Management of Fiscal and Monetary Policy

(The Case Of Developing Countries)

Mohammad T Mojtahedzadeh
Rockefeller College
State University of New York at Albany
Albany, NY, 12222, USA

Abstract

A system dynamics model is presented to analyze fiscal and monetary policies. The model describes an economy which suffers from infrastructure shortage. Further, government is responsible for the development of infrastructure. The model demonstrates the contradiction between fiscal policy and monetary policy in offsetting the rise of inflation. The contradiction can be addressed in terms of time horizon --from a short-run and a long-run perspective. In order to control inflation, a monetary policy may suggest a reduction in the rate of increase in money supply. This can be done by restricting budget deficit based on inflation. In contrast, a fiscal policy may suggest that in order to control inflation, aggregate supply (of goods) must be increased. An increase in aggregate supply requires infrastructure; thus, budget deficit expansion is unavoidable. The model also shows that a policy which restricts new project initiation based on government budget availability causes a lower inflation rate, particularly in the long run, without decreasing the production growth rate.

Management of Fiscal and Monetary Policy

INTRODUCTION

In the view of many economists, capital occupies the central position in the theory of economic development. The rate of increase in capital and investment and the ratio of capital utilization, are dependent upon infrastructure capacity. In order to attract capital investment, an area must have adequate facilities and must create the impression that it tends to always be able to meet the demand for facilities. In contrast, a shortage of basic facilities would lead to a decrease in the ratio of capital utilization and investment.

Most basic facilities have to be built in large-scale lumps. Construction on this scale naturally requires large capital investment commitments. Oftentimes, it is more difficult to attract capital investment in a speculative project than it is for an existing project. Therefore, it is necessary to build in advance of current demand. For example, a port must be built at a certain capacity in order to allow for future growth in demand before new investment capital can be obtained. Similarly, investment in electrical power, water and roads is also lumpy. As a result, all new installations have to be built with adequate potential to meet anticipated future growth demands. Primarily for these reasons, in most developing countries, infrastructure is created by government.

In the economic literature, there is little agreement about the appropriate degree of government intervention in the market place. The debate though one of the central issues in economic literature, is misplaced. The important issue is not whether government should or should not intervene in the economy, or even what the magnitude of government intervention should be; rather it is determining which policy is more effective and efficient in solving an economic problem. Unfortunately, economic literature often fails to determine the effect of public policies (fiscal or monetary). It is unable to determine the ultimate worth of the value added to the economy by government. In most analyses, government expenditures are thought to be exogenous, either in real or nominal terms, and affect only the demand side of economic transactions. Government expenditures decrease potential savings for private investment and the positive effect of government expenditures on private investment is not examined.

Government expenditures, on the one hand, increase total demand and money supply when there is a budget deficit that is financed by the government's creation of money. An increase in total demand and money supply causes the overall price levels to rise. As price level rise, so does the budget deficit. This happens because the budget has to expand in order to compensate for the erosion of purchasing power of the nominal budget caused by inflation. On the other hand, government expenditures create infrastructure, which then in turn increases investment. Under these conditions, production capacity and, hence, aggregate supply would be expanded. An increase in aggregate supply causes the total tax base to rise. As a result, budget deficits decline. Furthermore, the availability of infrastructure attracts private investment. In other words, there is a tradeoff between higher rates of inflation in the short run and conversely, less inflation in the long run. To examine why this occurs, a dynamic model is presented. The model will also show how mismanagement of fiscal and monetary policy leads to an inefficient usage of scarce resources, without a resulting increase in new infrastructure or capital investment capacity. In turn, this creates an increasing rate of inflation along with a lower growth rate in production.

The reminder of this paper is divided into four sections. In the first section, the model structure is described. The second section discusses some of the major feedback loops of the model. The third section introduces some policy to control inflation. Model behavior under different policies is presented in section four. The last section summarizes the results.

MODEL STRUCTURE:

A system dynamics model of a national economy is developed to examine the effects of fiscal and monetary policy on inflation and economic growth rate.

Figure 1 shows the sector overview of the model. The model is divided into five sectors: 1) Money Market, 2) Commodity Market, 3) Prices, 4) Government Expenditures and Infrastructure Development and 5) Capital. Each sector preforms certain functions and interacts with the other sectors. The dynamic behavior of the model is the result of interaction between

these sectors. A description of each of the five sectors is presented in the following section.

