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Research Article

Investigating the Role of Electronic Devices in Banking Costs

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Abstract

The purpose of this paper is to investigate the role of electronic payment and payment instruments on bank cost over the period 1999-2020 using the Dynamic Stochastic General Equilibrium (DSGE) approach. In this study, considering the information of private and public banks in the country, the effect of using electronic banking and the spread of electronic tools on banking costs was investigated. The results of the shock from the electronic banking index in order to measure the effects of the expansion of the use of electronic payment and payment instruments on operating costs can be seen that non-governmental banks have significantly higher operating costs than state-owned banks. Is. On the other hand, it can be seen that the increase in bank operating income in non-state banks has been more than state-owned banks. The e-banking index in this study is based on the number of bank transactions compared to the number of ATM and POS. The results obtained from the shocks in the area of e-banking index indicate that e-banking indices have a significant effect on bank costs. The use of electronic tools leads to a greater reduction in operating costs of non-governmental banks than banks. Has been government. On the other hand, it can be seen that the increase in bank operating income in non-state banks has been more than state-owned banks.
Keywords: Electronic Banking, Payment System, Electronic Payment, Operating Costs, Dynamic Stochastic General Equilibrium Model (DSGE).

Introduction

Today, the world is witnessing very rapid progress in various fields of science. In order to survive in competitive markets, organizations must adopt cost-cutting strategies and provide appropriate services. In the meantime, banks and financial institutions are required to adopt electronic banking methods in order to continue their economic life and develop their activities in domestic and global markets in order to be more competitive in order to attract more customers and reduce transaction costs. customer relationship management in Internet banking is an important phenomenon in the banking sector and is considered as a development of the banking sector. The implementation of services related to e-banking plays an important role in maintaining banking competition. Since the mere presence of the customer in the branch is costly for the bank, the development of electronic banking services and, consequently, the provision of services such as the use of ATM (Automated

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Teller Machine), POS (Point of Sale), and Internet banking, are good ways to reduce costs. The reason for banks' willingness to use e-banking can be summarized in the three main components of cost advantage, high profitability and risk reduction (Damtew, 2016).

E-banking is the most modernized automated delivery approach of banking products and services through e-communication channels. E-banking approach that enables customers of a bank or other financial institution to conduct a range of financial transactions through the website. Internet banking has appeared as one of the most profitable e-commerce applications (Samar et al., 2017).

Several banks have offered internet banking system in an attempt to reduce cost while improving customer services (Rahi et al., 2019). Therefore, banks are still finding difficulties in fully maximizing their operations, thereby attributing to customer's unwillingness to adopt internet banking irrespective of the benefits (Rahi et al., 2018; Rahi and Ghani, 2016). Banks are trying to discover new ways to dematerialize customers relationship with physical banking system (Kamdjoug et al., 2021; Bertin and Schaeffer, 2020; Mărăcine et al., 2020; Raza et al., 2020).

The adoption of internet banking services will not be only beneficial for banks but it will also give an opportunity to banks to satisfy their customers from a distance (Samar and Mazuri, 2019; Raza et al., 2020). Thus, understanding the reason for this resistance will be useful for policymakers in formulating new strategies aimed at increasing internet banking use. E-banking reduces costs and increases the bank's profitability, increases the speed and quality of customer service, removes time and space constraints, and expands the scope of banking and marketing activities. In addition, in many developed countries, in addition to banks new offer their services only to customers through electronic communications, and bank customers also want to communicate with their bank accounts through internet and mobile lines (Mbama et al., 2018; Kebede, 2021). Therefore, the main question is whether the use of electronic banking and electronic payment and receipt services in the country's banking system (private and public banks) has been able to significantly reduce the costs of banks or not? In order to consider this issue, the banking system section is included in the Dynamic Stochastic General Equilibrium (DSGE) model, which will change its operating costs through the use of information technology and electronic banking, and by considering Information of private and public banks of the country (Yang et al., 2020; Mohsani et al., 2021; Yu, 2019; Shobande and Shodipe, 2019; Chan, 2020).

The effect of using electronic banking and the spread of electronic tools on banking costs has been studied. The e-banking index in this study is based on the number of banking transactions in relation to the number of ATM and POS (Shahabi and Razi, 2019; Nazaritehrani and Mashali, 2020). The number of banking transactions, bank cards, ATM and other electronic services has been different for each bank, but in the form of this model, this issue has been considered for the entire banking system (Nazaritehrani and Mashali, 2020; Hota and Mishra, 2018; Ghasemi et al., 2012). Existing statistics examined by private banks and were considered government from 1999-2020. Statistical data are taken from the book of performance reports of the country's banks, balance sheets and financial statements of banks.

Literature review

Theoretical literature of research

In the present study, with the aspect of work innovation, using the DSGE model, e-banking indicators on reducing bank costs have been studied. It should be noted that this study has tried for the first time to implement e-banking indicators operationally Enter such models. This study deals

with the statistics of the entire banking system and is not a micro-view of each bank and examines the macro perspective of the entire banking system. The purpose of this study is investigating the role of electronic banking on banking costs and although this reaction is more or less, in the modeling, the effects of shock from the components of electronic banking on banking costs will investigated.

DSGE models are powerful tools that provide a logical framework for policy discussion and analysis. In essence, these models can help identify the source of fluctuations, answer questions about structural change, predict the effect of policy change, and provide fact-based experiences. These models allow the relationship between the structural features of the economy and the parameters of the abbreviated form, which was not possible in large-scale macroeconomic models. Over the years, a significant process has taken place in the characterization and estimation of DSGE models. Central banks have also paid increasing attention to the applications of these models in analysis. Today, most central banks in developed and emerging economies have developed their own models, and other economies have begun to plan for this. Random describes it this way: Most of the models in this literature have a basic structure that incorporates elements of the new Keynesian approach and real business cycles. A new Keynesian DSGE model is designed entirely on micro-bases with nominal and real adhesions in this model, households consume, decide on the amount of investment, and are the exclusive suppliers of different types of work that allow them to determine wages (Le et al., 2011; Steinbach et al., 2009; Schorfheide, 2008). In contrast, firms employ labor, lease capital, and are the exclusive suppliers of distinctive and price-determining goods. Both households and firms face a large number of constraints and nominal frictions (e.g., sticky prices and wages or partial price-wage indexes).

