \beta_i i_i \\ + \Omega \sum_{i=1}^{n}\sum_{j\neq i} \gamma_j i_j - \Omega\alpha_\beta \sum_{i=1}^{n} a_i - \Omega\alpha_\beta \sum_{i=1}^{n} \beta_i i_i + \Omega\alpha_\beta \sum_{i=1}^{n}\sum_{j\neq i} \gamma_j i_j + \Omega t_B \sum_{i=1}^{n} a_i + \Omega t_B \sum_{i=1}^{n} \beta_i i_i \\ - \Omega t_B \sum_{i=1}^{n}\sum_{j\neq i} \gamma_j i_j - \Omega\alpha_\beta t_B \sum_{i=1}^{n} a_i - \Omega\alpha_\beta t_B \sum_{i=1}^{n} \beta_i i_i + \Omega\alpha_\beta t_B \sum_{i=1}^{n}\sum_{j\neq i} \gamma_j i_j - k\Omega t_B \sum_{i=1}^{n} a_i \\ - k\Omega t_B \sum_{i=1}^{n} \beta_i i_i + k\Omega t_B \sum_{i=1}^{n}\sum_{j\neq i} \gamma_j i_j + r_p \Omega \sum_{i=1}^{n} X_e + \Omega\alpha_\beta \varphi_B \sum_{i=1}^{n} a_i + \Omega\alpha_\beta \varphi_B \sum_{i=1}^{n} \beta_i i_i \\ - \Omega\varphi_B \alpha_\beta \sum_{i=1}^{n}\sum_{j\neq i} \gamma_j i_j + \Omega\varphi_B y_0 - \Omega r_B \alpha_\beta \sum_{i=1}^{n} a_i - \Omega r_B \alpha_\beta \sum_{i=1}^{n} \beta_i i_i + \Omega r_B \alpha_\beta \sum_{i=1}^{n}\sum_{j\neq i} \gamma_j i_j \\ = \left(1 + \alpha_\beta - \Omega - \Omega\alpha_\beta + \Omega t_B - \Omega\alpha_\beta t_B - k\Omega t_B + \Omega\alpha_\beta \varphi_B - \Omega r_B \alpha_\beta\right)\left(\sum_{i=1}^{n} a_i \right. \\ \left. + \sum_{i=1}^{n} \beta_i i_i - \sum_{i=1}^{n}\sum_{j\neq i} \gamma_j i_j\right) + \Omega r_P \sum_{i=1}^{n} X_{ei} + \Omega\varphi_B Y_0\end{aligned} \tag{9}$$

$$\begin{aligned}\Omega\alpha_\beta r_B \sum_{i=1}^{n} \beta_i = \frac{1}{2}\sum_{i=1}^{n} \beta_i + \frac{\alpha_\beta}{2}\sum_{i=1}^{n} \beta_i - \frac{\Omega}{2}\sum_{i=1}^{n} \beta_i - \frac{\Omega}{2}\alpha_\beta \sum_{i=1}^{n} \beta_i - \frac{k\Omega t_B}{2}\sum_{i=1}^{n} \beta_i + \frac{\Omega\varphi_B\,\alpha_\beta}{2}\sum_{i=1}^{n} \beta_i - \frac{\Omega}{2}\sum_{i=1}^{n} r_i' \beta_i \\ + \frac{\Omega\alpha_\beta}{2}\sum_{i=1}^{n} r_i \beta_i - \frac{\Omega}{2}\sum_{i=1}^{n} a_i + \Omega t_B \sum_{i=1}^{n} \beta_i - \Omega\alpha_\beta t_B \sum_{i=1}^{n} \beta_i + \frac{\Omega}{2}\sum_{i=1}^{n}\sum_{j\neq i} \gamma_j i_j\end{aligned} \tag{10}$$

deposits for the bank C (i_3), a system of 4 equations and four unknowns consisting of the equations of the leader (Central Bank) and three followers is developed. These equations have been solved using MATLAB software. (Table 3) presents the known values of the above system of equations during 2016, for all scenarios extracted based on the financial statements of the follower banks. (see table 3)

Given the data in the above table, in order to determine the values of the objective function of the leader and follower players, different values are considered for the coefficient of the importance of the components of the function (social welfare) of Central Bank, including social and economic sectors, as well as the coefficient of facilities paid by Central Bank to the government companies, governmental institutions, and banks. After solving the system of 4 equations and 4 unknowns consisting of the equations of the leader (Central Bank) and three followers using MATLAB software, the values obtained from a DEB model are incorporated into the equations (6) and (10). Table 4 present the results. (see table 4)

Second scenario: Applying monetary policy while considering the legal deposit ratio α_β:

At this stage, as the legal deposit ratio α_β is considered as the variable of the game leader. First, equation (9) is derived in relation to this variable, and then the result is set to zero. Next, instead of ii variable, the equation (7) is used. Finally, the equation (11) can be obtained as follows:

$$\begin{aligned}\left[\frac{1}{2}\sum_{i=1}^{n} r_i S_i \beta_i - \frac{\alpha_\beta}{2}\sum_{i=1}^{n} r_i S_i \beta_i + \frac{1}{2}\sum_{i=1}^{n} r_i' \beta_i \right. \\ - \frac{1}{2}\sum_{i=1}^{n} r_i' S_i \beta_i - \frac{\alpha_\beta}{2}\sum_{i=1}^{n} r_i' \beta_i \\ + \frac{\alpha_\beta}{2}\sum_{i=1}^{n} r_i' S_i \beta_i \\ + \frac{\alpha_\beta}{2} r_B \sum_{i=1}^{n} \beta_i + \frac{1}{2}\sum_{i=1}^{n} a_i \\ - \frac{t_B}{2}\sum_{i=1}^{n} \beta_i + \frac{\alpha_\beta}{2} t_B \sum_{i=1}^{n} \beta_i \\ \left. - \frac{1}{2}\sum_{i=1}^{n}\sum_{j\neq i} \gamma_j i_j\right](1 - \Omega \\ - \Omega t_B + \Omega\varphi_B - \Omega r_B) = 0\end{aligned} \tag{11}$$

Assuming the values of α_β, t_B, β_i, r_i, r'_i, S_i, a_i, γ_j, Ω, φ_B during the year 2016, in order to determine the leader and follower variables, including the legal deposit ratio α_β, the interest rate on the bank A deposits i_1, the interest rate on the bank B deposits i_2, and the interest rate on the bank C deposits i_3, a system of 4 equations and four unknowns consisted of the leader (Central Bank) three followers' equations is developed. Table 4 shows the known values of the above system of the equation during the year 2016,

Table3. Values and parameters related to the leader and follower players in the game of pricing the interest rate on banking deposits across the Iranian banking system in all scenarios

Row	Variables and their values									
	Bank name	t_B	$_B\alpha$	a_i	γ_i	β_i	r_i	S_i	r'_i	K
First scenario (r_B:unknown)	Central	0.34	0.13	-	-	-	-	-	-	-
	A	-	-	a_1= -372398	γ_2= -1060186 γ_3= -5796847	β_1= -2227632	r_1=0.17	S_1=0.84	r'_1=0.09	0.7
	B	-	-	a_2= -682676	γ_1= 3750709 γ_3= -9945455	β_2= 2797662	r_2=0.26	S_2=1	r'_2=0.06	0.7
	C	-	-	a_3= -617058	γ_1= 3023411 γ_2= -2127548	β_3= 6285429	r_3=0.18	S_3=1.65	r'_3=0.08	0.7
Second Scenario (α_β:unknown)	Bank name	t_B	$\mathbf{r_B}$	a_i	γ_i	β_i	r_i	S_i	r'_i	K
	Central	0.34	0.01	-	-	-	-	-	-	-
	A	-	-	a_1= -372398	γ_2= -1060186 γ_3= -5796847	β_1= -2227632	r_1=0.17	S_1=0.87	r'_1=0.09	0.7
	B	-	-	a_2= -682676	γ_1= 3750709 γ_3= -9945455	β_2= 2797662	r_2=0.26	S_2=1	r'_2=0.06	0.7
	C	-	-	a_3= -617058	γ_1= 3023411 γ_2= -2127548	β_3= 6285429	r_3=0.18	S_3=1.65	r'_3=0.08	0.7
Third scenario (t_B:unknown)	Bank name	α_β	$\mathbf{r_B}$	a_i	γ_i	β_i	r_i	S_i	r'_i	K
	Central	0.13	0.01	-	-	-	-	-	-	-
	A	-	-	a_1= -372398	γ_2= -1060186 γ_3= -5796847	β_1= -2227632	r_1=0.17	S_1=0.87	r'_1=0.09	0.7
	B	-	-	a_2= -682676	γ_1= 3750709 γ_3= -9945455	β_2= 2797662	r_2=0.26	S_2=1	r'_2=0.06	0.7
	C	-	-	a_3= -617058	γ_1= 3023411 γ_2= -2127548	β_3= 6285429	r_3=0.18	S_3=1.65	r'_3=0.08	0.7

which have been extracted based on the financial statements of the follower banks. According to Equation (11), in which the multiplication of the two statements is set to zero, we will have Equation (12):

$$(1 - \Omega - \Omega t_B + \Omega\varphi_B - \Omega r_B)=0 \quad (12)$$

By embedding t_B=0.34 and r_B=0.01 from Table4 (second scenario) in the above statement, we will have Equation (13):

$$\Omega(1.35 - \varphi_B) = 1 \quad (13)$$

Hence, based on the mentioned equation and considering the equations/constraints in (Table 3), the optimal (maximum) values for coefficients Ω and φ_B are as follows:

$$\Omega=1,\ \varphi_B = 0.35 \quad (14)$$

Hence in this scenario, the optimal value of the coefficient of the importance of the components of the utility function (social welfare) of the Central Bank, including the social and economic factors, is equal to 1. The coefficient of the facilities paid by the Central Bank to the government, state companies, and governmental institutes and banks is equal to 0.35. Indeed, in this state, the coefficient of the importance of the social welfare function of the control back is the maximum. Nevertheless, as the Game leader, Central Bank will have 35% ability to offer the facilities to the government, companies, governmental institutes, and banks. Considering the values of Table 4 (second scenario), and solving the system of 4 equations and 4 unknowns using MATLAB software, the values obtained are incorporated into the equations (5) and (10). Table 5 presents the results.