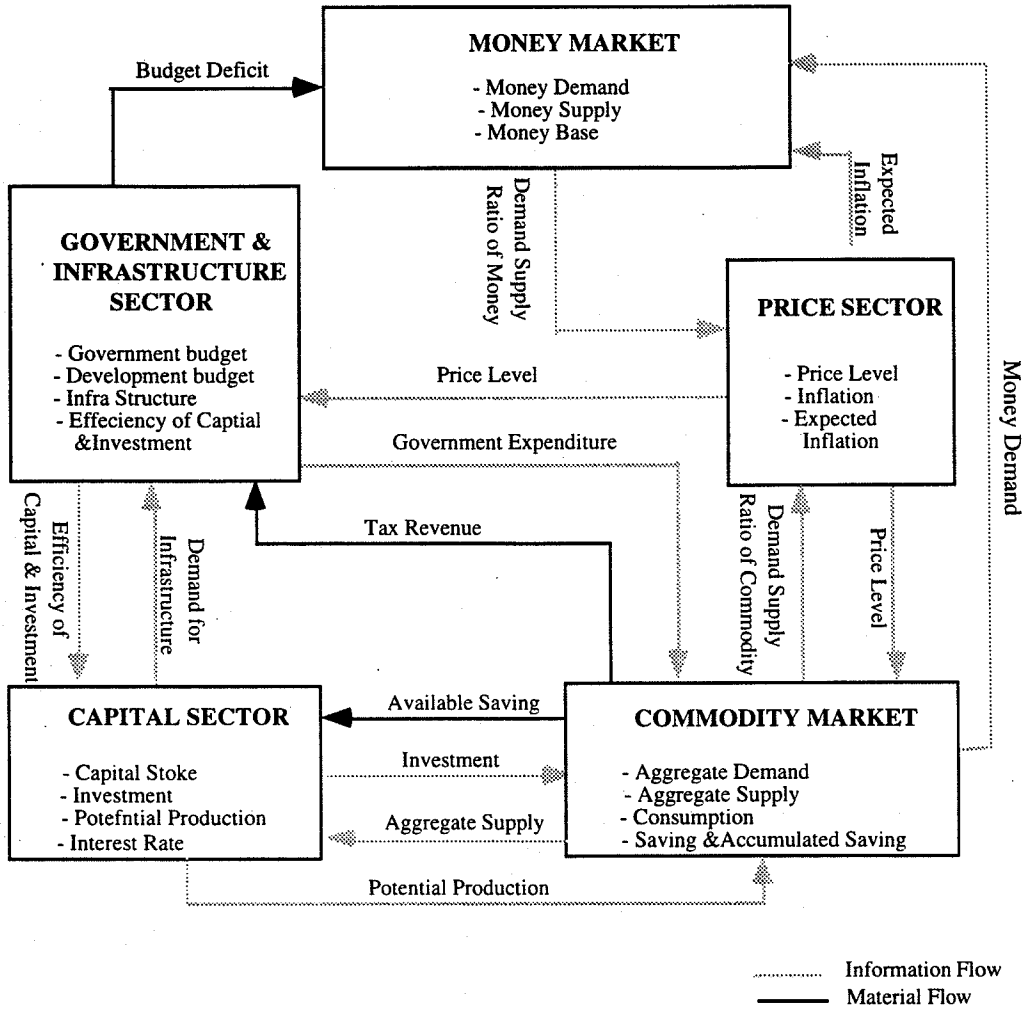

Figure 1: Sector Overview diagram of the model;
"Management of Fiscal and Monetary policy"

Money Market:

The money market sector represents the monetary side of the economy. It determines money demand; based on information such as inflation and total demand . This information is received from both the price sector and commodity market sector, respectively. This sector receives information on the budget deficit (defined as government borrowing from the central bank) from the government and infrastructure sector. The money market sector then uses this information as the basis from which it determines money supply. The money market sector also determines the disequilibrium effect of the money market (defined as the demand and supply ratio of money) on overall price levels. The economy reaches equilibrium only when both the goods market and the money market are at equilibrium (as discussed in conventional IS-LM analysis.)