In the electronic banking system, the use of bank cards is one of the tools that facilitates the provision of cash and speeds up the transfer of funds, as well as the accuracy of reducing the volume of operations related to money supply. Structural reforms in the real and financial sectors of the Iranian economy and banks the country has various components. Due to the many economic benefits of e-banking systems in terms of reducing costs and increasing the profitability of banks, increasing the quality of service to customers, removing temporal and spatial constraints and expanding the field of banking and marketing activities and in many cases in many parts of the country. In addition to new banks that provide their services to customers only through electronic communications, established banks also expand their operations in addition to their current activities or by establishing independent banks electronically. In the electronic payment system, money is exchanged from a tangible concept to an intangible concept. Therefore, with the electronic transfer of money, the concept of electronic money was introduced. On the other hand, at the same time with the era of electronic payment system, another tool was designed and presented that is very practical and was known as electronic bank card. It can also be considered as the foundation money of the electronic payment system. They are not only widely used in electronic face-to-face payments, but are also widely used in electronic payments in face-to-face transactions without the need for coins and banknotes. The bank card holder has a unique identification number, so in remote electronic payment systems, by entering your identification number and card details, it is possible to pay for the purchase of goods and services (provided that the amount payable corresponds to the account balance or credit in the card).

Review of previous studies

Some of the internal studies that have modeled the banking sector under the approach of dynamic random general equilibrium are as follows:

Gholami (2017) has studied the banking sector from the perspective of VAT. In this study, the role of financial intermediaries in understanding the shocks to the economy in a new Keynesian model that includes the banking sector for the Iranian economy and the loan applicant firm has been investigated. Mozini and Hozouri (2017) evaluated the effect of the expansion of electronic banking on reducing the operating costs of the country's banking system. In this study, in the framework of activity-based costing approach, the cost function of the banking system is extracted and estimated separately for private and public banks in Iran for the period 2006-2017 using the data panel method. The results indicate that the expansion of electronic banking in Iran has reduced the costs of private and public banks. But this is much bigger and more significant in private banks. This means that private banks have been more successful than state-owned banks in using e-banking to reduce their costs.

Shaygani and Dadashi (2015) examined the effect of the expansion of electronic banking on reducing bank costs. This study focuses on statistical data from 2003 to 2010 leading private banks in the field of electronic banking (Karafarien, Parsian, Eghtesad Novin, Saman and Sina), in the form of translog cost function and using the combined data technique of the impact of banking expansion Evaluates electronics along with other cost factors (Modrego et al., 2020). This study was conducted in two models of the total volume of bank facilities and the other number of bank accounts as bank output in the cost function along with other variables including variables of online branch control and the number of bank cards. While examining, it was found that considering the total volume of the granted facilities as output has resulted in more compliance of the results with the literature of cost functions. The results of this study showed that the expansion of the number of online branches was not only significant but also much more effective in reducing costs than increasing card issuance.

Fathieh Meghdadian et al. (2013) have conducted an applied research study with the aim of describing a method for prioritizing the factors affecting customers' use of electronic banking services under a fuzzy environment. In this study, using a descriptive-survey research method, a sample consisting of 50 customers of Saman Bank were examined and using AHP-Fuzzy, the factors were prioritized in order of importance. Research factors include 10 main criteria of responsiveness, efficiency, feasibility, reliability, confidentiality, received usefulness, ease of use, behavioral attitude, softness and perceived behavioral control. Findings show that the received factors of usefulness, feasibility, ease of use, reliability, accountability, confidentiality, efficiency, behavioral attitude, softness and behavioral monitoring affect customers' use of electronic banking services.

Paiva et al. (2021) have explored conflicts of interest in various areas of the banking industry. The development of banking in traditional ways to improve marketing, branding, and network development has been supported by many managers. In contrast, new banking methods - including electronic banking, social network banking, digital banking - have become very popular and have reduced costs and increased revenue. In their research, Paiva and colleagues have examined different policies despite these contradictions. In this way, they help to determine the priorities of the banks in order to choose the ideal combination. In the mentioned study, despite paying attention to the uncertainty of the level of planning, it is mainly in the form of strategy formulation and less policy-making has been done.

Akhiser et al. (2015) examined the impact of e-banking on equity returns of banks in 23 countries, including developing and developed countries, in the period 2005-2003. In this study, which examined the bank's performance in terms of profitability using the dynamic data panel method, and the return on equity as a profitability indicator, the results show that the effect of electronic banking on profitability of all countries studied is significant. The effect of the number

of sales terminals and the number of e-banking users on profitability was negative, while the number of cards issued and the ratio of the number of ATM to the number of branches had a positive and significant effect on profitability. It was the highest coefficient. May conducted a study at the German Central Bank Research Center (2012) on the impact of e-banking on banks' costs. As a result of the development of information technology, especially in the field of financial services, has caused the active institutions in this field, especially banks, to turn to new communication technologies.

Arnaboldi (2008) by examining the banks of Spain, England, Finland, Italy and using the fuzzy method concluded that the application of new technologies has reduced their costs compared to the application of traditional banking methods. The research of Yang and Ahmed (2009) with the help of statistical analysis shows that the expansion of e-banking has reduced the costs of banks in both developed and developing countries. This study confirms the results of previous research reduction. The operating costs of communicating with the bank's customers were the result of the use of new technologies.

The novelty of the present study compared to previous studies in this field is that the impact of using electronic payment and receipt services on reducing operating costs and increasing the profitability of banks in the form of random DSGE is examined and evaluated. It has received less attention in previous studies.

Method and Materials

Research models

In this research, we want to use the documented information taken from annual reports, financial statements and quarterly journals of private and public banks to seek the effect of electronic receipt and payment instruments on bank costs based on the DSGE model (Chan, 2020; Yang et al., 2020; Aminu, 2019; Josheski and Boshkov, 2022; Lee et al., 2021).

