

The Application of Optimal Control Through Fiscal Policy on Indonesian Economy

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Abstract

The budget deficit is closely related to expansionary fiscal policy as a fiscal instrument to encourage economic growth. This study aims to apply optimal control theory in the Keynesian macroeconomic model for the economy, so that optimal growth can be found. Macroeconomic variables include GDP, consumption, investment, exports, imports, and budget deficit as control variables. This study uses secondary data in the form of time series, the time period 1990 to 2018. Performing optimal control will result in optimal fiscal policy. The optimal determination is done through simulation, for the period 2019–2023. The discrete optimal control problem is to minimize the objective function in the form of a quadratic function against the deviation of the state variable and control variable from the target value and the optimal value. Meanwhile, the constraint is Keynes' macroeconomic model. The results showed that the optimal value of macroeconomic variables has a deviation from the target values consisting of: consumption, investment, exports, imports, GDP, and budget deficit. The largest deviation from the average during the simulation occurs in GDP, followed by investment, exports, and the budget deficit. Meanwhile, the lowest average deviation is found in imports.

Keywords: Optimal Control, Macroeconomic Variables, Budget Deficit

JEL Classification Code: E6, E62, F3

1. Introduction

Prior to the global financial crisis, the Indonesian economy was experiencing a fairly good growth, in the range of an average of 6.04 percent per year (period 2000–2007). However, during the global crisis in 2008 and 2009, the economy only grew at a rate of 5.0 to 5.3 percent per year.

Meanwhile, the economic growth in a number of ASEAN countries is in the range of 2.95 percent and the world economy is lower at an average level of 0.1 percent. The condition of the 2008 global economic crisis had a relatively small impact on the Indonesian economy. This is due to the high level of household consumption, which contributes around 55 percent to 58 percent of GDP. This condition was also supported by the increase in government spending to overcome the economic crisis.

Unemployment has decreased from 9.39 million people or 8.93 percent in 2008 to 8.96 million people or 7.87 percent in 2009. The decline in unemployment was followed by a decrease in the inflation rate, from 11.06 percent in 2008 to 2.78 percent in 2009. Inflation in 2009 was the lowest in the last 10 years. The decline in the unemployment rate was also followed by a decrease in the inflation rate. Household consumption in 2009 became the main driver for Indonesia's economic growth during the global crisis (Kementrian Keuangan, 2018).

The government, through fiscal policy, aims to regulate economic activity so that the economy is more stable in the long run (Sukirno, 2016). Fiscal policy must be supported by an appropriate and consistent monetary policy, thereby

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encouraging the acceleration of economic growth. Fiscal stimulus plays a role in increasing aggregate demand (Abimayu, 2003). Expansive fiscal policy as an instrument for accelerating economic recovery has a negative effect on increasing the budget deficit and fiscal risk. The budget deficit shows the fiscal conditions that can meet spending in the long run. Consequently, it must be able to take into account fiscal vulnerabilities (Adam, 2011). Vulnerability arises from direct liabilities that can be predicted in advance and contingent liabilities due to an event beyond its control (Brix & Schick, 2002). Several studies have stated that excessive budget deficits have become the focus of fiscal policy in a number of countries, especially as a result of increased government spending. In a deficit condition, if there is a slight increase in spending, it will greatly reduce fiscal performance. This is because the government tends to use debt instruments to cover the budget deficit. An increase in debt will reduce fiscal performance in the long term. Part of government spending is used to pay debts that are past due. Amid the budget deficit and increased government spending, efforts are needed to optimize the deficit. Optimal deficit as a measure to maximize fiscal performance and achieve economic growth.

