Short-Run Dynamic Effects of Debt Changes on the Primary Budget Surplus

Ki-Baeg Park and Woocheol Kim[1)]

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Abstract

This paper provides a modification of Bohn(1998)'s test for the sustainability of fiscal policy. The new aspect of the alternative test lies in the emphasis of the short-run adjustment of the primary budget surplus in a response to changes in debt. To capture the short-run dynamic effects of debt increase on the primary surplus, we use a structural VAR model whose identification is given by exploiting the period-by-period budget equation. A basic impulse-response analysis then can show how governments react to increases of debt. As an empirical illustration, the new method is applied to the real data from South Korea.

Key Words: Bohn's test, sustainability of fiscal policy, government debt

1)Fellow, Korea Institute of Public Finance, 79-6 Garak-Dong, Songpa-Gu, Seoul, Republic of Korea, 138-774, phone:+82-2-2186-2278 fax:+82-2-2186-2067 email:wkim@kipf.re.kr

I. Introduction

This paper develops a new approach to an assessment of the fiscal sustainability. The basic idea of the new method is to generalize the Bohn(1998) test in the framework of structural VAR models. Central to the sustainability of fiscal policy is whether a government responds to debt increase by increasing the primary surplus. Using Barro(1979)'s tax-smoothing model, Bohn(1998) analysed the relationship between the primary budget surplus and the public debt in order to examine whether governments take corrective measures. As well recognised by Bohn himself, such an approach puts more emphasis on the long-run relationship between the two variables. Their long-run relationship, of course, can provide useful information for the sustainability test, but the question raised above is also closely related to the short-run dynamic reactions of governments to debt increase. A VAR approach, in this context, may be considered an interesting alternative which can capture rich dynamic features in the relationship between the fiscal variables. Considering that governments adjust the primary surplus to larger public debt over a certain period of time, one can better understand the dynamic effects of debt increase with the help of impulse-response functions derived from a VAR model. Another advantage of VAR approach is that it does not require a special economic theory specifying the relation for the budget surplus and debt. While Bohn's method depends crucially on the validity of Barro's tax-smoothing model, an atheoretic VAR approach is relatively free from those theoretical restrictions. For an economic interpretation of impulse-response functions, it is important to be able to identify the sources of various shocks in VAR models. The structural VAR model chosen in the paper only uses a minimal set of standard economic assumptions such like the debt dynamic equation.

As will be seen in our empirical studies, a simple application of the Bohn test could not confirm the sustainability of fiscal policy in South Korea

which is well-known for its relatively lower level of public debt owing to the conservative operation of fiscal policy. This may be due partially to the systematic changes of fiscal policy adopted by the Korean government-i.e., the strong stabilization policy in the period of early 1980's through mid 1990's. During this period, at the top of the policy list was reduction of the size of the public debt as well as the realization of the primary budget surplus. In that time, it is more often than not to see the budget surplus increase after the debt decreases. Such institutional changes are prone to affect Bohn's estimates of the relationship between the primary budget surplus and the debt, according to which the two variables seem to have a positive or insignificant, rather than a negative, relation. Undesirably, South Korea's historical experiences, when combined with Bohn's regression, may end up with an misleading interpretation of the fiscal sustainability, even if the government in fact promoted a stabilizing fiscal policy. In contrast to Bohn's method, the Korean fiscal sustainability was confirmed by the structural VAR analysis focusing on the short-run dynamic relations. This is basically because our approach can internalize explicitly the contemporaneous co-movement of the budget surplus and debt changes within a structural VAR model through the identifying restrictions. More details of the VAR models are discussed in the later parts of the paper.

The paper is organized as follows. Section 2 introduces the basic concepts and the previous empirical tests of the fiscal sustainability. Section 3 briefly describes some salient features of the Korean fiscal data and applies the Bohn test to the case of South Korea. Section 4 presents the new methodology that assesses the sustainability of fiscal policy in the framework of a structural VAR model, and explains the results from the VAR analysis of South Korea's sustainability issue. Section 5 concludes.

II. Concept of Fiscal Sustainability

Most of discussions about fiscal sustainabiity start from the government budget constraint(GBC), which in nominal terms can be written

$$\text{(II-1)} \qquad \Delta B_t = B_t - B_{t-1} = G_t - T_t + i_t B_{t-1} \ ,$$

where B_t is the nominal value of government bonds issued at the end of period t, G_t is nominal government expenditure except interest payments, T_t is total nominal taxes, i_t is the (average) interest rate on bonds issued at the end of period t-1 and $i_t B_{t-1}$ is total interest payments made in period t. Eq.(II-1) shows that the increase in government bonds is equal to the budget deficit, implying that the size of the current government bonds is equal to the accumulation of the current and past budget deficits. The GBC can also be expressed in terms of proportions of GDP,