The e-banking index in this study is based on the number of banking transactions in relation to the number of ATM and POS. Also, operating and non-operating costs of the banking system have been used. For this purpose, by modeling the banking system in the banking sector, the model for operating costs of factors such as interest payments, fees paid, loan rewards costs, foreign exchange losses and receivables costs.

Suspicious receipts have been used as a whole and also for non-operating expenses, components of administrative and personnel expenses, depreciation costs of movable and immovable property, etc. have been used. All these components are from the information published by the Central Bank for the entire banking system is used and operating and non-operating costs are examined. This section will change the operating costs of banks through the use of information technology and electronic banking. The model consists of seven economic sectors: households, producers, the banking system, government budget constraints, and the central bank. Considering a Money-In-the-Utility function (MIU) for households, a measure will be made about the time spent on transactions using cash or electronic payments. On the other hand, in order to maximize the banking system, the use of electronic payment and receipt services has the lowest cost for the bank. Therefore, considering the model of the above model, the effects of using electronic banking indicators through electronic receipt and payment on the bank's operating costs will be examined. In this study, statistical information of governmental and non-governmental banks for the period 1999-2020 has been used.

Family

In this economy, there is a representative family that has an indefinite lifespan. The representative Family acquires the utility of goods and services and the maintenance of real assets, and its utility decreases due to work. According to the standard model of real business cycles, households are risk-averse and do not have the ability to manage investment. So they deposit their money in the bank and receive interest from the bank in return. In this model, it is assumed that the use of current accounts and electronic banking services through time savings has led to an increase in their usefulness. This Family has the following preferences (equation 1):

$$E_0 \sum_{t=0}^{\infty} U\left(C_t X_t^h N_t\right) \quad (1)$$

According to the consequential form of the utility function, the present value of the utilities that the Family acquires will be as equation 2, in which $\beta^T \lambda_T$ represents the value of an additional unit of Family consumption.

$$\sum_{t=0}^{\infty} (\beta^h)^s E_t \left[\frac{(c_t)^{1-\sigma_c}}{1-\sigma_c} - \frac{N_t^{1+\sigma_n}}{1+\sigma_n} + \frac{1}{1-\vartheta} \left(\frac{X_t^h}{P_t} \right)^{1-\vartheta} \right] \quad (2)$$

Where E_t is the operator of expectations, $0 \leq \beta \leq 1$, discount factor, c_t real Family consumption, N_t labor supply for use in the production process of intermediate goods, σ_c inverse of inter-time substitution elasticity, σ_I inverse of inter-time substitution elasticity, X_t^h, Withdrawal of assets that include cash, bank deposits, gold and currency, etc. ϑ is the elasticity of interest on assets. The representative Family starts period t with X_{t-1}^h units of assets (including cash as well as credit money due to the use of current deposits and purchase cards) left over from the previous period, and N_t force It has the job to supply it to the intermediate goods companies and in all periods it should $N_t = \int_0^1 N_{j,t} d_j$. The Family earns w_t (income) from the place of supply of labor and pays taxes to the government in the amount of T_t. In addition, the Family owns the shares of the enterprises and deposits D_t in the bank and the interest rate is R_{t-1}^d gross. The supply of deposits to different banks follows the equation $D_t = \int_0^1 D_{ji} d_t$ also $R_t^d = 1 + r_t^d$.

The Family spends part of its income on final goods, invests part, which i_t is a real investment, and keeps another part in cash. In addition, part of the Family income is transferred to the next period as a deposit. It is also assumed that the Family owns the firm and the bank, and as a result the bank's profits π_t^b and the firm π_t^f belong to it.

The investment i_t is added to the capital stock of the beginning of the k_t period and the capital stock of the next period creates k_{t+1}. Also, to adjust the capital, it faces the cost as $\frac{\varphi_k}{2}\left(\frac{k_{t+1}}{K_t} - 1\right)^2 k_t$. The capital stock at the beginning of period $t+1$ is determined as equation 3:

$$k_{t+1} = (1-\delta)\mathrm{k_t} + i_t - \frac{\varphi_k}{2}\left(\frac{k_{t+1}}{K_t} - 1\right)^2 k_t \quad (3)$$

According to the above points, the budget of the representative Family presented in equation 4.

$$x_t^h + c_t + i_t + t_t = w_t N_t + \left(1 + r_{t-1}^d\right)\frac{d_{t-1}}{\pi_t} + r_t^k k_t + \frac{x_{t-1}^h}{\pi_t} + \frac{\pi_t^f}{p_t} + \frac{\pi_t^b}{p_t} \quad (4)$$

Where, w_t real wage, $1 + r_{t-1}^d$ shows the interest rate received by the family on bank deposits $\pi_t = \frac{P_{t-1}}{P_t}$ inflation, $x = \frac{X_t^h}{P_t}$ is the actual amount of assets and $d_t = \frac{D_t}{P_t}$ is the amount of the actual

deposit. In this model, it is assumed that a person's monetary balance is either kept as cash balance or as an available deposit to facilitate the possibility of banking operations. The Family tries to maximize its utility function according to the budget constraint λ_t is the Lagrangian coefficient equations 5 to 11.

$$\max_{c_t,d_t,N_t,x_t^c,k_t} E_t \sum_{t=0}^{\infty}(\beta^t)\left[\frac{(c_t)^{1-\sigma_c}}{1-\sigma_c} - \frac{N_t^{1+\sigma_n}}{1+\sigma_n} + \frac{1}{1-\vartheta}\left(M_t^h\right)^{1-\vartheta}\right] \quad (5)$$

s. t.