This research refers to research conducted by (Tehranchian and Rad (2007), Correani et al. (2014), Rad and Zadeh (2009), and Blueshke et al. (2016). Their research uses optimal control in fiscal and monetary policy. Optimal control can determine the optimal value of the government's fiscal policy, through spending and income originating from taxes. Unlike the previous ones, this study uses fiscal policy through the budget deficit as a control variable. Optimal control of the budget deficit will result in optimal public consumption, investment, export, import and GDP, so that economic growth will be optimal. Economic problems will be modeled into a mathematical model based on the concept of economic theory. This model will calculate the level of the budget deficit which is a control variable and is carried out from time to time. So that it will produce optimal value in the Indonesian economy. The advantage of this model is that the government can control fiscal policy through a budget deficit so that the value of state and control variables will be optimum in achieving the target.

2. Literature Review

2.1. The Role of Fiscal Policy in the Economy

Tariq et al. (2020) state that economic growth responds positively when the level of financial development exceeds a certain threshold value. Safdari et al. (2011), an increase in government spending has a negative effect on economic growth. Meanwhile, tax growth and increased government investment spending have a positive effect on economic growth in Iran. This study uses a vector auto regressive

model in examining the impact of fiscal policy on Iran's economic growth in the 1973–2008 period. Bouakez and Normandin's (2014) the research measures fiscal policy with the SVAR model in the United States. The results showed that increasing government spending is more effective than cutting taxes and tends to stimulate economic activity. The dynamic effects of fiscal policy shocks change significantly and are believed to mark important changes in monetary policy. Fiscal policy in the medium term tends to produce smaller output through increases in government spending, inflation and the budget deficit. Fiscal consolidation of the budget through increasing the tax burden appears to be successful in the short and medium term. However, in the long term it actually slows down economic activity (Shaheen & Paul, 2009). Alzyadat and Al-Nsour (2020) state that public spending and tax revenue have a positive effect on economic growth. Tax revenue is used to finance government activities in Jordan.

Furthermore, Ialomitanu et al. (2016) examined fiscal policy on economic growth in Romania. Pro-cyclic fiscal policy has resulted in an increase in the budget deficit and an accumulation of public debt. Government investment and spending is unsustainable and contributes to an increase in the budget deficit. Ngo and Nguyen (2020) state that budget deficits are closely related to misuse of state finances. Babecký, Franta, and Ryšánek's (2018) research using the DGSE-VAR combination, examine the effects of fiscal policy. This combination of models has obtained a more accurate estimate of the impulse response and fiscal multiplier. The two models show differences from fiscal policy shocks. The multiplier result of fiscal is a fiscal instrument that has an impact on domestic activities. The form of change in government consumption and investment. Ouedragaogo and Sourouema (2018) stated that exports tend to increase pro-cyclicality triggered by public investment behavior. Diversifying exports can increase government revenue and pave the way for public investment.

2.2. The Role of Optimal Control in the Economy

The optimal control problem can be modeled in many deterministic and stochastic problems. The difference between the two is in the methods used in dealing with the problem of uncertainty. All uncertainties are neglected in deterministic control theory, whereas the uncertainty factor is considered in stochastic control problems. The deterministic problem is a control model that does not take into account the uncertainty factor. Many economic problems can be modeled and solved by applying a deterministic model. The deterministic model consists of two groups, namely quadratic problems and general nonlinear problems. This study considers the quadratic model in formulating and solving the problem topics being studied.

The quadratic linear problem is a model using the quadratic form as a criterion function (objective) and the linear form in a system of dynamic equations. In continuous problems the objective function uses the integral form and the system of differential equations. Whereas in the discrete case, the objective function is a form of addition and a system of dynamic equations in the form of different equations. In optimal control theory, dynamic variables are categorized into two groups, namely, state variables and control variables. The state variable describes the state of an economic system during the observation time and the control variable states the policy. In addition, because the optimal control model is a dynamic model, initial system values are usually given, and in certain cases and boundary conditions. This condition is given to the state variables. On the other hand, Chow's approach states economic stability at an optimal level, according to several objective functions that explicitly calculate the time horizon for macroeconomic variables that do not fluctuate too widely, but are followed by smooth growth. In quantitative economic policy theory, it is usually assumed to be a quadratic function with form;