$$\text{(II-2)} \qquad b_t = g_t - t_t + (1 + r_t - \theta_t) b_{t-1} = - s_t + (1 + \delta_t) b_{t-1} \ ,$$

where b_t is the debt-to-GDP ratio(g_t and t_t are defined in a similar way), s_t is the ratio of the primary surplus to GDP, r_t is the real interest rate, θ_t is the rate of economic growth, and the discount rate $\delta_t = r_t - \theta_t$ is the real interest rate adjusted for economic growth. Eq.(II-2), called the debt dynamic equation, specifies the evolution of the debt-to-GDP, and determines the sustainability of fiscal policy. Generally speaking, a fiscal policy is sustainable, if it satisfies the intertemporal government budget constraint. Eq.(II-2) shows that certain amount of the primary surplus is required to satisfy the fiscal sustainability, when the real interest rate is greater than the economic growth rate.

The previous works on the sustainability issue are different along with the

assumption about whether the discount rate $\delta_t (= r_t - \theta_t)$ is constant or not. For example, when δ_t is constant over time and greater than zero, the difference equation in Eq.(II-2) becomes an unstable difference equation which can be solved forwards by successive substitution[1)]

$$b_t = \frac{1}{1+\delta} E_t (b_{t+1} + s_{t+1})$$

$$= (1+\delta)^{-n} E_t (b_{t+n}) + \sum_{i=1}^{n} (1+\delta)^{-i} E_t (s_{t+i}).$$

Assuming *the transversality condition*, $\lim_{n\to\infty} (1+\delta)^{-n} E_t (b_{t+n}) = 0$, we get, by letting $n \to \infty$,

$$\text{(II-3)} \qquad b_t = \sum_{i=1}^{\infty} (1+\delta)^{-i} E_t (s_{t+i}).$$

Eq.(II-3) implies that the current debt should be paid off by the current and future primary surpluses. Assuming further that the future primary surpluses grow at a constant rate, i.e., $E_t (s_{t+i}) = (1+\gamma)^i s_t$ (with $\gamma < \delta$), then the righthand side of Eq.(II-3) reduces to $\frac{1+\gamma}{\delta - \gamma} s_t$ which can be interpreted as the maximum level of the sustainable current debt-to-GDP ratio. Note that the sustainable debt-to-GDP ratio, in this case, can grow at a rate equal to that of the primary surplus. If s_t is stationary, then $\gamma < 0$, and the sustainable b_t will also be stationary. If $\gamma = 0$, corresponding to the case of s_t being an I(1) process, it holds that $b_t = s_t / \delta$, implying that, for satisfaction of the fiscal sustainabiity, b_t and s_t should be cointegrated with cointegrating vector (δ, -1).

Noting that the government budget is intertemporally balanced only under Eq.(II-3), Hamilton and Flavin(1986) examined the fiscal sustainability by testing whether the transversality condition holds. On the other hand, Trehan and Walsh(1988) observed that the relevant variables have unit

1) See Polito and Wickens(2005) for more details.

roots and suggested a test for fiscal sustainability by investigating whether the debt-to-GDP ratio and the primary surplus are cointegrated with cointegrating vector (δ, -1). These tests, however, are valid only under the condition that the discount rate is constant, which in practice not the case, since the real interest rate or the growth rate are time-varying. For time varying δ_t, fiscal sustainability requires a similar but more complicated version of the transversality condition above. Wilcox(1989) extended Hamilton and Flavin(1988) to include the case of time varying δ_t, suggesting to test whether the discounted debt-to-GDP ratio is a zero-mean stationary process. Uctum and Wickens(2000) give a more general result that the fiscal sustainability holds even for I(1) debt-to-GDP ratio, as long as the discounted primary surplus is a zero-mean stationary process. Pointing out that Trehan and Walsh(1988)'s cointegration test suffer from a variable discount rate, Hakkio and Rush(1991) proposed an alternative test for cointegration between the government expenditure(including the interest payments) and the total revenue. In a similar way, Ahmed and Rogers(1995) performed a cointegration test for government expenditure, the interest payments, and the revenue.

Bohn(1998) took a somewhat new approach to testing the fiscal sustainability. Fiscal balance is the function of debt level in the Bohn's framework, in other words, $s = f(b) + u$. He then proved that fiscal policy is sustainable if the government improves the budget balance when the debt-to-GDP ratio increases. He argued that the cointegration tests will be inappropriate unless they adjust the short-term changes stemming from business cycles and discretionary spendings. Since Bohn's method does not require any assumption on interest rates, it is widely used to test the fiscal sustainability.

