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Investigating the Role of Monetary and Fiscal Policy Tools on Economic Growth Using Dynamic Simulation and Fuzzy Control Approach

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Abstract

In this study, a macro-economic model consisting of twelve behavioral equations and fourteen identity equations was estimated with the aim of investigating the effectiveness of monetary and fiscal policies set out in the fourth and fifth development plans. In the estimated model, the variables of development expenditures, current expenditures and tax revenues are used as fiscal policy tools and variables of liquidity and long-term interest rates of bank were used as monetary policy tools. The results of solving the model using a dynamic simulation showed that by the implementation of this scenario, one can achieve a steady growth rate for model's endogenous variables during the period and reduce its deviation from target values. Then, a fuzzy control system was designed with the aim of minimizing deviations and changes in the deviation of non-oil GDP from the values determined in the fourth and fifth development plans. Liquidity variables and government development expenditures were used as control tools in this system. Results obtained from the fuzzy system showed that using control rules, the growth rate of liquidity can be put at a lower level and growth rate of development expenditure around quantified targeted values in the fourth and fifth development plans. Also, the oscillation amplitude of the inflation and growth rates of non-oil production can also be reduced.

Keywords: Fiscal and Monetary Policy, Fourth and Fifth Development Plants, Simulation and Fuzzy Control Methods.
JEL Classification: O1, O23, C53.

1. Introduction

Determining the consistent composition of monetary and fiscal policy to achieve macro-economic objectives has always been controversial

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among economists. The earliest discussions on this case dates back to the struggle between the classical and Keynesian economics and discussions about the dominance of influence of a policy over the other. Since the 1980s, economists came to believe that to achieve the goals of economic stabilization policy; perhaps the best solution is to use a combination of consistent monetary and fiscal policies. In fact, in planning a comprehensive plan to achieve the policy stabilization goals, besides determining the optimal route for each of the fiscal and monetary policies, optimal and compatible route to combine monetary and fiscal policies needs to be considered. Determining a consistent route for combining monetary and fiscal policies would minimize the externalities and adverse effects that results from the implementation of policies on the economy.

Since 1948, medium-term economic plans have been designed to achieve economic and social goals in the economy of Iran. In 2005, a perspective plan was designed till 2025 with the aim of achieving long-term economic and social goals. To achieve these goals and ensure that the economy is placed in the long-term growth path, short-term quantitative targets are designed in the sectoral and sub-sectoral areas in the form of five-year medium-term development plans and it is expected to achieve long-term growth path through realization of these objectives. By the ending years of the fifth development plan and glancing at the trend of macro-economic variables such as economic growth, inflation, budget deficit and trade balance, it is observed that during these years the rate of realization of development goals was low and no acceptable value is obtained for these variables.

Given the importance of setting a consistent combination of monetary and fiscal policy as the most important demand-side policies that can put the economy on a path of long-term growth and development, in this study, using dynamic simulation the efficiency of quantitative targets for monetary and fiscal policies of the Fourth and Fifth Development plans is investigated during 2005-2016. Bank liquidity and long-term interest rates have been used as monetary policy tools and development expenditure and tax revenue are used as fiscal policy tools. In addition, the quantitative amount of monetary and fiscal policy instruments were determined using fuzzy control, with the aim of minimizing the deviation of realized non-oil GDP out

of targeted values in the fourth and fifth development plan. Liquidity and development expenditures were used as control variables in this system. So at first, to determine this subject, we summarized a review on the theatrical background of fiscal and monetary policy, and thereafter, research Literature and methodology are explained. At the end, summary and conclusion of the article are expressed.

2. Theoretical Foundations

Until the 1980s, monetary policy was controlled by financial policy makers in many countries, but the debate of independence of central bank and inflation targeting was raised after Friedman's monetary recommendations (Niemann & Hagen, 2008). With increase of the central bank independence and liberation of monetary policy from financial domination, monetary and fiscal policy coordination issue drew the attention of several economists (Melitz, 1997; Hagen et al., 2001). Regardless of independence or dependence between the two policies which creates externalities and uncertainty in the results of the implementing policy, mutual interaction between monetary and fiscal policies exists. Cooper (1969) and Tinbergen (1954) in their study showed that ignoring the interaction between monetary and fiscal policies creates financial instability, imbalance and failure to achieve the goals which will in turn impose costs on the economy. In fact, since the 1980s, economists began to believe that to achieve the goals of economic stabilization policy; perhaps the best solution is to use a combination of consistent monetary and fiscal policies. Nordhaus (1994) also stated that the lack of coordination between monetary and fiscal policy creates a sub-optimal mix of policies. To achieve a harmonious combination of the two policies, policy-makers can make decisions on the application of policy using a set of rules or constant contact with each other. In fact, policy-makers choose the most efficient method due to particular characteristics of each country and the degree of development of its institutions (Laurens & Piedra, 1998). The lack of efficient coordination of policy causes financial instability, high interest rates, and upward pressures on the exchange rate, inflation and adverse effects on economic growth.

3. Research Literature

Udah (2009) examined the mechanism of monetary policy effectiveness on various sectors of the Nigerian economy using an open macro-economic model in the 1970 to 2004 period. The model was divided into six sections, including monetary, fiscal, production, an aggregate demand, labor market and the external sector which consists of eighteen behavioral equations and thirteen identity equations. After estimating the model and confirming its accuracy, dynamic simulation results showed an increase in the fiscal deficit and increases the rate of growth of money supply. Also, the discipline in the financial sector could be increased by increasing the budget discipline. Five percent growth in the money supply will reduce inflation, production, imports of raw goods, and imports of capital goods and increase domestic consumption. The higher levels of growth rate of money supply will increase growth production, employment and price levels. The inflation results also showed that inflation equation in Nigeria was created by internal and external factors. Money supply, economic openness and the competitiveness of the external economy affects internal factors. Finally, it was recommended that by increasing credit to the manufacturing and technology sectors, the manufacturing sector can be strengthened and inflation reduced. In addition, the use of exchange rates and bank credit as a tool of monetary policy will increase the effectiveness of monetary policy.