Purpose function:

$$\text{Minimize } L = \frac{1}{2} x_T' W_T x_T + w_T' x_T + \sum_{t=0}^{T-1} \left(\frac{1}{2} x_t' W_t x_t + w_t' x_t + x_t' F_t u_t + \frac{1}{2} u_t' K_t u_t + s_t' u_t \right) \quad (2.1)$$

The system of equations:

$$x_{t+1} = A_t x_t + B_t u_t + c_t, \text{ For } k = 0, 1, 2, 3, T-1 \quad (2.2)$$

With the initial value of x_0 , where:

x_t = state vector for period k with n elements.
 u_t = control vector for period k with m elements.
 W_t = positive definite matrix of size $n \times n$.
 w_t = vector with n elements.
 F_t = matrix of size $n \times m$.
 K_t = positive definite matrix of size $m \times m$.
 s_t = vector with m elements.
 A_t = matrix of size $n \times n$.
 B_t = matrix of size $n \times m$.
 C_t = vector with n elements.

In many economic problems, the system of difference equations describes an econometric model that cannot be written into a first-order difference equation. But it can be expressed in the second- or higher-order difference equation.

If the difference equation is in second- order high-order form the system of equations can be converted into first-order difference equations. Conversion is performed on state and control variables. The conversion procedure can be carried out by introducing a new variable, which is equivalent to a variable in high order. Suppose a second-order econometric model is given as follows:

$$x_{t+1} = A_0 x_t + A_1 x_{t-1} + B_0 u_t + B_1 u_{t-1} \quad (2.3)$$

Then two new vectors are defined:

$$y_{t+1} = x_{t-1} \text{ and } v_{t+1} = u_t \quad (2.4)$$

Thus, a new form of econometric model is obtained:

$$z_{t+1} = A z_t + B u_t, \quad (2.5)$$

$$\text{Where: } z_t = \begin{bmatrix} x \\ y \\ v \end{bmatrix}_t, \quad A = \begin{bmatrix} A_0 & A_1 & B_1 \\ I & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix},$$

$$B = \begin{bmatrix} B_0 \\ 0 \\ I \end{bmatrix} \text{ and } I \text{ is the identity matrix}$$

In addition, different forms of equations that often appear in economic models are:

$$x_{t+1} = A x_t + B u_{t+1} \quad (2.6)$$

Unlike the previous model, in this model the state equation does not depend on u_t but on u_{t+1} . Although in some economic problems the effects of policies or controls can directly affect the state equation, usually the choice of policy or control requires a period of time before the variables can have an impact.

3. Research Methods and Materials

3.1. Model Analysis

The research uses optimal control theory for fiscal policy through the budget deficit on the Indonesian economy. The main objective of Indonesia's economic policy is to obtain the results of economic growth, namely, optimal GDP growth, either directly or indirectly related to fiscal policy instruments through the budget deficit. The analytical model in this study consists of: first, the formulation of a simultaneous Keynesian macroeconomic model of equations, which is built based on the framework of economic theory and empirical facts. Second, optimal model management, budget deficit fiscal policy as a variable controlled by the government on the economy.

3.2. Simultaneous Keynesian Macroeconomic Model of Equations

The model in this study uses a simultaneous Keynesian macroeconomic model. Simultaneous equation models are used to describe the relationship between related variables between fiscal variables and macroeconomic variables. Keynes's simultaneous equation model in research can be seen in equation (3.1) to equation (3.5).

Keynesian Macroeconomic Model:
 Equation of Behavior:

1. Household Consumption:

$$CRT_t = a_{11} + a_{12}GDP_t + a_{13}CRT_{t-1} + u_{1t} \quad (3.1)$$

Where:

CRT_t = Household Consumption, Real (billion rupiah)

GDP_t = Income real (billion rupiah)

CRT_{t-1} = Previous Year's Household Consumption (billion rupiah)

2. Total Investment:

$$INV_t = a_{21} + a_{22}GDP_t + a_{23}R_t + a_{24}INV_{t-1} + u_{2t} \quad (3.2)$$

Where:

INV_t = Total real investment (billion rupiah)

GDP_t = Gross Domestic Product (billion rupiah)

R_t = Domestic Interest Rate (%)

INV_{t-1} = Previous Year's Investment (billion rupiah)

3. Export

$$EX_t = a_{31} + a_{32}XR_t + a_{34}INV_t + u_{3t} \quad (3.3)$$

Where:

XR_t = Exports (billion rupiah)

XR_t = Exchange Rate (Rp/US \$)

INV_t = Investment (billion rupiah)

4. Imports

$$M_t = a_{41} + a_{42}GDP_t + a_{43}XR_t + a_{44}MR_{t-1} + u_{4t} \quad (3.4)$$

Where:

M_t = Imports (billion rupiah)

GDP_t = Gross Domestic Product (billion rupiah)

XR_t = Exchange Rate (Rp/US \$)

MR_{t-1} = Previous Year's Imports (billion rupiah)

Identity Equation

5. Gross Domestic Product

$$GDP_t = CRT_t + INV_t + Def_t + EX_t - M_t \quad (3.5)$$

Where:

GDP_t = Gross Domestic Product (billion rupiah)

CRT_t = Household Consumption (billion rupiah)

INV_t = Investment (billion rupiah)

Def_t = Budget Deficit (billion rupiah)

EX_t = Exports (billion rupiah)

M_t = Imports (billion rupiah)

In the simultaneous equation model, the identification of the model is determined on the basis of "order condition" as a necessity and "rank condition" as a requirement of sufficiency. According to Arief (1993), the rules used in the identification of a simultaneous equation model so that it can be estimated through order conditions are determined by:

$$(KM) \geq (G-1) \quad (3.6)$$

Where:

K = number of endogenous and predetermined variables in the simultaneous equation model,

M = number of endogenous and exogenous variables in a given equation in the model,

G = number of equations in the simultaneous model, namely the number of endogenous variables in the model.

The provisions in identifying a simultaneous equation model are:

If $(KM) > (G-1)$, then the equation is over-identified

If $(KM) = (G-1)$, then the equation is exactly identified

If $(KM) < (G-1)$, then the equation is under-identified

The identification results for each structural equation must meet the over-identified or exactly identified conditions in order to predict the parameters. Even though the order condition has been met, it is not sufficient to determine whether this equation can be identified. Therefore, a necessary and sufficient condition must also be met, namely the rank condition.

Based on the rank conditions, an equation in a simultaneous equation system consisting of G equations can be identified if there is a possibility to form at least one nonzero determinant of size $(G-1)$ of the variables removed from certain equations but included in other equations (Arief, 1993).

Based on the order conditions and the rank conditions have been met, the Two-Stage Least Square (2SLS) method is used in the structural simultaneous equation. The 2SLS method is used to obtain one estimator for one parameter and produce a standard error for each estimator. Furthermore, to evaluate the model based on statistical criteria, it can be done by looking at the coefficient of determination R^2 , t statistic, and the Durbin-Watson statistical (DW) test (Gujarati, 1994).

To get the optimum value, reduce the form for the simultaneous equation coefficient and put it into the constraint function in the optimal control model. The reduced form where the left side contains the value of the variable in year t or the endogenous variable (state), while the right side contains only the variable in year $t-1$ (lag variable), exogenous variables (non-control), and control variables.

3.3. Optimal Control Model

Determination of optimal control policies on economic problems obtained by considering several factors of circumstances that change dynamically and can be formulated as an optimal control model. Optimal control involves a differential equation or difference equation (discrete case). In this study, discrete dynamic optimal control is intended to obtain optimal fiscal policy.

The optimal control problem is the problem of choosing a control variable among all admissible control variables, namely, a control that brings the system from the initial state at the initial time to the final state at the end time, thus providing the maximum or minimum value for the objective function. Control variables and state variables in differential equations or different equations in optimal control models can represent various parameters.

