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Optimal Fiscal Policies in Iran: An Application of the Stochastic Optimal Control Theory

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Abstract: This paper analyzes the design of macroeconomic policies for Iran during the forth five year development plan (2005-2009). For this purpose, we develop and use a macroeconometric model for Iran. We determine optimal fiscal policies as solutions of optimum control problems with a quadratic objective function and the macroeconometric model as a constraint. The results show that, the optimal values of current and capital government expenditures (except for the first year of government current expenditures) are greater than those proposed in forth development plan whereas the tax revenues is less than the proposed one. The comparison between the effects of the optimal fiscal policies on goal variables, show that using the optimal fiscal policies will improve the economic growth rate.

JEL: C02 · C61 · E21

Key words: Optimal fiscal policies · Stochastic optimal control algorithm · Forth five year development plan of Islamic Republic of Iran

INTRODUCTION

The study of economic changes in economics literature shows that requirement of government policy-making as fiscal instrument in economy, avoidable to obtain the perceived goals [1]. Also, we know that carrying out several policies are likely to conflict with the other goals and in this condition cost all or some of other goals, in due to interaction feedback effects distortion. This revealed when intertemporal essence of decision- making is focus. Therefore in spite of substitution ability must optimize control of policy-makers variables [2]. So, especially in middle of 1990 the more of studies related to economic policies, used the optimization models. So determine the policies or the other words optimal fiscal instrument, state the important policy-making duties each economic system [3]. During the last few decades, Iran's economy has witnessed high inflation and unemployment, budget deficit and high fluctuations in economic growth. Combating the above problems has been one of the important goals of policy making in Iran. Therefore, at the end of the imposed war, the Iranian first, second and third development plan were launched. Due to lack of coordinating between the macroeconomic policies introduced some of the main important goals proposed in these plans were not accomplished. The present paper deals with the quantitative determination of Iran's optimal fiscal policies in order to obtain the goals of economic growth and inflation rate with minimum loss during the counting 4th economic plan (2005-2009). To do so, first we have defined a dynamic nonlinear system of macroeconomic equation and calculated the effects of different macroeconomic policies imposed during the forth development plan on macroeconomic variables using the simulation technique. Then the optimal macroeconomic policies are calculated by the optimal control algorithm "OPTCON". Finally we will compare the effects of the optimal fiscal policies on goal variables and ending paper with concluding remarks.

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The "Stochastic Optimal Control" Algorithm: We want to calculate time paths of macroeconomic policy instruments that are "optimal" according to an objective function of a hypothetical policy-maker for Iran. To obtain optimal economic policies, we apply the OPTCON algorithm, developed by Matulka and Neck [4] and Matulka, Neck and Karbuz [5]. OPTCON determines approximate solutions of optimum control problems with a quadratic objective function and a nonlinear multivariable model. The objective function has to be quadratic in the deviations of the state and control variables from their desired values. The objective function has the following form:

$$L = \frac{1}{2}\sum_{t=1}^{T}\begin{bmatrix} x_t - \bar{x}_t \\ u_t - \bar{u}_t \end{bmatrix}' W_t \begin{bmatrix} x_t - \bar{x}_t \\ u_t - \bar{u}_t \end{bmatrix}, \qquad (1)$$

$$W_t = \alpha^{t-1}.\ W,\quad t = 1,\ldots,T \qquad (2)$$

Where x_t denotes the vector of state variables, u_t denotes the vector of control variables $\bar{x}_t$ and $\bar{u}_t$ are the desired values of the state and control variables, W_t is the matrix containing the weights given to the deviations of the state and control variables from their desired values, respectively and a denotes the discount factor. The dynamic system has to be given in a state space representation. Although OPTCON can solve deterministic and stochastic optimum control problems, here we confine ourselves to deterministic optimizations only. So the dynamic nonlinear system is defined as:

$$x_t = f(x_{t-1}, u_t, \hat{\theta}, z_t) + \varepsilon_t \qquad (3)$$

In this system $\hat{\theta}, z_t$ and ε_t are the expected value of the stochastic parameter vector, exogenous variables vector and the matrix of the additive system noise respectively. As inputs of the algorithm, the user has to supply the followings: the system function, the initial value of the state vector, a tentative path for the control variables, the expected value and the covariance matrix of the stochastic parameter vector, the covariance matrix of the additive system noise, the weight matrices of the objective function, the planning horizon, the desired paths for the state and control variables, the tentative path for control and state variables and a discount rate of the objective function. This algorithm is executable in ''GAUSS'' programming system [6]. Therefore, we used the "OPTCON" algorithm in order to determine the optimal