Imoudu et al. (2012) tested and evaluated the effects of monetary and fiscal policy on the Nigerian economy in the context of an open macro-economic model for the period 1970 to 2009 in Nigeria. The model consists of three parts: internal, external and monetary sections and six behavioral equations and two identity equations were used to explain the model. After estimating equations and verifying the accuracy of the model using the dynamic simulation technique, the response of endogenous variables to changes in independent government expenditures and interest rates were investigated. The results showed that monetary and fiscal policies are important in stabilizing the economy of Nigeria and monetary policy of interest rate have more potentials in the stabilization process than the fiscal policy of government expenditures. Also, the fiscal policy of government expenditures in long-term adjustment policy for economy management and the power of monetary policy declines over time and over a long period of time.

Jafari et al. (2006) investigated optimal monetary and fiscal policies using Stochastic Optimal Control Algorithm for the third development plan in the floating exchange rate system. In this study, consumption and government investment expenditures to nominal prices, tax revenue and liquidity are used as control variables. In addition, GDP, economic growth, inflation and unemployment are the main target variables and percent budget deficit to GDP, private sector consumption expenditures and private sector investment expenditure to constant prices and current account balance are the target secondary variables. The equation system of the study involved two groups of behavioral and identity equations. The results showed that in the floating exchange rate system, Optimal Monetary Policy has less expansion with respect to the proposed monetary policy of the third plan. Furthermore, in the floating exchange rate system through obtaining monetary and fiscal policies proposed by the third plan, economic growth has a considerable deviation towards the goals of the third plan. Also, the volatility of economic growth indicates the non-stabilization of macro-policies being proposed by the third plan. Using the optimal macro policy stabilizes the economic growth with very low bias around the desired economic growth of the third plan. By adopting an optimized macro policy, the balance of the current account and budget deficit to GDP was not only improved in comparison with the results of the proposed policies of the third plan but also it was the case with the goals of the third plan, such that in the first three years the surplus in the current account and government budget became possible.

Shakeri et al. (2007) designed optimal routes for control and state variables in the second, third and fourth plans for the development of the Iranian economy. In this study, the system of equations was estimated using 2SLS in the period between 1963 and 2000. Results of the optimal control showed that in the second, third and fourth development plans based on the use of different scenarios, it can be concluded that the determined optimal routes by policy-makers for monetary policy tools are more efficient than the determined optimal paths for fiscal policy tools and by guiding fiscal policy tools toward their desired values, one cannot achieve many other goals intended for other variables. Furthermore, approaching the optimal path of

employment becomes possible through high deviation cost of other target variables than their desired target variables and the occurrence of instability phenomena. As a result the intended goals set by the development plans are exaggerated and inaccessible for unemployment rate. It was also proposed that the government should pay attention to the interaction and conflict between different objectives in order for the quantifying determination of the targets. It also seems that the intended purposes are appropriate for monetary policy tools and determining the constant growth rate of money supply increases the achievement of other goals. But the intended objectives for fiscal policy tools should be reconsidered.

Abdirad & Jafarzadeh (2009) studied macro-economic policies during the fourth development plan (2009 to 2005). In this study, an average macro-econometrics model was used for the economy of Iran. This model consists of 13 behavioral equations and 23 identity equations. The system of equations was estimated using ordinary least squares method and time series data from 2004 to 1960. After estimating the system of equations, the quantitative amounts of optimal monetary and fiscal policy were extracted using OPTCON algorithms. In this study, the current government expenditure, capital government expenditures, tax and oil revenues are introduced as fiscal policy variables and optimal balance of money as a monetary policy variable. In addition, the main objective variables include economic growth, inflation and unemployment rate and the secondary target variables include budget deficit to GDP. Target values for these variables have been determined in the Iranian development plan. The optimal control algorithm results showed that the optimal amount of current government expenditures, development government expenditures, government tax revenue are higher and optimal amounts of money are smaller than the amounts proposed in the fourth development plan. Using dynamic simulation method, the effects of optimized and proposed policy was also investigated on target variables. The results showed that using optimal policies, the time path of economic growth rate was considerably more stable. The growth rate was significantly improved and inflation and unemployment decreased. The proposed optimal policy also compared with the proposed policies of the fourth plan reduced the budget deficit to GDP ratio to some extent.

By investigating the empirical studies on the effectiveness of monetary and fiscal policies it is concluded that the effect of monetary and fiscal policies on different economic sectors depend on the time frame of the study and the country's economic structure. The successful policy combination in one country cannot be used in another country with a different economic structure, thus, one cannot expect to achieve the same results. Also, by comparing the derived behavioral equations in these studies it was concluded that a significant degree of uncertainty exists about the precise values of model parameters. This uncertainty has an impact on the use of policy tools. To achieve the predetermined goals, it is necessary for policy makers in addition to considering the overall impact of policy tools to pay attention to the value of the reaction of the target variables to changes in policy tools.

4. Research Methodology

To probe the interaction of monetary and fiscal policies and the impact of these responses on other sectors of the economy in this study, an open macro-economic model was used. The model is divided into four parts including goods markets, labor market, money market and the government budget. Fourteen identity equations and twelve behavioral equations were used to describe the model. Behavioral equations which include aggregate supply function, private consumption expenditure, government consumption expenditure, private investment expenditure, public investment expenditure, exports of non-oil goods and services, imports of goods and services, demand for money, the consumer price index, tax revenue, function of employment demand and GDP implicit index were used. These equations were estimated using Autoregressive Distributed Lag (ARDL) during 1972 to 2005. Table 1 shows the estimated equations. The results of single-equation estimates showed that the signs of all equations' coefficients were conducted in accordance with theoretical expectations and empirical studies. The results of meaningfulness, recognition and stability tests also suggest that the estimated single-equations do not have the meaningless issue, fault of classic main presumptions and instability and that they could be used to create a macro-economic model. After estimating single-equations, they were solved simultaneously during 1972 to 2005

