Investigating Impact of macroeconomic variables on the government budget deficit in Iran's economy: an approach with VAR-VECM

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ABSTRACT

The economic tasks of governments are the optimal allocation of resources, fair distribution of income, and economic stability; the budget is the most important economic tool for achieving these goals. Governments are incapable of implementing balanced budgets for various reasons and face a budget deficit to finance their current development expenses. The budget deficit in an economy is measurable by the difference between government revenues and payments; it is an important policy tool in developing countries. The state budget situation is important for government policy and its role as an economic policy tool. The study of the effect of macroeconomic variables on the government budget deficit through a model of correction of vector error in the period 2001-2018 was the goal of this research. The results show that in the Iranian economy during the period under study, the variables of the economic growth rate and the exchange rate have been reversely associated with the budget deficit, while the variables of the inflation rate and the supply of money have had a direct impact on the government budget deficit. The effect of interest rate changes has not been significant on the budget deficit.

KEYWORDS: Budget deficit, Economic growth, Inflation, Exchange rate

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1. Introduction

The most important economic tasks of governments are the optimal assignment of resources, the equitable division of income, and forming economic stability (Jafari Samimi, et al, 2015). Government expenditures and revenues constitute the two main pillars of the budget; because for various reasons, the governments' income does not meet their expenses, they cannot implement a balanced budget and face a budget deficit to meet their current and construction expenditures.

The budget deficit in an economy is measurable as the difference between government revenues and payments. As for the income, the items are the income from oil and gas exports, taxes, currency sales, monopolies and government ownership, sales of goods and services, interest received for government loans abroad, etc. The expenditures are current and construction payments, grants, etc. (Mohammad zadeh, 2017). Because of the high current payments, which include a huge part of the government's payments, the government cannot provide construction payments, and this budget deficit cycle continues every year.

Based on the statistics of the Central Bank of the Islamic Republic of Iran (Figure 1), during the period from 1989 to 2015, the government implemented five economic, social and cultural development programs in the country. In this period except for the years 1994 (in the first development plan), 1995 and 1996 (in the second development plan), and 2001 (in the third development plan), when the general budget of the government faced a surplus, in other years it has always experienced a budget deficit (Moulai and Abdian, 2017). In recent years, the increase in the budget deficit without oil revenues in Iran has reached an alarming level in terms of the financial independence of the government and reducing dependence on oil, and in 2017, it shows the largest amount of deficit.
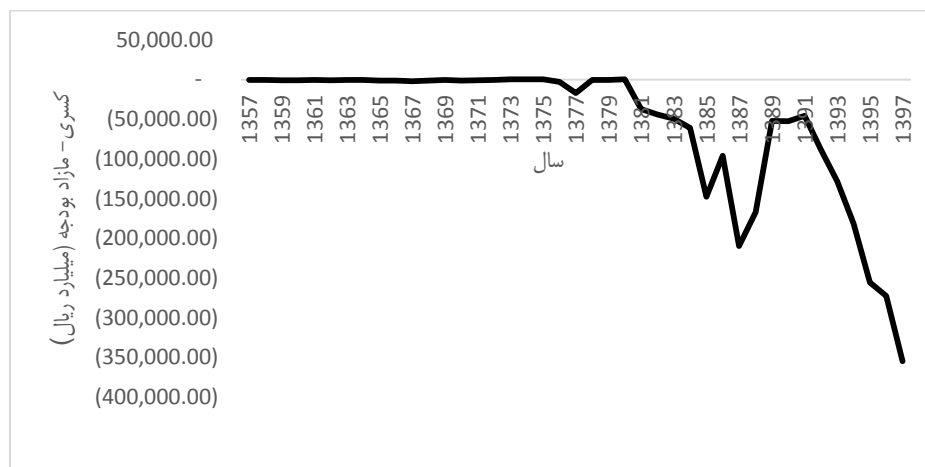

Figure (1): Budget deficit trend in the period 1978-2018
Source: Central Bank data

With the increase in the budget deficit, depending the government's budget on oil has increased, and providing the government's consumption expenses from tax revenues has not been realizable. It is associated with an increase in the operating balance and increases the dependence on the foreign exchange reserve account. Because of the stickiness of government expenses and depending revenues on oil revenues, the government budget deficit will increase. The large size of the government and the predominance of current expenses over construction expenses based on oil income have shaped the structure of the government's general budget so that from the middle of every year, the lack of the resources predicted in the annual budget law is raised and ends by borrowing or provision by the central bank. The accumulation and growth of liquidity pave the way for the conditions for the decrease in the value of the national currency and the increase in the general level of prices (Eslami et al., 2013). The increase in the budget deficit causes inflation, which intensifies the trend of the budget deficit.

