A Study on the Structural Change of Fiscal Policy after Korean Currency Crisis

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This paper studies the structural change of fiscal policy after the Korean currency crisis by comparing the macroeconomic effects of government expenditures in the pre-and post-crisis periods. The real GDP in the national account from BOK breaks down into five sub-sectors; private consumption(PC), private investment(IP), net exports(NX), government expenditure(GT = government consumption+government investment), and the other remaining sub-sector(ETC). A vector autoregressive method(VAR) is used to find the dynamic effects.

The results show that the effects of government expenditure on each national account sub-sectors and real GDP are very different in terms of growth rate when compare in the pre and post periods. There seems to be a structural change between the two periods. And also we can find out that government consumption crowds out private consumption before crisis but the two change to a complementary relationship after the crisis. A similar structural change of the relationship appear to have taken place between government investment and private investment.

We can find the propagation mechanism from government expenditures to real GDP through this analysis. The results seem to be consistent with the Keynesian multiplier implications.

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The characteristics of the Korean economy after currency crisis seem to be quite different from the previous periods in several aspects such as the sluggishness of growth and the rate of employment when we look at the main macroeconomic indicators. Meanwhile in the government sector, public debt has been growing owing to expansion of government expenditure and government borrowings after the crisis. So we need to investigate structural change between the pre-and post-crisis periods with respect to fiscal policy effects.

The structural change or non-linear response of fiscal policy is becoming one of the main issues in the macroeconomic literature. In the OECD sample, the non-linearity of the response to fiscal policy tends to be associated with large and persistent fiscal impulses and to be stronger for fiscal contractions than for expansions. Furthermore, in the case of a high-debt country, fiscal contraction may reduce the likelihood of public sector default, thus improving confidence and increasing consumption and investment, which appears to contradict the conventional Keynesian view.

The Korean economy seems to encounter a situation of this type after currency crisis at the end of 1997 since the public debt has been growing rapidly. Fiscal contraction was required in that situation and heated debate about fiscal soundness and sustainability, and it maybe follow a contraction in economic activity which would be a cause for concern. But if fiscal contraction had non-linear effect by helping economic expansion after the crisis, it would be a positive step toward sign at reducing public debt in Korea current situation. So I attempt to study it with this mind. Also I focus on the economic relations among real variables such as the effects of government expenditures on private consumption, private investment, and net exports, using a VAR approach.

This paper is organized as follows. Section Ⅱ surveys the fiscal effects and structural change. Section Ⅲ sets up the appropriate model and Section Ⅳ presents empirical results using Korean data. Section Ⅴ summarizes the main points and present their implications.

Ⅰ. Introduction

1. Theoretical Issues

The impact of fiscal policy on the economy has been extensively considered in the macroeconomic literature. Keynesian analyses have focused on studying the effect of fiscal policy through its influence on aggregate demand. According to standard macro models, government purchases have a multiplier effect on output no matter what the composition of the expenditure is. But this line of logic has been questioned by neoclassical economists. Government services would yield consumption benefits for individuals and production benefits for firms. Government consumption expenditures are allowed to influence utility directly by providing a current substitute for private consumption goods with no interaction with leisure. Government investments in public capital, on the other hand, have the potential of enlarging society's future production possibilities and of augmenting the rate of return on private capital.

The idea that there is not a unique effect of government purchases and taxes on the real economy but rather several according to the type of government purchases is considered in our theoretical model. I present the outline of a class of environments in which the path of government purchases is exogenously given and takes the form of public capital that increases the marginal product of the private production process. And also I consider an economy with two divisible goods, one is either consumed or allocated in private capital, the other is public capital. The available technology is a joint production process that requires both types of capital, private as well as public.

There is a single infinitely lived representative household that derives utility from consumption. Given the initial private capital stock and the stochastic process for public capital, the household has to allocate resources between consumption and capital for the next period's production. The government sets a nonstochastic process for the public capital which is known to the household.

The economy is composed of a 'representative' agent who attempts to maximize the utility functional form:

$$Max \sum_{t=0}^{\infty} \beta U(C_t + \theta GC_t) \quad (1)$$

$$s.t.\ C_t + K_{pt+1} = f(K_{pt}, K_{gt}) + (1-\mu)K_{pt} - GC_t - GI_t$$
$$\{K_0, K_{g0}, GC_t, GI_t\}\ \forall\ t \text{ given}$$

where, β is a subjective discount factor(=constant), $0<\beta<1$, $\beta=1/(1+\rho)$ (ρ time preference rate), C denotes physical private consumption, GC and GI are government consumption and government investment expenditures on goods and services, respectively. U(.) is continuous and twice differentiable with $U' > 0$, $U'' < 0$.

$C^e_t = C_t + \theta GC_t$ represents effective consumption at period t and assumes that government purchases are allowed to influence utility directly by providing a current substitute for private consumption goods, i.e. government consumption spending adds to private utility, possibly as a substitute for private consumption goods(e.g., school lunches, library books) or as a complement to leisure activity(e.g., public parks, scenic highways), $\theta(0\leq\theta\leq1)$ denotes the marginal rate of substitution between private and public consumption goods so that an incremental unit of publicly provided goods yields only a fraction of the utility to be derived from an extra unit of privately purchased goods. The provision of theses types of public services means that households obtain units of effective consumption that exceed the quantity of private real expenditures. This assumption is crucial for the modelling strategy since it implies that increases in government spending will impose negative wealth effects on the representative agent.[1)]

The production function $Y_t = f(K_{pt}, K_{gt})$ exhibits constant returns to scale form and twice continously differentiable, strictly concave on K_{pt} and K_{gt}. The capital stock is $K_t = K_{pt} + K_{gt}$(K_{pt}: private capital, K_{gt}: public capital).[2)] Labor supply is assumed to be perfectly inelastic(i.e., costant) over time. And we assume that f_1, $f_2 > 0$, f_2 denotes marginal product of public capital services as an input to private production processes. Private investment is $I_{pt} = K_{pt+1} - (1-\mu)K_{pt}$, μ proportionate depreciation rate on private capital($0\leq\mu\leq1$). Hence, net wealth in the private sector consists of $W_t = Y_t + (1-\mu)K_{pt}$. Each agent in the economy, after paying taxes to the government, uses its after tax income for consumption and investment.

The government sector has a flow budget constraint of the form;

$$G_t = GC_t + GI_t = T_t \quad (2)$$

where G : total government expenditure, GC: government consumption, GI :

Notes : 1) The recent empirical work of Kormendi(1983), Ahmed(1986), and Aschauer(1985) reports values for θ in the range .2 to .4, so that it does not appear that this assumption is unrealistic.

2) This type of production function can be found by looking at Chater Ⅳ of Arrow & Kurz(1970), particularly pp. 87 - 93.

Ⅱ. Fiscal Policy Effects and Structural Change

government investment which is $GI_t = K_{gt+1} - (1-\nu)K_{gt}$, ν: proportionate depreciation rate on public capital($0 \le \nu \le 1$).[3] The government finances its expenditures G_t by lump-sum taxes T_t in period t.