III. Data and Preliminary Results

1. Data

The annual fiscal data (1970 through 2003) of South Korea is used for the sustainability test in this paper. The official fiscal data set released by the Korean government is adjusted, since they may not represent the accurate size of the government debt and the fiscal balance due to the following reasons.

The first concerns the existence of the national pension fund. Currently, the surplus of the national pension fund is growing since it is funded system and it is in its early stage. The ballooning surplus has no connection with the efforts of the government to reduce the public debt. Thus, the fiscal balance except the surplus of the National pension fund is used in this paper. The second is related to the financial debt. In South Korea, the foreign currency stabilization bond is the legal national bond, and thus the outstanding amount of the bond is included in the government debt. However, the foreign currency stabilization bond is issued to stabilize foreign exchange market, not to finance the government spending. In other words, the movement of the foreign currency stabilization bond has no relation with that of the fiscal balance in the debt dynamic equation. The debt data of this paper will exclude the net increase of the foreign currency stabilization bond. Finally, we need to adjust the government-guaranteed bond that was issued to cope with the financial crisis and financial restructuring. Both the government and general public recognized the guaranteed bond as the national debt from the beginning. The Repayment plan announced in 2003 stipulates that the bonds should be paid off by the government and financial institutions. Thus, the fiscal burden of the government-guaranteed bonds issued since 1997 will be considered as the public bond in the paper. We use the following notations for the government

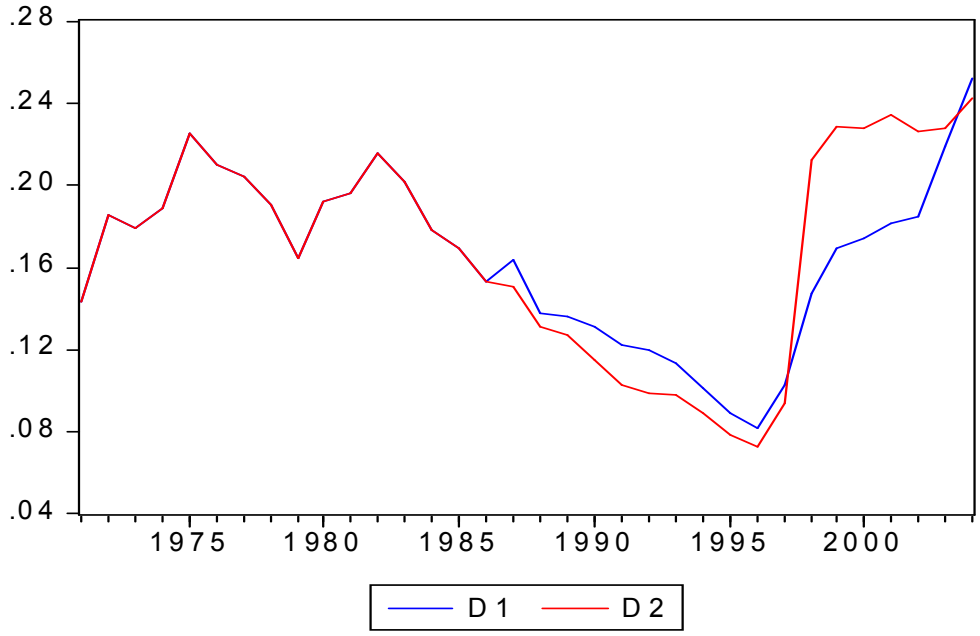
debt and the primary balance;

D1 = the official government bond
D2 = D1 - the financial debt + the government-guaranteed bond

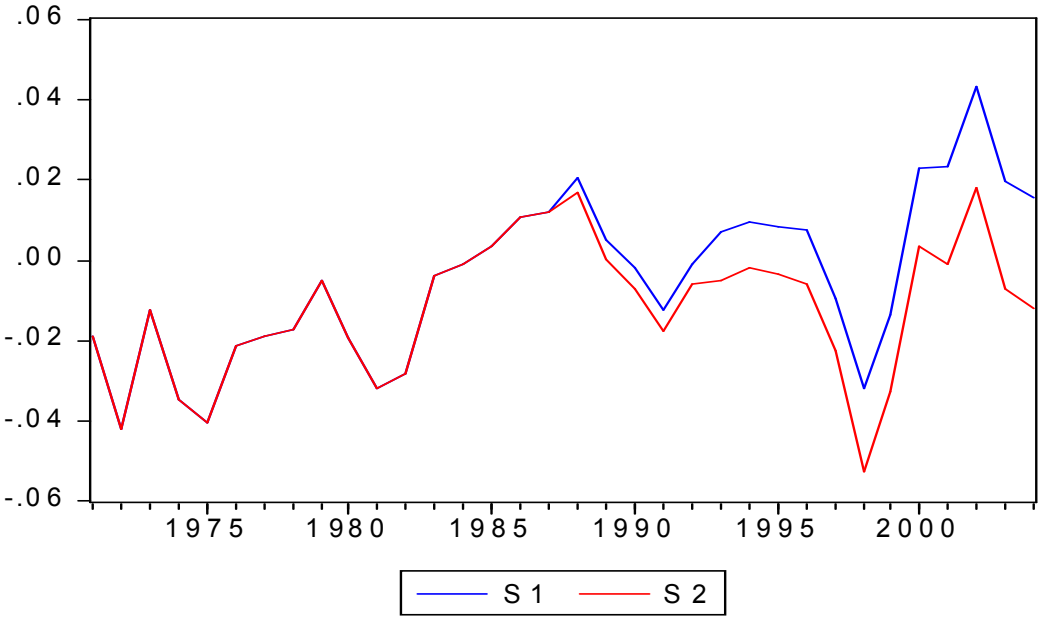
S1 = the official primary balance
S2 = S1 - the balance of the national pension fund.