Table 1: The equations

Number	Behavioral equations
1	CPR = 0.83 CPR (t-1) + 0.10 YDR
	t: (21.7) (3.4) (2.1) DW = 2.02 R^{-2} = %99
2	INVPR = 0.84 INVPR (t-1) + 0.21 INVGR + 0.26 Δ Demand – 24.19 LTIRR
	t: (11.54) (20.10) (14.30) (-0.14) DW = 1.49 R^{-2} = %88
3	CGR = 0.19 CGR (t-1) + 0.65GCER
	t: (1.83) (7.85) DW = 1.93 R^{-2} = %98
4	INVGR = 0.24 INVGR (t-1) + 0.05 GDPR + 0.48 GMER
	t: (1.98) (3.55) (3.65) DW = 2.11 R^{-2} = %87
5	IMPR = 0.69 IMPR (t-1) + 0.15 GDPR – 547.10 RPIMP
	t: (5.13) (1.81) (- 0.85) DW = 1.85 R^{-2} = %82
6	AGWN = 0.96 AGWN (t-1) + 3.54 CPI – 0.052 UR
	t:(18.61) (4.72) (- 0.21) DW = 1.68 R^{-2} = %99
	(Continued on next page)
7	CPI = 0.85 CPI (t-1) + 0.013 AGWN + 0.012 UTIL
	t: (4.45) (1.69) (1.67) DW = 1.90 R^{-2} = %99
8	EMP = 1.01 EMP (t-1) + 0.00057 GDPR – 0.053 AGWR
	t: (75.81) (2.46) (-1.91) DW = 1.6 R^{-2} = %99
9	LTIRN = 0.94 LTIRN (t-1) + 0.0000027 GDPR – 0.0000028 M3R
	t: (9.98) (0.91) (-0.62) DW = 1.71 R^{-2} = %93
10	GDPDEF = 0.55 GDPDEF (t-1) + 0.0000027 GDPR + 0.54 IMPDEF
	t: (5.42) (1.91) (6.29) DW = 1.89 R^{-2} = %99
11	GDPPOT = 0.31 CAPR + 26.49 LFORCE + 2050.64 TIME
	t: (6.13) (2.08) (8.53) DW = 1.83 R^{-2} = %99
	Identities
12	GDPR = CPR + CGR + INVR + EXPR – IMPR
13	GDPN = (GDPR*GDPDEF)/100
14	INVR = INVPR + INVGR + DINVR
15	Demand = GDPR + IMPR
16	GRGDPR = (GDPR – GDPR (t-1)/GDPR (t-1))*100
17	GRCPI = (CPI – CPI (t-1)/CPI (t-1))*100
18	LTIRR = LTIRN – GRCPI
19	AGWR = (AGWN/CPI)*100
20	M3R = (M3N/CPI)*100
21	RPIMP = (IMPDEF/CPI)*100
22	UTIL = (GDPR/GDPPOT)*100
23	CAPR = CAPR (t-1) + INVPR + INVGR – DEPR
24	UN = LFORCE – EMP
25	UR = (UN/LFORCE)*100
26	GCER = (GCEN/GDPDEF)*100
27	GMER = (GMEN/GDPDEF)*100
28	TAXRR = (TAXRN/GDPDEF)*100
29	YDR = GDPR – TAXRR

*t, R^{-2} and D.W are the t statistic, adjusted R and Durbin Watson statistic respectively

Source: Authors Calculations

fiscal policies for Iran during the forth development plan. The constraint to the optimization problem is given by a macro econometric model of the Iran's economy. The list of variables is shown in appendix. The dynamic nonlinear systems include two category of equation: behavioral equations and identities. Table 1 shows the estimated behavioral equations and identities. The behavioral equations of the model were estimated by O.L.S using time series data for the period 1959-2004 [7].

Table 2: The values of optimal and third plan control variables

		2005	2006	2007	2008	2009
GCEN	Optimal	199246	261699	347056	472436	656252
	Proposed in the Forth plan	222231	244457	268903	295793	325372
GMEN	Optimal	168764	241572	328304	436976	571494
	Proposed in the Forth plan	102820	134746	171070	214373	275841
TAXRN	Optimal					
	Proposed in the	64179	88938	116966	154931	211726
	Forth plan	117830	150397	182521	218558	262631

Source: Authors Calculations

Table 3: The result of optimization and simulation results

	2005	2006	2007	2008	2009
GRGDPR Optimization results	9.6	7.4	7.7	8.2	8.9
Simulation results	2.5	2.7	2.7	2.8	3.2
The forth plan targets	7.1	7.4	7.8	8.4	9.3
GRCPI Optimization results	15.6	15.7	15.8	15.9	15.9
Simulation results	15.4	15.6	15.8	15.8	15.9
The forth plan targets	14.6	11.5	9.1	7.9	6.8