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We should note that the budget deficit as a political tool plays a key role in achieving economic stability, poverty reduction, income distribution, and sustainable growth. Most governments use budget tools as effective tools to achieve their economic goals. This means that accumulating the government budget deficit should not be considered an inappropriate political goal (Samimi, 2013). In our country, since the budget deficit has grown in recent years and increased inflation in the country, it has become a problem for government policymakers who use different working procedures to provide it. The problem of the budget deficit and the ways of providing it in the country affects all sectors of the economy and macroeconomic variables. Since the trend of the budget deficit has increased in recent years, this research studies the impact of macroeconomic variables on the government budget deficit in the Iranian economy.

In the following sections, we have discussed the theoretical foundations of the research, the research method, the analysis of the findings, the conclusion, and suggestions.

2. Theoretical Foundations

The literature on public sector economics mentions two structural and non-structural sources for the government budget deficit. The structural origin of the government budget deficit is the lack of coordination in the government's public income and expenditure in the long-term period. Investigations show that in some situations, this lack of coordination results from prioritizing macroeconomic goals and policies, such as increasing construction expenditures and considering strengthening economic and social infrastructure in the long term. As for the non-structural origins, creating foreign networks like drought, oil price reduction, and economic sanctions are among the factors in reducing the government's revenues and creating the government's budget deficit (Eisavi and Qelich, 2014). Thus, since the government carries out all its financial activities, including earning and paying for implementing its many programs, within the framework of the budget law, the budget is linked with macroeconomic variables, including economic growth, exchange rate, inflation rate, interest rate, and money supply. Therefore, we should examine the impact of budget deficits on economic variables in terms of economic theories.

• Economic Growth

Based on the theoretical foundations and according to the theories of economic growth and GDP growth, the tax base channel can provide the conditions that the tax revenue increase and the budget deficit also decrease. The expectation is that the economic growth rate has an inverse relationship with the budget deficit (Komijani and Varahrami, 2011 Rahman, 2012).

According to the classical economists' point of view, reducing taxes leads to an increase in consumption expenditure and the total demand in the short term; so the level of production and employment increases, which increases economic growth and the government's income. It causes a decrease in the government budget deficit. Keynesian economists believe that the government's budget deficit can cause economic growth, unlike the increase in interest rates. According to this view, the budget deficit, when used for infrastructure investment, provides the possibility of increased production and helps improve economic growth (Moulai and Abdian, 2017).

• Inflation

In the economic literature of the public sector, the channel of inflation's effect on the government budget deficit is through its effect on tax revenues. This process is known as the Tanzi effect in public sector economics. Because Tanzi (1987) first presented it. According to the Tanzi effect, an increase in the inflation rate can reduce real tax revenues in developing countries, whose reason is the delay in paying taxes in these countries. In this situation, the longer the delay in tax payment and the more inflexible the tax system, the higher the impact of the inflation variable on the real tax revenue, which increases the budget deficit in these countries.

Tanzi's effect is reversed in developed countries; because in these countries, inflation increases real tax revenues. In this situation, the problem of these countries is to organize their approach to neutralize the adverse effects of this increase. An increase in the inflation rate leads to an increase in real tax revenues in conditions where a) the tax collection intervals are short; b) the tax system is elastic. When tax revenue

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collection is done with delays and long breaks in a country and the price elasticity of tax revenue is less than one, the result of the impact of inflation can be different, especially when the inflation rate is at a high level. In countries that have these conditions, inflation causes a decrease in the government's real tax revenues (Farzin Vash et al., 2012).

Patinkin (1993) has also explained the effect of inflation on the budget deficit through real government expenditures. According to Patinkin's theory, when the demand for expenditures is more than the government's income, the government can use the method of borrowing from the central bank to meet the required expenditures. This method of providing expenditures will increase the inflation rate and will reduce the government's real expenditures. The negative effect of inflation on real government spending is known as the Patinkin effect. Inflation from the area of incomes and the activation of the Tanzi effect causes amassing the government budget deficit and its aggravation. Inflation affects government expenditures from the side of costs and affects the budget, depending on economic conditions and inflation (Momeni et al., 2010).

