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FOREIGN CAPITAL INFLOWS AND REAL EXCHANGE RATE: KOREA, 1990s

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This study attempts to discriminate between the two competing hypotheses about the causal direction between capital inflows and the real exchange rate in Korea in the 1990s. A notable observation during the period was that the current account deficits were accompanied by capital inflows. Hypothesis 1 states that the inflow of foreign capital Granger-causes the real exchange rate whereas Hypothesis 2 claims that the causal direction goes the other way. The results based on both the bivariate and four-variable vector autoregression models support the Hypothesis 1. That is, capital inflows caused the real exchange rate to appreciate, which led to the current account deficits. This implies that the timing and extent of domestic capital market liberalization are important issues for Korea and other highly indebted capital recipient countries.

JEL Classification: F3
Keywords: Capital Inflows, Real Exchange Rate, Causality-Relations, VAR, Korea

I. INTRODUCTION

The purpose of this study is to investigate the causal direction between capital inflows and the real exchange rate in Korea for the time period 1990:01 - 1997:10. A notable empirical observation during the period was that the current account deficits were accompanied by capital inflows. Except for the year 1993, Korea had been running the current account deficits since 1990, hitting the peak of $23 billion in 1996. On the backside of the current account deficits, there

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was a massive inflow of foreign capital, especially in the form of portfolio investment. During the period 1990 - 1996, foreign portfolio investment reached $51.9 billion whereas the cumulative current account deficits amounted to $48.7 billion.

The cumulative current account deficits were considered as one of the key factors triggering the foreign exchange crisis that happened in November 1997. Since then, the issues of capital market liberalization and nominal exchange rate policy as a domestic price stabilization tool have attracted a lot of attention of the economists and government officials. However, the causal relations between foreign capital inflows and the current account deficits have not been investigated.

The key variable linking the current account and capital inflows is the real exchange rate. If the real exchange rate is appreciating, it would reflect the effect of either increasing foreign capital inflows or nominal exchange rate policy targeted for domestic price stabilization. Hypothesis 1 states that the inflow of foreign capital causes the real exchange rate to appreciate, which leads to the current account deficits via its negative effect on the trade balance. Thus, a foreign exchange crisis can originate if this inflow of foreign capital is suddenly halted. Hypothesis 2 claims that the appreciating real exchange rate affected by nominal exchange rate policy results in the current account deficits, which motivates capital inflows. Therefore, a crisis can occur when scared foreign lenders virtually cut all lending to a country in question. There would be, of course, some feedback between the two variables involved. In this connection, interest rate differentials are expected to play a role in interlinking these two variables. It is expected that high domestic interest rates encourage foreign capital inflows, thereby causing the real exchange rate to appreciate. In addition, the terms of trade would be another element in identifying the causal direction between capital inflows and the real exchange rate. Deterioration in the terms of trade could be a cause both of increasing capital inflows and of the real exchange rate, although a time lag would be involved between the two.

To assess the causal direction between capital inflows and the real exchange rate for the period where monthly observations are available, this study employs standard innovation accounting techniques in terms of impulse response functions and variance decompositions. The bivariate vector autoregression (VAR) model consists of the two variables directly involved in the hypothesis, capital inflows and the real exchange rate. And the four-variable model adds to the bivariate model the terms of trade and interest rate arbitrage variables. The empirical results based on various orderings of the variables show that the massive inflow of foreign capital caused the real exchange rate to appreciate, thereby producing the current account deficits in the 1990s. The real exchange rate was primarily driven by innovations in capital inflows that explain over 50 percent of its fluctuations in the long-run whereas those in the real exchange rate insignificantly affected capital inflows. These findings are consistent with Morande (1988) who studied the Chilean case for the period 1977-82, and

Agenor *et al* (1997) who found that in Turkey positive shocks to capital inflows and government spending led to an appreciation in the real exchange rate. The results suggest that the timing and speed of capital market liberalization are important issues for Korea and other highly indebted capital recipient countries.

The paper is structured as follows. Following the introduction, section II briefly describes the history of capital market liberalization policy since the 1980s and the movements of the current account, capital inflows and the real exchange rate during the 1990s. Section III presents the empirical results and a concluding summary is offered in the final section.

