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SOURCES OF MACROECONOMIC FLUCTUATIONS IN KOREA

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This study investigates the causes of macroeconomic fluctuations in Korea. Based on a model of small open economy, a structural VAR model incorporating cointegrating relations is developed as an analytical framework. It is found that there are two cointegrating relations among the five variables examined, implying there exist three common stochastic trends. A combination of long-run and contemporaneous restrictions is exploited to identify the structural parameters. The result shows that both the aggregate demand and supply shocks are important in explaining the macroeconomic fluctuations in Korea. Supply shocks bear significant responsibility for the fluctuations in income, trade balance and real interest rates whereas demand shocks are equally important as supply shocks for the price movements. Supply (Demand) shocks move output and price in the opposite (same) directions. In addition, trade balance responds negatively to supply shocks, which is consistent with the prediction of real business cycle model.

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I. INTRODUCTION

An important question in which economists have traditionally been interested is the one about the sources of aggregate macroeconomic fluctuations. The traditional Keynesian or monetarist view stresses the importance of aggregate demand shocks as the primary source of variations in macroeconomic variables. In contrast to the traditional view, real business cycle (RBC) theory identifies

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the supply shocks as the dominant source of variations in income. One reason that lends support to RBC theory is the well-known empirical observation that a lot of economic time series contain a unit root. Therefore, the proponents of RBC theory argue that supply shocks such as changes in productivity are dominant source of fluctuations in macroeconomic variables. However, there is a strong conviction of traditional view that aggregate demand shocks play an important role in explaining the macroeconomic fluctuations at least in the short-run.

The corresponding empirical literature concerning closed economy summarizes mixed findings. Blanchard and Quah (1989) show that demand shocks explain a substantial part of business cycles over short time horizon. Similar results are obtained by, among others, Shapiro and Watson (1988), King *et al* (1991) and Gali (1992). Bergman (1996) finds that both demand and supply shocks are important sources of business cycle fluctuations. Karras (1994) argues that demand shocks are significantly responsible for business cycles although supply shocks are also found important for short-run fluctuations.

The same line of empirical research has been extended to open economies. Employing cointegration restrictions in identifying structural parameters, Mellander *et al* (1992) report that permanent real shocks account for most of the fluctuations in GDP in the case of Sweden. Ahmed and Radha (1994) show the results from the Canadian economy that domestic supply shocks are important in explaining short-run fluctuations in output while they are not for the variations in real interest rate and terms-of-trade. Examining seven OECD small open economies, Ahmed and Park (1994) also report that output variations are primarily driven by domestic supply shocks. Thus the results are mixed as for the closed economy.

The purpose of this study is to investigate the sources of macroeconomic fluctuations in Korea, with special attention to the distinction between permanent and transitory shocks. And the results are compared with other findings for Korea and foreign countries. Most empirical application of the permanent-transitory distinction has been limited to such exogenous innovations as oil shock (Marion, 1984) or changes in tariffs (Edwards, 1989). However, whether a given change in a variable is permanent or transitory is not easy to know *a priori* and thus has to be estimated. The empirical results based on a model with clear distinction between permanent and transitory shocks should shed new light on policy implications. To this purpose, a structural vector autoregression model (SVAR) for a small open economy, incorporating cointegration relations, is developed as an analytical framework. One advantage of taking cointegration into account is to exploit a set of useful information about long-run relationship among the variables under consideration.

It is found in this study that domestic real income, trade balance and real interests are largely driven by supply shocks. Trade balance responds negatively to supply shocks, which is consistent with the real business cycle model of

Backus *et al* (1992) for instance, predicting countercyclical behavior of the trade balance. It is, however, in contrast to Sachs (1981) noting that a permanent change in income leaves the current account largely unaffected. Price movements are equally affected by both aggregate demand and supply shocks. And foreign supply shocks exert some significant effect on the price movements. It is noteworthy that supply shocks move output and price in opposite directions whereas demand shocks move them in the same directions. This result is consistent with the traditional interpretation of macroeconomic fluctuations. Finally, IS shocks bear significant responsibility for the real interest rates fluctuations in the short-and intermediate-run, and domestic supply shocks take over in the long-run.

The remainder of the paper is structured as follows. Section II specifies a structural vector autoregression model of a small open economy that consists of five variables. Section III discusses the structural decomposition necessary for identifying the structural parameters. A combination of long-run and contemporaneous restrictions is exploited for the identification of structural parameters. Section IV presents the empirical results in terms of variance decomposition and impulse responses. Finally, section V offers a concluding summary.