The optimality conditions for the agent's problem may be obtained from the Lagrangian functional, which, upon differentiation, yields the following first-order conditions if it is assumed to be the interior solution. They are:

$$C_t : U' = \lambda_t \qquad \forall t$$
$$K_{pt+1}: \beta\lambda_{t+1}(f_1(K_{pt+1}, K_{gt+1}) + 1 - \mu) = \lambda_t \quad \forall t \tag{3}$$
the agent's budget constraint: $C_t + K_{pt+1} + G_t =$
$$f(K_{pt}, K_{gt}) + (1-\mu)K_{pt} \quad \forall t$$

And the following relationships $U'(C_{t+1} + \theta GC_{t+1})/U'(C_t + \theta GC_t) =$ $\lambda_{t+1}/\lambda_t = 1/\beta(f_1(K_{pt+1}, K_{gt+1}) + 1 - \mu)$ yield the economy-wide equilibrium condition;

$$Y_t = C_t + GC_t + K_{pt+1} - (1-\mu)K_{pt} + GI_t \tag{4}$$

Considering the optimality conditions and the equilibrium condition together, we obtain the following:

$$U'(C_t + \theta GC_t) = \beta(f_1(K_{pt+1}, K_{gt+1}) + 1 - \mu)U'(C_{t+1} + \theta GC_{t+1}) \forall t \tag{5a}$$
$$f(K_{pt}, K_{gt}) = C_t + GC_t + GI_t + K_{pt+1} - (1-\mu)K_{pt} \quad \forall t \tag{5b}$$

Equation (5a) states that the agent adjusts his consumption profile so that the marginal rate of substitution between current and future consumption is equal to the marginal product of private capital minus net depreciation. Equation (5b) indicates the economy-wide equilibrium condition. Note that it is assumed that a resale market for physical capital exists.

In addition, the transversality condition at infinity is:

$$\lim_{t\to\infty} \beta^t U'(t) K_t = 0 \tag{6}$$

which are imposed on the agent's problem to rule out the possiblity of the agent increasing current consumption without the penalty of a reduction in consumption at some point in the future. Given the initial conditions $C_0 = C^{Y}$, $K_0 = K^{Y}$,

3) Refer to Sargent(1987), p.141.

equation (5) - (6) are necessary to insure an optimum for the agent's problem as given in equation (3).

As considered deterministic situation we assume the model has perfect foresight one for simplicity of analysis. Now the endogenous variables in the model are constant as the exogenous variables constantly given under stationary state. Under these conditions the optimal conditions (5a) - (5b) can be expressed as follows:

$$U'(C^* + \theta GC^*) = \beta\{1 + f_1(K^*_p, K^*_g) - \mu\}U'(C^* + \theta GC^*) \tag{7a}$$
$$f(K^*_p, K^*_g) = C^* + GC^* + \mu K^*_p + \nu K^*_g \tag{7b}$$

But under the steady state, equation (7a) means the agent's marginal utility terms in both sides can be cancelled out. Therefore we can express these equations as the following:

$$\beta[f_1(K^*_p, K^*_g) + 1 - \mu] = 1$$
$$f(K^*p, K^*g) = C^* + GC^* + \mu K^*_p + \nu K^*_g \tag{8}$$

Hence after adjusting in the long run, we get the relationships: subjective rate of time preference $((1/\beta) - 1)$ = (marginal product of private capital - depreciation rate) = constant under steady state. Total differentiating equation (8) for comparative statics we obtain,

$$\beta f_{11} dK^*_p + \beta f_{12} dK^*_g = 0$$
$$(f_1 - \mu)dK^*_p + (f_2 - \nu)dK^*_g = dC^* + dGC^* \tag{9}$$

Transforming these equation into matrix form,

$$\underbrace{\begin{bmatrix} 0 & f_{11} \\ -1 & f_1 - \mu \end{bmatrix}}_{W} \begin{bmatrix} dC^* \\ dK^*_p \end{bmatrix} = \begin{bmatrix} -\beta f_{12}\, dK^*g \\ dGC^* - (f_2 - \nu)\, dK^*_g \end{bmatrix} \tag{10}$$

And the sign of the determinant W is $W = f_{11}\beta < 0$. Using Cramer's Rule, we get the stationary state multipliers as follows:

$$\partial C/\partial GC = -f_{11}\beta/(f_{11}\beta) = -1$$
$$\partial K_p/\partial GC = 0$$
$$\partial C/\partial GI = \beta(-(f_2 - \nu)f_{11} + (f_1 - \mu)f_{12})/(-f_{11}\beta)$$

$$= (f_2 - \nu) - (f_1 - \mu)(f_{12}/f_{11}) > 0 \text{ if } f_{12} > 0,\ f_2 > \nu,\ f_1 > \mu$$

$$\partial K_p/\partial GI = -f_{12}\beta/(f_{11}\beta) = -f_{12}/f_{11} > 0 \text{ if } f_{12} > 0$$

	∂C	∂K_p
∂GC	-1	0
∂GI	+	+

$$\partial Y/\partial GC = 0$$
$$\partial Y/\partial GI > 0$$

The result of solution of the model shows that, in the steady state, government consumption expenditures crowd out private consumption fully – the multiplier is zero – as the case of M. Bailey(1971), but government investment expenditures raise private investment and so real output, producing a positive multiplier.

Dividing the composition ratio of total government spending into government consumption vs. investment, we can express $GC = \sigma G$, $GI = (1-\sigma)G$, $0 \le \sigma \le 1$. So in the stationary state total government spending G is $G^* = GC^* + \nu K^*_g$, and government investment is $GI^* = (1-\sigma)G^* = \nu K^*_g$ We substitute GC^* and K^*_g in the equation. (9) into these relationships including parameter σ and exogenous variable G^*, and take them the matrix form like equation. (10) as follows:

$$\underbrace{\begin{bmatrix} 0 & \beta f_{11} \\ -1 & f_1 - \mu \end{bmatrix}}_{W} \begin{bmatrix} dC^* \\ dK^*_p \end{bmatrix} = \begin{bmatrix} -\beta f_{12}[(1-\sigma)/]dG^* \\ [\sigma - (f_2 - \nu)\{(1-\sigma)/\nu\}]dG^* \end{bmatrix} \qquad (11)$$

And the sign of detevmiunit. W is $W = f_{11}\beta < 0$. Using Cramer's Rule here the stationary state multipliers are as follows:

$$\partial C/\partial G = -\beta\{[f_{12}(f_1 - \mu) - f_{11}(f_2 - \nu)][(1-\sigma)/\nu] + f_{11}\sigma\}/\beta f_{11}$$
$$= \underset{+}{[(f_2 - \nu) - f_{12}(f_1 - \mu)/f_{11}]}\,\underset{+}{[(1-\sigma)/\nu]} - \sigma \gtrless 0$$
$$\partial K_p/\partial G = -\beta f_{12}[(1-\sigma)/\nu]/\beta f_{11} = -f_{12}[(1-\sigma)/\nu]/f_{11} > 0$$

Hence the effect of government spending on private consumption($\partial C/\partial G$) may be uncertain, and the effect of government spending on private investment ($\partial K_p/\partial G$) is positive as long as there exists a complementary relationship between government spending and private investment, so that the sign of the effect of government spending on output($\partial Y/\partial G$) depends on the relative size of the forces between the two. The solution also shows that the larger the share of consumption components in total government spending, the more the government spending crowds out private spending. The theoretical results imply that the multiplier effect of government investment expenditures is bigger when the marginal product of government capital stock and the intensity of the complementary relationship between government capital stock and private capital stock are bigger, regardless of marginal rate of substitution of government consumption for private consumption.