II. CAPITAL MARKET LIBERALIZATION, CURRENT ACCOUNT, CAPITAL INFLOWS AND REAL EXCHANGE RATE

Korea had heavily regulated capital account transactions since the enactment of Foreign Exchange Management Act (FEMA) in 1961 not only to prevent capital flight but also to allocate its limited financial resources to the strategic sectors. In response to the cumulative current account deficits, Korea took several measures to facilitate capital inflows in the first half of the 1980s. In 1981, foreign investors were allowed to deal in Korean stocks via investment trust funds that were exclusively set up for them. In 1985, firms were allowed to borrow foreign capital under certain restrictions by issuing convertible bonds, bonds with warrants and depository receipts. These measures resulted in an increased foreign borrowing by firms and banks. In addition, as the current account switched to a surplus in the second half of the 1980s, Korea lifted regulations on capital outflow. For example, the government removed all restrictions on domestic residents' foreign direct investment below $1 million and allowed residents to purchase foreign real estate for business purposes. Institutional investors were allowed to invest in foreign securities below $50 million. However, the extent of capital account liberalization was quite limited in the 1980s.

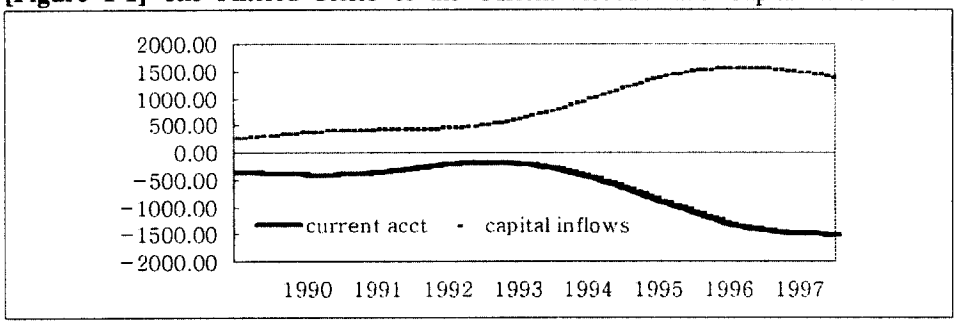
Capital account liberalization was accelerated with the beginning of the 1990s. Facing the current account deficits and an increasing demand of industrialized countries to open up the domestic capital market in the early 1990s, Korea began to take steps to further lower barriers to international capital movements. Under the FEMA amended in 1991, restrictions on capital inflows were liberalized first. Residents were allowed to borrow foreign capital by issuing securities abroad under certain conditions. Nonresidents were permitted to make foreign direct investment. Effective in January 1992, foreigners were allowed to directly invest in the Korean stock market although there were still some restrictions. For example, a 10 percent upper limit was present on the amount of firm's listed stock that non-residents as a group could hold. These measures encouraged foreign capital inflows to increase, especially in the form of portfolio investment. Net foreign investment increased from $0.084 billion in 1990 to

$3.05 billion in 1991, $10.01 billion in 1993 and rose to the peak of $15.18 billion in 1996 that comprised 65 percent of the capital account surplus.

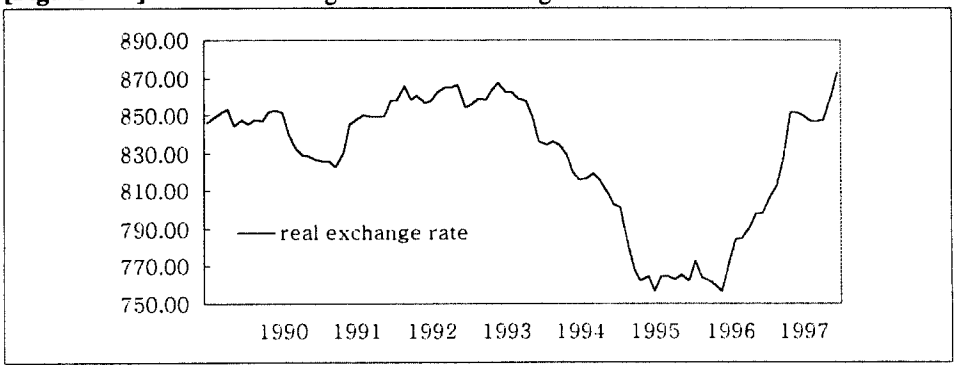
With this huge amount of capital inflow, measures were also taken to lift the restrictions on outward capital movements. Domestic institutional investors were permitted to invest in foreign securities with no restrictions. And the mode of controlling residents' direct investment abroad changed to a negative from a positive system in February 1994. In addition, the government launched a three-stage reform plan in December 1994 to completely liberalize the current and capital account transactions over a five-year period.