Third scenario: Applying monetary policy while considering the commission's rates received from the banks (t_B):

At this stage, considering the variable of commission rates received by Central Bank from the banks (t_B) as the leader variable of the game, firstly, the equation (9) is derived in relation to this variable, and the result is set equal to zero. Then, instead of i_i variable, Relation (7) is used. Finally, the relation obtained can be obtained (equation (15)).

Assuming the values of α_β, t_B, β_i, r_i, r'_i, S_i, a_i, γ_j, Ω, φ_B during the year 2016, in order to determine the variables of leader and player including the commission rates received by Central Bank from the banks t_B, the interest rate on deposits for bank A (i_1), the interest rate on deposits for bank B (i_2), and the interest rate on deposits for bank C (i_3), a system of 4 equations and 4 unknowns consisting of the leader (Central Bank) and three followers' equations is developed. Table 4 (third scenario) reports the known values of the above system during the year 2016, extracted based on the financial statements of the follower banks. three followers' equations is developed. Table 4 (third scenario) reports the known values of the above system

$$[\frac{1}{2}\sum_{i=1}^{n} r_i S_i \beta_i - \frac{\alpha_\beta}{2}\sum_{i=1}^{n} r_i S_i \beta_i + \frac{1}{2}\sum_{i=1}^{n} r_i' \beta_i - \frac{1}{2}\sum_{i=1}^{n} r_i' S_i \beta_i - \frac{\alpha_\beta}{2}\sum_{i=1}^{n} r_i' \beta_i + \frac{\alpha_\beta}{2}\sum_{i=1}^{n} r_i' S_i \beta_i + \frac{\alpha_\beta}{2} r_B \sum_{i=1}^{n} \beta_i + \frac{1}{2}\sum_{i=1}^{n} a_i - \frac{t_B}{2}\sum_{i=1}^{n} \beta_i + \frac{\alpha_\beta}{2} t_B \sum_{i=1}^{n} \beta_i - \frac{1}{2}\sum_{i=1}^{n}\sum_{j\neq i} \gamma_j i_j](\Omega - \Omega\alpha_B - k\Omega) = 0 \quad (15)$$

Table 4. Determining the variables and objective functions of the leader and follower players by applying the monetary policy through the legal deposit award variable

No.	Ω	φ_B	Variable	Notations	Value of variable (%)	Follower interest rate margin Δ_i	Objective function values (billion Rials)
1			Legal deposit award rate of the Central Bank	r_B	4.11	-	U(B)=1338821
2	0.5	0.5	Interest rate on bank A deposits	i_1	67	$0.5-\Delta_1=$	π_1 = -201213
3			Interest rate on Bank B deposits	i_2	4.7	$\Delta_{2=}$ 0.213	$\pi_{2=}$ 423453
4			Interest rate on Bank C deposits	i_3	43	$0.25-\Delta_{3=}$	$\pi_{3=}$ -11156
5			Legal deposit award rate of the Central Bank	r_B	2.266	-	U(B)= 1458595
6	0.75	0.75	Interest rate on Bank A deposits	i_1	27.2	$0.1-\Delta_1=$	π_1 = -41989
7			Interest rate on Bank B deposits	i_2	3.8	0.222 $\Delta_{2=}$	π_2 = 16471
8			Interest rate on Bank C deposits	i_3	21.4	$0.034-\Delta_{3=}$	π_3= 14591-
9			Legal deposit award rate of the Central Bank	r_B	1.81	-	U(B)=2272239
10	1	1	Interest rate on Bank A deposits	i_1	17.4	$0.004-\Delta_1=$	π_1 = -21181
11			Interest rate on Bank B deposits	i_2	3.6	Δ_2= 0.224	π_2 = -35407
12			Interest rate on Bank C deposits	i_3	16.1	$\Delta_{3=}$ 0.019	π_3 = -14164
13			Legal deposit award rate of the Central Bank	r_B	3.92	-	U(B)= 1686342
14	1	0.45	Interest rate on Bank A deposits	i_1	32.5	$0.155-\boldsymbol{\Delta_{1=}}$	π_1= -649625
15			Interest rate on Bank B deposits	i_2	27.1	$0.001-\boldsymbol{\Delta_{2=}}$	π_2=-946910
16			Interest rate on Bank C deposits	i_3	37.1	$0.191-\boldsymbol{\Delta_3=}$	π_3=-606652

during the year 2016, extracted based on the financial statements of the follower banks. Based on the equation (14), as the multiplication of two terms is equal to zero, we will have the equation (16):

$$(\Omega\text{-}\Omega\alpha\_B\text{-}k\Omega)=0 \quad (16)$$

Considering the constraints in table3, the above statement is wrong. This is because the condition for this equation is the equality of Ω value to zero, or the quality of k value to 0.87, where both of these values violate the constraints mentioned. Hence, this equation will be independent of Ω and φ_B values, and as with scenario 1, three states are considered for determining the values of the leader and follower variables and their objective functions. Accordingly, as shown in Table 4, after solving the system of 4 equations and four unknowns using MATLAB, the values obtained are incorporated into Equations (5) and (10) for three different states of Ω and φ_B. Table 6 presents the results.