In the view of monetarist economists, a two-way causal relationship between budget deficit and inflation is confirmable. In this way, the increase in the budget deficit because of the increase in government spending creates the basis for the growth of liquidity, which causes an increase in inflation. Causing the increase in inflation is the increase in government expenditures, which increases the government budget deficit (Koyuncu, 2014).

• Exchange rate

Exchange rate changes in the macroeconomy affect the macroeconomy from the two areas of total demand and total supply. In Iran's economy, where foreign exchange sources of oil exports provide an important part of the government's income, the importance of the exchange rate is twofold. Because this rate affects the government's revenues and expenses. In this theoretical framework, the effect of the exchange rate on the government budget deficit is explainable: in the conditions of an increase in the exchange rate, the income of the government, which is provided by oil exports, increases; the expenses of the government increase because of the increase in the exchange rate. Because of the increase in the exchange rate, the government's expenses increase both from the side of produced consumer goods and the side of imported goods. The exchange rate can have a positive or negative effect on the budget deficit depending on the number of changes in the government's expenses and revenues (Baradaran Khanian, 2016).

• Money supply

The money supply is a variable that affects inflation, and a continuous increase in money supply leads to an increase in inflation. There is a two-way cause-and-effect relationship between budget deficit and inflation. The increase in inflation has caused an increase in expenses and a decrease in income, so the budget deficit will remain constant. Here, the government borrows from the banking system to compensate for its budget deficit, which leads to the growth of the money supply. An increase in the money supply will increase demand and consumption, and because the total supply cannot meet the total demand, prices will increase and lead to an increase in inflation. Therefore, we can see that the budget deficit is a vicious cycle that affects liquidity and inflation (Hosseinipour, 2016).

The increase in the amount of money in the economy has led to an increase in the general level of prices, which causes an increase in government expenditures and an increase in non-petroleum revenues of the government so which increases or aggravates the budget deficit (Emami Meybodi and Karimzadeh, 2012).

3. Research method

The current research investigates the impact of macroeconomic variables on the budget deficit. The econometric model for this investigation of the Iranian economy follows a study conducted by Epaphra (2017). It is as the equation (1):

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$$\ln(BD_t) = \varepsilon_0 + \varepsilon_1 \ln(GDP_t^{real}) + \varepsilon_2 \ln(P_t) + \varepsilon_3 \ln(R_t) + \varepsilon_4 \ln(M_t)$$
$$+ \varepsilon_5 \ln(ER_t) + u_t \tag{1}$$

In this equation, BD_t is the government budget deficit, GDP_t^{real} is a real gross domestic product, P_t is the inflation rate, R_t^l is the interest rate, M_t is money volume, and ER_t is the exchange rate. The government budget deficit is a dependent variable and the variables of real gross domestic product, inflation rate, interest rate, money volume, and exchange rate are the independent variable. This research will test the following hypotheses:

H1: The economic growth rate has an inverse and significant effect on the government budget deficit in Iran's economy.
H2: The inflation rate has a direct and significant effect on the government budget deficit in Iran's economy.
H3: The exchange rate has an inverse and significant effect on the government budget deficit in Iran's economy.
H4: Money supply has a direct and significant effect on the government budget deficit in Iran's economy.

Nowadays, one of the best methods to investigate the relationship between variables presented in equation (1) is the use of Johanson's co-integration test, which estimates long-term and short-term relationships between variables. This method has three important limitations: 1) Estimates do not have asymptotic efficiency. 2) Hypothesis testing cannot be done on the coefficients. 3) If there is more than one equilibrium vector, the OLS method does not provide consistency estimation from any of the co-accumulated vectors. The basis of their work is a VAR (vector autoregression) model to get a vector or vectors of co-integration. In the VAR model, the behavior of a variable is explainable based on the past values of that variable and several other variables. If the variables in the VAR model are non-durable, there is a possibility of an equilibrium relationship (co-accumulation) between them; we can show that a vector error correction model (VECM) is also provided for each VAR model (Suri, 2014).
The reason for using the co-integration method is to avoid occurring false regression. Most macroeconomic time series move in the same direction, which is because of existing a trend that is common to all of them. If time series variables that are unstable are used in estimating the coefficients of model variables, it may cause a false regression. This method is used only when the trend of the variables is a definite trend. When the time series variables are not stable trends, using the usual econometric methods invalidates the t and F tests and leads the researcher to wrong conclusions. One solution is to use differing each variables in regression, but through this method, we lose valuable information regarding the level of the variables. Therefore, although by using the difference of the variables, the reliability condition of the variables can be provided, we can nothing do for maintaining long-term information regarding the level of variables. This is where the co-integration method helps to estimate the regression without fear of falsity based on the level of time series variables. Johanson and Juselius (1988) first introduced this method. After proving the co-integration relationship, we can estimate it as a single equation or multiple equations, but when the number of variables involved in the co-integration regression is over two variables, it becomes possible to have more than one co-integration vector. Here, the use of multi-equation models will be useful, the most famous of which is the vector error correction model (VECM) (Nofarsti, 2018).
As for the estimation of co-accumulative vectors using Johanson's method, first, we should determine the optimal interval length and secondly the type of co-accumulative relationship model. For this purpose, in the first step, the durability of the variables is examined to determine accumulation (number of unit roots). To examine the durability of the variables, there are augmented Dickey-Fuller tests, Phillips-Perron test,