II. THE VAR ANALYSIS OF A SMALL OPEN ECONOMY

To investigate the sources of macroeconomic fluctuations in a small open economy, we develop a VAR model that consists of five variables: the foreign income (y^*), domestic income (y), price level (p), trade balance (tb) and real interest rate (r). Korea is taken as a small open domestic economy. The domestic real income uses real GDP and the foreign income is the weighted average of industrial production index of four major trading partners of Korea: U.S.A., Japan, Germany and Canada.[1] The weights are based upon the 1985-87 total trade volume of each country. The price level is represented by the wholesale price index, real interest rates by the nominal yield on corporate bond minus *ex post* inflation rate. The trade balance used is the ratio of net exports to the current GDP. All variables are in logarithm except for the trade balance and real interest rate. Quarterly data for the period 1975:1-1998:2 are obtained from *International Financial Statistics*-CD ROM except for the corporate bond yields that are taken from monthly bulletin of Bank of Korea.

A VAR model under the assumption of cointegration is represented as follows:

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[1] All income variables are seasonally adjusted. In a small open economy, macroeconomic performance will reflect the economy's responses to foreign as well as domestic shocks. Foreign shocks may be idiosyncratic. Therefore, using as a proxy for foreign income the weighted average of industrial production index of major trading partners would cover wider range of shocks given to a small open economy.

$$X_t = \mu + \sum_{i=1}^{k} A_i X_{t-i} + V_t \tag{1}$$

where $X_t = (y_t^*, y_t, p_t, tb_t, r_t)$, μ is the vector of constants, A_i's are coefficient matrices, and $V_t = (v_{1t}, \cdots, v_{5t})$ is the vector of reduced-form disturbances with $cov(V) = \Omega$. The lag length (k) is set at 3 quarters based on the Schwarz (1978) criterion.

The above equation (1) can be rewritten as:

$$\Delta X_t = \mu + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-k} + V_t \tag{2}$$

where $\Gamma_i = -I + A_1 + \cdots\cdots + A_i \quad i = 1, 2, \cdots, k-1$
$\Pi = -I + A_1 + \cdots\cdots + A_k$.

We can also rewrite equation (1) in moving average form as follows:

$$X_t = \overline{X}_t + \sum_{i=0}^{\infty} B_i V_{t-i} \tag{3}$$

where $B_0 = I$ which is an identity matrix and $\overline{X}_t$ is the deterministic path of X_t. The Γ_i matrices in equation (2) capture the short-run dynamics while the Π matrix shows the possible long-run relationships. We can also identify the number of cointegrating relationships as the rank of Π matrix in equation (2). If Π is a matrix of full rank, X_t is stationary and the VAR model can be analyzed in level form. If Π is a null matrix, the variables in X_t are not cointegrated and the equation (2) reduces to a traditional VAR model of first-differenced series. And if Π matrix has a rank that is greater than zero but less than the number of the variables in the system, then the cointegrating relationship is said to exist. Thus, for the empirical analysis of VAR model, we need to determine the extent of cointegration among the variables in the system. In this regard, we first apply augmented Dickey-Fuller (1981) unit root test to examine the stationarity of the data. Though not reported, the presence of a unit root is not rejected for all variables in level but for real interest rate. However, the corresponding first-differenced series are found to be stationary.

To test for the possible long-run relationships among the variables in level, we employ the Johansen (1988, 1991) and the Johansen and Juselius (1990) cointegration test procedure of maximum likelihood estimation of a fully specified error correction model. Table 1 shows that the null hypothesis of there being one cointegration vector as opposed to two vectors is rejected at 10% level due to the maximal eigenvalue tests, and the null of there being at most two cointegrating vectors is not rejected at 5% level due to the trace test. We

[Table 1] The Johansen Tests of Cointegration

H^0	$r \leq 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$	$r \leq 4$
Trace (r)	90.02**	49.31**	22.33	10.60	3.71
λ-max (r)	40.70**	26.98*	11.74	6.88	3.71
	β_1	β_2	α_1	α_2	
y^*	-1.309	-1.955	-0.005	0.053	
y	0.433	0.499	-0.008	0.075	
p	0.173	0.133	0.026	-0.076	
tb	1.000	1.000	-0.029	0.033	
r	3.896	-0.803	-0.217	0.266	

(1) The lag length (3) was chosen based upon the Schwarz criterion. The maximal eigenvalue statistic (λ-max (r)) is the likelihood ratio test for the null hypothesis of there being r cointegrating vectors as opposed to $r+1$ vectors. The trace statistic (trace (r)) is the likelihood ratio test that there are at most r cointegrating vectors in a system of p variables.
(2) **(*) denotes the rejection of the null hypothesis at 5%(10%) level. The critical values of the maximal eigenvalue statistic at 5%(10%) significance level for $r=0,1,2$ are 33.18(30.77), 27.17(24.71), and 20.78(18.70), and the corresponding critical values for the trace statistic are 68.91(65.06), 47.18(43.96), and 29.51(26.80). The critical values are those from Johansen and Juselius (1990).