Table 5. Determining the variables and objective functions of leader and follower players by applying the monetary policy through the variable of legal reserve ratio

No.	Variable name	Notations	Value (%)	Follower interest rate margin Δ_i	Objective function values (billion Rials)
1	Legal deposit ratio of Central Bank	α_β	0.3164	-	U(B)= 840839
2	Interest rate on Bank A deposits	i_1	71.6	Δ_1= -0.546	π_1 = 234
3	Interest rate on Bank B deposits	i_2	15.1	Δ_2= 0.109	π_2 = -110001
4	Interest rate on Bank C deposits	i_3	31.2	Δ_3= -0.132	π_3 = 175053

Table 6. Determining the variables and objective functions of the leader and follower players by applying the monetary policy through the variable of commission rates received from the banks

No.	Ω	φ_B	Variable	Notations	Value of variable (%)	Follower interest rate margin Δ_i	Objective function values (billion Rials)
1	0.5	0.5	Commission rate received by Central Bank from the banks	t_B	18	-	U(B)= 557884
2			Interest rate on Bank A deposits	i_1	5	Δ_1= 0.12	π_1 = 2412
3			Interest rate on Bank B deposits	i_2	4.6	Δ_2= 0.214	π_2 = -74647
4			Interest rate on Bank C deposits	i_3	8	Δ_3= 0.1	π_3 = -32470
5	0.75	0.75	Commission rate received by Central Bank from the banks	t_B	18	-	U(B)= 1289696
6			Interest rate on Bank A deposits	i_1	5	Δ_1= 0.12	π_1 = 2412
7			Interest rate on Bank B deposits	i_2	4.6	Δ_2= 0.214	π_2 = -74647
8			Interest rate on Bank C deposits	i_3	8	Δ_3= 0.1	π_3 = -32470
9	1	1	Commission rate received by the Central Bank from the banks	t_B	18	-	U(B)=2295295
10			Interest rate on Bank A deposits	i_1	5	Δ_1= 0.12	π_1 = 2412
11			Interest rate on Bank B deposits	i_2	4.6	Δ_2= 0.214	π_2 = -74647
12			Interest rate on Bank C deposits	i_3	8	Δ_3= 0.1	π_3 = -32470

The Current scenario: Current scenario of the leader and follower players and their objective functions in the banking system

After investigating the research scenarios based on three variables of legal deposit award rate, the legal deposit ratio, and commission rates received from the banks for the leader player (Central Bank) and the variable of interest rate on deposits for the followers (selected banks), in the final state the actual situation of the variables mentioned including (Ω=1,φ_B=0.45, t_B=0.34, r_B=0.01, $\alpha_\beta = 0.13$) and interest rates on deposits (i_1=0.153, i_2=0.157, i_3=0.168) are explored based on Table 6 in 2016 across the banking system. Based on that, the values of the objective function of a leader and follower players are also determined. The results obtained are shown in Table 7.

Comparing the values obtained from the three main scenarios with the current situation

After investigating the three scenarios of determining the variables of follower players (the interest rate on deposits) and the leading player (Central Bank), as well as their objective functions, and investigating the real value of the mentioned variables in 2016 and the objective functions,

Table 7. Determining the objective function value of the leader and follower players based on the real value of parameters in 2016

Row	Real values of variables and objective functions of the leader and followers in the research												
Bank name	φ_B	α_β	r_B	t_B	a_i	γ_i	β_i	r'_i	S_i	r_i	i_i	Δ_i	Objective function values (billion Rials)
Central	0.45	0.13	0.01	0.34	-	-	-	-	-	-	-	-	U(B)=1065647
A	-	-	-	-	a_1=-372398	γ_2=-1060186 γ_3=-5796847	β_1=-2227632	r'_1=0.09	S_1=0.87	r_1=0.17	0.153	0.117	π_1 = -78654
B	-	-	-	-	a_2=-682676	γ_1= 3750709 γ_3=-9945455	β_2= 3797662	r'_2=0.06	S_2=1	r_2=0.26	0.157	0.103	165411- π_2 =
C	-	-	-	-	a_3=-617058	γ_1= 3023411 γ_2=-2127548	β_3= 6285429	r'_3=0.08	S_3=1.65	r_3=0.18	0.168	0.12	π_3 = -52062

Table 8. Comparing the scenarios with the real value achieved for the study variables in Stackelberg state