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Levin test, Pesaran and Shin test, and KPSS (Kwaitkowski, Philips, Schmidt, and Shin) test. This study used the KPSS method to check the durability of the model variables.

After checking the durability of the variables, we should determine the number of optimal intervals of the model, which guarantees that the error sentences of the vector error correction model (VECM) are white noise. The most common method for determining the number of optimal intervals is to estimate a vector autoregressive model (VAR) using the data level and then the tests to determine the length of the optimal intervals. Entering a variable with many intervals causes errors in the prediction, and a variable with a few intervals causes unusual results, so experience, knowledge, and theory are necessary to determine the number of optimal intervals. Most of the software report criteria for determining the number of optimal intervals, such as the Schwarz Information Criterion, Akaike Information Criterion, and Hannan-Quinn Information Criterion. The likelihood ratio test can also determine the number of optimal intervals.

Johansen-Juselius's method determines the long-term equilibrium relations (co-integration vectors). The number of long-term equilibrium relations is equal to at most n-1, where n is the number of exogenous variables. According to the co-accumulation theory, model estimation by the VAR method requires at least one convergence vector, which shows an existing long-term relationship between the variables. The likelihood Ratio test and Maximal eigenvalue determine Long-term equilibrium relationships. If the test statistics of these variables are more than the critical values at the 5% level, the opposite hypothesis is acceptable and, hence the number of co-integration vectors. Another problem that is raised at the same time as determining the number of long-term equilibrium relations is the examination of the necessity of considering the by-intercept and the time trend in the co-integration vectors and the short-term pattern of vector error correction. Johansson (1992) suggests that we test the necessity of introducing certain variables into the model by determining the number of long-term equilibrium relationships.

4. Findings

This research is applied research. It is a descriptive, analytical one and based on econometric models using VAR-VECM patterns. The time domain of this study is the period of 2002-2019. The library method and internal and external sources were suitable for collecting the research literature, and the economic time series database of the Central Bank of the Islamic Republic of Iran and the Iranian Statistics Center was appropriate for collecting the data of measuring the research variables. Statistical and econometric techniques were used to analyze the data and Eviews econometric software package for estimating the model.

First, the durability of the variables of the model was checked through the KPSS test for all variables at zero and one level. Table (1) shows the results of the durability test. For example, the value is 0.529 for the government's budget deficit variable at the zero level. This value is greater than the critical values at the 5% level. Based on this, the null hypothesis that the variables are durable is not confirmable. Based on the statistical value in Table (1), this result is also confirmable for other variables. Therefore, none of the model variables was at the durable level, and the KPSS test is necessary for the first-order difference of the model variables. The results of the table show that the value of the KPSS statistic is 0.197 for the first-order difference of the budget deficit variable. This value is smaller than the critical values at the 5% level (0.216) and so the null hypothesis is confirmable based on which the variables are durable at this level. Based on the value of the KPSS statistic, this result is confirmable for other variables.