Taking the Cobb-Douglas production function form(i.e., $Y = AK_p^k Kg^{1-k}$, $0<k<1$, A: positive constant as an indicator of the state of technology),

$$f_1 = k A(K_p/K_g)^{k-1},\ f_2 = (1-k)A(K_p/K_g)^k,$$
$$f_{11} = k(k-1)A(K_p/K_g)^{k-1}(1/K_p),\ f_{12} = k(1-k)A(K_p/K_g)^k(1/K_p)$$

In case of disregarding depreciation terms, we can derive $\partial Y/\partial GI = f_2 + (f_{12} f_1/(-f_{11})) = (K_p/K_g)^k$. If we apply the Euler theorem to the production function having the property of homogeneity of degree one, using the following equation $Y = f_1 K_p + f_2 K_g = f(.)$, we get the relationship $(-f_{21}/f_{11}) = K_p/K_g$, and the multiplier is $\partial Y/\partial GI = f_2 + (f_{12} f_1/(-f_{11})) = Y/K_g$.

Therefore, taking the Cobb-Douglas production function form, we find that the size of the government investment multiplier depends upon the ratio of [private capital stock/public capital stock] and the output elasticity of private capital or [total output/government capital stock].

If we assume that government capital is chosen below the optimal level,[4] increasing K_g at some point in time provides the possibility of greater production for this economy. This will result in a higher level of output for some periods and most likely a larger path for consumption.

The theoretical model has improved upon the Barro(1981)-Aschauer(1989) type model in the sense of distinguishing between government consumption components and government investment components explicitly in the dynamic optimizing general equilibrium model based on the microfoundation of macroeconomics in the infinite time horizon. It can also be pointed out that existing models have passed over the fact that public capital stock would be important to determine the size of the government investment multiplier.

Next we should discuss the structural change issues. Recent research about the

4) The work by Hulten and Peterson(1984) illustrate the fact that to set state and local government purchases below the optimal level is a reasonable assumption.

OECD sample shows averages of some macroeconomic variables change before and after episodes of sizable and persistent fiscal impulses that they identified separately for fiscal expansions and contractions. The figures suggest that the effects of fiscal policy may be asymmetric and non-linear. For instance, real GDP and consumption growth decline relative to their previous average but the average decline is sharper after fiscal expansions than after contractions. And real GDP and consumption growth are also higher during fiscal contractions than expansions. How does that happen? Expansionary fiscal contractions may be explained by the effects of fiscal policy on the market value of wealth and on expectations about future taxes. A fiscal contraction often reduces interest rates, raising the market value of assets, thus stimulating aggregate demand. And also it may change people's view of the future and the valuation of their human capital. For example, in a high-debt country, a fiscal correction may reduce the likelihood of public sector default, thus improving confidence and increasing consumption and investment.

2. Literature Survey

Barro(1981), focusing on the distinction between temporary versus permanent changes in government purchases, provides empirical evidence that the effect on real output of temporary changes(defense purchases related to war) is bigger than that of permanent changes(military as well as non-military, and state and local purchases). Aschauer(1985) investigates the effects of fiscal policy on private consumption and aggregate demand within an explicit intertemporal optimization framework. Aschauer(1988) has surveyed the various elements of fiscal policy from the perspective of a model with a competitive equilibrium approach. Aschauer and Greenwood(1985) construct a neoclassical general equilibrium model over two periods to investigate the macroeconomic effects of fiscal policy. The policy variables considered are government consumption, government production services, public investment goods, transfer payments, labor income tax, and corporate income tax. Government services would yield consumption benefits for individuals and production benefits for firms. Government consumption expenditures are allowed to influence utility directly by providing a current substitute for private consumption goods with no interaction with leisure. Government investments in public capital, on the other hand, have the potential of enlarging society's future production possibilities and of augmenting the rate of return on private capital. This is the direct crowding-out or-in effect caused by fiscal expansion.[5)]

Barro and Sala-i-Martin(1992) study the role of tax policy in various models of endogenous economic growth. If the social rate of return on investment exceeds the private return, then tax policies that encourage investment can raise the growth rate and thereby increase the utility of the representative household. An excess of the social return over the private return can reflect learning by doing with spillover effects, the financing of government consumption purchases with income tax, and monopoly pricing of new types of capital goods. On the other hand, tax incentives to investment are not called for if the private rate of return on investment equals the social rate of return. In growth models that incorporate public services, the optimal tax policy hinges on the characteristics of the services. Baxter and King(1993) study four classic fiscal policy experiments within a quantitatively restricted neoclassical model. Their main findings are: ⅰ) permanent changes in government purchases can lead to short-run and long-run output multipliers that exceed one, ⅱ) permanent changes in government purchases induce a larger effect than temporary changes, contrary to the suggestions of Barro(1981) and Hall(1980), ⅲ) the financing decision is quantitatively more important than the resource cost of changes in government purchases, ⅳ) public investment has dramatic effects on private output and investment. These findings stem from important dynamic interactions of capital and labor absent in earlier equilibrium analyses of fiscal policy. Easterly and Rebelo(1993) show that the cross-section data from 1970 to 1988 are broadly consistent with the theoretical predictions of growth models regarding the effects of taxation and public investment on economic growth. They find that investment in transport and communication is consistently correlated with growth with a coefficient that implies a high return to public investment. They also find evidence that public enterprise investment crowds out private investment. Kim(1996) examines the business cycle implications of productive public capital in a general equilibrium model of optimal fiscal policy. In the model, public sector capital evolves according to an optimal accumulation process chosen by the government and financed by distorting taxes on private sector income. On the expenditure side, a distinction is made between public consumption, which affects the demand side of the economy through production technology. And public capital is a direct input to the neoclassical production technology and is intended to capture the productive effects of items such as core infrastructure, the largest single category of public capital. Calibrated

5) Refer to Barro(1984, p.304) and Arrow & Kurz(1970) for a more detailed explanation. Concerning the classification of the crowding-out concept, please see Buiter(1977) for details.

versions of the model are solved using recursive methods and simulated to study the business cycle properties of the model relative to Korean data.

These papers focus on the fiscal multiplier issues in the framework of a dynamic optimizing general equilibrium model[6] and try to analyze its implications empirically. Thorough studies on this topic are important in Korea since the government sector plays an important role in the economy but has been rather neglected so far. The results can be used to evaluate the effectiveness of fiscal policy and to draw policy implications.

Next let's talk about the structural change issue. Several empirical studies have confirmed that expansionary fiscal contraction does indeed occur. Research attempting to shed light on the issue has gained new impetus, as a result of the astonishing consequences of two instances of the sharp fiscal retrenchment that occurred in Denmark and Ireland in the 1980s. Both episodes, as well as the asymmetric consequences of the Swedish fiscal expansion of the early 1990s, appear to contradict the conventional view that an increase in the government surplus is contractionary.

Sutherland(1997) shows how the power of fiscal policy to affect consumption can vary depending on the level of public debt. At moderate levels of debt, fiscal policy has the traditional Keynesian effects. Current generations of consumers discount future taxes because they may not be alive when taxes are raised. But when public debt reaches extreme values, a fiscal deficit can have a contractionary effect since current generations of consumers know there is high probability that they will have to pay extra taxes. Perotti(1999) finds that the outcome of a consolidation is more likely to be expansionary when public debt is high or growing rapidly. Giavazzi and Pagano(1996) find that private sector behavior following a fiscal impulse depends on the size and persistence of the impulse. Alesina and Perotti(1995) find that the composition of the fiscal adjustment also matters: the private sector response may differ depending on whether the budget is cut by slashing public sector wages and reducing social benefits, or by raising taxes and cutting public investment. Giavazzi, Jappelli and Pagano(2000) find that non-linear effects tend to be associated with large and persistent fiscal impulses in both sample of OECD countries and one of developing countries, using World Bank data. In the OECD sample the non-linearity of the response is stronger for fiscal contractions than for expansions. An increase in net taxes has no effect on national saving during large fiscal contractions, while it has a positive effect in less pronounced contractions.