The evolutions of the fiscal data are depicted in <Figure III-1> and <Figure III-2>. One may observe that the debt-to-GDP ratio in Korea shows a significant trend. The debt-to-GDP ratio remained around 20% on average until mid 1980s, started to fall from 1987 and reached 8.2% in 1996. Hit by the financial crisis of 1997, the government had to increase expenditures to reduce the unemployment rate and assist the financial restructuring. The debt ratio consequently jumped and reached 26.3% in 2004. From looking at <Figure II-2>, there seems to be a possibility of a structural break in the ratio of primary balance to GDP around the mid 1980's. The balance was a deficit on average until 1984, and then changed into a surplus. The primary surplus continued before the 1997 financial crisis.

[Figure III-1] Debt-to-GDP ratio



[Figure III-2] Ratio of The Primary Balance to GDP (S1 vs S2)



2. Bohn's Tests: South Korea

We start with a replication of Bohn's test to the Korean fiscal data. The same regression equation as in Bohn(1998) is used.

(III-1) $$s_t = \rho \cdot b_t + \mu_t = \rho \cdot b_t + \alpha_0 + \alpha_G GVAR_t + \alpha_Y YVAR_t + \epsilon_t,$$

$$GVAR = (G - G^*)/Y, \;\; YVAR = (1 - Y/Y^*)\,(G^*/Y),$$

where Y is GDP, μ_t and ϵ_t are error terms, and * indicates trends of the variables (the trends are calculated with Hodrick-Prescott filtering).

The regression results in <Table III-1> show the insignificance of the coefficient for the debt-to-GDP ratio, whether a non-linear reaction term is included or not. This means a rejection of the fiscal sustainability in the case of South Korea.

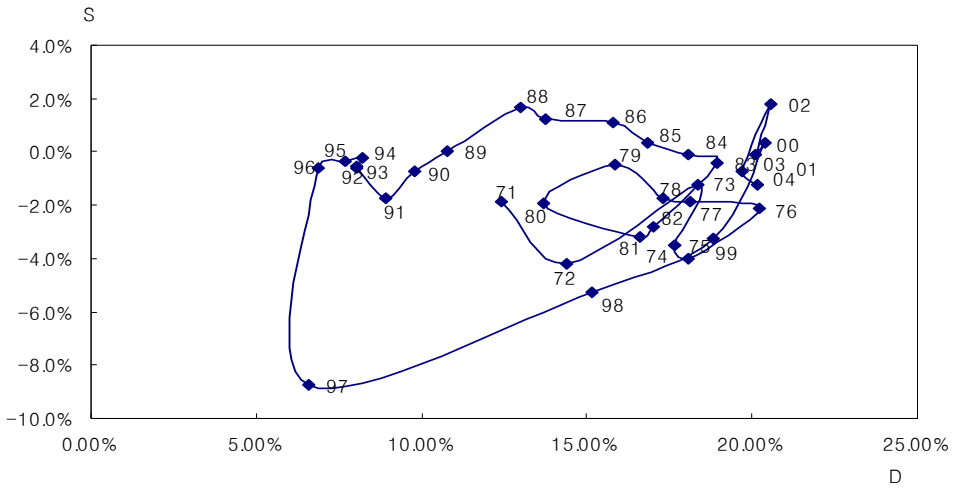
<Table III-1> Results from Bohn's Test

	Reg1	Reg2
Constant	-0.018 (-1.317)	-0.028 (-1.507)
D	0.028 (0.320)	0.070 (0.680)
GVAR	-0.526* (-2.351)	-0.532* (-2.363)
YVAR	-1.760** (-2.741)	-1.561* (-2.257)
$(D - avr.D)^2$		2.155 (0.807)
R^2	0.299	0.315
D-W	1.303	1.222

note: t-value are in ( )
* means 5% significance level, ** means 5% significance level