The discrete optimal control problem in this study is to minimize the objective function in the form of a quadratic function against deviations in the state variable and the control variable from the target value. The quadratic form of the objective function mathematically guarantees a single solution. This means that the minimization of the quadratic function has a single extreme. The target values for the state and control variables in the objective function are given so that the optimal state and control variable values approach the expected values for each time being observed. Meanwhile, the constraint function is in the form of a macroeconomic model for the economy in Indonesia. The optimal control model used in general can be written as follows:

Min objective function

$$L = \frac{1}{2} \sum_{t=1}^T \begin{bmatrix} x_t - \bar{x}_t \\ u_t - \bar{u}_t \end{bmatrix} W_t \begin{bmatrix} x_t - \bar{x}_t \\ u_t - \bar{u}_t \end{bmatrix} \quad (3.7)$$

Against constraints,

$$x_t = Ax_{t-1} + Bu_t + Cz_t, \quad t = 1, \dots, T \quad (3.8)$$

Where:

- x_t = is the n -dimensional state variable vector for time t
- u_t = is the m -dimensional control variable vector
- \bar{x}_t = is the target value in the state variable
- \bar{u}_t = is the target value for the control variable
- W_t = is a matrix that contains the weight of the deviation on state variables and variables control over its target value.
- z_t = is a vector of exogenous (non-control) variables
- A = is the parameter matrix of the lag variables
- B = is the parameter matrix of the control variable
- C = is the parameter matrix of endogenous (non-control) variables
- T = is the final time period of the specified time horizon

The variables used in the model Keynesian economics in this study consists of:

Endogenous Variable (State):

- $x[1]$: CRT \rightarrow = Household consumption
- $x[2]$: INV \rightarrow = Total real investment
- $x[3]$: ER \rightarrow = Export
- $x[4]$: $M \rightarrow$ = Import
- $x[5]$: GDP \rightarrow = Gross Domestic Product

Control Variables:

- $x[1]$: Def \rightarrow = Budget Deficit

Exogenous variables (non-control):

- $x[1]$: $R \rightarrow$ = Domestic Interest Rate
- $x[3]$: XR \rightarrow = Exchange Rate

In the optimal control dynamic model, the initial conditions for the state variable and control variable are given. The initial value is the final value of the estimated time horizon. The target value of the state variable and the control variable (\bar{x}_t dan \bar{u}_t). In the objective function is given based on the growth rate (%) at the last value on the observation time horizon. The constant matrix weight W on the objective function is the determination of the weight of the variable, where each variable is given the same weight, namely 1, describes that each variable is expected to contribute or have the same role to achieve the optimal value, meanwhile, if given a greater weight, this means that it is prioritized to achieve the target.

4. Results and Discussion

4.1. Keynesian Macroeconomic Model Estimation Results

The estimation results of the macroeconomic model with two-stage least square (2SLS), the effect of the budget deficit on the economy through prediction and optimization models are shown in Table 1.

Estimates of household consumption are strongly influenced by the level of income. An increase in income leads to an increase in consumption. The test results show that the increase in income has a positive and significant effect on the increase in consumption. Meanwhile, the increase in household consumption had a positive and significant effect on previous consumption.

The 2SLS results show that the Y value (economic growth) has a negative turn on investment. This condition is a result of global economic uncertainty affecting financial markets and investment risks in developing countries. Investments are experiencing an outflow. The estimation results using the interest rate (R) and previous investments. Economic growth is not significant to the decline in investment.

Furthermore, interest rates have a negative and significant effect on investment.

In an open economy, exports have an influence on economic growth. Table 3 shows the test results, an increase in the exchange rate (ER) has a positive and significant effect on an increase in exports. Likewise, investment has a significant effect on increasing exports.

Table 4 shows the test results of the exchange rate and economic growth are not significant to the increase in imports. The increase in imports has a positive and significant effect from the increase in imports in the previous year. To get the optimal value, the simultaneous equation coefficient is carried out by reducing the form and entering it into the constraint function in the optimization control model.