The common finding of these studies is that the response of the private sector to fiscal policy may be non-linear: both the magnitude and the sign of the response appear to change depending on the conditions under which the impulse occurs and on its characteristics.

I employ a five-variable VAR system with national account identity for analysing fiscal policy effect appropriately. So the reduced form equations of the theoretical idea may be expressed as the following:

$$\begin{aligned} PC &= F_1(GT, PC_{-1}, IP_{-1}, NX_{-1}, ETC_{-1}, U_1) \\ IP &= F_2(GT, PC_{-1}, IP_{-1}, NX_{-1}, ETC_{-1}, U_2) \\ NX &= F_3(GT, PC_{-1}, IP_{-1}, NX_{-1}, ETC_{-1}, U_3) \\ ETC &= F_4(GT, PC_{-1}, IP_{-1}, NX_{-1}, ETC_{-1}, U_4) \\ GDP &= PC + IP + NX + ETC + GT \end{aligned} \tag{12}$$

where PC is private consumption, IP is private investment, NX is net export, ETC is the other remaining sector, GDP is real income(real GDP), GT is total government expenditure, and $U_i (i = 1,2,3,4)$ is a residual term.

And we assume that the equation system transforms into log-linear form approximately for the estimableness and then take the first difference for each variable for transforming time series data into a stationary state as we see later, and consider appropriate lags for explanatory and dependent variables in a VAR system form.

The VAR system annexing the national account identity can be used for the general equilibrium approach to fiscal policy effects since the fiscal policy effect to each sector in the national account would be equal to the weighted average of each sector consisting of GDP in the system.

The estimated model has the basic form:

6) The general equilibrium model that they use is based upon the microfoundation of macroeconomics in the sense that it analyzes optimizing agents making decisions in a competitive equilibrium setting while conventional macro models do not. General equilibrium models form a convenient context for analyzing alternative government policies, because their construction requires feasible contingency plans for government actions, explicitly and completely spelled out, as well as a set of consistent assumptions about private agents' perceptions of the government's plans. A more detailed description can be found in Sargent(1987; Introduction), Kydland & Prescott(1977), Rotemberg(1987), Mankiw(1987), Stiglitz(1987), and Dow(1985; pp. 143 - 154).

Ⅲ. Vector Autoregressive Model and Methodology

$$Y(t) = C + \sum_{s=1}^{m} A_s Y(t-s) + GT(t) + U(t) \quad (13)$$

where, Y : 4×1 vector components of GDP(the variables are PC, IP, NX, ETC)
C : 4×1 vector of constant terms
A_S : 4×4 matrix of coefficients for s(=1,2,....,m)
GT: 4×1 vector of policy variables
U : 4×1 vector of residuals

$U(t)$ is uncorrelated with $Y(s)$ for $s<t$. We will refer to U as the vector of innovations in the sense that at each t, $U(t)$ is the part of $Y(t)$ that at time $t-1$ could not be predicted with the information available at $t-1$. The variance-covariance matrix of U is $EUU' = \Sigma$. Due to the fact that all the equations in the system have the same right hand side variables, the estimation of C and A_s by OLS is efficient.[7)]

Once the coefficients of the autoregressive form, As, have been estimated, under an invertibility condition, we can compute the estimated coefficients for the moving average(MA) representation B_s by successive substitution in equation (13) obtaining:

$$Y(t) = \sum_{s=0}^{\infty} B_s U(t-s) + D \quad (14)$$

As GDP enters the system as an identity, our complete model is a slightly modified version of equation (13). Let us rewrite (13) in the form:

$$Y(t) = A(L)Y(t) + C + GT(t) + U(t) \quad (15)$$

where A(L) is a 4×4 matrix whose elements are m^{th} order polynimials in positive powers of the lag operator.

Let ,

$$Y^*(t) = \begin{pmatrix} Y(t) \\ GDP \end{pmatrix},$$

Then

$$Y^*(t) = \begin{pmatrix} A(L) & 0 \\ i & 0 \end{pmatrix} Y^*(t) + \begin{pmatrix} C + CT(t) \\ GT(t) \end{pmatrix} + \begin{pmatrix} U(t) \\ 0 \end{pmatrix} \quad (16)$$

7) Refer to Judge et al.(1982, p.325) for details.

where i is a 4-dimensional vector of ones.

Let ,

$$B^* = \left(I - \begin{pmatrix} A(L) & 0 \\ i & 0 \end{pmatrix}^{-1}, \right)$$

Then, under fullfilling the invertibility condition, the moving average representation for $Y^*(t)$ can be written as;

$$Y^*(t) = B^*(L)U^*(t) + D^* \quad (17)$$

where , $U^*(t) = \begin{pmatrix} U(t) \\ 0 \end{pmatrix}$, $D^* = \begin{pmatrix} C+GT(t) \\ GT(t) \end{pmatrix}$

or,

$$Y^*(t) = \sum_{s=0}^{\infty} B^*_s U^*(t-s) + D^* \quad (18)$$

where the last row of equation (18) gives GDP as a function of present and past innovations of each component of GDP.

To understand the information embodied in the MA coefficients, it helps to think of the MA representation as resulting from simulations of the model. Let b_{ij}(s) be the i^{th} row, j^{th} column element of B^*_s. Then $b_{ij}(s)$ is the response of Y_i after s periods to an initial condition where all variables are zero except for Y_j which equals one. If the innovations $U_i(t)$ for $i=1,2,3,4$ present a strong contemporaneous correlation, it is unrealistic to trace out the response of the system to a shock in one of the elements of $U(t)$ alone. If, say, u_i and u_j have strong contemporaneous correlation, an innovation in variable i is unlikely to occur unless a shock in variable j also occurs. It is more realistic to look at the MA coefficients of a transformed system where residuals are contemporaneously uncorrelated, so that the shocks applied to the system are more like the ones that have occurred historically. We therefore want to replace U with variance-covariance matrix Σ by a transformed vector V such that $U = SV$, $EVV' = I$, and where $SS' = \Sigma$. Then we can rewrite (14) as;

$$Y(t) = \sum_{s=0}^{\infty} B_s SS^{-1} U(t-s) + D \quad (19)$$

or

$$Y(t) = \sum_{s=0}^{\infty} C_s V(t-s) + D \quad (20)$$

Then equation. (6) becomes:

$$Y^*(t) = B^*(L)S^*\hat{S}^*\,U^*(t-s)+D \tag{21}$$

or

$$Y^*(t) = \sum_{s=0}^{\infty} C^*{}_s V^*(t-s)+D^*$$

where

$$\underset{5X5}{S^*} = \begin{pmatrix} S & \cdots & 0 \\ \cdots & & \\ 0 & \cdots & 0 \end{pmatrix} \cdots \quad \underset{5X5}{\hat{S}^*} = \begin{pmatrix} S^{-1} & \cdots & 0 \\ \cdots & & \\ 0 & \cdots & 0 \end{pmatrix} \cdots$$

There is not a unique way to transform the residuals to orthogonal ones, but if we impose the restriction that S be lower triangular with positive elements on the diagonal, then the transformation is unique. That is the kind of transformation used in this paper. What the lower triangular transformation does is to let an innovation at t of the first variable in the system affect all other variables at t. However, as we move down in the ordering of the variables, an innovation at t of variable lower in the ordering(i.e. variables j such that $j > i$). Each V_i is a linear combination of u_j for $j < i$, which depends on the contemporaneous correlation of u_i and u_j. The ordering chosen for the transformation is therefore important when the residuals have strong correlation.