Scenario-case No.	Values of leader variable			Values of followers' variable			leader objective function value	Followers' objective function value		
	r_B	$\beta\alpha$	t_B	i_1	i_2	i_3	U(B)	$_3\pi$	$_2\pi$	$_1\pi$
Scenario1-1	4.11	0.13	0.34	0.67	0.047	0.43	133821	11156-	423453	-201213
Scenario1-2	2.226	0.13	0.34	0.272	0.038	0.217	1458595	14591-	16471	41989-
Scenario1-3	1.81	0.13	0.34	0.174	0.036	0.161	2272239	14164-	35407-	21181-
Scenario1-4	3.92	0.13	0.34	0.325	0.271	0.371	1686342	606652-	946910-	649625-
Scenario2	1	0.316	0.34	0.716	0.151	0.312	840839	175053	110001-	234
Scenario3-1	1	0.13	0.18	0.05	0.046	0.08	557884	-32470	-74647	2412
Scenario3-2	1	0.13	0.18	0.05	0.046	0.08	1289696	-32470	-74647	2412
Scenario 3-3	1	0.13	0.18	0.05	0.046	0.08	2295295	-32470	-74647	2412
Current status	1	0.13	0.34	0.153	0.157	0.168	1065647	-52062	165411-	78654-

this section has dealt with comparing the values obtained from the scenarios and real value.

Accordingly, Table 8 compares the values obtained from the previous stages with each other. As seen in Table 8, in scenario 2, the value of α_β does not hold in constraints, and hence this scenario is not acceptable and is no longer investigated as a better scenario.

Among the remaining scenarios, the scenarios 1-3 and 3-3 have the maximum value of an objective function of Central Bank, and the values of the objective function of followers were better than those of the objective function in the current status.

Hence, scenarios 1-3 and 3-3 are chosen as the ideal scenarios in the pricing interest rate on deposits between the two players, leader (Central Bank) and followers (selected banks: A, B, and C). Accordingly, the research hypotheses have examined further:

Investigation of research hypotheses

Hypothesis 1: The current monetary policy of Central Bank (the game leader) for the profitability of this bank is optimal.

As seen in (Table 8), the current strategy of Central Bank (2016) in the form of monetary policies of legal deposit award rate and the commission rates received from the

banking system is not optimal for the profitability of this bank. This is because the value of the objective function of this bank in the current status (2016) is lower than that of the objective function of this bank in the two scenarios, including scenario 1-3 (the scenario of changing the legal deposit award rate to 1.81, instead of 1%, assuming that the coefficient of the importance of the components of the utility function (social welfare) of Central Bank including the social and economic sector as well as the coefficient of facilities paid by Central Bank to the government, state companies, governmental institutes and banks is equal to 1) and scenario 3-3 (applying monetary policy while considering the commission rates received from the banks as 0.18 instead of 0.34). Hence, the first research hypothesis suggesting the optimality of the current strategy of Central Bank regarding monetary policies is rejected.

Hypothesis 2: The current strategy of the bank C (follower) in determining the interest rate on deposits is optimal against the strategy of Central Bank (leader) for the greater profitability of the bank C.

As shown in (Table 8), the current strategy of the bank C has not been optimal in determining the interest rate on deposits and facilities for the profitability of the bank. This is because the value of the objective function of this bank in the current status (2016) is lower than that of objective function of this bank in the two scenarios, including scenario 1-3 (the scenario of changing the legal deposit award the rate to 1.81 instead of 1% and altering the interest rate on deposits of Bank C from 16.8 to 16.1%) and scenario 3-3 applying monetary policy while considering the commission rates received by Central Bank from banks by 0.18 instead of 0.34 and reducing the interest rate on Bank C deposits from 16.8 to 8%. Thus, the second research hypothesis regarding the optimality of the current strategy of the bank C in determining the interest rate on deposits is rejected.

Hypothesis 3: The current strategy of competitors of the bank C (follower) in determining the interest rate on deposits is optimal against the strategy of Central Bank (leader) for the profitability of competitors.

As depicted in Table 8, the current strategy of the competitors of the bank C (banks A and B) is not optimal in determining the interest rate on deposits and facilities for the profitability of these banks. This is because the value of the objective function of the bank A in the current status (2016) is lower than that of the objective function of this bank in the two scenarios, including scenario 1-3, the scenario of changing the deposit reserve award the rate to 1.81 instead of 1% and altering the interest rate on deposits of the bank A from 15.3 to 17.4%) and scenario 3-3 applying monetary policy while considering the commission rates received by Central Bank from these banks by 0.18 instead of 0.34 and reducing the interest rate on bank A deposits from 15.3 to 5%. Also, the value of the objective function of the bank B in its current status (2016) is lower than that of the objective function of this bank in the two scenarios, including scenario 1-3 changing the legal deposit award rate to 1.81 instead of 1% and the wearing interest rate on deposits of the bank B from 15.7 to 3.6%, and the scenario 3-3 applying monetary policy while considering the commission rates received by Central Bank from the banks by 0.18 instead of 0.34 and reducing the interest rate on deposits of the bank B from 15.3 to 4.6%. Thus, the third research hypothesis regarding the optimality of the current strategy of the competitors of the bank C in determining the interest rate on deposits is rejected.