thus conclude that there are two cointegrating vectors in the system, which in turn implies that there exist three common stochastic trends in the system.[2]

In the cointegrated system of equation (2), the Π matrix can be decomposed into $p \times r$ matrices α and β such that $\Pi = \alpha\beta'$ where p and r denote, respectively, the number of variables in the system and the cointegrating relations.[3] Then, β is interpreted as the matrix of cointegrating vector implying that $\beta' X_t$ is stationary. In this sense, $\beta' X_t$ is called the error correction term. On the other hand, α matrix is interpreted as the weight of the cointegrating relation entering a particular equation in the system. The estimated α and β matrices are also reported in Table 1. The β matrix is normalized by the trade balance variable so that it is read as a trade balance equation. The trade balance is positively associated with foreign income and negatively associated with

[2] If one test is in conflict with the other, we need to conclude the extent of cointegrating relationship based upon the other characteristics of the model specification. For example, the test for the exclusion of the error correction terms from a particular equation in the VAR model (α's being jointly zero in a particular equation) would provide a guideline. This will be explained later in more detail. A dummy variable was added in the test equation to control for a possible structural break due to the foreign exchange crisis occurred in the fourth quarter of 1997 (1 for 1997:4-1998:2, and 0 otherwise)

[3] Here p and r do not denote price level and real interest rate, respectively.

domestic income. This is consistent with the traditional theory of international trade as surveyed in Goldstein and Khan (1985). It is negatively related to price, which is intuitively appealing.

Based on the fact that there are two cointegration relations among the variables, we specify the error correction model such as equation (2). See Kim (1994) for detailed procedure. First, we need to test whether a particular variable is absent in all two cointegrating vectors. The χ^2 test results in Table 2 of the hypotheses H_0^1 through H_0^5 show that no variable is absent in all two cointegrating relations. Second, we test whether all the elements of the α matrix in a particular equation are jointly zero. The rejection of the hypothesis implies that the corresponding equation should include the error correction term. The results show that the null hypothesis (H_0^6 through H_0^{10}) of there being no error correction term is rejected in the first and the fifth equations at conventional significance levels. Thus, the equations corresponding to the foreign income and the real interest rate are modeled in the first differenced terms with lagged variables in level whereas the other three equations are modeled in the first differenced terms only. In addition to the constant term, a dummy variable that has value one for the period 1997:4-1998:2 and zero otherwise was added to capture the effect of foreign exchange crisis occurred in 1997:4.

[Table 2] Hypothesis Test on β and α

Hypothesis (H_0)	Test Statistic	Significance level
$H_0^1 : \beta_{\cdot 1}=0$	$\chi^2(2)=18.23$	0.00
$H_0^2 : \beta_{\cdot 2}=0$	$\chi^2(2)=16.36$	0.00
$H_0^3 : \beta_{\cdot 3}=0$	$\chi^2(2)=9.15$	0.01
$H_0^4 : \beta_{\cdot 4}=0$	$\chi^2(2)=10.13$	0.01
$H_0^5 : \beta_{\cdot 5}=0$	$\chi^2(2)=28.03$	0.00
$H_0^6 : \alpha_{\cdot 1}=0$	$\chi^2(2)=10.61$	0.00
$H_0^7 : \alpha_{\cdot 2}=0$	$\chi^2(2)=2.67$	0.26
$H_0^8 : \alpha_{\cdot 3}=0$	$\chi^2(2)=4.88$	0.09
$H_0^9 : \alpha_{\cdot 4}=0$	$\chi^2(2)=0.69$	0.71
$H_0^{10} : \alpha_{\cdot 5}=0$	$\chi^2(2)=6.18$	0.05

[Table 3] Long-run Responses to Reduced Form Innovations (β_∞)

	v_1	v_2	v_3	v_4	v_5
y^*	0.0	0.25168	-0.12140	0.20943	0.0
y	0.0	0.76835	-1.00539	-0.02706	0.0
p	0.0	-0.16750	6.26357	-0.14613	0.0
tb	0.0	0.04690	0.22301	0.58016	0.0
r	0.0	-0.03646	1.09703	0.26213	0.0

Entries are the responses of the vertical variables to a unit innovation in the horizontal reduced form disturbances in 250 periods. v_i's are reduced-form innovations to the equation for foreign real income (v_1), domestic real income (v_2), the price level (v_3), the trade balance (v_4), and the real interest rate (v_5).