The VAR equation system consists of 5 equations and 5 variables namely as private consumption(PC), private investment(IP), net export(NX) , government expenditure(GT), and the other sector(ETC), which can be estimated by OLS. To use dynamic multiplier analysis, I also employ the impulse response function method, i.e. analysis of the system's response to innovations. The response is obtained by tracing out the system's moving average representation. The moving average representation expresses the current value of each variable in terms of current and lagged values of the residuals, i.e., innovation of each equation. Impulse traces the response of the system to a 1.0 % standard deviation shock in the errors.[8] I employed the pure exogenous shocks here with the above modified VAR system as follows:

$$GT_t = 0.0 + U_{1t} \ldots\ldots\ldots\ldots\ var(U_1) = 1.0$$

or

$$GC_t = 0.0 + U_{2t} \ldots\ldots\ldots\ldots\ var(U_2) = 1.0$$

$$GI_t = 0.0 + U_{3t} \ldots\ldots\ldots\ldots\ var(U_3) = 1.0$$

8) Refer to Doan & Litterman(1986: ch.12) and Pindyck & Rubinfeld(1986: ch.13) for the impulse response function and dynamic multiplier method.

where GT = GC(government consumption) + GI(government investment)

It concerns itself soley with the dynamic properties of the model and looks at the single effect in isolation. Hence we can get cumulative elasticities as summing the responses coefficient of dependent variable to a change in fiscal variables in the VAR equations until the point converging a stationary state.

These results may be useful in the sense that we can investigate the dynamic response path of each variable in the system owing to exogenous shock of the policy variable and interrelationship among variables in the macro system, by using this simple analysis.

1. Data Analyses

The Korean economy has since the currency crisis experienced a lot of events in several respects such as the growth rate having sluggish and volatile and unemployment swing up and persistent. And also looking at the government sector as shown at [Table 1], public debt has been growing owing to expansion

(unit: %, composition ratio to GDP)

	1996	1997	1998	1999	2000	2001
expenditure & net lending	20.2	22.1	26.0	25.0	25.0	25.0
revenue	20.4	21.3	21.8	22.6	26.1	26.4
deficit	0.3	-1.5	-4.2	-2.7	1.3	1.3
central gov. expenditure	100.0	100.0	100.0	100.0	100.0	100.0
defense	17.3	13.3	12.1	11.2	11.4	9.9
economic development	22.7	24.5	26.9	27.5	25.2	26.4
(agri. fisher.& forest)	8.8	8.1	8.2	7.3	6.2	5.9
(other econ.)	2.3	1.3	2.1	3.4	5.8	6.0
social welfare	9.2	9.7	10.9	12.4	15.3	11.6
housing & regional devel.	8.4	6.7	6.3	8.1	5.3	7.7
cosolidated gov. national debt	8.8	11.1	16.1	18.6	19.3	20.8

Source: Ministry of Finance and Economy, *Government Finance Statistics in Korea*, various years. Ministry of Planning and Budget, *Public Finance in Korea*, various issues.

Ⅳ. Empirical Results and Findings

Table 1 Main Indicators of Government Finance before and after the crisis of government expenditure and government borrowing since the crisis, mainly in response to the need for structural adjustment funds injected to the financial sector and social welfare needs for a public safety net. Against this background, government tries to have made efforts to engineer fiscal soundness and the stabilization of the economy.

The quarterly GDP components data(1995 year constant prices with seasonal adjustment, unit: 1 billion won) in the National Accounts obtained from the BOK data base, from 1970:I to 2002:I in Korea, were used in the estimation. Real GDP breaks down into five sub-sectors; private consumption(PC), private investment(IP), net exports(NX), government expenditure(GT = government consumption + government investment), and the remaining other sub-sector(ETC). Vector Autoregressive Method is used to find out dynamic effects.

The raw data of each time series show nonstationary with time trend, but change into stationary time series after log-difference data transformation for each series. For investigating the stationality of time series I ran the unit root tests using Augmented Dickey-Fuller as shown in [Table 2] and got the results indicating rejection of the null hypothesis of unit root at the 1~5% level after transforming log-difference or growth rate data. The series of net exports and ETC are transformed by growth rate terms equivalent to log-difference terms since they have negative values. Nonstationarity of the series also can be eliminated after that transformation of data, at the 1% significance level. Yet such transformation of data would be helpful in that we are trying to find the characteristics of structural change.

The co-integration test about raw data by Johansen Maximum Likelihood Procedure also would be rejected. So I used each series of the data after log-difference transformation.[9] Hence the meaning of each estimated coefficient may be changed into the elasticity concept.

Now look at the characteristics of data before and after crisis periods, displayed in as [Table 3] and [Table 4]. The series of data is transformed by log-difference term after detrending. Mean, standard deviation, maximum value, and minimum value of the other remaining sector of GDP components are the largest among the variables in terms of absolute value and volatility before the currency crisis period. This comes from the fact that the sector may include 'change in inventories'. The next largest are net exports and private investment. However, after the crisis, the order change to private investment, government investment in

9) But the log-difference transformation may make it possible to be able to bias the empirical results since the zero frequency component may be eliminated by that.

variable	test statistic	var.	test stat.	var.	test stat.
GDP	2.46	PC	1.55	IP	-0.58
DLGDP	-5.08***	DLPC	-5.09***	DLIP	-3.93**
GT	1.10	NX	0.016	ETC	-2.17
DLGT	-5.79***	DGNX	-4.71***	DGETC	-5.95***
GC	0.41	DLGC	-4.81***	GI	1.03
DLGI	-3.77***				

Notes) critical value : -4.03 at 1% level, -3.45 at 5% level, -3.15 at 10% level
The name of each variable is the same as that in equation (1) as shown above. Prefix DL of each variable indicates log-difference term, and DG means growth rate term. The test results about the log transformation terms of each variable are omitted here.

size, and net exports, private investment in terms of volatility. In particular, we can find the fact that private consumption has become more volatile since the crisis, which may mean to show a change of the private consumption pattern.

Next we look at the correlation of these variables. [Table 5] and [Table 6] show the correlation coefficient matrices before the crisis and after the crisis period, respectively. First of all, over the whole sample period from 1970 to 2002, the correlation coefficient between IP and GDP is 0.5, the largest, and the next largest one is that between IP and GC, which is 0.2. But before the crisis, as shown [Table 5], the correlation coefficient between GC and PC is -0.19, that between GC and NX is -0.26, GI and IP is -0.10, and corr(GI, NX) is 0.004. The correlation coefficients between (GT, PC), (GT, IP), and (GT, NX) are -0.16, 0.14, and -0.28, respectively.