Commodity Market:

The commodity market determines total supply and total demand for goods and services in both real and nominal terms. This sector receives information on the levels of private investment and government expenditures from the capital sector and the government and infrastructure sector, respectively. The level of total demand is based on the current levels of private investment, government expenditures and private consumption. Private consumption determined in the commodity sector based on total supply. The determination of total supply is

based on potential production (which is explained in the section describing the Capital Sector below.) The commodity sector takes information on savings available for utilization in the capital sector and determines the sequential levels of tax revenue that will be available for the government and infrastructure sector. The commodity market also determines the disequilibrium effect of the goods market (demand and supply ratio of commodities) on price level. The economy reaches equilibrium only when both the goods market and the money market are at equilibrium, (as discussed in conventional IS-LM analysis.)

Capital Sector:

The primary purpose of the capital sector is to determine potential levels of production. This determination is based on both the existing stock of capital and the utilization of this capital. The utilization ratio is calculated by determining the current infrastructure relative to the demand for infrastructure by current capital holders. The capital sector receives information on the efficiency of investment from the government and infrastructure sector. This sector also receives information about aggregate supply and available savings from the commodities sector. This information is then used to determine investment.

Government and Infrastructure Sector:

The government and infrastructure sector receives information on potential tax revenues from the commodity market. This sector also receives information on demand for infrastructure from capital sector. With this information, it then determines the appropriate level of government expenditure. This estimate is then returned to the commodity sector, in order to calculate aggregate demand. The government and infrastructure sector also determines budget deficit information that is used by the money market sector. Finally, this sector receives information on price levels from the price sector.

BASIC FEEDBACK LOOPS IN THE MODEL

The system dynamics model consists of three major feedback loops in commodities market: 1)Multiplier loop, 2) Accelerator loop and 3)Adjustment loops. Investment plays an important role in these three loops. Investment is determined by desired investment and the effect of saving availability. In equilibrium, or near equilibrium, the effect of saving availability is one, and hence investment is equal to its desired amount. The desired investment is calculated by subtracting the desired capital and the current level of capital. The formula for desired capital is based on the standard neoclassical assumption of profit maximizing behavior in the acquisition of production factors. In this model, profit is total revenue less the holding cost of capital. This translates into output times price of output minus capital times the price of capital (interest rate) as shown in equation [1]:

$$\begin{aligned} \text{Profit} &= \text{Revenue} - \text{Cost} \\ &= P*Q - R*K \end{aligned} \qquad [1]$$

Where, P is the price of output, Q is output (revenue = P*Q), R is price of capital, and K is capital.

The profit maximizing level of capital is obtained by setting the derivative of profit with respect to capital equal to zero and solving for capital.

$$d(\text{Profit})/ dK = P* (dQ/ dK) - R = 0 \qquad [2]$$

The production function is Cobb-Douglas, hence;

$$\begin{aligned} dQ / dK &= d(A*K\hat{}ß)/ dK \\ &= ß * Q / R \end{aligned} \qquad [3]$$

Where ß is the exponent on capital, and A is the technology coefficient. Substituting the above equation in equation [2] yields;

$$DK = ß * P * Q / R \qquad [4]$$

In the above equation DK is desired capital, which is the function of the price level, production,

and price of capital. Therefore, investment, desired capital less current capital, links the three above-mentioned loops through price level, production, and price of capital.