Table 1: Results of 2SLS Consumption Regression (CRT)

Variable	Efficient	Standard error	T statistic	Prob
C	-12994.37	27135.06	-0.478878	0.6362
Y	0.175699	0.030037	5.849318	0.0000
CRT (-1)	0.723141	0.055717	12.97889	0.0000
R-Squared	0.995			
Adj R-Squared	0.998	Instrument Rank	7	
F-Stat	8354.87			

Table 2: Regression Results 2SLS Investment (INV)

Variable	Efficient	Standard error	T statistics	Prob
C	382013.8	83738.25	4.561999	0.0001
Y	-0.042516	0.043010	-0.988522	0.3328
R	-18579.50	2579,094	-7.203888	0.0000
I NV (-1)	1.117192	0.122226	9.140401	0.0000
R-Squared	0.993			
Adj R-Squared	0.992	Instrument Rank	7	
F-Stat	1213.48			

Table 3: Results of 2SLS Export Regression (EX)

Variable	Efficient	Standard error	T statistics	Prob
C	82816.18	63139.45	1.311639	0.2016
XR	27,26918	8.659863	3.148916	0.0042
INV	0.570754	0.043230	13.20278	0.0000
R-Squared	0.948			
Adj R-Squared	0.944	Instrument Rank	7	
F-Stat	233.40			

Table 4: Import 2SLS Regression Results (M)

Variable	Efficient	Standard error	T statistic	Prob
C	9641,507	80650.06	0.119547	0.9058
Y	0.038090	0.052624	0.723816	0.4762
XR	-21.29704	12.21238	-1.743889	0.0940
M (-1)	1.003877	0.239425	4.192868	0.0003
R-Squared	0.922			
Adj R-Squared	0.913	Instrument Rank	7	
F-Stat	100.34			

The reduced form on the left side contains the variable value in year t or the endogenous variable (state). Meanwhile, the right side only contains the variables in year $t-1$ (lag variable), exogenous variables (non-control), and control variables. The reduced form is as follows:

$$CRT_t - 0.175699 Y_t = -12994.37 + 0.723141 CRT_{t-1}$$

$$INV_t + 0.042516 Y_t = 382013.8 - 18579.50 i_t + 1.117192 INV_{t-1}$$

$$EX_t - 0.570754 INV_t = 82816.18 + 27.26918 XR_t$$

$$M_t - 0.038090 Y_t = 9641.507 - 21.29704 XR_t + 1.003877 M_{t-1}$$

$$Y_t - CRT_t - INV_t - EX_t + M_t = Def_t$$

Furthermore, the Keynesian macroeconomic model above is represented in the form of a multiplication matrix, so that the reduced form is obtained:

$$\begin{pmatrix} 1 & 0 & 0 & 0 & -0.175699 \\ 0 & 1 & 0 & 0 & 0.042516 \\ 0 & -0.570754 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & -0.038090 \\ -1 & -1 & -1 & -1 & 1 \end{pmatrix} \begin{pmatrix} CRT_t \\ INV_t \\ EX_t \\ M_t \\ Y_t \end{pmatrix} = \begin{pmatrix} 12994.37 & 0.723141 & 0 & 0 & 0 \\ 382013.8 & 0 & -18579.50 & 1.117192 & 0 \\ 82816.18 & 0 & 0 & 0 & 27.26918 \\ 9641.507 & 0 & 0 & 0 & -21.29704 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\begin{pmatrix} I \\ CRT_{t-1} \\ i_t \\ INV_{t-1} \\ XR \\ M_{t-1} \end{pmatrix} + \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \end{pmatrix} Def_t$$