$$x_t^h + c_t + i_t = w_t N_t + \left(1 + r_{t-1}^d\right)\frac{d_{t-1}}{\pi_t} + r_t^k k_t + \frac{x_{t-1}^h}{\pi_t} + \frac{\pi_t^f}{p_t} + \frac{\pi_t^b}{p_t} \quad (6)$$

$$\frac{\partial \ell}{\partial c_t} = \beta^t (c_t)^{-\sigma_c} - \beta^t \lambda_t = 0 \quad (7)$$

$$\frac{\partial \ell}{\partial N_t} = -\beta^t N_t^{\sigma_n} + \beta_t \lambda_t w_t = 0 \quad (8)$$

$$\frac{\partial \ell}{\partial d_t} = E_t\left\{-\beta^t \lambda_t + \beta^{t+1}\left(\frac{1+r_t^d}{\pi_{t+1}}\right)\lambda_{t+1}\right\} \quad (9)$$

$$\frac{\partial \ell}{\partial m_t^h} = E_t\left\{\beta^t\left(M_t^h\right)^{-\vartheta} - \beta^t \lambda_t + \beta^{t+1} E_t \frac{\lambda_{t+1}}{\pi_{t+1}}\right\} = 0 \quad (10)$$

$$\frac{\partial \ell}{\partial k_t} = -\lambda\left[1 + \varphi_k\left(\frac{k_{t+1}}{k_t} - 1\right)\right] + \beta\left\{E_t \lambda_{t+1}\left[r_{t+1}^k + 1 - \delta - \frac{\varphi_k}{2}\left(\frac{k_{t+2}^2 - k_{t+1}^2}{k_{t+1}^2}\right)\right]\right\} = 0 \quad (11)$$

The combination of equations 7 and 9 indicates that the consumption of the current period depends on the consumption of the future period and the interest rate on the deposit. The combination of equations 7, 9 and 10 indicates that liquidity in the hands of individuals depends on the interest rate on deposits and consumption. Equation 11 also indicates that the interest rate on capital depends on the capital stock, the cost of capital adjustment and the depreciation rate.

Manufacturers

The production of goods in the economy is done by two groups of producers: the producer of final goods and the producer of intermediate goods. Intermediate goods companies produce distinct goods and sell them to a collector, the final goods company. The collector combines the distinctive goods under a homogeneous final product. The final commodity can be supplied to the economy for private consumption, government expenditure, or investment commodity.

Manufacturer of the final product

The producer of the final commodity plays the role of a collector, purchases distinct products from the producers of intermediate goods denoted by *j* and produces the final commodity using the Dixit Stiglitz collector (equation 12).

$$Y_t = \left(\int_0^1 Y_{jt}^{\left(\frac{\theta-1}{\theta}\right)} d_j\right)^{\frac{\theta}{\theta-1}} \qquad \theta > 1 \quad (12)$$

Y_{jt} represents the intermediate commodity j and θ represents the constant substitution elasticity between the intermediate commodities.

The producer of the final product tries to determine his purchase of intermediate goods according to the price of differentiated intermediate goods in such a way that his profit is maximized and as a result the demand function for the distinctive product produced by each intermediary firm is as equation 13:

$$Y_{jt} = \left(\frac{P_{jt}}{P_t}\right)^{-\theta} Y_t \tag{13}$$

The demand for product j is a function of the relative price of P_{jt}/P_t (the ratio of its price to the price of the final product) and the production of the final product, and by imposing a zero-profit condition on the producer of the final product, the final product price will be as equation 14:

$$P_t = \left(\int_0^1 P_{jt}^{1-\theta} d_j\right)^{\frac{1}{1-\theta}} \tag{14}$$

Manufacturer of intermediate goods

The economy is made up of a chain of monopoly firms producing intermediate goods, each of which produces distinct goods. These firms use labor and capital and other inputs to produce intermediate goods and sell them in the face of imperfect competition. Each firm receives a loan from a bank to pay part of the cost of labor and capital. The intermediate goods manufacturer seeks to minimize its costs by producing a certain amount. Therefore, the Rotemberg (1982) rule is used in terms of the cost of price adjustment (equation 15).

$$\mathrm{Y_{jt}} = \mathrm{A_t N_{jt}^{1-\alpha} K_{jt}^{\alpha}} \tag{15}$$

Where N_{ji} the number of working hours, $\alpha \in (0,1)$ and A_t represent the technology shock that follows as equation 16:

$$A_t = \rho_A A_{t-1} + (1-\rho_A)\bar{A} + \varepsilon_{A,t} \qquad \varepsilon_{t,A} \approx N\left(0, \sigma_{\varepsilon t, A\epsilon}\right),\ \rho_A \in (0,1) \tag{16}$$

Each firm receives j loan amount of L_{ti} from the bank at the beginning of each period and finances γ_t from the cost of capital and labor, which follows an *AR(1)* process as follows (equation 17).

$$\gamma_t = \left(1-\rho_\gamma\right)\bar{\gamma} + \rho_\gamma \gamma_{t-1} + \varepsilon_{\gamma,t} \qquad \varepsilon_{\gamma,t} \approx N(0, \sigma\varepsilon t, \gamma),\ \rho_\gamma \in (0,1). \tag{17}$$

The amount of the loan received is determined in equation 18:

$$L_{jt} = \gamma_t (P_{jt} r_{jt}^k + P_{jt} W_t N_{jt}) \tag{18}$$

The loan repayment rate at the end of the period is r_{jt}^k. As with Rotemberg (1982), the intermediary firm faces the following adjustment costs (equation19).

$$PAC_t^j = \frac{\varphi_f}{2}\left(\frac{P_{jt}}{(\bar{\pi})P_{jt-1}} - 1\right)^2 Y_t \tag{19}$$

$\varphi_f \geq 0$ is the parameter of adjustment cost or degree of price stickiness, $\bar{\pi}$ is inflation rate at steady equilibrium, Y_t stand for total production.

Banking system

This issue is considered for the whole banking system and in the model of this article, it is assumed that the goal of these banks (governmental and non-governmental) is to maximize corporate profits. In the structure, banks allocate deposits to loans. Despite the existence of an exclusive competitive market in the banking system, the bank does not determine the interest rate on deposits, and the interest rate on deposits is set by the central bank as a monetary authority.

The representative bank receives the D_t deposit from the Family and pays the interest rate r_t^d in return. The bank also offers the loan to the firm L_t^b and receives the interest rate r_t^l. In this study, it is assumed that the bank will bear the costs of EBC_t for investing in the field of electronic banking infrastructure and information technology. Banking costs include personnel costs, interest on deposits, fixed assets depreciation costs, administrative costs, equipment maintenance costs.