applying dynamic simulation method and using the Eviews 8 software package, so as to ensure efficiency and measure the validity of the designed equation models. After simultaneous solving of the equations, both quantitative index of *Theil's inequality coefficient or U* statistic and the Root Mean Square Percentage Error (RMSPE) were used to measure the validity of simulated macro model. These two indexes are calcalated as:

$$U = \frac{\sqrt{\sum (A_t - P_t)^2}}{\sqrt{\sum A_t^2}} \quad U = \frac{\sqrt{\sum (A_t - P_t)^2}}{\sqrt{\sum A_t^2}} \quad U = \frac{\sqrt{\sum (A_t - P_t)^2}}{\sqrt{\sum A_t^2}} \tag{1}$$

$$RMSPE = \sqrt{\frac{1}{T}\sum \left(\frac{A_t - P_t}{A_t} \times 100\right)^2} \tag{2}$$

whenever U is smaller and closer to zero, the model is better in simulating the trend of the real path of variables. Lewis (1982) and Delurgi (1998) determined four areas for comparison in predicting the power of models by the RMSPE index. If this index is below 10%, predecting the power of the model is best, if this index falls between 10 to 20%, the predecting power of the model is good, if this index is between 20 to 50%, the predecting power of the model is acceptable, and if this index is beyond 50%, prediction is imprecise.

The results of these two index for the endogenous variables of the model are reported in Table 2.

Table (2): Quantitative Amounts of U and RMSPE Indexes

Variables	RMSPE	U	Variables	RMSPE	U
GDPR	2.03	0.01	GDPRNO	2.46	0.02
CPR	4.12	0.047	INVPR	9.68	0.09
INVGR	11.16	0.12	EXCS	14.59	0.12
IMR	11.77	0.11	M	3.43	0.02
EMP	0.83	0.008	CPI	6.20	0.046
TI	10.46	0.04	UR	6.78	0.06
GDPDEF	4.11	0.04	AGWR	6.36	0.05
CGR	5.57	0.06			

Resource: Result of Research

Based on the results of these indexes, the estimated model efficiency was approved and could be used to make predictions about the

endogenous variables of the model. To observe the behavior of simulated endogenous variables and to compare them with the behavior of actual endogenous variables, especially at the turning points, the graphical results are reported in Figure 1. Graphical simulation results showed that simulated endogenous variables follow the path of real variables acceptably, especially at turning points. After validation of the designed model by quantitative and graphical tests, the model was used to make predictions. To examine the effects of monetary and fiscal policies' discipline on the realization of quantitative aims of developmental plans, a scenario was designed in this paper in which the growth rate in the documents of the fourth and fifth development plans for some monetary and fiscal policies alternates the growth rate of realized values during 2006 to 2014 and by implementing this scenario, the growth rate of quantitative values of model's endogenous variables during 2006 to 2014 was predicted and compared with the growth rate of realized values at the time mentioned. Also, by implementing this scenario, the growth rate of non-oil productions and inflation as the most important indicators of economic stability, prospective prediction during 2015 to 2017 would occur. In the scenario designed, the growth rate of tax revenue, development expenditure and current expenditures of the government's was used as fiscal policy goals, and the growth rate of liquidity and long-term bank interest rate used as monetary policy goals. It should be noted that vision documents, like the plan which Tinbergen (1954) and Cooper (1969) mentioned, could be considered as a comprehensive and coordinated plan to achieve macro-economic objectives through which the cost of lost opportunity to achieve macro-economic goals is minimized and could settle the path of each of the policies in the optimized path in addition to settling the path of combined policies in the optimized path. Table 3 shows the realized values and quantitatively determined goals in the fourth and fifth development plans for monetary and financial policies' tools.

Table 4 shows the results of dynamic simulation for the endogenous variables of the model while Table 5 shows the results of the predicted values of non-oil production and inflation that occurred in the year 2015 to 2017.

Table (3): Suggested and Realized Values of Fiscal and Monetary Policy (%)

Variables		2005	2006	2007	2008	2009	2010	2011	2012	2013
M	Realized	31.29%	39.43%	27.73%	15.92%	23.91%	25.17%	19.44%	30.80%	29.11%
	Suggested	20%	20%	20%	20%	20%	20%	20%	20%	20%
INTLN	Realized	17%	16%	16%	19%	17.5%	17%	20%	-	-
	Suggested	17%	16%	16%	19%	17.5%	17%	20%	20%	20%
TI	Realized	59.41%	12.67%	26.51%	24.99%	25.15%	-5.17%	26.33%	9.94%	25.07%
	Suggested	63.25%	16.92%	27.46%	33.55%	17.80%	2.08%	25.50%	25.50%	25.50%
JARI	Realized	42.67%	25.66%	1.32%	38.32%	1.90%	11.04%	33.12%	1.40%	34.57%
	Suggested	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%
OMRANI	Realized	62.69%	23.74%	1.5%	50.94%	-11.14%	7.40%	35.78%	-47.31%	44.58%
	Suggested	36%	36%	36%	36%	36%	36%	36%	36%	36%

Resource:Central Bank, Economic Report and Balance Sheet, Various years

Table (4): Simulation Results

Years / Variables		2005	2006	2007	2008	2009	2009	2010	2011	2012
GDPRNO	Suggested Value	8.3%	8.6%	9%	8.6%	10.6%	-	-	-	-
	Predicted Value	8.35%	9.87%	9.71%	7.99%	6.29%	5.82%	7.38%	5.98%	6.57%
	Realized Value	5.22%	6.53%	6.97%	0.86%	4.81%	6.30%	2.77%	-2.8%	-1.06%
GDP	Suggested Value	7.1%	7.4%	7.8%	8.4%	9.3%	-	-	-	-
	Predicted Value	7.42%	9.2%	8.86%	7.05%	5.41%	5.51%	6.92%	3.03%	5.86%
	Realized Value	4.65%	6.21%	6.36%	0.57%	3.95%	5.89%	2.64%	-5.6%	
CPR	Suggested Value	-	-	-	-	-	-	-	-	-
	Predicted Value	2.72%	4.11%	4.58%	4.19%	4.31%	4.55%	4.38%	3.83%	4.35%
	Realized Value	9.95%	6.06%	6.8%	-4.48%	-1.12%	1.87%	7.61%	-1.19%	-
CGR	Suggested Value	-	-	-	-	-	-	-	-	-
	Predicted Value	-2.28%	-1.12%	-0.95%	-1.69%	-2.45%	-2.56%	-1.58%	-2.27%	-1.86%
	Realized Value									
INVPR	Suggested Value	-	-	-	-	-				
	Predicted Value	0.98%	2.82%	3.32%	6.13%	2.92%	2.76%	3.06%	3.18%	4.06%