Table 1: Durability results of variables using the KPSS test

Time series		KPSS statistic at zero level	Critical values	Result	KPSS statistics at one level	Critical values	Result
Government budget deficit	Critical values with the trend	0.529	0.146	Durable	0.197	0.216*	Durable
	Critical values	0.893	0.463		0.614	0.739**	

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	without trend						
Volume of money	Critical values with the trend	0.586	0.146	Durable	0.203	0.216*	Durable
	Critical values without trend	0.917	0.463		0.682	0.739**	
Real GDP	Critical values with the trend	0.329	0.146	Durable	0.212	0.216*	Durable
	Critical values without trend	0.489	0.163		٠/٧٢٢	0.739**	
Inflation	Critical values with the trend	0.708	0.146	Durable	0.209	0.216*	Durable
	Critical values without trend	0.865	0.463		0.708	0.739**	
Interest rate	Critical values with the trend	0.458	0.146	Durable	0.196	0.216*	Durable
	Critical values without trend	0.657	0.463		0.698	0.739**	

Source: research findings

The results of Table (1) show that all the variables of the model become durable after differentiating once. These variables are I(1). Since the condition for using the Johansen and Juselius method is that the variables are reliable, we can use this method to determine equilibrium relationships.

After examining the durability of the variables by estimating a vector autoregressive model (VAR) using the level of data and then using relevant tests, we determine the optimal length of the interval. Akaike, Hanan-Quinn, and Schwartz-Baysin criteria are usable. We used the Schwartz-Baysin criterion because it follows the principle of saving, is more suitable for small data, and suggests a lower optimal interval. Its results are presented in Table (2).

Table 2: Determining the optimal interval of the model

Number of intervals	1	2	3	4	5
Value of Schwartz-Bayesian statistic	-2.14	-2.48	-2.59	-2.36	-2.24

Source: research findings (* shows the optimal interval)

Now, with the described method, we determine the number of co-integration relations and the pattern. The quantity of the effect test statistic and the maximum eigenvalue of estimating the five mentioned patterns have been calculated by Eviews software. According to Table (3), all test statistic quantities listed in the first row of this table are greater than the critical values presented by Johanson and Juselius. As a result, the null hypothesis is rejected in all five mentioned models. Now we test the hypothesis of existing one co-integration vector against two or more co-integration vectors. Based on the results of the Trace test, this hypothesis cannot be rejected in all five patterns. Therefore, an existing co-integration vector is confirmable. Since the first time the null hypothesis is not rejected is in the first pattern, this pattern should be acceptable. Considering that the first and fifth cases are less likely, we can disregard these two patterns and investigate the other three patterns. By discarding the first pattern, the second pattern will be acceptable. Of course, based on the eigenvalues test, there is a possibility of having 2 co-

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integrative vectors in patterns 1 and 2, so in the first 2 patterns, the results of the Trace test and the maximum eigenvalues regarding the number of co-integrative vectors are not the same. In such cases, a smaller number of vectors should be used as a reference. Therefore, co-accumulation analyzes are performed based on one-dimensional co-accumulation space, so according to the results of the Trace test and the maximum eigenvalues test, a co-accumulation vector among the variables of the model is confirmable.

Table 3: Comparison of the results of the Trace test and the maximum eigenvalue test for the number of co-integration vectors

Number of co-integration vectors	Pattern type	First pattern	Second pattern	Third pattern	Fourth pattern	Fifth pattern
	Trace test	1	1	1	1	2
	Test of maximum eigenvalues	2	2	1	2	1

Source: Research findings

Using the results, we estimate the model. Table (4) presents the results of estimating the model.

Table 4: Estimation results of the co-integration vector for the variables of the model

Variable	Coefficient	P-Value	Statistic t
GDP_t^{Real}	-0.76	**0.031	-3.48
ER_t	-0.53	***0.000	-5.16
M_t	0.08	**0.048	2.01
r_t	0.2	0.17	1.31
P_t	0.12	***0.000	6.39
C	-3.94	0.11	-1.56

Source: Research findings
** shows significance at the 5% level and *** shows significance at the 1% level.

Based on the results, we can see that the GDP coefficient is negative. The value of this effect is 0.76%. With a one percent growth of GDP, the budget deficit decreases by 0.76%. According to the t statistic, the coefficient of this variable in the model is significant.

The relationship between the exchange rate and the government budget deficit has been reversed so that with the increase in the exchange rate, the government budget deficit has decreased and the value of this effect has been 0.53. This means that with a one percent increase in the exchange rate, the government budget deficit will decrease by 0.53 percent. According to the t statistic, the coefficient of this variable in the model is also significant.

The coefficient of the effect of the inflation rate on the government budget deficit is also positive and significant. This means that in the Iranian economy during the period under study, the increase in the inflation rate has caused an increase in the government budget deficit, and the relationship between the changes in the inflation rate and the government budget deficit is direct. The coefficient of this variable in the model is 0.12. With a one percent increase in the inflation rate, the government budget deficit increases by 0.12 percent.