It is also assumed that in case of shortage of resources, the bank will have to borrow from the interbank market D_t^i at the interest rate r_t^i. In the interbank market, banks with resource surpluses lend to banks with resource shortages, depending on their bank soundness indicators, balance sheet status, and asset-debt flow. Banks must comply with a certain amount of debt to the interbank market, and the deviation of debt to the interbank market of banks from a stable equilibrium, exposes them to the quadratic cost as equation 20.

$$\frac{1}{2}\varphi di\left(\frac{D_t^i}{\overline{D}^i}-1\right)^2 \tag{20}$$

If the resources available in the interbank market are not sufficient to meet the needs of banks, banks will be forced to borrow from the central bank. Borrowing from the central bank D_t^c is in fact an injection of liquidity by the central bank in cases of need, to prevent the banks from borrowing illegally from the central bank, a penalty rate of r_t^c is considered for it every year. Banks must comply with a certain amount of debt to the interbank market, and the deviation of banks' debt to the central bank from a stable equilibrium position will expose them to a quadratic cost as equation 21.

$$\frac{1}{2}\varphi di\left(\frac{D_t^c}{\overline{D}^c}-1\right)^2 \tag{21}$$

Therefore, the bank's profit function is as equation 22:

$$\pi_t^b=\left(1-\alpha_t^b\right)\left(1+r_t^l\right)L_t-\left(1+r_t^d\right)D_t-\left(1+r_t^i\right)D_t^i-\frac{1}{2}\varphi di\left(\frac{D_t^i}{\overline{D}^i}-1\right)^2-(1+r_t^c)EBC_t \tag{22}$$

Which is maximized according to the following condition presented in equation 23.

$$l_t=d_t^i+(1-\eta_t)d_t+d_t^c-l_t^i \tag{23}$$

According to the maximization of the bank's profit function, the amount of bank deposits attracted, facilities granted, the use of electronic payment and receipt services and investment in this area will be determined in order to minimize the bank's expenses.

Government budget constraint

The government seeks to balance its expenditures (g_t) with taxes (T_t), sales of bonds (b_t), revenues from oil sales ($\omega_g^{or}.e_t.or_t$) and other revenues ($other_t$) holds. In this case, the government budget constraint on real prices is expressed in the equation 24:

$$g_t + \left(1 + R_{t-1}^b\right)\frac{b_{t-1}}{\pi_t} = \omega_g^{or}.e_t.or_t + b_t + T_t + other_t \quad (24)$$

Government expenditures consist of two components: current and development expenditures. It is assumed that the current and development expenditures of the government, in addition to being affected by past conditions and its stable amount, are also affected by changes in oil foreign exchange earnings, as in equations 25 and 26:

$$gc_t = \left(1 - \rho_{gc}\right)\overline{gc} + \rho_{gc}gc_{t-1} + \upsilon_{or}^{gc}or_t + u_t^{gc},\ u_t^{gc} \sim N(0, \sigma_{gc}^2) \quad (25)$$

$$gk_t = \left(1 - \rho_{gk}\right)\overline{gk} + \rho_g gk_{t-1} + \upsilon_{or}^{gk}or_t + u_t^{gk},\ u_t^{gk} \sim N(0, \sigma_{gk}^2) \quad (26)$$

Taxes are also a function of income in which τ is the tax revenue elasticity and b is the tax rate: $T_t = b.y_t^{\tau}$. In the event of a positive expenditure shock or a negative revenue shock, a budget deficit (bd_t) occurs. Under these circumstances, the government tries to cover the resource deficit by borrowing from the people and borrowing from the central bank. Therefore, in the government budget, in addition to converting part of the foreign exchange earnings into rails, the monetary base is also affected by the budget deficit and therefore the government debt to the central bank (dg_t). If the share of borrowing from the people ω_{bd}^b is taken into account, the rest will be provided through the central bank. In this case, the net debt of the government to the central bank at real prices will be as equation 27:

$$dg_t = \left(1 - \omega_{bd}^b\right)bd_t + \frac{dg_{t-1}}{\pi_t} \quad (27)$$

Central Bank

The central bank is a monetary authority and one of the economic policy makers. In modeling the behavior of the central bank, it is assumed that the monetary authority follows Taylor's rule in setting the policy rate (equation 28):

$$\left(1 + r_t^d\right) = \left(\frac{1+r_{t-1}^d}{1+\bar{r}^1}\right)^{\rho r}\left(\frac{1+\pi_t}{1+\bar{\pi}}\right)^{\rho\pi}\left(\frac{y_t}{\bar{y}}\right)^{\rho y}\left(\frac{\mu_t}{\bar{\mu}}\right)^{\rho m}\varepsilon_{t,r} \quad (28)$$

That $\bar{r}^d$, $\bar{\pi}$, $\bar{y}$ and $\bar{\mu}$ are the interest rate, inflation, output and growth rate of money in equilibrium, respectively. As a result, the central bank determines the interest rate on deposits according to the growth rate of production, the growth rate of money and inflation ρ_m, ρ_y, ρ_π are the weights of the variables of inflation, production and money growth rate in monetary policy, respectively. The shock $\varepsilon_{t,r}$ is also due to a mistake in the central bank's policy in determining the bank interest rate. This shock directly enters the monetary policy rule and as an exogenous and random variable, it affects the policy interest rate variable. Money growth rate is defined as equation 29:

$$\mu_t = \frac{M_t}{M_{t-1}}(\pi_t) \quad (29)$$

In order to formulate the policy-making and controlling role for the central bank, it is assumed that the central bank, in addition to determining the bank interest rate, also uses the legal reserve ratio as a monetary policy tool and the legal reserve ratio follows a subordinate form doing equation 30.

$$\eta_t = \pi_t^{\phi_\eta^\pi}\eta_{t-1}^{\phi_\eta^\eta}\varepsilon_{t,\eta} \qquad \varepsilon_{t,\eta} \approx N(0, \sigma_{\varepsilon_{t,\eta}}) \quad (30)$$