Variables \ Years		2005	2006	2007	2008	2009	2009	2010	2011	2012
	Realized Value	3.2%	1.39%	9.7%	6.04%	5.23%	8.08%	0.99%	-18.2%	-
INVGR	Suggested Value	-	-	-	-	-	-	-	-	-
	Predicted Value	8.29%	9.29%	9.80%	9.93%	9.65%	9.45%	7.95%	4.20%	2.73%
	Realized Value	21.16%	6.01%	0.74%	20.74%	-11.84%	4.37%	0.98%	-	-
EXCG	Suggested Value	11.81%	11.84%	11.87%	11.90%	11.93%	-	-	-	-
	Predicted Value	18.50%	23.90%	19.40%	16.12%	12.92%	13.80%	19.29%	11.08%	1 4.54%
	Realized Value	14.81%	14.73%	-3.93%	-4.84%	28.84%	13.56%	6.04%	24.08%	-
IMPR	Suggested Value	6.54%	6.54%	6.54%	6.54%	6.54%	-	-	-	-
	Predicted Value	3.14%	10.96%	11.03%	10.83%	8.04%	5.84%	3.87%	3.38%	7%
	Realized Value	2.21%	7.11%	3.11%	7.80%	-1.6%	8.22%	-5.29%	-23.5%	-
CPI	Suggested Value	14.6%	11.5%	9.1%	7.9%	6.8%	-	-	-	-
	Predicted Value	9.89%	7.46%	6.19%	10.13%	8.45%	7.99%	11.05%	11.01%	10.05%
	Realized Value	10.4%	11.86%	18.38%	25.37%	10.74%	12.41%	21.47%	30.50%	34.69%

Table (4): Simulation Results

EMP	Suggested Value	-	-	-	-	-	-	-	-	-
	Predicted Value	3.91%	4.46%	4.50%	4.41%	4.48%	4.78%	5.21%	4.77%	5.13%
	Realized Value	3.14%	5%	3%	-2.80%	2.44%	-1.63%	-0.53%	2.99%	-
GDPDEF	Suggested Value	-	-	-	-	-	-	-	-	-
	Predicted Value	13.81%	16.52%	15.24%	15.73%	13.82%	9.12%	11.51%	15.85%	2.79%
	Realized Value	19.14%	14.31%	20.62%	16.93%	2.53%	14.37%	37.54%	17.65%	41.37%

Resource: Result of Research

Table (5): Predicted Values of Non-Oil GDP (%)

Variables		2014	2015	2016
GDPRNO	Predicted Value	7.51%	7.53%	7.95%
CPI	Predicted Value	8.89%	8.28%	7.53%

Resource: Result of Research

The overall results of the model simulations showed that by applying quantitative goals of monetary and fiscal policy of the fourth and fifth

development plans, predetermined values in the fourth and fifth development plans cannot be achieved, but the fluctuations in the macro variables can be reduced. The point that should be considered here is the key role of non-oil GDP in the various sectors of the economy. By strengthening these variables and creating a stable process for it, better results could be achieved in other sectors as well. In this study, the production function is estimated from the supply side, and the reason is minimizing the effects of policies on the demand side on the production part and creating a more stable process for it. In fact, a glance at the high rate of liquidity growth, government's current and developmental expenditures suggest that the use of restrictive monetary and fiscal policies is a priority. But on the other hand, implementing restrictive policies have negative effects on production. It is recommended that due to the necessity in implementing restrictive and fiscal policies, and in order to minimize the negative effects of these policies on the production part of the supply side policies, enhancing investment capacity, technology development and increasing exploitation of production factors can be used to strengthen the aspect of production. Examining the targeted monetary and fiscal variables in Table 3, also shows that during the years of implementation of the plan, the aforementioned values have never been realized. It is recommended that in addition to implementing long-term and medium-term policies, short-term regulatory policies can be used to ensure the realization of targeted amounts in the plan, for fiscal policies in particular. In the quantitative targeting of fiscal policy, the size of government in the economy of Iran should be given special attention. The bigger the size of government in the economy, the greater is its costs, especially current costs of the state. Regarding the kind of government expenditures in Iran economy and its more stable effect in comparison to monetary policy, decisions must be taken more realistically in the case of government restrictive budget and attempts made to reduce the budget fluctuations as much as possible. The central bank should take short-term decisions about monetary policy more hesitantly as well. Monetary policy fluctuations with a short gap can lead to an uncertain space in the public and would have irreversible effects on the investment expenditure.

After the implementation of scenarios related to efficiency of

monetary and fiscal policy objectives using dynamic simulation and analysis of its results, the estimated model was used to perform fuzzy control in the next stage. Verifying the accuracy of the model using graphical tests and RMSPE and Theil's quantitative tests is a test for confirming the suitability of the designed model to use in fuzzy control system and becoming sure of its results. With the use of a MATLAB software package, 2014b version, a control system was designed. The system was designed such that it can minimize deviation and changes in non-oil GDP deviation using control rules. Following the process of designing, different parts of the control system were explained.

Designed controller reference input errors and changes in non-oil GDP errors. Error and error changes are defined as follows.

$$e(t) = \dot{r(t)} - \dot{gdprno}(t) \quad (3)$$

$$\frac{d}{dt}e(t) = \frac{d\dot{r(t)}}{dt} - \frac{d\dot{gdprno}}{dt} \quad (4)$$

Where the e(t) is the error, $\frac{d}{dt}e(t)$ the error changes, $\dot{r(t)}$ the growth rate of non-oil GDP reference level, $\frac{d\dot{r(t)}}{dt}$ changes in the growth rate of reference, $\dot{gdprno}(t)$ non-oil GDP growth rate and $\frac{d\dot{gdprno}}{dt}$ is its changes. The growth rate of the reference has been reported in the table (6).