Or it can be written to be:

$$Ax_t = By_t + C Def_t$$

$$A^{-1}Ax_t = A^{-1}By_t + A^{-1}C Def_t$$

$$x_t = \Pi y_t + \Gamma Def_t$$

Where:

$$A = \begin{pmatrix} 1 & 0 & 0 & 0 & -0.175699 \\ 0 & 1 & 0 & 0 & 0.042516 \\ 0 & -0.570754 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & -0.038090 \\ -1 & -1 & -1 & -1 & 1 \end{pmatrix}$$

$$B = \begin{pmatrix} -12994.37 & 0.723141 & 0 & 0 & 0 \\ 382013.8 & 0 & -18579.50 & 1.117192 & 0 \\ 82816.18 & 0 & 0 & 0 & 27.26918 \\ 9641.507 & 0 & 0 & 0 & -21.29704 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$C = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 1 \end{pmatrix}$$

$$\Pi = A^{-1} B$$

$$\Gamma = A^{-1} C$$

4.2. Optimal Control Simulation Results

Fiscal policy simulations through the budget deficit as government control are carried out to determine optimal results for public consumption, government investment, exports, imports, and GDP. The initial value of the state variable and control variable in the objective function is defined based on the last value in the observation time horizon. Policy simulations were selected in the 2019–2023 period. The constraint function of optimal control is a

reduced form of the Keynesian macroeconomic model. From the calculation results using the `fmincon` () function feature in Mat lab, optimal results are obtained for the value of the state and control variables as in Table 5.

Table 5 is the initial year of estimation (2019) which shows that the optimal consumption value (CRT) in the initial estimate year is greater than the consumption target value set by the government. Whereas for the estimation of the next year (2020 to 2023), the optimal value of consumption (CRT) is smaller than the target value set by the government. The optimal investment value (INV) during the simulation period (2019 to 2023) is less than the target value set by the government. The optimal export value (EX) during the estimation period is less than the export target value set by the government. The optimal import value (M) at the beginning of the estimated period (2019) is greater than the import target value set by the government. The optimal value of GDP during the initial estimate (2019) is greater than the GDP target value determined by the government, while for the next estimate (2020 to 2023) the optimization value is below the target value. The optimal value of the budget deficit (Def) during the estimated period (2019 to 2023) is

Table 5: Results of Optimal Value and Target Value (Billion Rupiah)

			2019	2020	2021	2022	2023
Variable State	CRT	Target	6,062,830.73	6,365,972.26	6,684,270.87	6,684,270.87	7,018,484.42
		Optimal	6,068,292.99	6,000,000.00	6,067,245.74	6,062,234.31	6,066,269.98
		Deviation	5,462.27	365,972.26	617,025.00	622,036.56	952,214.44
	INV	Target	3,650,765,504	3,869,811,434	4,102,000.12	4,348,120,128	4,609,007.34
		Optimal	3,648,679.75	3,609,776.16	3,648,311.43	3,650,297.77	3,647,952.50
		Deviation	2,085.75	260,035.27	453,688.69	697,822,358	961,054.84
	EX	Target	2,429,881.83	2,582,964,385	2,745,691,141	2,918,669,683	3,102,545,873
		Optimal	2,428,413.16	2,429,385.03	2,428,307.32	2,429,441.12	2,428,206.84
		Deviation	1,468.67	153,579.36	317,383.82	489,228.56	674,339.03
	M	Target	2,062,456,374	1,932,521,622	1,810,772.76	1,696,694,076	1,589,802,349
		Optimal	2,063,265,020	2,061,744.92	2,063,467.96	2,061,594.77	2,063,483.05
		Deviation	808,650	129,223.29	252,695.20	364,900.69	473,680.70
	GDP	Target	10,977,858.06	11,592,618.12	12,288,175.2	13,086,906.59	14,002.99005
		Optimal	11,021,452.78	11,004,047.09	11,009,218.03	11,005,453.56	11,007,797.96
		Deviation	43,594.72	588,571.03	1,278,957.17	2,081,453.03	2,995,192.09
Control Variable	Def	Target	329,196,370	332,488,3337	335,813,217	339,171,3492	342,563,0627
		Optimal	329,110,230	300,000,000	300,000,000	300,000,000	300,000,000
		Deviation	86.14	32,488,330	35,813,220	39,171,350	42,563,060

Table 6: Optimal Contribution and Target of Macroeconomic Variables to GDP (percent)