Source: Authors Calculations

The models include goods, services market and money markets from the aggregate demand side and a production function and the labor market from the aggregate supply side. The goods and services market contain private consumption function, private investment function, government consumption function, government investment function, imports and exports functions. Also, the models include a money demand equation and wage price system. The wage-price system can be regarded as an enhanced Phillips curve. Wages are determined by the price level and the unemployment rate. The price level depends on wages and the capacity utilization rate. A production function is included to determine potential GDP. The labor market is modeled by specifying an employment equation, whereas the labor supply is exogenous to the model. As the stochastic model equations are estimated by OLS, no full covariance matrix of the parameters is available. In this case, only a limited stochastic optimization can be run with the estimated standard errors of the coefficients and the standard errors of the regression equations taken into account. In order to determine the approximate solutions optimum government currency and capital expenditures as well as optimum tax revenues (the optimum fiscal policy), two “main” and two “minor” objectives are considered. The “main” objective variables are economic growth rate and inflation rate. Also, the minor objectives are real GDP and consumer price index. The values of target for these variables are the values, which targeted in Iran’s forth development plan. So, the planning horizon for the control experiments has been chosen as 2005 to 2009. After several experiments sensitivity analysis we hare chosen a discount factor α =1, the weight 1000 for main and 100 for minor objective variables. Then, in the weight matrix of the objective function, off diagonal elements were all set equal to zero. In addition, all state variables in the model not mentioned above, got the weight zero. In order to compare the optimal fiscal policies effects on the main and minor objective function variables with that of the proposed fiscal policies in forth plan and the tentative path for state variables, we used $MAPLE_{10}$ program for the simulation of the model; we used GAUSS program to determine the optimal fiscal policies. The calculated optimum government current and capital expenditures and optimum tax revenues are compared with those proposed valued in third development plan in Table 2.

The table shows that, the optimal values of government currency (to expect of first year plan) and capital expenditures are greater than those proposed in forth development plan whereas the tax revenue is less than the proposed one. On other hand, to achieve the targeted economic growth there will be a big pressure on government budget. Table 3 shows the target values and the results for the most important state variables of the simulation and optimization run, respectively.

As seen from the table, the rate of economic growth is close to forth plan targets with the optimum fiscal policies than those proposed by forth plan. Also, under optimum fiscal policies the inflation rate will be the bigger than the proposed forth plan fiscal policies. As we have shown in Table 3, in this condition according to the inactive the role of monetary policy, there will be a big pressure on fiscal policies and government general budget. This may suggest that applying mix fiscal and monetary policies may be more appropriate in this regard.

Concluding Remarks: In this paper we have shown how stochastic Optimal Control Algorithm can be used to obtain insights into the design of policy decisions for the forth five year's Iranian development plan (2005–2009) under condition that inactive the monetary policy instrument. Hence, the objective function is quadratic in deviations of the state and control variables from their respective desired values. Also, the constrain of optimization problem is given by a nonlinear stochastic system. We implemented the "OPTCON" algorithm in the programming language "GAUSS" and applied an econometric model to the Iran economy in order to show the feasibility of the algorithm. An empirical optimization result, show that the optimum fiscal policies may lead to a considerable stabilization of the time path of the rate of economic growth. It is also shown that the executing optimal fiscal policies put pressure on government budget as well as inflation due to the above results. Therefore, based on the above results it were found that in the absence of an active monetary instrument, there must be "big push" in fiscal policy in order to achieve the rate of economic growth in Iran forth plan.

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Appendix:

List of Variables

State (Or Endogenous) Variables

AGWN	Average gross wage rate per employee, nominal
AGWR	Average gross wage rate per employee, real
CAPR	Capital stock, real
CGR	Government consumption, real
CPI	Consumer price index
CPR	Private Consumption expenditures, real
Demand	Total final demand, real
EMP	Employment; 1,000 persons
GCER	Government currency expenditure, real
GDPN	Gross domestic product, nominal
GDPR	Gross domestic product, real
GDPDEF	GDP deflator
GDPPOT	Potential GDP
GMER	Government capital expenditure, real
GRCPI	Annual growth rate of CPI (rate of inflation)
GRGDPR	Annual growth rate of real GDP
IMPR	Imports, real
INVGR	Government investment, real
INVPR	Private Investment, real
INVR	Total investment, real
LTIRN	Long-term interest rate, nominal
LTIRR	Long-term interest rate, real
M3R	Money stock M3, real
RPIMP	Relative price of import
TAXRR	Government tax revenue, real
UN	Number of unemployed persons
UR	Unemployment rate, % of the labor force
UTIL	Capacity utilization rate
YDR	Personal disposable income, real

Exogenous variables

DINVR	Inventory change, real
EXPR	Exports, real
DEPR	Depreciation of fixed capital, real

IMPDEF	Import price level (import deflator)
LFORCE	Labor force; 1,000 persons
M3N	Money stock M3, nominal
NTAXRN	Government non-tax revenue, nominal
TIME	Linear time trend

Control variable

GCEN	Government currency expenditure, nominal
GMEN	Government capital expenditure, nominal
TAXRN	Government tax revenue, nominal