Next, we generate impulse responses to reduced-form innovations using the estimated VAR model. The long-run responses are then used to identify the structural parameters. The entries of Table 3 are the long-run responses of the variables to a unit reduced-form shock after 250 periods.[4] Innovations to the foreign income (v_1) and to the real interest rate (v_5) have no long-run effects on any of the five variables, which is indicated by the fact that the first and the fifth columns of Table 3 contain zeros only. Note that each of these reduced-form innovations is a combination of structural shocks. Therefore, structural interpretations for the estimated impulse responses are not always possible. Innovations in the other three variables have permanent effects on all five variables. This confirms that there are three common stochastic trends in the system, which in turn implies that there exist two cointegrating vectors in the system.

Ⅲ. STRUCTURAL DECOMPOSITION

We have specified reduced-form VAR model and obtained all the necessary information for structural decomposition. Since it is assumed that the reduced-form innovations in equation (2) are linear combinations of the primitive structural shocks, the reduced-form shocks are to be decomposed into structural shocks.

[4] An analytical solution for B_∞ matrix is not available since the system is not invertible. Thus, the estimated B_∞ matrix is obtained by iteration. The estimated B_i matrix shows stability after about 120 periods.

Since ΔX_t is vector-stationary, we can rewrite equation (2) as moving average form by Wold decomposition theorem:

$$\Delta X_t = \mu + \sum_{k=0}^{\infty} C_k U_{t-k} \tag{4}$$

where $U_t = (u_{1t}, \cdots, u_{5t})$ is the vector of structural shocks with the assumption of $cov(U) = I$. The assumption of $cov(U) = I$ implies that these structural innovations, with a convenient normalization, are serially and mutually uncorrelated. The shocks are usually classified into aggregate supply and aggregate demand shocks according to the traditional Keynesian model. Thus, the structural shocks, $(u_{1t}, \cdots, u_{5t})$ might be called, respectively, foreign supply shock, foreign demand shock, domestic supply shock, domestic IS shock and domestic LM shock. Foreign IS and LM shocks are dumped into the foreign demand shock.

The dynamic effects of structural shocks on the level of X_t can be obtained by rewriting the equation (4) as:

$$X_t = \overline{X}_t + \sum_{i=0}^{\infty} D_i U_{t-i} \tag{5}$$

where

$$D_i = \sum_{k=0}^{i} C_k$$

Comparing the two alternative representations of X_t, equation (3) and (5), we have:

$$V_t = D_0 U_t, \tag{6}$$

and

$$B_k D_0 = D_k\,,\ k = 1, 2, \cdots \tag{7}$$

From (6) and (7), we obtain:

$$\Omega = D_0 D_0' \tag{8}$$

$$B_\infty D_0 = D_\infty \tag{9}$$

where $\Omega = cov(V)$ is the covariance matrix of reduced-form disturbances. The identification of D_i matrix depends upon the identification of D_0 matrix since Ω

and B_k matrices can be estimated from reduced-form VAR model and the implied impulse responses. Notice that in equation (8) there are 15 independent elements in Ω while there are 25 unknowns in D_0. Consequently, we need to impose 10 restrictions on D_0 to just-identify the structural parameters.

There are two types of restrictions: contemporaneous [see Bernanke(1986) and Blanchard(1989)] and long-run restrictions [see Blanchard and Quah(1989), King *et al* (1991), and Ahmed *et al*(1993)]. Gali (1992) and Kim and Kim (1996) applied a combination of these restrictions. We follow a similar strategy and identify the structural parameters by imposing a combination of six long-run and four contemporaneous restrictions. The long-run restrictions are based upon the long-run neutrality and small open economy assumption.

(A) Foreign demand shocks have no long-run effects on foreign income.

$$B_{11}(1)D_{12}+B_{12}(1)D_{22}+B_{13}(1)D_{32}+B_{14}(1)D_{42}+B_{15}(1)D_{52}=0$$

where $B_{ij}(1)$ is the long-run responses to reduced-form innovations.

(B) Domestic demand shocks have no long-run effects on domestic income.

$$B_{21}(1)D_{14}+B_{22}(1)D_{24}+B_{23}(1)D_{34}+B_{24}(1)D_{44}+B_{25}(1)D_{54}=0$$

$$B_{21}(1)D_{15}+B_{22}(1)D_{25}+B_{23}(1)D_{35}+B_{24}(1)D_{45}+B_{25}(1)D_{55}=0$$

(C) Domestic shocks have no long-run effects on foreign income.

$$B_{11}(1)D_{13}+B_{12}(1)D_{23}+B_{13}(1)D_{33}+B_{14}(1)D_{43}+B_{15}(1)D_{53}=0$$

$$B_{11}(1)D_{14}+B_{12}(1)D_{24}+B_{13}(1)D_{34}+B_{14}(1)D_{44}+B_{15}(1)D_{54}=0$$

$$B_{11}(1)D_{15}+B_{12}(1)D_{25}+B_{13}(1)D_{35}+B_{14}(1)D_{45}+B_{15}(1)D_{55}=0$$

The four contemporaneous restrictions are based on the short-run assumptions. First, we assume that foreign income is contemporaneously independent of domestic shocks. In terms of our notation, the restrictions are $D_{13}=D_{14}=D_{15}=0$. Second, real interest rates are assumed to be contemporaneously independent of LM shocks, which implies $D_{55}=0$.