The conclusion is somewhat surprising, considering that South Korea maintained a relatively lower level of public debt even after the financial crisis of 1997. We think that such result is related to the special historical experiences in the fiscal policy of Korea. After Korea suffered from the economic unstability caused by high inflations, a side-effect of the high-growth policies in the late 1970s, the new government then pursued a strong stabilization policy from early 1980s. The current relatively lower level of debt in fact is founded on the fiscal consolidation of that period. <Figure III-3> below illustrates how the fiscal consolidation affects the relationship between the public debt and the primary surplus. Apparently, they have a negative relation during 1983 to 1988, which is opposite to Bohn's framework characterizing the fiscal sustainability. The long-lasting consolidation policy was so strong and the fiscal balance continued to improve even after the debt-to-GDP ratio reduced significantly. Thus, it is hardly expected that sustainability of the Korean fiscal policy can be confirmed by the simple Bohn's test.[1)]

[Figure III-3] Ratios of the debt and the primary surplus to GDP



1) To consider the changes of the government fiscal policy, we may use a simple adjustment of the regression with a dummy variable for the period 1983 - 1996. This is similar to Valderrama(2005) who divided the series before and after the 1990 to test the sustainability of Korean fiscal policy.

IV. The Structural VAR Approach

1. Methodology

The reactions of governments to larger public debts can be analysed from two different lines of perspectives. One point of view is to examine whether there is any stable long-run relationship between the *levels* of the relevant fiscal variables. This is actually what was done by Bohn's test. The other point of view is to investigate the relation at the short-run basis, that is, how the variables behave when there occurs a deviation, due to some economic shocks, from a certain long-run equalibrium. Since it usually takes time to return to long-run equalibrium, it is important to study the dynamic adjustment process of the variables in the latter case. Apparently, such short-run adjustment of fiscal variables will be crucial to the determination of the fiscal sustainability. If the government responds to positive shocks in the public debts by increasing the primary surplus gradually, the equalibrium level of the debts will finally be recovered, implying the sustainability of the fiscal policy. One advantage of studying the short-run dynamic process lies in being able to understand the speed of adjustment to equalibrium. Even if the government takes actions in the right direction, too slow or weak adjustment process can make the fiscal sustainability uncertain. For these reasons, this section develops a tool for analysing the sustainability issue form the short-run perspective of governments' reactions.

What matters in the short-term approach are the directions of changes in the variables, which, rather than the levels, are often to be modeled, except the stationary variables. Also, unlike the case of long-run relationship, there is usually no available economic theory tailored for a short-run adjustment process, so that most of short-run dynamic studies need to be carried out in an atheoretic manner. VAR models, in this case, are a popular and useful tool to study the intertemporal relationship between economic variables,

having an advantage of capturing rich dynamic effects of exogenous shocks on the endogenous variables. Based on the unit-roots results in the appendix, the alternative sustainability test of this section applies a trivariate structural VAR model that consists of the primary surplus-to-GDP ratio, the changes in the debt-to-GDP ratio, and the growth rate of GDP.

The reduced form VAR model considered is given as follows

$$X_t = \gamma + \beta(L) X_{t-1} + e_t \qquad \text{(IV-1)}$$

where $X_t = [gr_t, \Delta d_t, s_t]'$ denotes (3×1) column vector including the growth rate of GDP in period t(gr_t), the change in the debt-to-GDP ratio at the end of period t-1(Δd_t), and the ratio of the primary surplus to GDP at the end of period t-1. $\beta(L)$ is a 3×3 lag polynomial, and $e_t \equiv [e_t^{gr}\ e_t^{\Delta d}\ e_t^{s}]'$is the unexpected disturbance term that is assumed to be not serially correlated and have variance-covariance matrix, Σ_e. Since the reduced form error term $e_t \equiv [e_t^{gr}\ e_t^{\Delta d}\ e_t^{s}]'$is a mixture of various economic shocks, additional restrictions are needed to identify the sources of those errors. Letting $u_t \equiv [u_t^{gr}\ u_t^{\Delta d}\ u_t^{s}]'$be the structural errors to $X_t = [gr_t, \Delta d_t, s_t]'$, with $Cov(u_t) = I$, we will assume the following[1]:

$$e_t^{gr} = c_1 u_t^{gr}, \qquad \text{(IV-2)}$$

$$e_t^{s} = b_1 e_t^{gr} + b_2 u_t^{s} + b_3 u_t^{\Delta d}, \qquad \text{(IV-3)}$$

$$e_t^{\Delta d} = a_1 e_t^{gr} - e_t^{s} + a_2 u_t^{\Delta d}. \qquad \text{(IV-4)}$$