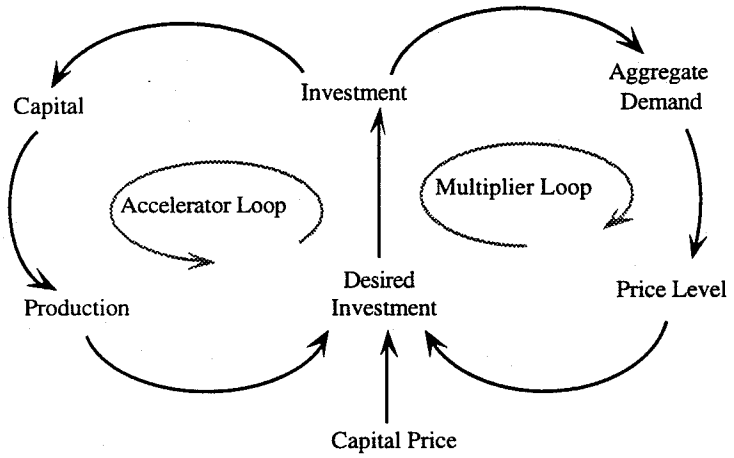

Figure 2; Accelerator and Multiplier Loops

Figure 2 shows the accelerator and multiplier loops. The multiplier loop depicts how a change in investment (or government expenditure) can produce over time an even greater change in total income. In this loop an increase in investment increases aggregate demand, which increases price level. An increase in price level causes desired investment, and consequently actual investment, to increase. The multiplier behaves as a negative loop. The accelerator is a positive loop. As investment increases, capital increases, which causes production to rise. An increase in production increases desired investment and, therefore, investment.

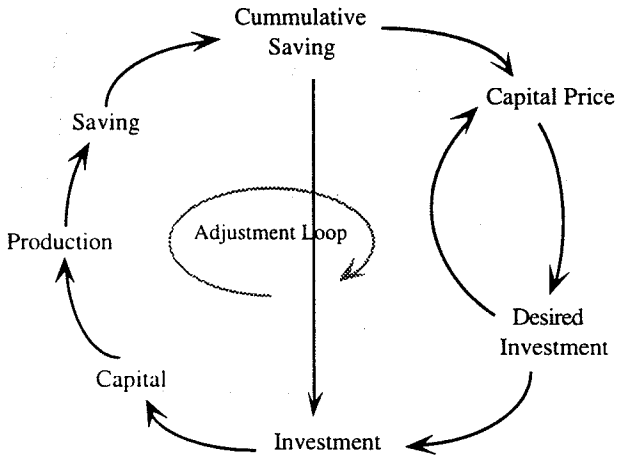

Figure 3; Adjustment Loop

Figure 3 shows the structure of the adjustment loop. In this loop, if the desired investment (desired capital stock less current capital) is greater than available resource for investment, the price of capital will increase. The price of capital then decreases the desired investment. In the absence of this loop, desired investment can be greater than cumulative savings --available resource for investment. It should be noted that in this model the effect of disequilibrium in the money market on interest rate is not considered.

POLICY ALTERNATIVES:

It is obvious that for an economy which suffers from infrastructure shortage, the rate of inflation will rise. On one hand, infrastructure shortage increases desired government budget which in turn leads to a budget deficit. On the other hand, infrastructure shortage decreases capital utilization which causes aggregate supply to decrease. In this condition government is responsible to apply some appropriate policies to control inflation. In this section some policies are introduced in order to control inflation.

a - Budget deficit expansion: Under this policy the government can produce as much budget deficit as need. This policy suggest that government expenditure can be equal to desired government expenditure which in turn is a function of infrastructure shortage. Some part of the government expenditure is provided by tax revenue and the remainder is provided by money creation. This policy attempts to control inflation by increasing aggregate supply.

b - Budget deficit restriction based on inflation: This policy is shown in Figure 4. Budget deficit restriction policy does not allow government to expand budget deficit as much as demand. Under this policy, as the inflation rises the negative effect of inflation on government expenditure increases and thus the budget deficit decreases. Hence, government expenditure is not only determined by desired government expenditure but also by the effect of inflation. This policy attempts to control inflation by controlling money supply.

c - Increase in tax rate based on budget deficit ratio: The Budget deficit can decrease by either decreasing the government expenditure or increasing tax revenue. Increases in tax rate policy attempts to decrease the budget deficit by increasing tax revenues. As Figure 4 shows, in order to increase tax revenues, the tax rate is increased. The increase in the tax rate is based on the budget deficit ratio. Under this policy, as the ratio of budget deficit to government expenditure rises, the tax rate rises as well. An increase in the tax rate increases tax revenue which decreases the budget deficit. As the budget deficit decreases, the tax rate increase if government expenditure remains unchanged.