On the other hand, after the crisis, the correlation coefficient over (GC, PC) is shown to be 0.31, corr(GC, NX) is -0.16, corr(GI, IP) is 0.22, and corr(GI, NX) is 0.24. Also that between GT and PC is 0.12, corr(GT, IP) is 0.39, corr(GT, NX)

variable	mean	std. dev.	min.	max.
PC	0.0005	0.015	-0.050	0.052
GC	0.0003	0.030	-0.107	0.100
GI	-0.0018	0.057	-0.170	0.261
IP	0.0024	0.083	-0.406	0.291
GDP	0.0006	0.018	-0.054	0.052
NX	0.0025	0.071	-0.245	0.332
ETC	-0.0221	0.173	-1.751	0.150
GT	-0.0002	0.025	-0.081	0.079

Table 2 Augmented Dickey-Fuller Test(ADF test)

Table 3 Characteristics of data before the crisis(1970: II-1997: IV)

variable	mean	std. dev.	min.	max.
PC	0.0071	0.039	-0.050	0.024
GC	0.0087	0.012	-0.019	0.033
GI	-0.0164	0.026	-0.032	0.076
IP	-0.0269	0.065	-0.239	0.072
GDP	-0.0074	0.026	-0.093	0.019
NX	0.0052	0.084	-0.069	0.312
ETC	0.0052	0.019	-0.008	0.071
GT	-0.0101	0.013	-0.022	0.025

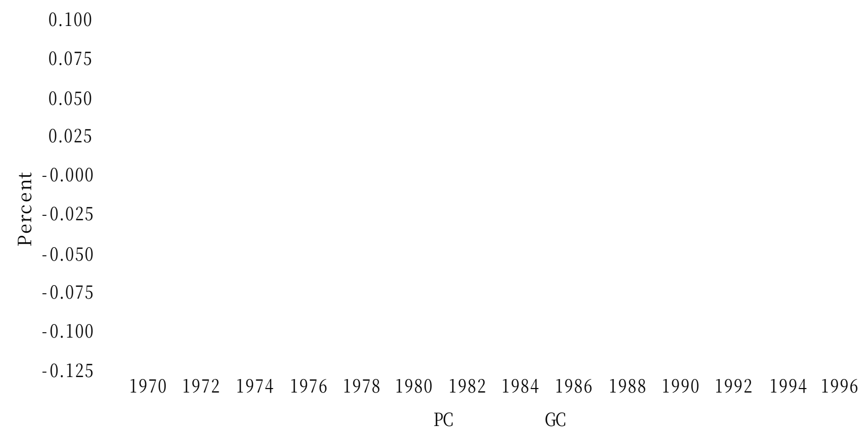
	GDP	GC	GI	PC	IP	NX	ETC	GT
GDP	1.00	0.09	-0.03	0.31	0.24	-0.07	-0.22	0.10
GC		1.00	-0.18	-0.18	0.19	-0.26	-0.01	0.87
GI			1.00	0.10	-0.10	0.004	-0.02	0.26
PC				1.00	0.02	-0.09	-0.01	-0.16
IP					1.00	-0.32	0.008	0.14
NX						1.00	0.007	-0.28
ETC							1.00	-0.03
GT								1.00

	GDP	GC	GI	PC	IP	NX	ETC	GT
GDP	1.00	0.19	-0.05	0.89	0.86	-0.81	-0.12	0.08
GC		1.00	0.05	0.31	0.36	-0.16	0.15	0.63
GI			1.00	-0.08	0.22	0.24	0.91	0.80
PC				1.00	0.89	-0.90	-0.04	0.12
IP					1.00	-0.77	0.22	0.39
NX						1.00	0.21	0.08
ETC							1.00	0.80
GT								1.00

is 0.08. Summing up those results, the correlation between (GC, PC), (GI, IP), (GT, PC), and (GT, NX) is shown to have changed from negative(-) before the crisis to positive(+) after the crisis, which presumably indicates the fact that the

structural change occurs during the period. And also we can find that the correlation between GDP and PC, IP, NX has increased significantly since the crisis.

Now looking at the trend of each time series data graphically, we note a distinct difference between the pre and post crisis periods in the shape of change as shown from [Figure 1] to [Figure 4]. Comparing [Figure 1] to [Figure 2], the shape of changing trends between PC and GC seems to be moving in opposite direction to each other before the crisis period but moving in the same direction after the crisis period. The same trends may be found in the relationship between



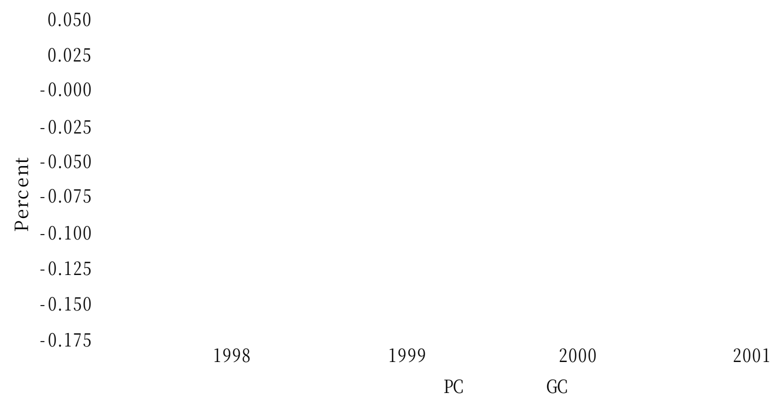


Table 4 Characteristics of data after the crisis(1998 : I-2002 : I)

Table 5 Correlation coefficient over the period 1970 : II-1997 : IV

Table 6 Correlation coefficient over the period 1998 : I-2002 : I

Figure 1 Trends of PC and GC (pre crisis)