Overall, the results of this study indicated that in this Game, the optimal strategy of Central Bank involved "reducing the commission rates received" from the banking system and "increasing the legal deposit award rate", while the strategy of changing the legal deposit ratio is not optimal. Meanwhile, the optimal strategy of the follower players (the banks A, B, and C) reduces the interest rate on deposits during the year 2016. Thus, in this Game, the first, second, and third hypotheses of the research regarding the optimality of strategies of leader and follower players are rejected. The results also showed that if the players of this game choose Stackelberg cooperative game, they will gain higher profitability than their current status.

4.4. Discussion

The results of this study demonstrated that irrespective of the optimal monetary policy adopted by Central Bank, whenever the coefficient of the importance of the components of social welfare function of Central Bank including the social and economic sectors, and the coefficient facilities paid by Central Bank to the state companies, the banks, and governmental institutes is equal to their maximum value, the utility of Central Bank (leader of the Game) and followers (selected banks) increases. In other words, when Central Bank deals with offering facilities to the state companies, banks, and governmental institutes with its maximum power (100%), and the coefficient of the importance of the components of the social welfare function by this bank converges to its maximum value, the banking system of the country including the leader (Central Bank) and its governed banks will have greater profitability. Also, in the case that the players of this Game adopt Stackelberg cooperative Game (leader- follower), they will gain greater profits compared to their current status, which is inconsistent with the results found by (Khanizad & Montazer, 2018). Further, the issue of choosing Stackelberg optimal strategy (leader-follower) is consistent with previous studies suggesting the superiority of cooperative Game strategies compared to non-cooperative strategies when confronting monetary and fiscal policies (between the government and Central Bank and the contradistinction between them) Mahmoudinia et al., (2016), as well as extracting the rule of the optimal monetary and fiscal policy in Iranian economy (Mahmoudinia et al., 2016). They concluded that social welfare is greater than non-cooperative Game when the government and Central Bank treat each other within a cooperative Game framework.

According to our results, determining the percentage of legal deposit (legal deposit ratio), as a monetary policy while considering the range of the rate approved by

monetary and banking laws of the country (10-30%), is not a suitable means of determining the interest rate on deposits in the Game of pricing this rate between Central Bank and banking system. In other words, determining the legal deposit ratio, which is considered as a monetary policy tool in both usurious and non-usurious systems, is not efficient. This confirms the results found by GholiBeglo, (2011). He found that Central Banks in Western countries regularly use this tool as a monetary policy, and the Game can have a legal deposit ratio due to the adverse consequences. Nevertheless, there is no single legal deposit approach along with economists and Central Banks, even in developed countries. Some countries such as Britain, New Zealand, Australia, and Sweden have changed their banking system to "no legal deposit". This is because in these countries, the banks are controlled and constrained regarding "the required capital", and some believe that this index, which is sometimes also characterized as "capital adequacy", is conceived more critical than legal deposit even in countries with "banking with legal deposit" system. Indeed, it is no longer considered essential for economic changes. Even in the countries that have preserved their legal deposit system like USA, when it comes to control, target or manage "money supply", this means targeting interest rates for controlling the liquidity supply. Controlling the monetary stream while targeting the monetary base or legal deposit level has been abolished for many years. Also, among developed economies, only four countries, including Brazil (45%), India (4%), Russia (4%), and China (18.5%) use the changes in the legal deposit (the legal deposit ratio) to alter the level of liquidity.

Based on the points above, according to, "determining the legal deposit interest rate and the ratio of banks" in Central Bank of Islamic Republic of Iran is one of the duties of this bank. Indeed, as one of the governmental institutions, which is mainly responsible for monetary and credit policies, Central Bank does not use the legal deposit resources to gain profit or revenue. Instead, even to encourage banks to good faith deposit of the legal deposit at the end of the year, it considers some sums as "legal deposit award" for banks. Thus, although Central Bank uses legal deposit as a means of monetary policies to regulate the part of the liquidity in the society or for other goals, its usage as a tool should not be considered an obstacle or rational justification for not paying the accrued rate on the deposits- at least equal to in-part rate- of people kept in Central Bank as legal deposit. Nevertheless, the legal deposit award can play a minor role in Central Bank policies during the time of the study; the legal deposit award is fixed as 1%.

On the other hand, our results indicated that in 2016 and Stackelberg optimal scenario, optimal legal deposit award would be larger than 1%, and grow to around 1.8%. In this way, the interest rate on deposits of the two selected banks also decreases compared to their current interest rate. In contrast, the utility of the Central Bank (leader) and followers (selected banks) would increase. Evidently, if the legal deposit award rises from 1 to 1.8%, the tendency of banks to invest in Central Bank will increase. Where, the legal deposit ratio of the banks would also grow in Central Bank. The increase of the legal deposit ratio would also result in the increased value of the domestic money and effective control of the inflation rate. Also, the investigation of the research scenarios in the monetary policies of changing the legal deposit award indicated that although the elevation of this ratio to 2-4.2% yields less profit for the players, their objective function will improve compared to the current status at the following values: legal deposit award of 4.11%, coefficient of the importance of the components of social welfare function of Central Bank and the coefficient of facilities paid by Central Bank equaling to 50%, or at legal deposit award of 2.26%, coefficient of the importance of components of social welfare function and the coefficient of facilities paid by Central Bank as 75% will have a better value compared to the current status.