Table (6): Reference Input of Controller

Years	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
$\dot{r(t)}$	7.89%	8.3%	8.6%	9%	9.6%	10.6%	10.6%	10.6%	8.3%	8.6%	9%	9.6%	10.6%

Resource: Balance Sheet and Reports of Central Bank

Designed controller output is expenditure and liquidity growth rate. Due to the characteristics of the system, after numerous trial and errors, it was concluded that asymmetric membership functions should be used for fuzzification of inputs and outputs of the system and one-dimensional triangular membership functions are considered as the most suitable type of membership function to display asymmetry. Table 7 shows the approximation of the classification for the ten levels of each input and output defined with the exception of liquidity.

Table (7): Bounds of Inputs and Outputs

	1	2	3	4	5
Liquidity	$x \le 15.7\%$	$15.5\% \le x \le 16.3\%$	$16\% \le x \le 16.75\%$	$16.5\% \le x \le 17.25\%$	$17\% \le x \le 17.65\%$
	$15.7\% \le x \le 16\%$	$16.3\% \le x \le 16.5\%$	$16.75\% \le x \le 17\%$	$17.25\% \le x \le 17.5\%$	$17.65\% \le x \le 18\%$
Omrani	$x \le 33.75\%$	$33.5\% \le x \le 34.4\%$	$34\% \le x \le 34.8\%$	$34.5\% \le x \le 35.3\%$	$35\% \le x \le 35.8\%$
	$33.75\% \le x \le 34\%$	$34.4\% \le x \le 34.5\%$	$34.8\% \le x \le 35\%$	$35.3\% \le x \le 35.5\%$	$35.8\% \le x \le 36\%$
Error	$x \le -1.5\%$	$-1\% \le x \le -0.90\%$	$0\% \le x \le 0.08\%$	$1\% \le x \le 1.1\%$	$1.5\% \le x \le 1.8\%$
	$-1.5\% \le x \le 0\%$	$-0.90\% \le x \le 1\%$	$0.08\% \le x \le 1.5\%$	$1.1\% \le x \le 2\%$	$1.8\% \le x \le 2.5\%$
Error Changes	$x \le -3.5\%$	$-3.2\% \le x \le -3.10\%$	$-3\% \le x \le -2.70\%$	$-2.5\% \le x \le -2.30\%$	$-2.25\% \le x \le -2.10\%$
	$-3.5\% \le x \le -3\%$	$-3.10\% \le x \le -2.5\%$	$-2.7\% \le x \le -2.25\%$	$-2.30\% \le x \le -1.70\%$	$-2.10\% \le x \le -1.5\%$
	6	**7**	**8**	**9**	**10**
Liquidity	$17.5\% \le x \le 18\%$	$18\% \le x \le 18.30\%$	$18.5\% \le x \le 18.85\%$	$19\% \le x \le 19.20\%$	
	$18\% \le x \le 18.5\%$	$18.30\% \le x \le 19\%$	$17.85\% \le x \le 19.5\%$	$19.20\% \le x \le 20\%$	
Omrani	$35.5\% \le x \le 36\%$	$36\% \le x \le 36.3\%$	$36.5\% \le x \le 36.8\%$	$37\% \le x \le 37.3\%$	$37.5\% \le x \le 37.6\%$
	$36\% \le x \le 36.5\%$	$36.3\% \le x \le 37\%$	$36.8\% \le x \le 37.5\%$	$37.3\% \le x \le 38\%$	$37.6\% \le x \le 38.5\%$
Error	$2\% \le x \le 2.25\%$	$2.59\% \le x \le 2.90\%$	$3\% \le x \le 3.20\%$	$3.5\% \le x \le 3.70\%$	$4\% \le x \le 4.30\%$
	$2.25\% \le x \le 3\%$	$2.90\% \le x \le 3.50\%$	$3.20\% \le x \le 4\%$	$3.70\% \le x \le 4.5\%$	$4.20\% \le x \le 8\%$
Error Changes	$-1.75\% \le x \le -1.60\%$	$-1.5\% \le x \le -1.30\%$	$-1\% \le x \le -0.70\%$	$-0.75\% \le x \le -0.5\%$	$-0.25\% \le x \le -0\%$
	$-1.60\% \le x \le -1\%$	$-1.30\% \le x \le -0.75\%$	$-0.70\% \le x \le -0.25\%$	$-0.5\% \le x \le 0.75\%$	$0\% \le x \le 2\%$

Resource: Result of Research

As was earlier explained, the realized liquidity growth rate in the economy of Iran was beyond the planned targeted growth rate, and since the onset of the third plan, the emphasis has been on the optimization of government expenditures. With respect to the items in Table 8 attempt was made to define the threshold of liquidity and development expenditures growth rate, or using skewness of membership functions as a higher weight got assigned to more reasonable levels in each level.

After fuzzification of inputs and outputs, control laws were designed. Considering the fact that the controller has two inputs, we can at most extract 2^n rules for it where n represents the number of levels. In fact, by defining ten levels for each input we can define up to 100 rules for the controller. In designing the rules, the economy conditions of Iran was considered, and except in necessary cases the very top or bottom of the variables were not used. Also, Table 9 reports the rules involved in the use of more monetary policy to control errors with little scope.