Figure 1-1 plots the pre-filtered series of the current account balance and capital inflows for the period 1990:01 - 1997:10. It clearly shows that the current account deficits were accompanied by capital inflows. They show mirror images of each other. Figure 1-2 depicts the movements of the real exchange rate during the period.[1] Despite the huge amount of the current account deficits as shown in Figure 1-1, the real exchange rate was appreciating, at least until 1996.

[Figure 1-1] The Filtered Series of the Current Account and Capital Inflows



[Figure 1-2] The Trade-weighted Real Exchange Rate



[1] Here the real exchange rate is the nominal exchange rate of Korean Won against US dollar times the trade-weighted foreign consumer price index divided by the consumer price index in Korea. Detailed explanation on this will be given later.

Ⅲ. EMPIRICAL RESULTS

Based on the above Korean facts, we contrast the two competing hypotheses about the causal direction between capital inflows and the real exchange rate. It might be suspected that the real exchange rate influenced by the nominal exchange rate policy for domestic price stabilization resulted in capital inflows. However, the empirical results in this study show the reverse.

1. Bivariate model

We first examined the causal relationship using a bivariate vector autoregression model between capital inflows (CI) and the real exchange rate (REX). To check for the sensitivity of the results to a definition of the real exchange rate, we explored five bivariate VAR systems with different definitions of the real exchange rate, each of which can be termed as a real effective exchange rate. REX1 defines the nominal exchange rate of Korean won against US dollar (NEX) times the trade-weighted foreign wholesale price index (TWWPI) divided by the consumer price index in Korea (KCPI). REX2 replaces TWWPI by the trade-weighted foreign consumer price index (TWCPI). REX3 and REX4, respectively, substitute the US wholesale (USWPI) and consumer price index (USCPI) for TWWPI. Finally REX5 uses the wholesale price index in Korea (KWPI) instead of KCPI.[2]

The data used were monthly observations from January 1990 to October 1997, right before the foreign exchange crisis occurred.[3] Since the capital inflow variable measured by the balance of capital account is highly volatile, it was pre-filtered by Hodrick-Prescott (1997) method.[4] Prior to estimation of the VAR model, Dickey-Fuller (1981) unit root test was applied to the variables. Because of presence of a unit root in both series, their first-differenced series were used in VAR estimation, and transformed back to the levels when deriving impulse responses and variance decompositions.

Table 1 summarizes the estimation results of the bivariate VAR systems in terms of variance decomposition. The systems were estimated with log-linear form of the variables including a constant term, and the lag length was determined by Sims' (1980a) likelihood test.[5] The results show that for all

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[2] The five major trading partners of Korea in 1990s, U.S.A., Japan, United Kingdom, Germany and Singapore, were included in generating the trade-weighted foreign prices.

[3] Nominal exchange rate of Korean Won vs. US dollar: IFS line number 542.RF.ZF
Wholesale price index: IFS line number --63.ZF
Consumer price index: IFS line number --64.ZF
Capital Account: Bank of Korea Website (www.bok.or.kr)

[4] The EViews program with λ =14400 for monthly observations was used to get the solution series, where λ is a parameter which penalizes variability in the growth component series. See, for details, Hodrick and Prescott (1997).

definitions of the real exchange rate, capital inflows are primarily driven by their own shocks over the entire forecasting horizon, explaining over 90 percent of the fluctuations. This implies that capital inflows are close to being exogenous. The shocks to the real exchange rate account for below 10 percent of the fluctuations in capital inflows even in the long-run.[6] On the other hand, even though the real exchange rate is mainly driven by its own shocks in the short- and the intermediate-run, their effects are dominated by the shocks to capital inflows in the long-run. Shocks to capital inflows account for more than 60 percent of the forecast error variance of the real exchange rate for four definitions of that variable after 48 months. For definition 3, they explain approximately 50 percent of the fluctuations in the real exchange rate in the long-run. Since the results do not depend much upon the definition of the real exchange rate, we henceforth report the empirical results with definition 2, which seems to be the most appropriate foreign price index.