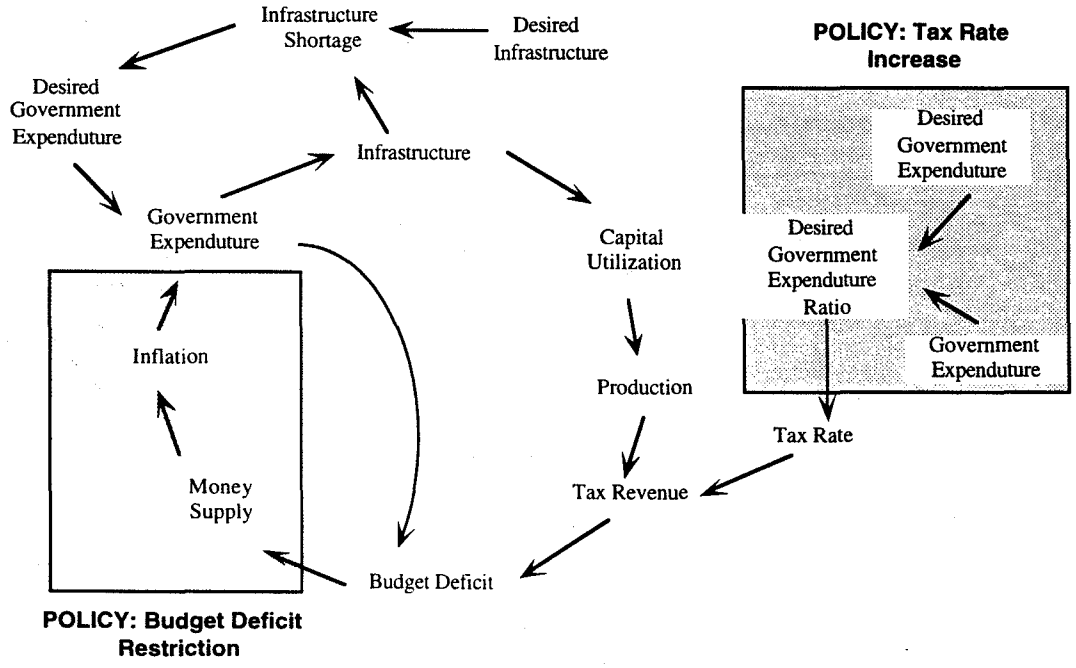

Figure 4; Budget deficit restriction policy and increase in tax rate policy

d - Restriction on new project initiation based on the government budget availability: Figure 5 presents a co-flow in the government and infrastructure sector of the model. This co-flow introduces the concept of base cost and progress budget in executing infrastructure projects, and determines the completion time of the infrastructure under development.

Base cost refers to those expenditures on a project which are necessary to keep a

project ready for real progress. Expenditures related to the base cost include such items as the salaries of a project manager and his staff, building and building maintenance, constructi machinery and equipment which are held in the project site, minimum charge made by consultants and constructors which are ready to provide the necessary services to the project as requested. Desired base cost is a function of infrastructure under development. The progress budget refers to those expenditures that generate real progress in the projects. Expenditures related to the progress budget includes items such as engineering, construction, procurements, and commission. The desired progress budget determines the desired increase in infrastructure. Desired government budget then is the sum of desired base cost and desired progress budget. The government budget depends on the desired government budget and policies which have been chosen for stabilization. The progress budget is determined by the government budget minus the desired based cost. The desired progress budget refers to the starting rate of new projects. It increases the desired infrastructure under development. The desired infrastructure under development is decreased by desired infrastructure formation. When the government budget is equal to the desired government budget, the desired infrastructure under development ratio is one. Hence, completion time for infrastructure under development is equal to its normal amount. As the government budget becomes less than its desired amount, infrastructure under development ratio becomes less than one. Under this condition, completion time would increase, therefore, infrastructure under development would increase, which causes the desired base cost to increase and the available budget for real progress to decrease.