Table (9): Controller Rules

		Changes in Error					
		1	**2**	**3**	**4**	**5**	
Error	**1**	2	2	2	3	3	**m**
		2	2	2	2	2	**omrani**
	2	3	3	3	3	3	**m**
		2	2	2	2	2	**Omrani**
	3	4	4	4	4	4	**m**
		2	2	2	2	2	**omrani**
	4	5	5	5	5	5	**m**
		3	3	3	3	3	**omrani**
	5	6	6	6	6	6	**m**
		4	4	4	4	4	**omrani**
	6	7	7	7	7	7	**m**
		5	5	5	5	5	**omrani**
	7	7	7	7	7	7	**m**
		7	7	7	7	7	**omrani**
	8	8	8	8	8	8	**m**
		7	7	7	7	7	**omrani**
	9	8	8	8	8	8	**m**
		8	8	8	8	8	**omrani**
	10	9	9	9	9	9	**m**
		9	9	9	9	9	**omrani**

		Controller Rules					
		6	**7**	**8**	**9**	**10**	
Error	**1**	3	3	3	3	3	**m**
		2	2	2	2	2	**omrani**
	2	4	4	4	4	4	**m**
		2	2	2	۲	2	**omrani**
	3	4	4	4	4	4	**m**
		2	2	2	2	2	**omrani**
	4	5	5	5	5	5	**m**
		4	4	4	4	4	**omrani**
	5	6	6	6	6	6	**m**
		5	5	5	5	5	**omrani**
	6	7	7	7	7	7	**m**
		6	6	6	6	6	**omrani**
	7	8	8	8	8	8	**m**
		7	7	7	7	7	**omrani**
	8	8	8	8	8	8	**m**
		8	8	8	8	8	**omrani**
	9	8	8	8	8	8	**m**
		9	9	9	9	9	**omrani**
	10	9	9	9	9	9	**m**
		10	10	10	10	10	**omrani**

Resource: Result of Research

Mamdani inference mechanism was used in this study and defuzzification also done by Centroid of Area (Z_{COA}). After designing the different parts of the fuzzy system and preparing information for entry in each of these sectors, fuzzy system was solved using fixed-step solver ode3 type. This type of solver solves all models with discrete and continuous variables and has a medium level of complexity. Table 10 shows the designed controller outputs.

Table (10): Output of Controller

Year	2005	2006	2007	2008	2009	2010
$\dot{M}$	-	-	18.44%	18.47%	19.24%	19.32%
$\dot{O}mrani$	-	-	35.56%	36%	37.69%	37.77%

Year	2011	2012	2013	2014	2015	2016
$\dot{M}$	18.95%	18.47%	18.93%	18.67%	18.95%	18.96%
$\dot{O}mrani$	37.27%	36%	36.41%	36.19%	36.76%	36.68%

Resource: Result of Research

The results showed that the liquidity growth rate is lower and the government investment expenditure growth rate is approximately equal to the average growth rate during the proposed fourth and fifth development plans. During the period, the domain of controller volatility was also limited. Limited volatility represents the fact that compensation policies with limited volatility are used to reduce errors and changes of error. The use of this kind of policy limits the amplitude of other variables.

Table 10 shows the non-oil GDP growth rate and inflation extracted according to the outputs and controller rules, by reviewing the process of these variables and its comparison with the results of dynamic simulation it can be concluded that the use of control policies reduces volatility of non-oil GDP growth and inflation. As a result, control policies in comparison to the fourth and fifth development plans policies are somewhat more successful in the control of growth and inflation, but using these policies we are not able to achieve the pre-determined targets in development plans for growth and inflation.

Table (11): Output of Controller

Years	2005	2006	2007	2008	2009	2010
P	-	-	13.06%	14.62%	10.84%	9.69%
$\dot{gdp}$rno	-	-	6.45%	6.99%	6.32%	5.42%

Years	2011	2012	2013	2014	2015	2016
P	12.37%	14.65%	10.54%	9.59%	9.87%	7.87%
$\dot{gdp}$rno	6.78%	5.72%	5.60%	6.31%	6.31%	7.42%

Resource: Result of Research

5. Summary and Conclusions

In this study, to investigate the effect of discipline of monetary and financial policies on macro-economic variables using dynamic simulation, a scenario was designed in which the variables of liquidity, long-term interest rates of banks, development expenditures, current expenditures and tax revenue were used as monetary and fiscal policy tools and during the period a growth rate equal to the growth rate set by the fourth and fifth development plans was considered. The results showed that during the period of implementation of this scenario a steady growth rate was reached for non-oil GDP, private consumption expenditure, government consumption expenditure, private sector investment expenditure, public sector investment expenditure, exports of non-oil goods and services, imports of goods and services, consumer price index, the implicit index of GDP and also reduced the amount of its deviation from the target values. A fuzzy control system was designed in this system with the aim of minimizing the deviation and change that the non-oil GDP deviation from the values determined in the fourth and fifth development plans. For this purpose, the government investment expenditure and liquidity variables were used as control tools and for each variable, ten levels were defined. The results of the fuzzy system showed that using control rules, one can put the liquidity growth rate at a lower level and the growth rate of development expenditures around quantitative targeted amount in the fourth and fifth development plans. With this, the amplitude of the inflation rate and growth rate of non-oil production can also be reduced.