[Table 1] Variance Decomposition of Bivariate Model (Ordering: REX, CI)

Variables explained	Months Ahead	By shocks to					
		REX1	CI	REX2	CI	REX3	CI
REX(i)	4	98.42	1.58	98.38	1.62	99.77	0.23
	12	92.43	7.57	90.51	9.49	98.02	1.98
	18	81.45	18.55	78.01	21.99	92.17	7.83
	24	66.99	33.01	60.32	39.68	80.76	19.24
	36	46.38	53.62	33.79	66.21	57.89	42.11
	48	39.18	60.82	24.22	75.78	47.97	52.03
CI	4	0.38	99.62	0.01	99.99	0.17	99.83
	12	3.73	96.27	0.26	99.74	3.24	96.76
	18	5.45	94.55	0.44	99.56	5.02	94.98
	24	6.55	93.45	0.57	99.43	6.19	93.81
	36	7.89	92.11	0.73	99.27	7.62	92.38
	48	8.65	91.35	0.83	99.17	8.45	91.55

Note: The optimal lag length is 3 for the systems 2 and 5, and 4 for the other systems. REX1(2) = NEX*TWWPI (TWCPI)/ KCPI, REX3(4) = NEX*USWPI(USCPI)/KCPI, REX5 = NEX*TWWPI/KWPI.

[5] The pre-filtered capital inflows are positive throughout the sample period.

[6] Changing the ordering of the bivariate system to capital inflows first and then the real exchange rate did not significantly alter the empirical results.

[Table 1] Continued

Variables explained	Months Ahead	By shocks to			
		REX4	CI	REX5	CI
REX(i)	4	98.47	1.53	98.95	1.05
	12	95.51	4.49	92.63	7.37
	18	85.97	14.03	81.99	18.01
	24	69.98	30.02	65.68	34.32
	36	45.03	54.97	37.61	62.39
	48	36.31	63.69	26.24	73.76
CI	4	0.34	99.66	1.00	99.00
	12	2.61	97.39	0.24	99.76
	18	3.83	96.17	0.10	99.90
	24	4.65	95.35	0.04	99.96
	36	5.67	94.33	0.01	99.99
	48	6.28	93.72	0.01	99.99

Table 2 provides additional evidence on the causal relationship between capital inflows and the real exchange rate. For all definitions of the real exchange rate, the inflow of foreign capital Granger-causes the real exchange rate whereas the latter does not Granger-cause the former. The *F*-test results of blocks of lags show that the null hypothesis of capital inflows causing the real exchange rate

[Table 2] *F*-test of Blocks of Lags: Bivariate Model

Dependent variable	Independent variable	
	REX(i)	CI
REX1	--	3.61(0.01)
CI	1.05(0.39)	--
REX2	--	5.71(0.001)
CI	0.40(0.76)	--
REX3	--	2.56(0.04)
CI	1.40(0.24)	--
REX4	--	3.77(0.007)
CI	0.69(0.60)	--
REX5	--	4.24(0.008)
CI	0.27(0.85)	--

Note: Numbers in parentheses are significance levels at which the null hypothesis of all lagged values of independent variables being jointly zero is rejected.

is not rejected at standard significance levels while the other way of causality-relations is soundly rejected.

2. Four-variable model

To further assess the causality-relations between capital inflows and the real exchange rate, we set up a four-variable VAR model as in Morande (1988) by adding to the bivariate model the commodity terms of trade (TOT) and interest rate differentials between domestic and foreign country (ID). The former measures the index of unit value of exports against unit value of imports, and the latter represents the corporate bond rate in Korea minus the sum of three-month LIBOR rate and the actual depreciation rate of the nominal exchange rate of Korean Won against the US dollar.[7] The inclusion of interest rate differentials in the VAR system is motivated to remove almost all the predictive power of the undoubted Granger-causally prior, the money supply, as indicated by Sims (1980b) and Litterman and Weiss (1985).

The system was also estimated with log-linear form of the variables except for interest rate differentials. A three-period lag structure was chosen based on Sims' (1980a) likelihood ratio test. Since the terms of trade show a unit root, their first-differenced series were used in VAR estimation and later transformed back to the level for impulse responses and variance decompositions.