Finally, in the central bank balance sheet, the monetary base (MB_t) in terms of resources includes net foreign assets (FR_t), net government debt (DG_t) and bank debt (DC_t), which is divided into components by price index, it will be in the form of equation 31.

$$mb_t = fr_t + d_t^g + d_t^c \tag{31}$$

According to the equation 32, the net foreign assets of the Central Bank are the accumulation of reserves of the previous period and the amount of dollars that the government converts into Rials due to the impossibility of selling in the market.

$$fr_t = \omega_{fr}^{or}.e_t or_t + \frac{fr_{t-1}}{\pi_t} \tag{32}$$

In equation 32 ω_{fr}^{or} is the percentage of oil dollars that are sold directly to the central bank and e_t is the real exchange rate, which is defined as equation 33. In this regard p_t^* is the global price index, which is assumed to be constant, and s_t is the nominal exchange rate, which is considered as the *AR (1)*, (equation 34).

$$e_t = s_t \frac{p_t^*}{p_t} \tag{33}$$

$$s_t = \rho_s.s_{t-1} + (1-\rho_s)\bar{s} + u_t^s, \qquad u_t^s \sim N(0, \sigma_s^2) \tag{34}$$

The monetary base in terms of expenditures is the total amount of money in circulation and reserves of banks with the Central Bank according to equation 35.

$$mb_t = m_t^c + rr_t.d_t \tag{35}$$

According to the monetary base and the increasing liquidity coefficient, which consists of the money-to-deposit ratio (cu_t) as well as the legal deposit ratio (rr_t), The volume of liquidity is equal to the sum of banknotes and coins in circulation and the types of deposits, obtained according to equation 36.

$$m_t^2 = \frac{1+cu_t}{cu_t+rr_t}.mb_t \tag{36}$$

It is also assumed that the legal deposit ratio follows a first-order autoregression process as equation 37.

$$rr_t = \rho_{rr}.rr_{t-1} + (1-\rho_{rr})\overline{rr} + \varepsilon_t^{rr} \tag{37}$$

The Taylor rule of interest rates is used in the literature on conventional monetary models for monetary policymakers. However, in the Iranian economy, the policy-making rule is based on the growth rate of the monetary base. Under these circumstances, it is assumed that the central bank, in order to achieve its goals of reducing the output gap and inflation, acts in the form of equations 38 and 39.

$$rmb_t = \frac{mb_t}{mb_t/\pi_t} - 1 \tag{38}$$

$$rmb_t = \left(\frac{rmb_{t-1}}{rmb}\right)^{\rho rmb} \left(\frac{y_t}{y}\right)^{\varpi_{rmb}^{y}} \left(\frac{P_t}{P}\right)^{\varpi_{rmb}^{y}} \tag{39}$$

Estimation of model parameters and research results

In this research, to estimate the model parameters from Bayesian method, it is estimated using DINER program under MATLAB software, and based on it, economic variables are simulated in which the initial values for the parameters are distributed. The former is determined and these initial values are combined with the results of the maximum likelihood estimate based on actual data.

If the initial information in the previous distribution is complete and accurate and the maximum likelihood estimate fails to aid the model estimate, the Bayesian method becomes a calibration. But if the previous distribution information is completely incorrect and inaccurate, the Bayesian method becomes the most plausible method. In the intermediate state, Bayesian method is a combination of two methods of calibration and maximum likelihood (Yavari et al. 1397). With λ=677 cyclic components, the logarithm of the data is extracted. Before estimating the model parameters, it is necessary to calibrate the parameters and indicators that are parabolic or do not need to be estimated. These parameters are obtained through the steady-state values of the variables in the steady state, and the average data of these ratios are considered as their steady-state values and there is no need to estimate them.

To estimate the Bayesian parameters of the model, first the distribution, mean and standard deviation of the parameters must be determined, then using diner software under MATLAB software based on Monte Carlo method with Markov chain in the form of Metropolis-Hastings algorithm, mean values and standard deviation the latter parameters are calculated. In table 1, the distribution and the mean of the anterior and posterior parameters of the model are reported, and the values of the posterior mean show the estimation of the parameters of the model using the Bayesian method.

Brooks and Gelman (1988) diagnostic test is used here to evaluate the accuracy of the estimates obtained from the Markov Chain Monte Caro (MCMC) method. This diagnostic test is reported as univariate and multivariate, where only its multivariate test is reported in figure 1.

The results of this diagnostic test show that the variance within the sample and between samples are converged to a constant value, which indicates the appropriate accuracy of the estimates made from the model parameters using the Bayesian method.

In figures 1, 2 and 3, the horizontal axis of the time period and the vertical axis show the magnitude of the deviation from the equilibrium position.

Figure 2 and 3 show the instantaneous reaction functions of major macroeconomic variables and operating costs to a positive shock in e-banking by a standard deviation.

Clearly, as a result of a positive random shock as large as a standard deviation in e-banking, it shows the variables of production, investment, employment rate, production costs, and total amounts paid for operating expenses (consumption and expenses paid for wages, etc.). Initially, they react negatively to the e-banking shock and deviate negatively from their equilibrium level. For the GDP variable, the shock effect is completely discharged during 5 periods and this variable returns to its static level (Figure 3), but for other variables, it takes about 10 periods to completely adjust the positive shock effect of e-banking. Those variables return to their long-term static state.

After estimating the model parameters, in this section, by placing the results of estimating the model parameters, the effect of instantaneous reaction functions against shock, the use of electronic payment and payment instruments on operating costs and macroeconomic variables is plotted as a standard deviation. The e-banking index in this study is the ratio of electronic transactions to the number of ATM and POS.