5. Conclusions

Considering the commission rates received by Central Bank from the banking system, it seems that the monetary policy of high commission rate received from the banks by Central Bank (the Game leader), which has been fixed as 34% during the study period, should be revisited. This is because the commissions received by Central Bank from the followers are used for their free resources (followers). These free resources are an outcome of subtracting the sum of the legal deposit ratio and the facilities paid from the entire resources of the bank. A study conducted in 2016 indicated that reducing the commission rates received by Central Bank from the followers from 34% to 18% would improve the utility of both the leader and follower players. Indeed, the scenario of reducing the commission rates of Central Bank, regardless of the coefficient of the importance of the components of social welfare function of Central Bank and the coefficient of facilities paid by this bank, would reduce the interest rate on deposits of the follower players compared to their current status, and yield the maximum income in all scenarios for the leader players (Central Bank) and the follower (selected banks). Finally, in order to reduce interest rates on deposits and consequently reduce interest rates on facilities, Central Bank, as the leader of the game, must first manage the volume of liquidity between the three "interest rates on bank deposits", "inflation" and "liquidity", than to control the inflation rate and the level of the price index, and finally to reduce the interest rate on bank deposits to reduce the interest rate on facilities and increase the production and economic prosperity.

Recommendations

According to the results and in order to managerial implication, the suggestion can be as follows:

1. The independence of Central Bank in Islamic Republic of Iran from the government is considered as the essential success factor for the monetary policies of this bank. In this regard, it seems that the process of choosing the general director of Central Bank by the presidents of governments governing the country should be fundamentally reviewed,

and the selection of this general should be relegated to a nonpolitical, independent, scientific, economic, and policymaker reference or institute.
2. Regarding the inefficiency of the legal deposit ratio tool and the monetary policies of the country, it is inevitable to review the determination of the legal deposit ratio. This should be done by authorities or institutes such as Islamic Consultative Assembly, Central Bank, and Money and Credit Council after careful investigations by considering the macroeconomic and microeconomic indicators and conditions.
3. Noncurrent claims of the banks as the most critical toxic assets of banks show aggregate losses precipitated in response to the persistence of a set of ups and downs on the macro scale and mismanagement in the financial sector of the economy. The ratio of noncurrent claims to total facilities in Iran has always been greater than international norms, clearly indicating the inefficiency of credit allocation and financial intermediation in Iran.

Funding
This research did not receive any specific grant from funding agencies in the public, commercial, or not-for profit "Funding information is not available." Funding information will be entered during the submission stage and will be included in the final publication.

Acknowledgements
We gratefully acknowledge the comments by the editor, three anonymous referees, and experts at Central Bank of Islamic Republic of Iran. Views and conclusions expressed in this paper are those of the authors and do not necessarily represent those of Central Bank of the Islamic Republic of Iran. The authors alone are responsible for any remaining errors.

Conflicts of Interest
The author declares that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

References
Akçelik F. & Talaslı A. (2020), Market-based monetary policy expectations for Turkey. Central Bank Review, 20(1): 9-19. https://doi.org/10.1016/j.cbrev.2019.11.001

Anwar S. & Nguyen LP. (2018), Channels of monetary policy transmission in Vietnam. Journal of Policy Modeling, 40(4): 709-729. DOI: 10.1016/j.jpolmod.2018.02.004

Bakhshi Dastjerdi R. & Taleb Baghebani M. & Mojahedi Moakher MM. & Ahmadniya MS. (2019), The system Dynamics Approach to Money Creation Effect on Inflation in Iran Economy. Journal of Economic Research and Policies. 27(89): 99-137. URL: http://qjerp.ir/article-1-1725-en.html

Borio C. & Gambacorta L. (2017), Monetary policy and bank lending in a low interest rate environment: diminishing effectiveness?. Journal of Macroeconomics, 54(1): 217-231. https://doi.org/10.1016/j.jmacro.2017.02.005

Dai T. & Liu X. & Sun W. (2020), The effects of monetary policy on input inventories, The B.E. Journal of Macroeconomics, 20(1): 20170251-59. https://doi.org/10.1515/bejm-2017-0251

El Alaoui AO. & Jusoh HB. & Yussof SA. & Hanifa MH. (2019), Evaluation of monetary policy: Evidence of the role of money from Malaysia. The Quarterly Review of Economics and Finance, 74(1): 119-128. DOI: 10.1016/j.qref.2019.04.005

Engwerda J. & Mahmoudinia D. & Dalali Isfahani R. (2016), Government and Central Bank Interaction under Uncertainty: A Differential Games Approach. Iranian Economic Review, 20(2): 225-259. doi: 10.22059/ier.2016.58

GholiBeglo MR. (2011), Investigating the effectiveness of monetary policy on legal reserve ratio and evaluating its balance sheet effects in the country's banking network. Process (Economic Research Process). 19(59): 59-94. Available from: https://www.sid.ir/fa/journal/ViewPaper.aspx?id=163194.