In the above, it is assume that GDP is not affected contemporaneously by

1) One may find that a similar type of identifying restirctions were assumed in the VAR analysis of the effects of fiscal policy by Blanchard and Perotti(2002).

u_t^s or $u_t^{\Delta d}$, from a notion that the effects of the fiscal policy are realized with time lags. Also, we assume that the government use the whole amount of the primary surplus to pay off the public debts, according to the debt dynamic equation in Eq.(II-2). The main interest of Bohn's test was in the unidirectional effect from the changes in the debt on the primary surplus, which is incorporated in Eq.(IV-3) by the above VAR model. In contrast to Bohn's approach, our VAR model also gives an explicit consideration to the contemporaneous effect from the primary surplus on the debt-to-GDP ratio, as seen in Eq.(IV-4). This means that the debt-to-GDP ratio is no longer treated as an exogenous variable, and its contemporaneous relation to the primary surplus now can internalize their comovements within the model.

For a comparison to the standard representation of structural VAR model, we first express the restrictions in Eq.(IV-2) through Eq.(IV-4) in terms of

(IV-5)
$$\begin{pmatrix} 1 & 0 & 0 \\ -b_1 & 1 & 0 \\ -a_1 & 1 & 1 \end{pmatrix} \begin{pmatrix} e_t^{gr} \\ e_t^{s} \\ e_t^{\Delta d} \end{pmatrix} = \begin{pmatrix} c_1 & 0 & 0 \\ 0 & b_2 & b_3 \\ 0 & 0 & 0a_2 \end{pmatrix} \begin{pmatrix} u_t^{gr} \\ u_t^{s} \\ u_t^{\Delta d} \end{pmatrix}.$$

Letting A and B be the coefficient matrix of the righthand and lefthand side in Eq.(IV-5), respectively, the contemporaneous effects are given by the matrix, $D^{-1} \equiv A^{-1}B$. From Eq.(IV-5), one can easily find the coefficient b_3 to represent the contemporaneous effect form the structural shock, $u_t^{\Delta d}$, on the primary surplus. Positive b_3 is then interpreted as a partial sign to the fiscal sustainability such that the government tries to respond instantaneously to a temporary increase in the debt-to-GDP ratio by running a larger surplus. Once the sources of economic shocks are identified, the dynamic effects of the structural shocks on the three endogenous variables are derived from the impulse-response functions. The sustainability test from the short-run

dynamic perspective follows from investigating both responses (over time) of the primary surplus and the debt-to-GDP ratio to the exogenous shock, $u_t^{\Delta d}$.

2. Empirical results: South Korea

In this section, we apply the VAR method explained above to probe into the fiscal sustainability of South Korea, using the data set described in section III-1. Considering that the annual fiscal data is used and the number of the whole observations available is 34, the lag choice of two for the VAR model appears to be reasonable.[1] <Table IV-1> and <Table IV-2> summarize the estimation results of the VAR model. <Table IV-1> shows the estimates of the coefficients of the lagged variables, with each column corresponding to a single equation of the reduced form VAR model. Relating to the sustainability issue, one may be interested in the effects of the lagged debt-to-GDP ratio on the current primary surplus, which are located in the lower part of the second column in the table. The estimates of the coefficients are 0.224 and 0.086 for the first and second-order lagged variables of the debt-to-GDP ratio, respectively. Thus, with no additional shocks, 1% increase in the debt-to-GDP ratio this period will predict 0.2 % increase in the ratio of the primary surplus to GDP in the next period. This should be interpreted only as a partial evidence of the government's actions towards the fiscal sustainability, since it is not possible at this stage to clarify the source of the changes in the debt-to-GDP ratio. Those coefficients describes simply the intertemporal interactions among the variables during the adjustment process.

More informative to the sustainabiity test is to examine the responses (over time) of the primary surplus to the exogenous shock($u_t^{\Delta d}$) that occurs

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1) A better method to optimize on the choice of lags may be to use Akaike or Schwartz criterion, which will be added soon.

<Table IV-2> Estimates of the coefficients of the reduced form VAR

	GR(t)	S(t)	ΔD(t)
GR(t-1)	0.953	0.141	-0.307
	(0.406)	(0.158)	(0.298)
GR(t-2)	-0.246	-0.013	0.050
	(0.359)	(0.139)	(0.263)
S(t-1)	-0.006	0.684	-0.528
	(0.6809)	(0.265)	(0.500)
S(t-2)	0.256	0.069	0.323
	(0.675)	(0.262)	(0.496)
ΔD(t-1)	1.308	**0.224**	-0.362
	(0.6098)	(0.237)	(0.448)
ΔD(t-2)	-0.4438	**0.086**	0.212
	(0.635)	(0.247)	(0.467)
Const.	0.021	-0.011	0.017
	(0.029)	(0.011)	(0.021)
R-squared	0.210	0.405	0.131
F-statistic	1.110	2.845	0.630

* standard errors are in the parentheses

in the bond market. The estimates associated with the identifying restrictions are collected in <Table IV-2> where the estimate of b_3 indicates the contemporaneous effect of the debt shock on the ratio of the primary surplus. The estimate turns out to have a statistically significant positive value, implying that the initial reaction of the government to the exogenous change in the debt is consistent with the fiscal sustainability.