Table 1. Anterior and posterior distribution of model parameters

Source	Late average	Previous average	Parameter distribution	Description	Parameter
Komijani and Tavaklian (2012)	0.967	0.968	Beta	Discount rate between Family mental periods	β
Ahmad and Anders (2012)	0.79	0.085	Gamma	Lending coefficient	φ
Researcher calculations	0.249	0.248	normal	Capital adjustment	ξ
Komijani and Tavaklian (2012)	0.014	0.014	Beta	Depreciation rate	δ
Researcher calculations	1.58	1.52	Gamma	Bank operating income	α
Goudarzi Farahani (2018)	0.89	0.9	Beta	Tax self-explanatory process coefficient	ρ_c
Researcher calculations	1.485	1.660	Gamma	Reverse substitution elasticity between consumption periods	σ_C
Researcher calculations	2.256	2.891	Gamma	Reverse the labor force pull	σ_L
Komijani and Tavaklian (2012)	1.58	1.072	Gamma	Reverse elasticity of real money balance	σ_M
Komijani and Tavaklian (2012)	0.265	0.260	Beta	Self-explanatory coefficient of oil revenue shock	ρ_{oilr}
Researcher calculations	0.552	0.899	Beta	Self-explanatory coefficient of government current expenditure shock	ρ_{gc}
Researcher calculations	0.981	0.852	Beta	Self-explanatory coefficient of government construction spending shock	ρ_{gi}
Allegret and Benkhodja (2015)	0.44	0.75	Beta	Calvo price adhesion parameter	θ_N
Komijani and Tavaklian (2012)	0.46	0.427	Reverse gamma	Deviation of the oil revenue shock standard	σ_{oilr}
Researcher calculations	0.42	.0365	Reverse gamma	Tax revenue shock standard deviation	σ_{tax}
Researcher calculations	0.42	0.930	Reverse gamma	Deviation of the money supply shock standard	σ_{mb}
Researcher calculations	0.09	0.01	Reverse gamma	Standard Shock Operating Cost Shock	σ_{tc}

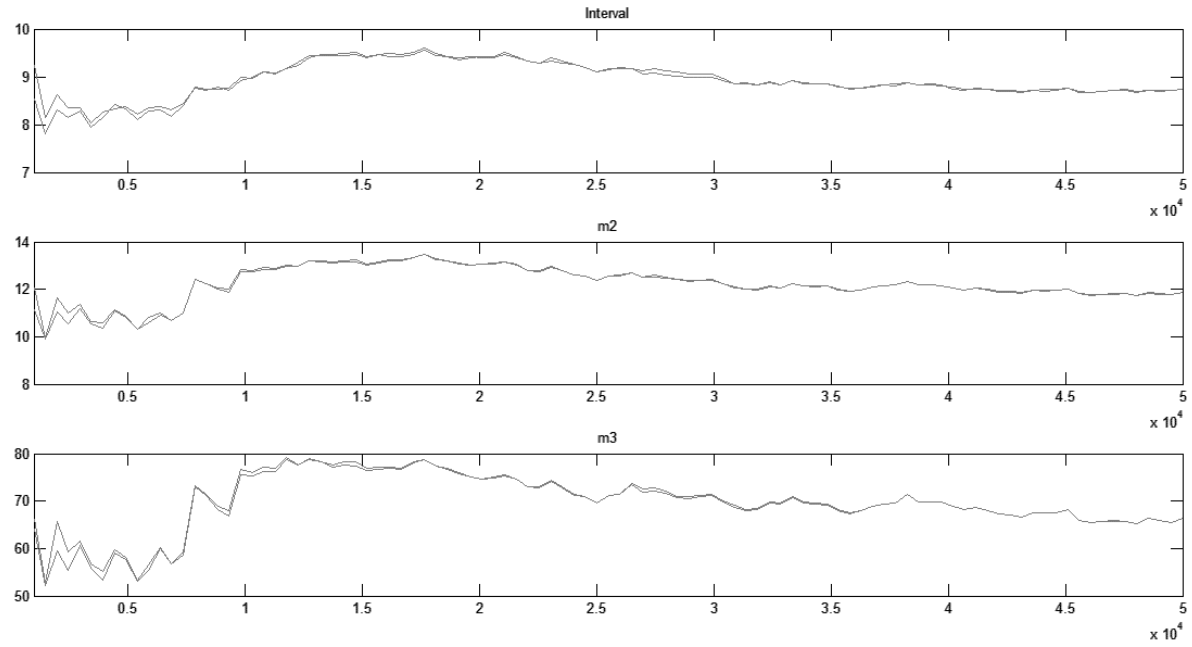

Figure 1. Brooks and Gelman multivariate diagnostic test

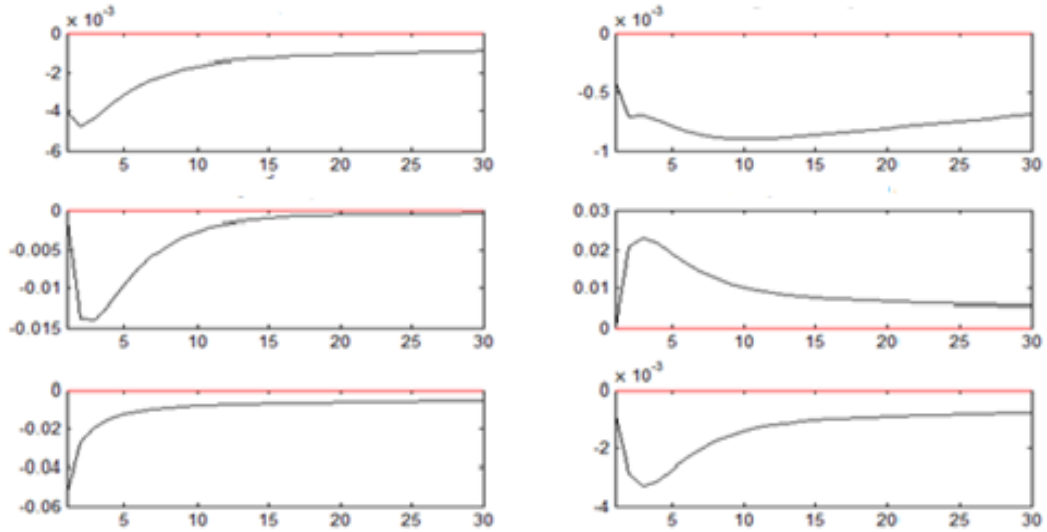

Figure 2. Response of variables and operating costs of non-governmental banks to the e-banking index shock

Considering that the expansion of the use of electronic payment and receipt tools has led to a reduction in operating costs, it should be noted that banks in the country incur high costs for creating, equipping and maintaining the quality of services in branches. Costs increase the cost of money in the banking network. Over the past years, however, the development and diversification of banking tools and methods and electronic payment have had a great impact on reducing and preventing a sharp increase in banks' operating costs. It has an investment aspect and will have the necessary return over time.