Based on the estimation results of the model, the effect of the amount of money on the government's budget deficit has become positive and significant, so with the increase in the money in the Iranian economy, the government's budget deficit has also increased. This means that with an increase of one percent in the money, the budget deficit has increased by 0.08 percent.

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5. Conclusion and Suggestions

This part of the study discusses research hypotheses, and results analysis, and then presents research proposals.

According to the results of the study, economic growth has an inverse and significant effect on the government budget deficit in Iran's economy. According to the presented theoretical foundations, the growth of the GDP through the tax base channel increases the tax revenue and thus reduces the budget deficit. According to classical economists, with the increase in economic growth, the level of production and employment increases, the government's income increases, which can cover its expenses, and the budget deficit decrease. Thus, the results of the study are consistent with the theoretical foundations.

Now, the inflation rate has a direct and significant effect on the government budget deficit in Iran's economy. We already said that the effect of inflation on the government budget deficit is according to the Tanzi effect. According to this effect, with an increase in the inflation rate in developing countries, real tax revenues decrease and cause an increase in the budget deficit in these countries. For monetarist economists, there is a two-way causal relationship between the budget deficit and inflation, where the increase in inflation causes an increase in inflation and an increase in the budget deficit.

The result of estimating the model of this research also shows that in the Iranian economy during the period under study, there is a direct relationship between the changes in the inflation rate and the government budget deficit. This result is consistent with the studies of Ziyai Bidgoli and Maghsoudi (2006), Moulai and Abdian (2017), and Komijani and Varahrami (2013) and with the stated theoretical foundations; so the research hypothesis based on the direct relationship between inflation and the government budget deficit is confirmable.

According to the results, the changes in the exchange rate have an inverse and significant association with the government budget deficit in the Iranian economy. This stems from depending on Iran's economy on oil export revenues, so that with the increase in the exchange rate, the government's foreign exchange income increases, and with the increase in the government's income, the deficit decreases. Although some import costs of the government increase with the increase of the exchange rate, the effect of this variable are greater because of relying the economy on oil revenues.

As for money supply, which is a variable affecting inflation, the expectation is that with the increase in money supply, inflation will increase, and the budget deficit too. Because of the increase in the budget deficit, the government uses more borrowing from the central bank and increases the amount of money, this increase in the volume of money causes an increase in demand, which increases the volume of prices and increases government expenditures, which leads to a larger budget deficit. Dehghani et al. (2018) and Hosseinipour (2018) also concluded in their research that there is a positive and significant relationship between the government budget deficit and the growth of the money supply in Iran's economy. Therefore, the research hypothesis that the money supply has a direct and significant effect on the government's budget deficit in Iran's economy is confirmable.

Based on the results, the economic growth rate and exchange rate have an inverse relationship with the budget deficit, and the inflation rate and money supply have a positive and significant effect on the government budget deficit in Iran's economy. The following recommendations were put forward based on the research findings:

Reducing expenses and financial discipline should be first on the agenda of the government to reduce the budget deficit, to direct it on a favorable path.

Economic growth reduces the government's budget deficit; therefore, appropriate policymaking to improve economic growth is the most efficient way to solve the government's budget deficit problem. Adopting this policy, besides solving the problems of inflation and unemployment in the economy, also lays the foundation for reducing the budget deficit.

According to the results, the increase in the volume of money in Iran's economy causes an increase in the government's budget deficit. When the government is facing a budget deficit and finances this deficit through borrowing from the central bank this policy itself, because of its inflation effects on the economy, will cause the government's budget deficit to increase again in the next period, so policy making that is appropriate to finance the budget deficit is needed.

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Based on the results, the increase in the exchange rate in the Iranian economy reduces the government's budget deficit. This effect is because of depending Iran's economy on the currencies got from the export of oil and gas. Of course, we should note that if the export of these products decreases for any reason (like economic sanctions), the increase in the exchange rate will only cause inflation in the country. Therefore, adopting the policy of increasing the exchange rate to reduce the government's budget deficit is not a suitable policy. This policy can be effective when it provides the foundation for increasing production, employment, and export of other products. Investigating the extent and direction of the impact of trade openness, financial development, export and import, and even economic sanctions on the government budget deficit is one thing that the author suggests for future research.

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ETHICAL CONSIDERATION

Authenticity of the texts, honesty and fidelity has been observed.

CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.