The long-run restrictions, (A) and (B) are not uncontroversial in that there could be channels for aggregate demand shocks to affect real income. For example, IS shocks have permanent effects on output through the steady-state change in capital in equilibrium growth model of King *et al* (1988). Also hysteresis provides an another channel for the monetary shocks to affect output.

However, we ignore these effects assuming they are minor. Blanchard and Quah (1989) ignore the importance of these effects relative to output effects of supply shocks. The restrictions, (C) are much less controversial because our domestic country is taken as a small open economy. Although the short-run assumptions are essentially *ad hoc*, the major reason for choosing the set of the above assumptions is to minimize the effects of the domestic shocks on the foreign income following the small open economy assumption, and to leave free the trade balance effects of various shocks.

Although alternative restrictions may be imposed, they are not tried as they could reduce the matrix to the point of being trivial. For example, the restriction of monetary shocks having no long-run effects on real interest rates can be entertained. If this restriction is adopted, however, elements of the last column of all D_i matrices will be made zero because of the special form of B_∞ matrices. This implies that monetary shocks will have no effect on any of the variables. The special form of B_∞ provides two restrictions on the five elements of each column of D_0. Imposing three long-run restrictions on the monetary shocks render all the five elements of the last column to be zero. To avoid this, a contemporaneous restriction that real interest rates are contemporaneously independent of monetary shocks is adopted instead. If the so-called liquidity effect is present, an increase in money stock reduces nominal and thereby real interest rates given the prices, output and inflation. However, empirical findings on the presence of liquidity effect are mixed. Here we follow the empirical literature that the liquidity effect is not so strong.

It should be noted that the reduced-form shocks, V_t, have three common stochastic trends as indicated by the non-zero columns in Table 3. These shocks are related to the five structural shocks as shown in equation (6). And it is true that each of the five structural shocks can have permanent effects on at least one endogenous variable. However, it does not imply that there exist five common stochastic trends. Since $B_\infty D_0 = D_\infty$ and B_∞ contains only three non-zero columns, the rank of D_∞ is three at maximum.[5] That is, the five structural shocks are not linearly independent in the long-run and there are still three common stochastic trends in the system.

Ⅳ. EMPIRICAL RESULTS

Now we discuss the dynamic characteristics of structural innovations on the domestic endogenous variables. Since our interest lies in the variables in level, the differenced series (Δy^*, Δy, ΔP, Δtb, Δr) are transformed back to the level form of equation (5) for the variance decomposition and impulse responses.[6] The

[5] Note that the particular form of B_∞ did not result from the identifying restrictions, but from the specification of the reduced-form equations.

[Table 4] Structural Decomposition Matrix ($D_0 \times 10^6$)

	u_1	u_2	u_3	u_4	u_5
y^*	663	8825	0	0	0
y	10952	-1921	9240	12806	8182
p	-6433	-1019	-11101	10044	6417
tb	21167	1717	-17541	-9567	-6112
r	26107	2937	41699	-45398	0

Entries are the contemporaneous responses to the vertical variables to a unit innovation in the horizontal structural disturbances. u_i's are structural innovations to the equation for foreign real income (u_1), domestic real income (u_2), the price level (u_3), the trade balance (u_4), and the real interest rate (u_5).

structural decomposition matrix (D_0) used for dynamic characteristics of structural shocks is reported in Table 4.

Variance Decomposition

Table 5 reports the variance decomposition that conveys information on the relative contribution of each structural shock to the forecast error variance of the endogenous variables.

Domestic monetary and IS shocks account for a substantial fraction of variations in domestic income in the short-run. Although the effects are short lasting, the combined effects are comparable to those of supply shocks in the short-run. The effects of supply shocks are significant at all horizons, and become more important over time. The combined effects of domestic and foreign supply shocks explain almost entire fluctuations of domestic income in the long-run, accounting for, respectively, 55 and 40 percent. The effects of foreign shocks are found to be much greater than the estimates by Park (1993), and largely correspond to the ones found for five OECD countries by Bergman (1996). Our findings seem to be more consistent with the assumption of Korea being a small open economy.