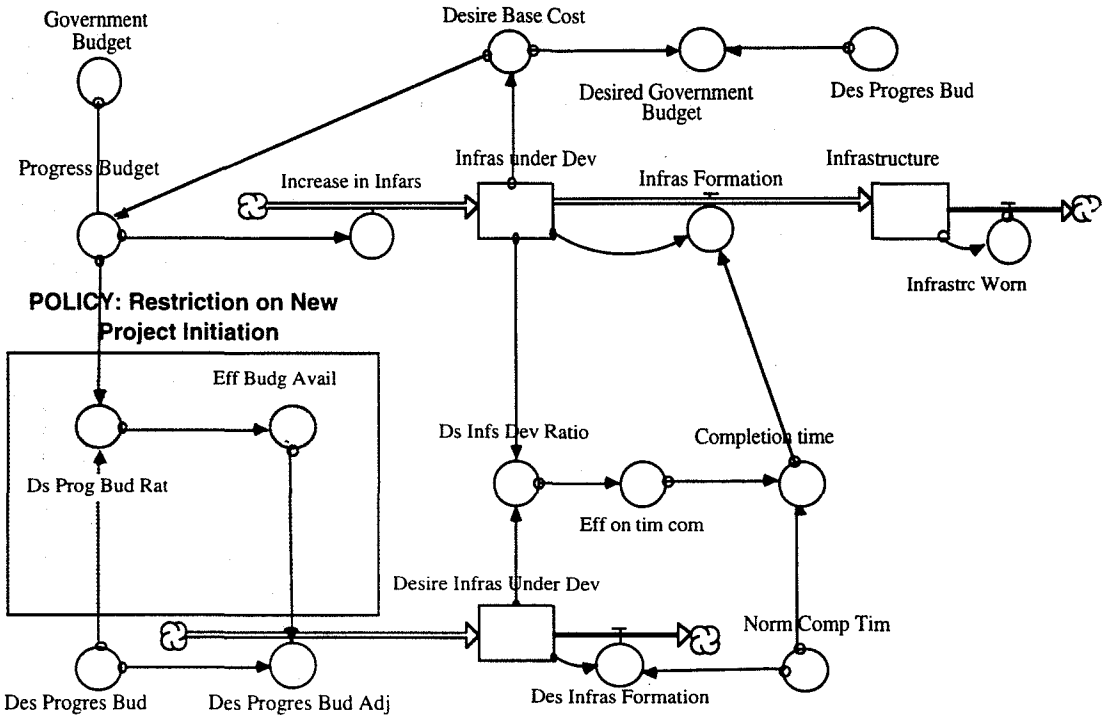

Figure 5; Restriction on New Project Initiation Policy

In most developing countries, the starting rate of new projects does not respond to government budget availability. This causes the completion time of the projects to rise. Restriction on new project initiation policy suggests when government expenditure is less than its desired amount, in which case the rate of new project initiation must be reduced. Under these circumstances, the rate of increase in the desired infrastructure under development would decrease and, therefore, the completion time of the project would not increase. Base cost would not increase, which causes available budget for real progress to increase.

MODEL BEHAVIOR:

In this section six different combinations of the alternative policies which were described in the previous section will be introduced and examined.

Policy 1: Budget deficit expansion
Policy 2: Budget deficit restriction based on inflation
policy 3: Tax rate increase based on budget deficit ratio along with budget deficit expansion
Policy 4: Tax rate increase based on the budget deficit ratio and budget deficit restriction based on the inflation
Policy 5: Budget deficit expansion along with restriction on new project initiation based on budget availability
Policy 6: Tax rate increase based on the budget deficit ratio along with restriction on new project initiation based on budget availability.

Figures 6 through 9 show the behavior of inflation, real growth rate, budget deficit ratio and government expenditure ratio under four different policies. As can be seen in figure 6, under budget deficit expansion policy (policy 1) the inflation rate rises drastically due to budget deficit expansion and, therefore, a high growth rate of money supply. The inflation rate under this policy decreases from time 6 because of a decrease in budget deficit and an increase in production. Under budget deficit restriction policy (policy 2), however, short-run inflation rate does not increase as much as it does in policy 1.

In contrast to policy 1, under policy 2, long-run inflation rate does not drop due to lower real growth rate (growth rate in production). Under budget deficit expansion policy and increase in tax rate policy (policy 3), inflation rates, both short run and long run, are lower than under policy 1. Under this combined policy real growth is slightly lower than in policy 1. This is because of a lower private investment (as compared to policy 1) due to a higher tax rate which decreases the available saving for investment. The combined policy of budget deficit restriction and increase in tax rate (policy 4) causes inflation to rise slower than under other policies. However, the growth rate is also lower than policies 1 and 3. In summary, policies 2 and 4 lead to a lower real growth rate and higher inflation rate in the long run, but lower inflation rate in the short run. Policies 1 and 3, cause a higher inflation in the short run but a lower inflation and a higher growth in the long run. Figure 7 shows the budget deficit ratio and government expenditure ratio. As can be seen, under policies 1 and 3 government expenditure is lower than under policies 2 and 4. This indicates that the model does not suggest big government for economic development.