			2019	2020	2021	2022	2023	Average
State Variable	CRT	Target	55.23	55.91	54.40	51.08	50.12	53.15
		Optimal	55.05	54.53	55.11	55.08	55.12	54.98
	INV	Target	33.26	33.38	33.38	33.22	32.91	33.23
		Optimal	33.11	32.80	33.14	33.17	33.14	33.07
	EX	Target	22.13	22.28	22.34	22.30	22.15	22.24
		Optimal	22.03	22.08	22.06	22.07	22.06	22.06
	M	Target	18.79	16.67	14.74	12.96	11.35	14.90
		Optimal	18.72	18.74	18.74	18.73	18.75	18.74
Control Variable	Def	Target	2.99	2.87	2.73	2.59	2.45	2.73
		Optimal	2.99	2.73	2.72	2.73	2.73	2.77

less than the budget deficit target value determined by the government.

The determination of the target value is based on the movement of the annual average growth for each variable. The achievement of optimal values is done through control of the budget deficit (optimal deficit), which will produce optimal values for each variable. The smaller the deviation value between the optimal value and the target value, the better. The optimal control model is to minimize the deviation between the target value and the optimal value.

Table 6 shows the contribution of consumption (CRT) to GDP in the simulation period (2019–2020), which shows that the contribution value of consumption to the optimal value is smaller than the target growth. Meanwhile, for the next period (the period from 2021 to 23) the contribution to the optimal value consumption is greater than the target contribution. For the simulation period (2019–2023) the contribution of optimal consumption with an average value of 54.98 percent of GDP, or greater than the contribution of the target consumption average of 53.15 percent. The investment contribution (INV) to GDP in the simulation period (2019 to 2023) shows that the optimal value investment contribution is smaller than the target contribution. For the simulation period (2019 to 2023) the optimal investment contribution shows an average value of 33.07 percent, and is less than the average contribution of the target.

The contribution of export value (EX) to GDP in the simulation period (2019 to 2023) shows that the optimal export contribution is smaller than the target contribution, where the optimal contribution value of the average export shows a value of 22.06 percent. The contribution of import value (M) to GDP in the initial simulation period (2019) shows that the optimal contribution value of imports is smaller

than the target value. For the next simulation period (2020 to 2023) the optimal value of the average import contribution is greater than the target value. For the simulation period (2019 to 2023) the optimal value of imports to GDP shows a value of 18.74, and is greater than the average import target value.

The contribution value of the budget deficit (Def) to GDP in the initial simulation period (2019) shows that the optimal contribution value of the budget deficit to GDP is the same as the target value. For the next simulation period (2020 to 2021) the optimal value of the average budget deficit contribution is smaller than the target value. On the other hand, for the simulation period (2022 to 2023) the optimal value of the budget deficit contribution is greater than the target value. For the simulation period (2019 to 2023) the optimal value of the average contribution of the budget deficit to GDP shows a value of 2.77, and greater than the average deficit target value. Thus, to encourage optimal contribution and target variables to macroeconomics, efforts are needed to control the deficit (optimal deficit). So far, there is a tendency for the government to not control the deficit (floating deficit).

5. Conclusions

This study uses a budget deficit policy with a Keynesian macroeconomic model. To get the optimal economy, which includes consumption, investment, export, import, and GDP, the government needs to control the budget deficit. The optimal contribution of consumption to GDP for the simulation is not too different from the real value, which is an average of 0.2 percent. Meanwhile, the investment growth in GDP for simulation is different from the real one, namely, 2.67 percent on average, the difference between the simulation value and the real export value is an average of

0.44 percent. The simulated and real value for imports to GDP an average of 2.86 percent. In the budget deficit control variable on GDP, the difference between the simulation and real value is an average of 1.07 percent. For the control variable, namely the budget deficit, a maximum limit on GDP is required. The government controls the budget deficit by maximizing revenue and increasing the quality of spending. For further research, it is necessary to develop a Keynesian macroeconomic model with a monetary policy approach, so as to produce a comprehensive analysis.

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