No long-run restrictions are imposed on the price level. Therefore, all shocks can affect the long-run movements of the price level. Aggregate supply and demand shocks are equally responsible for the price movements over the entire forecasting horizon, each explaining 50 percent, respectively. As forecasting

[6] The nonlinear equation system was solved by GAUSS.

[Table 5] Variance Decomposition

Var	Q/A	u_1	u_2	u_3	u_4	u_5
	1	27.2 (-)	0.8 (-)	19.4 (-)	37.3 (-)	15.2 (-)
	2	27.3(22.8,30.4)	0.5(0.4,1.0)	23.6(19.1,31.7)	36.4(29.6,42.4)	12.1(10.0,15.3)
	4	26.4(21.5,32.2)	0.3(0.2,1.3)	34.9(28.0,41.0)	30.2(24.2,37.6)	8.1(6.6,11.9)
y	8	32.5(27.8,38.8)	0.2(0.1,1.5)	45.2(37.6,49.4)	17.7(13.5,25.0)	4.4(3.6,8.0)
	16	37.1(31.5,44.2)	0.1(0.08,1.5)	53.2(44.0,57.1)	7.7(6.1,16.3)	1.9(1.5,5.7)
	24	39.2(32.8,47.0)	0.1(0.04,1.5)	55.3(44.6,59.7)	4.4(3.4,14.1)	1.1(0.9,5.0)
	32	40.5(32.9,49.5)	0.1(0.04,1.5)	55.8(44.0,60.8)	3.0(2.3,12.9)	0.7(0.6,4.8)
	1	13.4 (-)	0.3 (-)	40.1 (-)	32.8 (-)	13.4(-)
	2	21.5(20.0,24.0)	0.9(0.7,1.6)	28.3(26.5,31.3)	25.1(24.5,27.7)	24.1(23.0,24.1)
	4	21.0(19.9,26.2)	0.7(0.5,1.8)	27.6(24.2,32.1)	26.0(23.5,30.0)	24.7(22.7,24.7)
p	8	20.4(17.4,26.2)	0.2(0.1,1.4)	30.0(25.4,34.8)	28.6(25.1,33.1)	20.9(18.3,20.9)
	16	18.4(14.7,24.8)	0.0(0.03,1.4)	33.6(27.8,38.7)	31.1(27.0,36.1)	16.8(14.3,17.9)
	24	16.8(13.0,24.3)	0.0(0.02,1.4)	35.1(28.5,41.5)	32.6(28.0,38.1)	15.5(13.1,17.3)
	32	15.3(11.6,24.2)	0.0(0.02,1.3)	35.9(28.7,42.7)	33.7(28.2,39.4)	15.1(12.6,17.2)
	1	50.5 (-)	0.3 (-)	34.7 (-)	10.3(-)	4.2 (-)
	2	49.9(39.7,53.3)	2.9(2.1,4.6)	31.2(27.4,37.1)	6.6(6.4,12.3)	9.4(7.4,10.0)
	4	42.1(34.1,48.3)	3.7(2.8,5.3)	41.4(34.8,47.4)	5.1(4.8,12.1)	7.7(6.1,9.3)
tb	8	37.0(29.9,44.9)	2.7(2.1,4.5)	52.5(44.2,58.2)	3.1(3.1,10.4)	4.7(3.8,7.0)
	16	33.5(26.2,41.6)	2.2(1.7,4.1)	58.7(47.1,64.8)	2.5(2.5,10.66)	3.1(2.5,6.1)
	24	29.9(22.5,38.9)	2.1(1.5,3.9)	62.5(49.2,68.8)	2.9(2.4,11.9)	2.6(2.1,5.9)
	32	25.2(18.5,35.8)	1.9(1.4,3.8)	67.7(52.4,73.6)	3.0(2.4,12.5)	2.3(1.7,5.9)
	1	15.2(-)	0.2 (-)	38.7 (-)	45.9 (-)	0.0 (-)
	2	21.3(18.0,25.4)	0.8(.06,2.5)	35.4(33.0,39.1)	41.8(38.8,43.1)	0.6(0.4,2.7)
	4	20.0(17.1,24.2)	1.3(1.0,3.0)	34.8(32.1,38.3)	42.0(37.8,43.5)	1.9(1.4,4.2)
r	8	21.0(17.4,24.9)	1.5(1.1,3.5)	35.0(31.5,39.8)	39.8(35.5,41.2)	2.7(2.1,5.1)
	16	17.8(14.2,23.1)	1.4(1.0,3.4)	41.7(36.1,47.4)	35.3(31.4,37.5)	3.9(2.9,6.3)
	24	14.8(11.4,20.9)	1.2(0.9,3.3)	47.9(40.5,54.0)	31.5(27.8,34.5)	4.6(3.5,7.2)
	32	13.0(9.6,20.0)	1.0(0.7,3.2)	52.2(43.2,57.9)	28.8(25.1,32.4)	5.1(3.9,7.8)

(1) See Table 4 for the definition of u_i's

(2) Numbers in parentheses are estimated one standard error band around the point estimate, obtained from a Monte Carlo simulation of normal random drawings (200 times) from the distribution of reduced-form VAR coefficients. Initial decomposition matrix D_0 was used to generate impulses based on randomly drawn coefficients.