Variance Decomposition

Variance decompositions of the four-variable model are reported in Table 3. We tried several orderings of the variables to check for whether the causal direction is reversed depending upon the ordering. This could be an issue because the orthogonalization of the shocks was made by the contemporary correlation. However, the results reported below show that this is not a central issue for the case of Korea during the period under investigation.

The first panel of Table 3 summarizes the variance decomposition of each endogenous variable with the ordering of the real exchange rate, the terms of trade, interest rate differentials and capital inflows. This is such an ordering that giving the real exchange rate the greatest chance of being causally prior with respect to capital inflows that is placed last. However, shocks to the real exchange rate do not affect capital inflows at all over the entire forecasting horizon. They account for below 1 percent of the fluctuations in the inflow of foreign capital. Capital inflows are primarily driven by their own shocks for the entire forecasting horizon. They account for over 75 percent of the fluctuations

[7] Corporate bond rate in Korea: IFS line number 54260BC.ZF
LIBOR rate: IFS line Number 11160LDDZF
Terms of trade: index of (Unit Value of Exports/Unit Value of Imports): Bank of Korea Website (www.bok.or.kr)

even in the long-run. These findings confirm that capital inflows are close to being exogenous with respect to the real exchange rate, although less so than in the bivariate system. On the other hand, even though the movements of the real exchange rate are primarily influenced by its own shocks in the short- and the intermediate-run, innovations in capital inflows mainly account for its movements in the long-run. They explain approximately 55 percent of the fluctuations in the real exchange rate. These results reinforce the previous findings based on the bivariate systems. The terms of trade show a strong exogeneity as expected. Over 95 percent of their variations is explained by their own shocks at all forecasting horizons. And the shocks to the real exchange rate bear significant responsibility for the fluctuations in interest rate differentials in this ordering of the variables. It is conjectured that the link of the real exchange rate and interest rate differentials is through the nominal exchange rate depreciation.

The results of an alternative ordering are presented in the second panel of Table 3. The capital inflow variable is placed in the first and the real exchange rate in the third. The results are not significantly different from the previous one. The real exchange rate is by no means exogenous with respect to capital inflows whereas capital inflows are mainly driven by their own shocks. The terms of trade confirm their exogeneity again and innovations in the real exchange rate significantly account for the fluctuations in interest rate differentials. Interestingly, comparing these results with the bivariate case, we note that the loss in the forecasting power of capital inflows with respect to itself is mostly attributable to the innovations in the terms of trade although they never explain over 23 percent of the fluctuations in capital inflows.

The third panel of Table 3 tabulates the decomposition of 24- and 48-month forecast error variance based on several different orderings. It is shown that the shocks to capital inflows are mostly responsible for the movements of the real exchange rate, regardless of the ordering of the variables. They never account for less than 48 percent of the fluctuations in the real exchange rate. However, innovations in the real exchange rate explain below 2 percent of the fluctuations in capital inflows at all forecasting horizons. In short, including the terms of trade and interest rate differentials variables does not change the results of the bivariate model. That is, the terms of trade and interest rate differentials do not play an important role in connecting capital inflows and the real exchange rate. This confirms Litterman and Weiss (1985) who showed that inclusion of omitted variables is not likely to alter the causal direction although it is not impossible. Finally, one thing that deserves mentioning is that the shocks to the real exchange rate explain, to a significant degree, the forecast error variance of interest rate differentials when the former is placed ahead of the latter. If the ordering is reversed, however, shocks to the real exchange rate do not account for the fluctuations in interest rate differentials whereas the shocks to interest rate differentials explain, somewhat significantly, the variations in the real exchange rate in the intermediate-run. The ordering of the variables may matter

if the contemporaneous correlation between the variables is high. Indeed, the contemporaneous correlation between the real exchange rate and interest rate differentials is calculated to be - 0.82.