Policies 1 and 3 are compared with policies 5 and 6 in figure 10 through 13. As can be seen in these figures, when budget deficit expansion is applied with restriction on new project initiation (policy 5) the inflation rate will be lower than when budget deficit expansion is used alone. This decrease in inflation does not cause real growth rate to decrease. A combination of tax rate increases policy, and restriction on new project initiation policy (policy 6) will also lead to a lower inflation without decreasing real growth rate. When restriction on a new project initiation is applied, completion time of the project under development will decrease. The decrease in completion time leads to a lower base cost which increases available budget for real progress. In summary, in relative terms policies 5 and 6 lead to lower inflation and higher growth rate in comparison with other policies.

Judgment about whether policy 5 or 6 is more appropriate, in terms of inflation and growth rate remains obscure from the simulation results. Policy-makers have to choose between having lower inflation and lower real growth rate or higher inflation and higher growth rate.

CONCLUSION:

A system dynamics model is presented to analyze fiscal and monetary policies. The model describes an economy which lacks adequate infrastructure. Further, the government is responsible for the development of infrastructure. The model demonstrates the contradiction between fiscal policies and monetary policies to offset the rise of inflation. The contradiction can be addressed in terms of time horizons --from a short-run or a long-run perspective. In order to control inflation, a monetary policy may suggest a reduction in the rate of increase of the

money supply. This can be done by restricting budget deficit based on inflation. In contrast, a fiscal policy may suggest that, in order to control inflation, aggregate supply (of goods) must increased. An increase in aggregate supply requires infrastructure. Hence, budget deficit expansion is unavoidable.

The model shows that contradictory monetary policy action reduces the rate of inflation in the short-run. However, inflation would not decrease in the long-run due to a lower aggregate supply. By contrast, expansionary fiscal policy causes inflation to rise drastically in the short-run due to increase in the budget deficit; but inflation would decrease in the long-run because of a higher growth rate of aggregate supply. A expansionary fiscal policy action-- increase in tax rate based on the budget deficit ratio-- reduces the rise in inflation rate in the short run. Although the growth in inflation rate is lower under this policy, the production growth rate is always lower than that under an expansionary fiscal policy. Furthermore, the model also shows that policies that restrict new project initiation based on government budget availability causes a lower inflation rate, particularly in the long run, without decreasing the production growth rate.

REFERENCES:

Baro, Robert J. 1983. "A Positive Theory of Monetary Policy in a natural Rate Model" Journal of Monetary Economics. 91. PP 589-610.

Baro, Robert J. 1979. "On the Determination of Public Debt" Journal of Political Economy. 87. PP 940-71.

Forrester, Jay W. 1974. "Understanding Social and Economic Change in the United State" Working paper from the System Dynamics Group. Sloan School of Management. Massachusetts Institute of Technology. Cambridge, MASS. MIT, Working Paper #D-2103

Forrester, Jay W. 1974. "An Alternative Approach to Economic Policy: Macro behavior from Microstructure", System Dynamics Group. Sloan School of Management. Massachuse Institute of Technology. Cambridge, MASS. MIT

Forrester, N. B. 1982. A Dynamic Synthesis of Basic Macroeconomic Theory: Implication for Stabilization Policy Analysis. Ph.D. Dissertation, Sloan School of Management, M.I.T., Cambridge, MA 02139.

Low, G., 1980, "The Multiplier Accelerator model of Business Cycle interpreted from a System Dynamics Perspective, in J. Randers (ed.) Elements of the System Dynamics Method, MIT Press, Cambridge.

Mashayekhi, Ali N., D. 1991, "Dynamics of Developing Cost Structure", Proceeding of 1991 International System Dynamics Conference in Bangkok.

Richardson, George P. & Pugh, III, Alexander L. 1981. Introduction to System Dynamics Modeling with Dynamo. Productivity Press. Cambridge, MASS.

Samuelson, P. A., 1939. "Interaction Between the Multiplier Analysis and the Principal of Accelerator", The Review of Economic Statistics, 21, 75-78.