(3) Q/A: Quarter(s) Ahead

horizon becomes longer, domestic real shocks become more important whereas the importance of foreign real shocks diminishes. The role of IS shocks are shown to be long lasting, which corresponds to the findings by Park (1993). Also IS shocks have more importance than LM shocks, which is similar to those found for Switzerland by Jordan and Lenz (1995) and for some OECD countries by Ahmed and Park (1994).

As for the price level, there are no restrictions placed on the trade balance. The trade balance variation is mainly driven by the permanent shocks throughout the horizon. The combined effects of foreign and domestic supply shocks account for 93 percent of the variations in the long-run. In particular, foreign supply shocks account for over 40 percent in the short-run while the role of domestic supply shocks become more important over time. Shocks to domestic output explain over 60 percent of the fluctuations of the trade balance in the long-run. This finding is very similar to the one found for the United States by Kim (1994). Demand shocks, regardless of its origin, are of little significance for the trade balance fluctuations.

The domestic real and IS shocks are significantly responsible for the variations in the real interest rates. In particular, IS shocks explain over 40 percent of the fluctuations in the short-run whereas the domestic supply shocks become more important over time, accounting for approximately 50 percent in the long-run. The effects of foreign supply shocks are not insignificant over the entire forecasting horizon, explaining 13-20 percent of the fluctuations in real interest rates.

Though not reported, foreign demand shocks are mainly responsible for the fluctuations of foreign income in the short-run, but they become dominated by foreign supply shocks after 16 quarters. Foreign supply shocks explain over 80 percent of the fluctuations in the long-run. Domestic shocks have insignificant effects on foreign income. Overall, the results of variance decomposition seem to be consistent with the assumption of Korea being a small open economy.

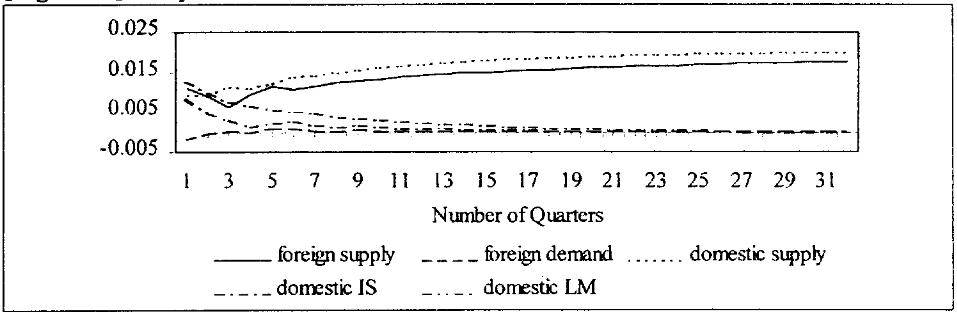
Impulse Responses

Impulse responses are those in the level of each domestic variable to a one standard deviation shock, which are shown in Figure 1 through Figure 4. Once a favorable foreign or domestic real shock is given, domestic output increases. The effects of domestic shocks are greater than those of foreign shocks. Despite the fact that Korea is a small open economy, national output is more dependent upon the domestic economic environment. IS shocks exert quite a long lasting effects on domestic output whereas the other demand shocks have insignificant effects.

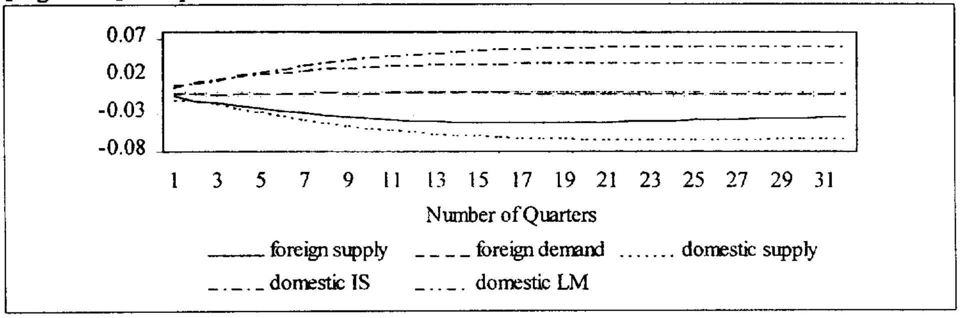
A favorable domestic supply shock produces a fall in the price whereas a favorable demand shock results in a price rise. This finding is consistent with the traditional interpretation of macroeconomic fluctuations. That is, aggregate supply shocks move output and price in opposite directions whereas aggregate demand shocks move them in the same directions. Blanchard (1989) obtains the same empirical results for the U.S. economy.