Diagram (1): Comparison the Trend of Simulated and Real Endogenous Variables

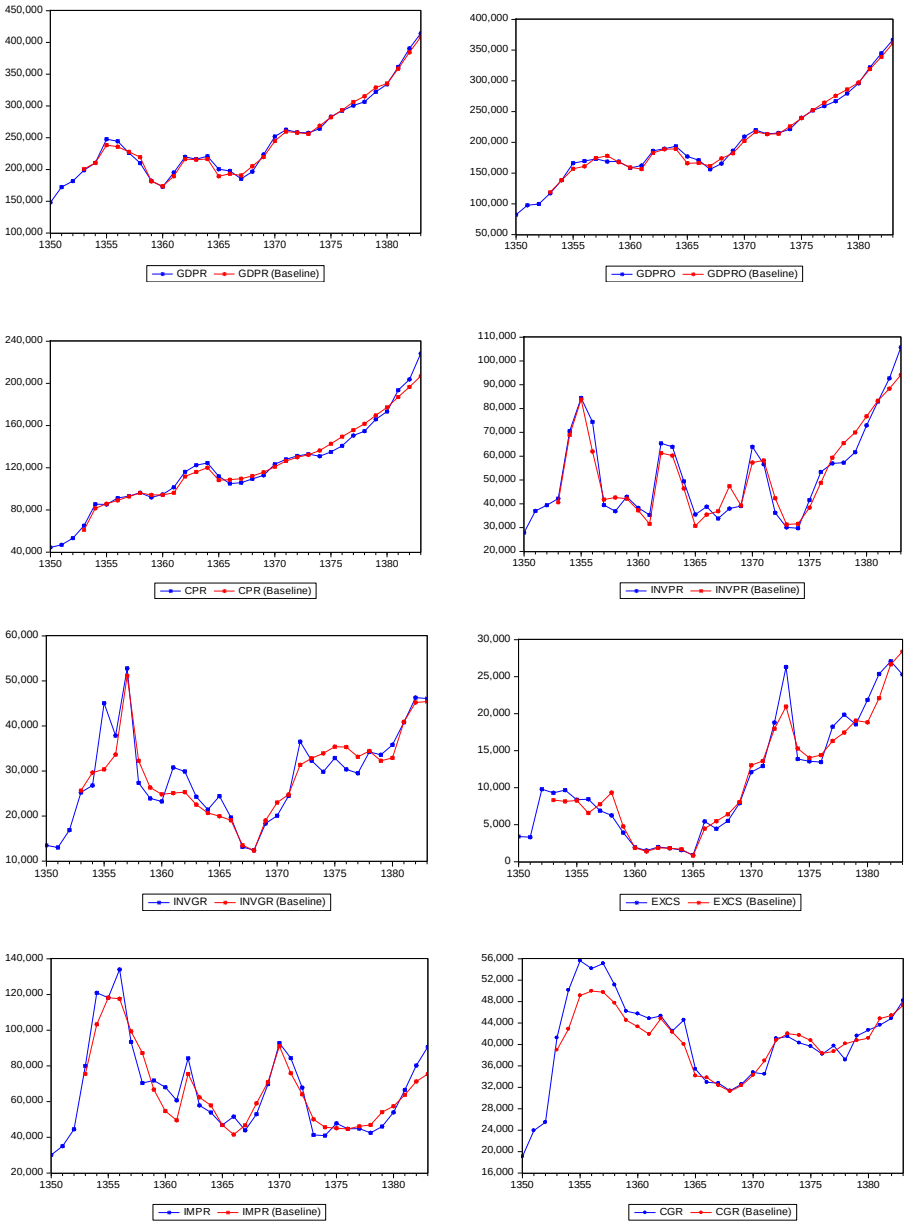
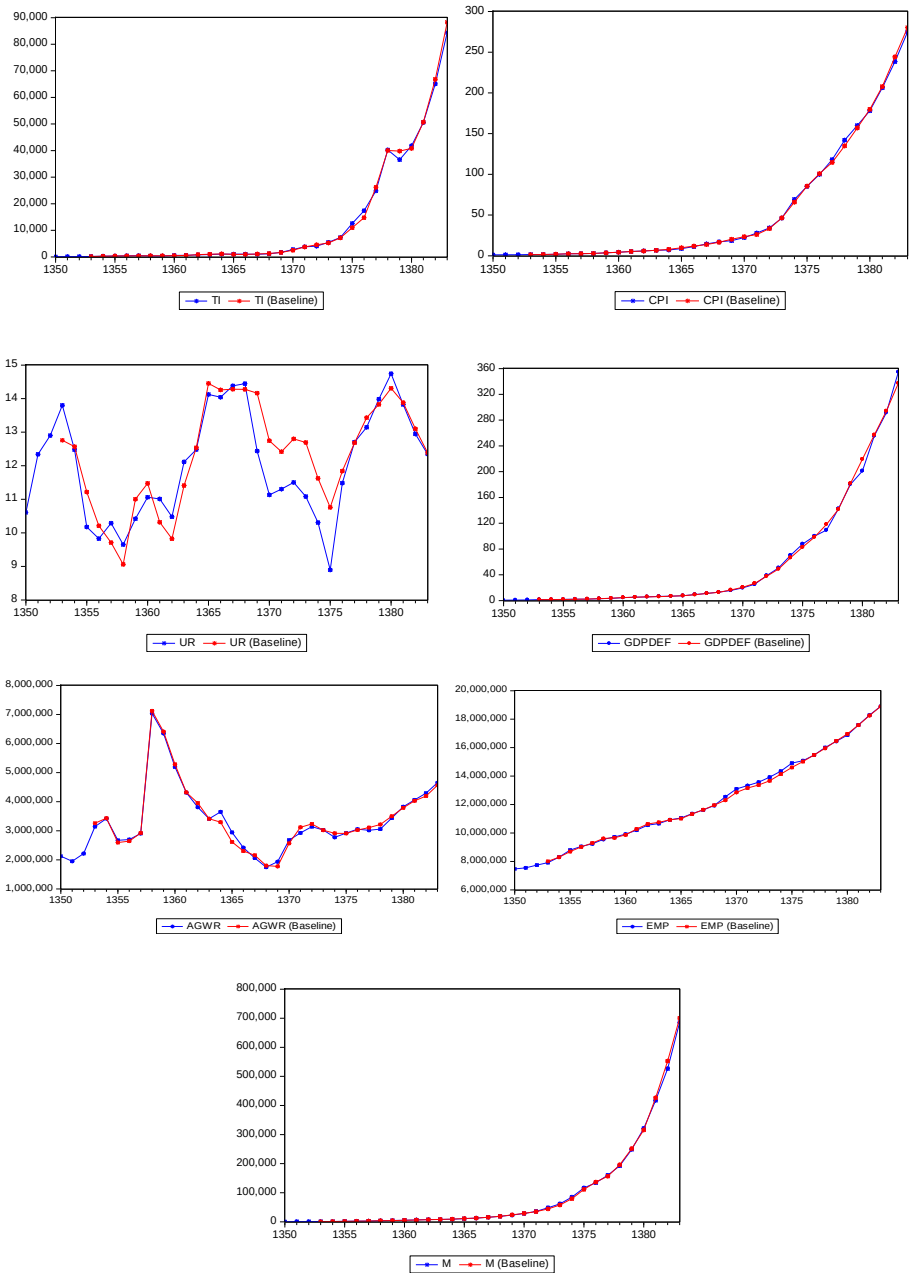