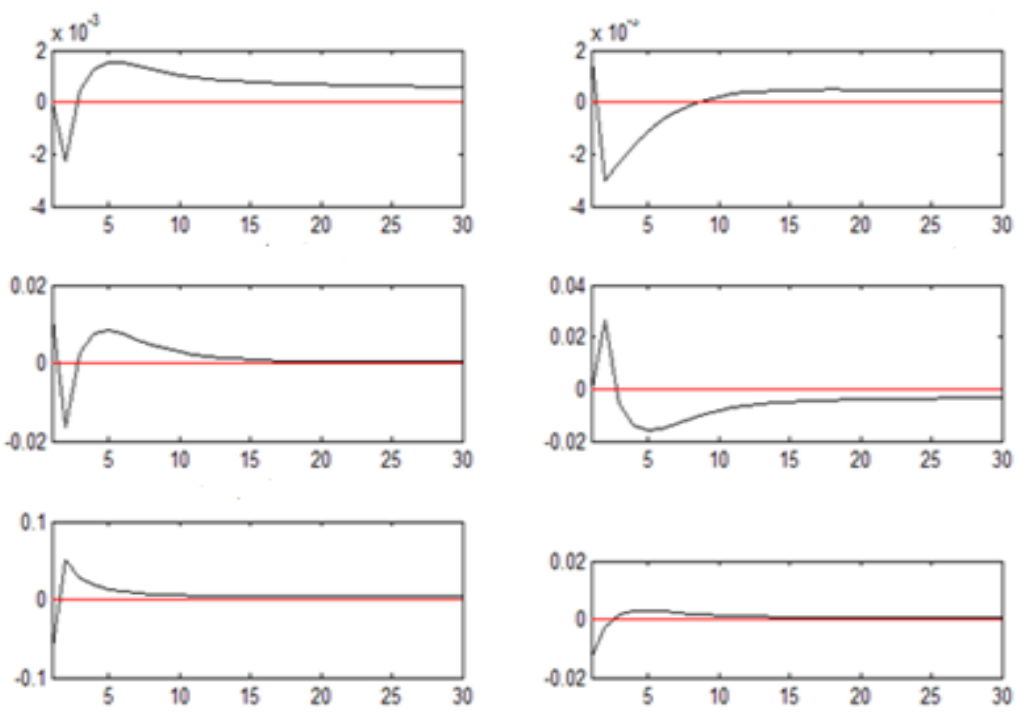

Figure 3. The response of macroeconomic variables and operating costs of state-owned banks to the e-banking index shock

It can be said that today information technology has had a tremendous impact on the banking industry. Banks and financial institutions have also established their presence in the field of new technology with various goals. The use of new technologies in the banking system is an undeniable necessity. The results of the shock from the e-banking index to measure the effects of the expansion of the use of electronic payment and payment instruments on operating costs can be seen that non-governmental banks have significantly higher operating costs than state-owned banks. On the other hand, it can be seen that the increase in bank operating income in non-state banks has been more than state-owned banks. In the macroeconomic dimension, it can be seen that the shock from the e-banking sector has led to an increase in production and investment in the economy. In addition, the results indicate that with the increase in e-banking indicators, the amount of manpower and payments made for the labor force has also been affected. Given that one of the factors that leads to an increase in the cost of equipping financial resources in the banking network is the low rate of productivity in branch operations and high operating overhead costs. However, the development and diversification of banking tools and methods and electronic payment have had a significant impact on reducing the operating costs of banks. It will have the necessary returns over time. Accordingly, it can be seen that the shock from the use of electronic banking and payment instruments has led to a reduction in operating costs and an increase in profitability. Accordingly, reducing common operating costs, such as branch services and online transaction costs, will greatly reduce the cost of equipping resources in the banking network and the cost of sustainability of the payment network and e-banking, respectively. Reduce some of the problems of access to cheap banking resources for the real sector of the economy in Iran.

Given the positive effect of e-banking on reducing operating costs and increasing the profitability of banks, the need for more attention to this issue becomes apparent. Banks need to

develop e-banking in order to be more profitable, more attractive and more productive, on the one hand, and to increase customer satisfaction and attract more deposits, on the other hand.

Conclusions and suggestions

Considering the effect of electronic banking on banking costs and the relationship that this institution has with different economic sectors such as households and businesses and the role it can play in transmitting various shocks to different economic agents and macroeconomic variables, modeling in this study from the area of electronic banking components, banking costs are discussed in the framework of random DSGE models. The results of the shocks in the e-banking index indicate that e-banking indices have a significant effect on bank costs. The use of electronic tools leads to a greater reduction in operating costs of non-governmental banks than banks has been government. On the other hand, it can be seen that the increase in bank operating income in non-state banks has been more than state-owned banks. In the macroeconomic dimension, It can be seen that the shock from the e-banking sector has led to an increase in production and investment in the economy. In addition, the results indicate that with the increase in e-banking indicators, the amount of manpower and payments made for the labor force has also been affected. Citing the positive effect of e-banking on reducing operating costs and increasing the profitability of banks, the need More attention to this category becomes apparent. Banks should strive to develop e-banking in order to be more profitable, more attractive and more efficient, on the one hand, and increase customer satisfaction and attract more deposits, on the other hand. According to the results obtained from this research, It can be stated that the expansion of competition along with extensive developments in the field of trade and banking, has transformed many traditional methods and has created a competitive atmosphere in the use of new technologies. The banking system is no exception to this rule and with the emergence of new concepts in banking, the way of providing services to customers around the world has changed. It is obvious that the provision of e-banking services in Iran requires extensive changes. These changes are essential in the process of implementing e-banking. Therefore, software in the field of electronic banking such as ATMs, digital telephone systems, credit cards, smart cards and diversification of methods and tools can be among the corrective measures in this field.

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