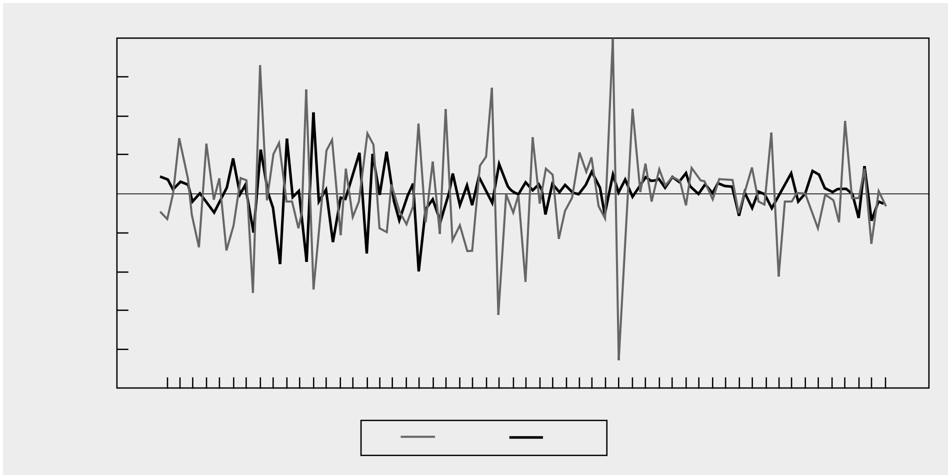
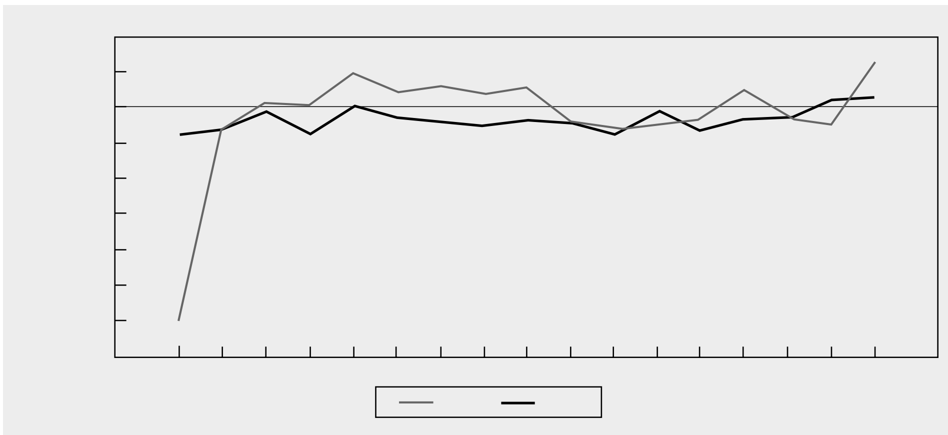
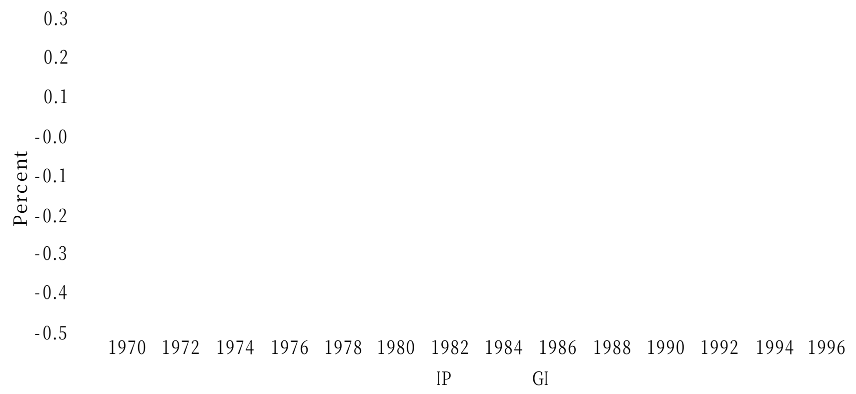
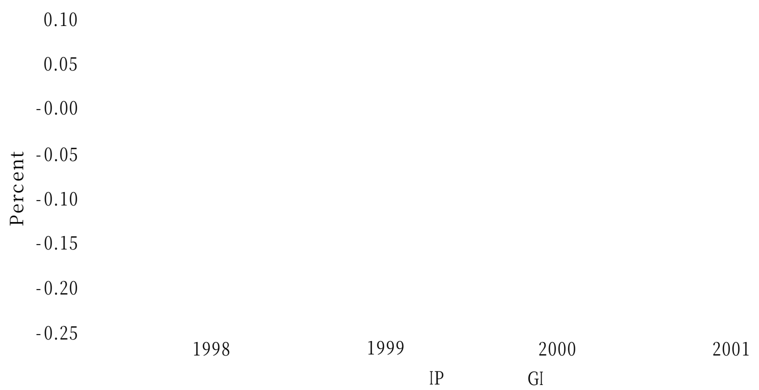


Figure 2 Trends of PC and GC (post crisis)



IP and GI when we compare [Figure 3] to [Figure 4]. The characteristics of graphical changing trends would be able to confirm the results of the correlation coefficient matrix as shown above.





I have also run regression analysis with dummy variables in order to check the structural change more rigorously. The dummy variables on intercept and slope are employ about after 1998:I period with OLS regression equations. I also used dummy variables in 1979 - 81 and 1998 since the estimation was not significant. The economic trough period owing to the second oil crisis(1979 - 80), socio-

political unrest etc. in Korea occurred in 1980, and another economic trough period occurred at the end of 1997 caused by the currency crisis. As the results of estimation on the intercept dummy and the slope dummy have significant values as shown in [Table 7] we can find a distinct difference between the pre and post crisis periods.

	GT	D	DS	$\overline{R}^2$	D.W.	Q(Sig.level)
PC	-0.5(-1.84)*	.92(1.33)	-.44(1.67)*	.30	2.01	17.3(.98)
IP	.38(1.70)*	.82(1.17)	1.51(2.85)***	.29	2.05	32.0(.46)
NX	-.68(-2.39)**	-.43(-.29)	.87(1.17)	.21	1.98	21.8(.91)
ETC	-1.3(-.97)	1.77(1.30)	.09 (.31)	.12	1.97	2.18(1.0)

Notes : GT, PC, IP, NX, ETC are dependent variables which are defined as above. GT, D, DS are explanatory variables. D is an intercept dummy, DS is a slope dummy over the post-crisis period. Other explanatory variables are omitted. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1%, level.

2. VAR Analysis and Estimation Results

The estimation results seem to be appropriate in view of the test statistics (D.W.(Durbin Watson statistic), Ljung-Box Q-statistic, $\overline{R}^2$ shown in [Table 8].[10] In terms of two diagnostic tests(D-W, Q), the model used seems appropriate since the estimated residuals turn out to be white noise. Also $\overline{R}^2$ implies that the model fits the data reasonably well. I also considered lag length test and block exogeneity test before estimation. Choosing it appropriate lag length, I employed the likelihood ratio test by Sims(1980) what results indicate two lags as acceptable.[11] For examining the exogeneity of fiscal policy variables I used the block exogeneity test which is a multivariate generalization of Granger-Sims causality test, and obtain the result that it could not be rejected.[12]

However some values of the contemporaneous correlation coefficients shown in [Table 9] are not that small. But it does not matter in our estimation as I used

10) See Ljung and Box(1978) or Doan & Litterman(1986: ch.1) for the Ljung-Box Q-statistic.

11) The test statistic I used is $x^2(m) = (T - c)[\log\det \Sigma_r - \log\det \Sigma_u]$ where Σ_r and Σ_u are the restricted and unrestricted covariance matrices, T is the number of observations, c is a correction to improve the small sample properties which equal to the number of variables in each unrestricted equation in the system, and m is the degree of freedom.
The calculated statistic is $x^2(16) = 16.48$ with significance level 0.42. So we can not reject the null hypothesis that a two lags length system is equal to a three lags length system.

12) The calculated statistic is 2(48) =10.89 with p-value equal to 1.00.

Figure 3 Trends of IP and GI (pre crisis)

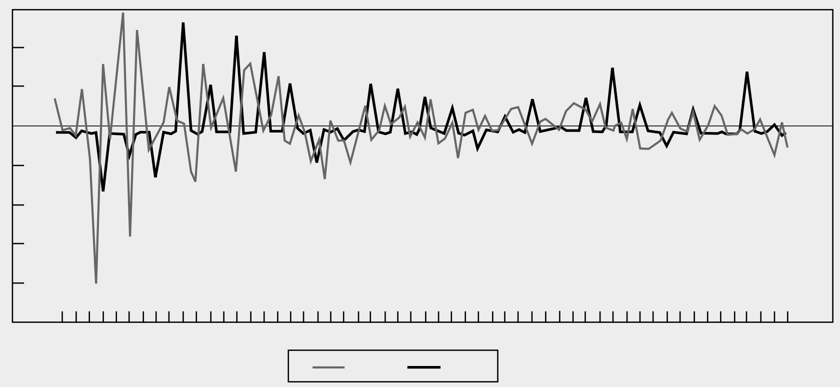


Figure 4 Trends of IP and GI (post crisis)

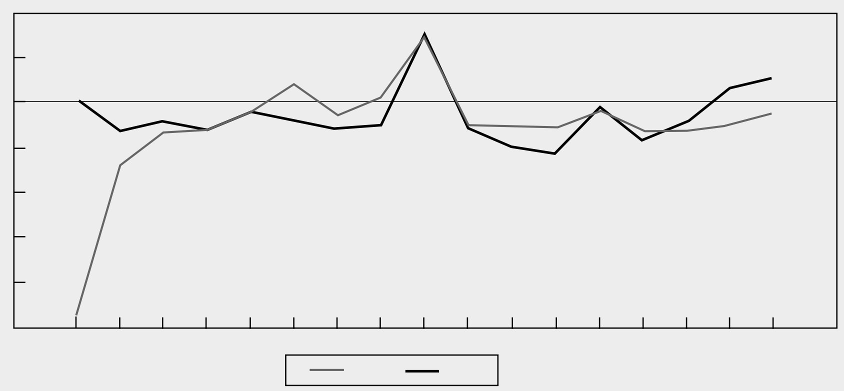


Table 7 Regression analysis with dummy variables

fiscal policy variables in the deterministic part of the VAR system so the ordering of the variables does not affect the results.