A permanent increase in income due to real shocks deteriorates the trade balance of the country where the shocks occur. A permanent increase in foreign income deteriorates the trade balance of foreign country, implying improvement

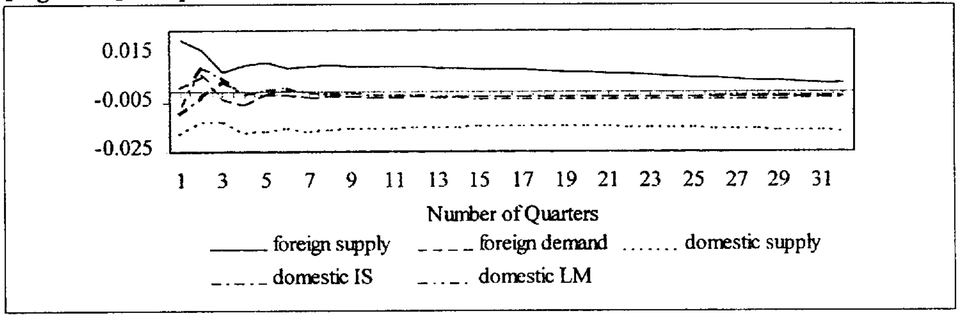
[Figure 1] Responses of Domestic Income



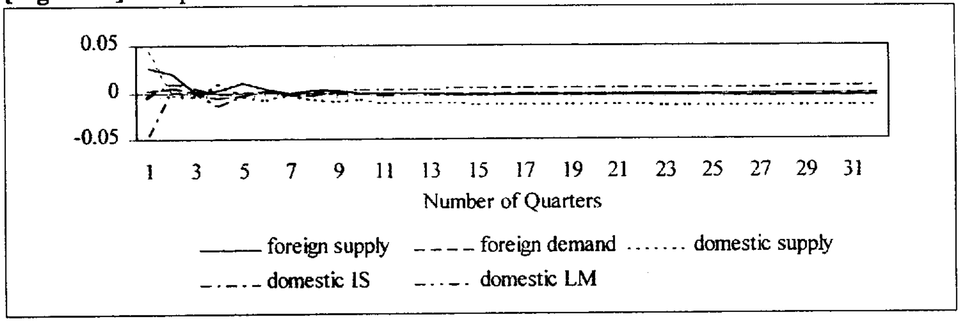
[Figure 2] Responses of Price



[Figure 3] Responses of Trade Balance



[Figure 4] Responses of Real Interest Rate



in the trade balance of Korea. Symmetrically, a permanent increase in domestic income deteriorates the trade balance of Korea. This finding is consistent with the real business cycle model of Backus *et al* (1992) for instance, which predicts countercyclical behavior of the trade balance. It is in contrast to Sachs (1981) claiming that a permanent change in income leaves the current account largely unaffected since income and consumption change by similar magnitudes. The effects of aggregate demand shocks on trade balance are of little significance compared to those of real shocks, which is similar to the empirical findings by Kim (1994).

Finally, a favorable domestic real shock produces a permanent decline in real interest rates. Though small, foreign real shocks also produce a permanent decrease in real rate of interest. Positive IS and LM shocks result in an increase in real interest rates over time, but the magnitude is very small.

V. CONCLUDING SUMMARY

This study investigates the sources of macroeconomic fluctuations in Korea. Based on a small open economy model, a structural VAR model incorporating cointegrating relations is developed as an analytical framework. It is found that there are two cointegrating relations amongst the variables examined, which imply there exist three common stochastic trends. A combination of long-run and contemporaneous restrictions is exploited for identifying the structural parameters.

It is found that supply shocks bear significant responsibility for the fluctuations in income, trade balance and real interest rates while demand shocks for the price movements. Trade balance responds negatively to supply shocks. This finding is consistent with the real business cycle model of Backus *et al* (1992), but in contrast to Sachs (1981). Price movements are equally driven by aggregate demand and supply shocks. It is noteworthy that supply shocks move output and price in opposite directions whereas demand shocks move them in the same directions. This conforms to the traditional interpretation of macroeconomic fluctuations. Finally, domestic supply shocks followed by IS shocks are largely responsible for the fluctuations in real interest rates. In sum, the empirical result shows that both the aggregate demand and supply shocks are important in explaining the macroeconomic fluctuations in Korea.

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