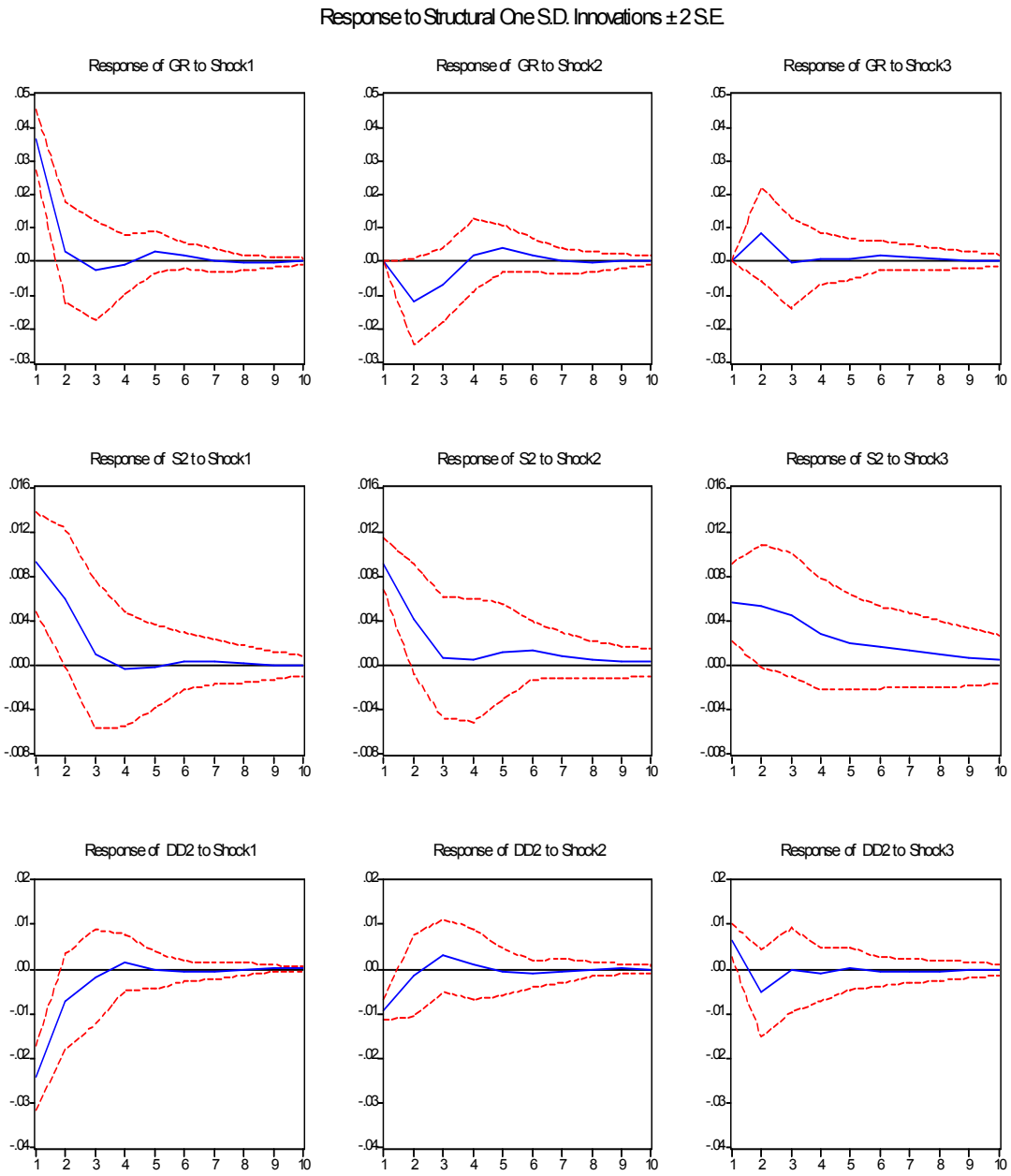
<Table IV-3> Estimates of the SVAR

Ae = Bu, where E[uu']=I			
Estimated A matrix	1	0	0
	-0.254	1	0
	0.414	1	1
Estimated B matrix	0.036	0	0
	0	0.009	**0.006**
	0	0	0.012