	$\bar{R}^2$	D. W.	Q - stat (sig. level)
PC	.73	2.38	37.22(0.10)
IP	.81	2.54	25.50(0.54)
NX	.69	1.89	23.10(0.67)
ETC	.84	2.03	37.49(0.09)

Note: Some data thought to have seasonality are adjusted with X - 12 ARIMA.

	PC	IP	NX	ETC
PC	1.00	.19	-.39	.02
IP		1.00	-.34	.03
NX			1.00	.002
ETC				1.00

The estimation results are shown in [Table 10]. The cumulative effect of GC on GDP is -0.03 over the pre-crisis period(BC), vs. 0.013 over the post-crisis period(AC), and that of GC on PC; -0.06(BC) vs 0.06(AC). But on the other hand, the effect of GI on GDP is -0.005(BC) vs. 0.245(AC), and that of GI on IP is -0.09(BC) vs. 0.90(AC) surprisingly. The results show that government consumption crowds out the private consumption before the crisis but they changed to a complementary relationship after the crisis. And government investment crowds out private investment over BC but crowds it in over AC. As the results of that total government expenditure also has similar effect on GDP over BC vs. AC. There seems to have been a clear structural change between two periods. We can say that fiscal policy has been more effective after the crisis. These results seem to be consistent with the Keynesian multiplier implications. At moderate levels of debt fiscal policy seems to have the traditional Keynesian effects. As a matter of fact, the Korean economy recovered rapidly by benefiting from the injection of pblic funds to revive the private sector just after the economy plunged into recession as a result of the outbreak of the currency crisis.

	PC	IP	NX	ETC	GDP
Pre crisis					
GT	-.08	.49	-.86	-.13	-.064
GC	-.06	.49	-.71	-.16	-.03
GI	-.01	-.09	-.07	-.02	-.005
GT	.05	.79	-.04	.24	.021
GC	.06	.31	-.27	.09	.013
GI	-.07	.90	.61	.66	.245

Note) PC : private consumption, IP : private investment, NX : net export(export - import), ETC: other remaining factors, GC: government consumption, GI: government investment, GT: total gov. spending, GDP: gross domestic product. All variables are measured in terms of real growth rates or equivalent.

Next I try to run variance decomposition analysis to examine how much forecast error variance in each variable is explained by its own and other lagged variables. The results are as shown in [Table 11] and [Table 12]. The fiscal shocks to ETC among GDP components explain 70% of the variance, those to IP explain 15 - 17%, and those to NX explain 10 - 11% in the pre-crisis period, but after the crisis the fiscal shocks to NX explain 61 - 63% of the variance, those to IP explain 25 - 27%, those to PC explain 9 - 10%, and those on ETC explain the least %. Thus fiscal policy has a large effect on ETC before the crisis, but a big effect on NX, IP, and PC after the crisis. According to the results, government expenditure seems to have affected GDP mainly through the channel of ETC sector before the crisis but through net exports, private investment, private consumption after the crisis. The presumption maybe confirmed from the facts that the weighted average value of the decomposition value about each subsector of GDP is approximate to the value of the cumulative multiplier. Also we can confirm the fact that the weighted average value of government consumption and investment effects is approximately equal to that of the total government expenditure effect.[13)]

But the results are the opposite of those predicted by our theoretical hypothesis and do not show an expansionary fiscal contraction effect. The reason seems to be that strong Keynesian multiplier effect has been working in the exceptional conjecture of a deep trough, high unemployment rate, and large idle capacity as

13) The share of government investment in total government expenditure is shown to have increased after the crisis, in view of the fact that the average share of GC vs. GI is 75.07% : 24.93% in the period before the crisis, but 61.97% : 38.03% in the period after the crisis.

Table 8 Test statistics

Table 9 Correlation coefficient matrix

Table 10 Steady state cumulative multiplier(10 lags)

1970:II - 1997:IV unit: %

Step	Std Error	PC	IP	NX	ETC
1	0.21	0.36	15.31	10.42	73.91
2	0.21	0.41	15.48	10.69	73.42
3	0.21	0.48	17.26	11.13	71.13
4	0.21	0.48	17.38	11.18	70.96
5	0.21	0.49	17.41	11.18	70.92
6	0.21	0.49	17.44	11.18	70.90
7	0.21	0.49	17.44	11.18	70.90
8	0.21	0.49	17.44	11.18	70.90
9	0.21	0.49	17.44	11.18	70.89
10	0.21	0.49	17.44	11.18	70.89

1998:I - 2002:I unit: %

Step	Std Error	PC	IP	NX	ETC
1	0.10	9.32	25.67	63.35	1.66
2	0.11	9.76	25.92	61.69	1.63
3	0.11	9.78	26.81	61.72	1.69
4	0.11	9.78	26.82	61.71	1.69
5	0.11	9.78	26.82	61.71	1.69
6	0.11	9.78	26.82	61.71	1.69
7	0.11	9.78	26.82	61.71	1.69
8	0.11	9.78	26.82	61.71	1.69
9	0.11	9.78	26.82	61.71	1.69
10	0.11	9.78	26.82	61.71	1.69

a consequence of the currency crisis. Yet the level of public debt in Korea has not been high compared to developed countries in the OECD group. But the results does not mean that fiscal policy in Korea is doing well. The economy has been less stable after crisis with consumption, investment, and net exports for example becoming more volatile. Also we need to keep in mind the fact that fiscal policy may have only short run effects.

This paper has studied on the structural change of fiscal policy since the Korean currency crisis by looking at the macroeconomic effects of government expenditures comparing the periods before and after the crisis. Real GDP in the National Accounts from BOK is broken down into the five sub-sectors; private consumption(PC), private investment(IP), net exports(NX), government expenditure(GT = government consumption + government investment), and the other remaining sub-sector(ETC). The Vector Autoregressive Method was used to find out the dynamic effects.

The results show that the effects of government expenditure on each national account sub-sector and real GDP are very different in terms of growth rate in the period after the crisis compared with that before. There seems to have a structural change between two periods. And also we find that government consumption crowds out private consumption before crisis but the two changed to a complementary relationship after the crisis. A similar structural change relationship would also appear to have taken place between government investment and private investment.

We can find a propagation mechanism running from government expenditures to real GDP through this analysis. These results seem to have quite different economic implications between the pre-and post-crisis periods, that is, the fiscal policy effect of the post-crisis period are consistent with the Keynesian multiplier implications in contrast to the pre-crisis period.

However this positive analysis would need to be confirmed by a more thorough assessment of the normative aspect.

Table 11 Decomposition of Variance for GDP

Table 12 Decomposition of Variance for GDP

Ⅴ. Conclusions

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