Diagram (1): Comparison the Trend of Simulated and Real Endogenous Variables



Resource: Result of Research

Table (12): List of Variables

UN	Unemployment	EMP	Employment	GDPRNO	Non-oil GDP at constant 1997 prices
INVPR	Private investment expenditures at constant 1997 prices	INVGR	Government investment expenditures at constant 1997 prices	INV	Total investment expenditure at constant 1997 prices
CPR	Private consumption expenditures at constant 1997 prices	EXCG	Non-oil exports of good and service at constant 1997 prices	TM	Average tariff rate on imports
IMPR	Imports of good and service at constant 1997 prices	IMPN	Nominal Imports of good and service	TX	Import tax
TI	Tax income	YDR	Disposable income at constant 1997 prices	GDPDEF	GDP deflator
GDPR	GDP at constant 1997 prices	INTLN	Nominal long-term banking interest rate	INTLR	Real long-term banking interest rate
FK	Central Bank Net Foreign Assets	CREDIT	outstanding Facilities by Banks and Credit Institutions to Non-Public Sector	OMRANI	Development expenditure
AGWN	Minimum nominal wage	AGWR	Minimum real wage	M	Money stock (liquidity)
ERN	Nominal exchange rate	ERR	Real exchange rate	CPUS	USA Consumer price index
UR	Unemployment rate	LFORCE	Labor force	CPI	Consumer price index at constant 1997 prices
P	Inflation	TFP	Total Factor Productivity	D	Dummy variables

Table (1): System of Equations

1	$D(LNCPI) = 3.787+0.35*D(LNM)+0.25*D(LNINTLN)-0.554D(LNGDPRNO)-0.36*ecm(-1)$
2	$D(LNCPR) = 2.361 + 0.134*D_{1975} + 0.007*D(D_{1964\text{-}1966lncpr}) + 0.210*D(LNYDR) +0.047*D(LNM)-0.001*D(P) - 0.46*ecm(-1)$
3	$D(LNCGR)=2.16-0.046*t-0.035*D_{1995\text{-}1997}+0.159*D(LNJARI)+0.44*D(LNGDPRNO)-0.76*ecm(-1)$
4	$D(LNINVPR) = -0.681 + 0.453*D_{1983} - 0.026*D(D_{1993\text{-}1994lninvpr}) +0.000791*D(INTLR)-0.238 * D(LNINVGDPR) +6.425*D(LNK)-2.490*D(LNK(-1))-0.511*ecm(-1)$
5	$D(LNINVGR) = 7.7883 + 0.0087*T + 0.478*D_{1978} - 0.0423*D(D_{1988\text{-}1989lninvgr}) -0.216 * D(LNERN) + 0.223*D(LNOMRANI) - 0.803*ecm(-1)$
6	$D(LNEXCG) = -13.675-8.765 - 8.765*D_{1981\text{-}1986} + 1.035*D(D_{1981\text{-}1986lnexcg}) + 0.0274*D(D_{1993\text{-}1995lnexcg}) + 0.141*D(LNERR) + 0.978*D(LNGDPR) - 1.250*D(LNGDPR(-1)) + 0.268*D(LNINVGR)+0.758*D(LNINVGR(-1)) - 0.734*ecm(-1)$
7	$D(LNIMPR) = -4.362+ 0.406*D_{1983} + 0.313*D_{1989\text{-}1990} -0.002*D(GTM) - 0.612*D(LNERN) + 0.921 *D(LNGDPR) - 0.536*ecm(-1)$
8	$D(LNGDPRNO) = -13.096-0.00567*D(D_{1986\text{-}1988lnGDPRNO}) +0.337*D(LNGDPRNO (-1) + 0.1866 * D(LNGDPRNO(-2))+0.815*D(LNEMP)+0.309*D(LNINV)-1.006D(LNK)-0.706D(LNK (-1))-0.695 *D(LNK(-2))+0.286D(LNTFP)-0.574*D(LNTFP(-1)-0.196*DLNTFP(-2)-1.362ecm(-1)$

9	D(LNM) = 2.6366 - 0.094*$D_{1980\text{-}1988}$ + 0.015*D(LNERN) + 0.058*D(LNFK) - 0.012*D(LNGDPR) - 0.192*D(LNGDPR(-1)) - 0.362*D(LNGDPR(-2)) - 0.226*ecm(-1)
10	D(LNTI) = -28.74+0.038*D($D_{19988lnti}$) - 0.111*D(LNERN) + 1.909*D(LNGDPR) + 0.0134 * D(LNY) - 0.717*ecm(-1)
11	D(LNGDPDEF) = 2.921 + 0.041*D(LNCREDIT) - 0.444*D(LNCREDIT(-1)) -0.126D(LNERN)-0.139D(LNGDPRNO)+0.114*D(LNINTLN)-0.521*D(LNINTLN(-1))-0.321*D(LNINTLN(-2))-0.726 *ecm(-1)
12	D(LNEMP) = 0.217+ 0.016*D_{1991} –0.01*D(LNAGWR)+0.139*D(LNGDPR)-0.06*D(LNGDPR(-1)) -0.075D(LNGDPR(-2))-0.06*ecm(-1)
13	P=((CPI-CPI(-1))/CPI(-1))*100
14	GDPR=GDPRNO+OILPROD
15	INVGDPR=INVGR/GDPR
16	AGWR=(AGWN/CPI)*100
17	ERR=(ERN*CPUS)/CPI
18	INTLR=INTLN-P
19	INV=INVGR+INVPR
20	TIR=(TI/GDPDEF)*100
21	YDR=GDPR-TIR
22	Y=AGWN*EMP
23	TM=(TX/IMPN)*100
24	GTM=((TM-TM(-1))/TM(-1))*100
25	UN = LFORCE – EMP, UR = (UN/ LFORCE) * 100

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