Goczek Ł. & Partyka KJ. (2019), Too small to be independent? On the influence of ECB monetary policy on interest rates of the EEA countries. Economic Modelling, 78(1): 180-191. DOI: 10.1016/j.econmod.2018.09.019.

Ida D. (2019), Cross-checking monetary policy and equilibrium determinacy under interest rate stabilization. Economics Letters, 179(1): 75-77. DOI: 10.1016/j.econlet.2019.03.025

Khanizad R. & Montazer G. (2018), Participation against competition in banking markets based on cooperative Game theory. The Journal of Finance and Data Science, 4(1): 16-28. https://doi.org/10.1016/j.jfds.2017.09.002.

Lee KS. & Werner RA. (2018), Reconsidering monetary policy: An empirical examination of the relationship between interest rates and nominal GDP growth in the US, UK, Germany and Japan. Ecological Economics, 146(1): 26-34. https://doi. org/10.1016/j.ecolecon .2017.08.013

Mahmoudinia D. & Bakhshi Dastjerdi R. & Jafari S. (2018), Extraction of Optimal Fiscal and Monetary Policy

Rules in Framework of Game Theory: Application of Dynamic Stochastic General Equilibrium Model. Quarterly Journal of Applied Theories of Economics, 4(4): 143-174.

Mahmoudinia D. & Dalali Esfahani R. & Engwerda J. & Bakhshi Dastjerdi R. (2016), Game theory and its role in determining optimal policies and strategic interaction between fiscal and monetary policymakers (application of differential Game theory and stackelberg Games). Journal of Applied Economics Studies in Iran, 5(18): 1-34. https://www.sid.ir/en/journal/ViewPaper.aspx?id=573349

Memarpour M. & Hafezalkotob A. & Khalilzadeh M. & Saghaei A. & Soltani R. (2021), Determining the interest rate on deposits in the Iranian banking system: cooperative or competitive Game between the Central Bank and followers?, Advances in Mathematical Finance and Applications, (Accepted Manuscript). Articles in Press, Available Online from 10 October 2021. doi: 10.22034/amfa.2022.1957780.1745

Mansouri N. & Mosavi jahromy Y. & Abolhasani A. & Shayegani B. (2017), Analyzing the Relationship among Government, Central Bank and Speculators in Iran: Approach of Game Theory and Nash Equilibrium. Journal of Economics and Modeling, 7(28): 139-167. https://ecoj.sbu.ac.ir/article_45059_en.html

Murgia LM. (2020), The effect of monetary policy shocks on macroeconomic variables: Evidence from the Eurozone. Economics Letters, 186(1): 108803. https://doi.org/10.1016/j.econlet.2019.108803

Naiborhu ED. (2020), The lending channel of monetary policy in Indonesia. Journal of Asian Economics, 67(1): 101175-87. https://doi.org/10.1016/j.asieco.2020.101175

Reza-Gharehbagh R. & Hafezalkotob A. & Makui A. & Sayadi M. (2020), Competition of risk-averse and risk-neutral financial chains under government policy-making. Journal of Industrial and Systems Engineering, 13(1): 147-162.

Rubio M. (2016), Short and long-term interest rates and the effectiveness of monetary and macroprudential policies, Journal of Macroeconomics, Elsevier, 47(1): 103-115. DOI: 10.1016/j.jmacro.2015.09.007

Sá AI. & Jorge J. (2019), Does the deposits channel work under a low interest rate environment?. Economics Letters, 185(1): 108736. DOI: 10.1016/j.econlet.2019.108736

Shirinbakhsh S. & Jabari E. (2010), The study of legal reserve and bank's assets on banking facilities (by using gmm method). Financial Knowledge of Security Analysis (Financial Studies), 3(5): 19-32. https://www.sid.ir/en/journal/ViewPaper.aspx?id=208287

Sun R. (2020), Monetary policy announcements and market interest rates' response: Evidence from China. Journal of Banking & Finance, 113(1): 105766-85. DOI: 10.1016/j.jbankfin.2020.105766

Thornton D. (2014), L Monetary policy: Why money matters (and interest rates don't). Journal of Macroeconomics, 40(1): 202-213. DOI: 10.1016/j.jmacro.2013.12.005

Tillmann P. (2019), Robust monetary policy under uncertainty about the lower bound. The B.E. Journal of Macroeconomics, 2(1): 77-86. DOI:10.1515/bejm-2019-0077

Varlik S. & Berument MH. (2017), Multiple policy interest rates and economic performance in a multiple monetary-policy-tool environment. International Review of Economics & Finance, 52(1): 107-126. DOI: 10.1016/j.iref.2017.10.004

Valipour Pasha M. & Biabani J. (2016), The Effect of Regulatory Policy on Efficiency under Prudential Framework among Listed Iranian Banks. Journal of Money and Economy, 11(2): 153-171.

Wingender AM. (2011), Monetary policy shocks and risk premia in the interbank market. The B.E. Journal of Macroeconomics, 11(1): 1-28. https://doi.org/10.2202/1935-1690.2147