	Coefficient	Std. Error	P-Value
b(1)	0.254	0.052	0.000
a(1)	-0.41	0.058	0.000
c(1)	0.036	0.004	0.000
b(2)	0.009	0.001	0.000
b(3)	**0.006**	**0.001**	**0.001**
a(2)	0.012	0.001	0.000

The consecutive responses of the primary surplus is illustrated in the impulse-response function(the third graph in the middle row) of <Figure IV-1>. The primary surplus continues to respond in the positive direction during all the periods considered, which supports again the fiscal sustainability of South Korea. Its responses maintain a certain positive(and statistically significant) level up to the second or the third year, and then decrease rather rapidly, converging finally to zero. Another instructive evidence concerning the sustainability can be provided by the responses of the change in the debt-to-ratio to the same exogenous shock(see the third graph in the lowest row of Fig.IV-1). It shows that the change in the debt-to-GDP ratio takes a positive value in the first period and a negative one of the similar absolute size in the second, being very close to zero thereafter. From this we obtain an obvious implication for the level of the debt-to-GDP ratio. That is, the debt-to-GDP ratio itself may increase by a certain amount in the initial period, owing to the exogenous shock in the bond market, for example. The ratio, however, turns out to be able to recover its original level as early as in the next period, and then continues to stay the same. The last interpretation is equivalent to a direct and somewhat strong evidence of the fiscal sustainability, which supports the stabilizing actions of the government of South Korea.

[Figure IV-2] Impulse-Response functions



* shock 1= u_t^{gr}; shock 2 = u_t^{s}; shock 3 = $u_t^{\Delta d}$

** See the third graph in the middle row for the response of the primary surplus to the shock, $u_t^{\Delta d}$.

*** See the third graph in the lowest row for the response of the debt-to-GDP ratio to the shock, $u_t^{\Delta d}$.

V. Conclusion

Using a structural VAR model, this paper proposes a short-run dynamic approach to the sustainability test of fiscal policy. It is inferred from our empirical application that the government of South Korea has historically taken the right measures in terms of the fiscal sustainability. Responding to the exogenous shocks that increase temporarily the debt-to-GDP ratio, the government seems to try to restore the original state by raising the primary surplus (or reducing the primary deficit). The same conclusion, however, could not be reached by the well-known Bohn(1998) test that addresses the issue through the long-run relationship between the primary surplus and the public debt. In general, the confliction of the results may arise partly from the difference in the perspectives of two approaches. One puts an emphasis on the short-run adjustment process, and the other on the existence of the stable long-run relationship. In practice, one needs to give a careful consideration to the rejection of the fiscal sustainability by the Bohn(1998) test, since South Korea experienced with the active fiscal consolidation during the mid 1980's through the mid 1990's.

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Appendix

<Table A-1 > Unit-Roots Test for the growth rate of GDP

	ADF Test		P&P Test	
	Test St.	P-Value*	Test St.	P-Value*
GR	-4.967199	0.0003**	-4.972336	0.0003**

* : The optimal lag is chosen by Schwartz Information Criterion.
** : the rejection of the unit-roots at 5% significance level
note : a constant is included

<Table A-2> Unit-Roots Test for the debt-to-GDP ratio

	ADF Test		P&P Test	
	Test St.	P-Value*	Test St.	P-Value*
D1	-2.008488	0.2817	-1.149860	0.6838
D2	-1.160400	0.6794	-1.455964	0.5430
ΔD1	-0.804781	0.8023	-4.447804	0.0013**
ΔD2	-4.612811	0.0008**	-4.628387	0.0008**

* : MacKinnon (1996) one-sided p-values.
** : the rejection of the unit-roots at 5% significance level

Note: 1. ADF and P&P include a constant
2. The lags for ADF are chosen by Schwartz Information Criterion.
3. P&P uses the Bartlett kernel and the Newey-West Bandwidth choice

<Table A-3> Unit-Roots Test for the ratio of the primary surplus to GDP

	ADF Test		P&P Test	
	Test St.	P-Value*	Test St.	P-Value*
S1	-2.198081	0.2107	-2.212630	0.2058
S2	-2.908629	0.0551	-2.950412	0.0504

* : MacKinnon (1996) one-sided p-values.

Note: 1. ADF and P&P include a constant

2. The lags for ADF are chosen by Schwartz Information Criterion.

3. P&P uses the Bartlett kernel and the Newey-West Bandwidth choice

<표 4-3> Unit-Roots Test(with a structural break) for the primary surplus

	통계치	5% critical value	the optimal lag
S1	-2.9415**	-2.88	2*

* : The optimal lag is chosen by Schwartz Information Criterion.

** : the rejection of the unit-roots at 5% significance level

note : a constant is included