[Table 3] Variance Decomposition of Four-variable Model
(1) Ordering: REX, TOT, ID, CI

V/E	M/A	By shocks to			
		REX	TOT	ID	CI
REX	4	88.40(83.06,90.90)	8.13(5.93,12.96)	2.72(1.94,5.67)	0.75(0.53,2.69)
	12	72.25(62.63,78.08)	16.95(12.73,24.13)	6.11(4.31,11.23)	4.69(3.33,12.51)
	18	60.35(49.98,68.42)	20.92(16.02,28.37)	5.68(3.98,10.79)	13.06(9.47,22.97)
	24	44.93(36.32,54.91)	24.02(18.70,31.43)	4.66(3.30,9.47)	26.38(19.62,36.34)
	36	23.06(17.93,33.45)	26.79(20.95,34.34)	2.96(2.10,7.30)	47.19(37.11,47.19)
	48	15.49(11.58,25.56)	27.88(21.59,35.77)	2.37(1.72,6.71)	54.26(43.41,54.26)
TOT	4	0.16(0.13,1.84)	97.95(94.20,98.35)	0.96(0.70,3.50)	0.93(0.66,3.61)
	12	0.12(0.10,2.81)	94.74(84.52,95.85)	1.48(1.09,5.65)	3.66(2.67,12.84)
	18	0.13(0.10,3.06)	94.62(82.44,95.67)	1.59(1.17,6.05)	3.66(2.65,14.82)
	24	0.12(0.09,3.18)	95.21(82.10,96.15)	1.60(1.17,6.18)	3.07(2.21,15.06)
	36	0.11(0.08,3.26)	96.35(81.47,97.09)	1.50(1.08,6.15)	2.05(1.58,15.68)
	48	0.09(0.07,3.27)	96.92(79.75,97.59)	1.43(1.03,6.13)	1.57(1.22,17.40)
ID	4	56.19(52.62,58.87)	10.10(8.08,13.92)	30.32(27.96,33.82)	3.39(2.38,6.14)
	12	52.47(47.41,55.50)	11.95(9.88,16.52)	28.65(25.90,28.65)	6.93(5.24,12.50)
	18	49.78(43.89,53.08)	12.49(10.38,12.49)	27.18(24.11,30.86)	10.55(8.17,17.57)
	24	46.86(40.08,50.51)	13.11(10.90,13.11)	25.60(22.10,29.32)	14.43(11.32,22.85)
	36	43.86(35.37,43.86)	13.97(11.49,20.40)	23.99(19.73,27.77)	18.18(14.05,28.79)
	48	43.59(34.15,47.59)	14.04(11.55,21.00)	23.85(19.15,27.63)	18.51(14.42,30.27)
CI	4	0.94(0.67,1.86)	4.83(3.73,6.44)	0.45(0.34,1.12)	93.78(91.95,94.92)
	12	0.11(0.08,1.75)	12.93(9.75,18.04)	0.02(0.01,1.32)	86.94(81.52,89.97)
	18	0.02(0.01,1.93)	16.15(12.12,22.55)	0.09(0.06,1.99)	83.75(76.80,87.57)
	24	0.01(0.01,2.23)	18.19(13.55,18.19)	0.16(0.11,2.53)	81.64(73.70,86.03)
	36	0.06(0.04,2.75)	20.66(15.30,28.62)	0.26(0.19,3.28)	79.02(69.95,84.13)
	48	0.11(0.08,3.11)	22.09(16.38,30.54)	0.33(0.24,3.73)	77.47(67.74,82.94)

Note (1) Numbers in parentheses are estimated one standard error band around the point estimate, obtained from a Monte Carlo simulation of normal random drawings (500 times) from the distribution of reduced-form VAR coefficients. Initial decomposition matrix was used to generate impulses based on randomly drawn coefficients.
(2) V/E : Variables Explained
(3) M/A : Months Ahead

[Table 3] Continued
(2) Ordering: CI, TOT, REX, ID

V/E	M/A	By shocks to CI	TOT	REX	ID
CI	4	96.93(95.13,97.67)	2.21(1.60,3.70)	0.01(0.01,0.50)	0.84(0.58,1.73)
	12	88.42(81.92,91.13)	8.65(6.34,14.28)	0.43(0.30,2.61)	2.50(1.70,5.63)
	18	84.80(76.66,88.41)	11.47(8.38,18.50)	0.71(0.49,3.61)	3.03(2.05,7.00)
	24	82.46(73.32,86.64)	13.30(9.70,21.13)	0.90(0.64,4.27)	3.34(2.30,7.85)
	36	79.59(69.34,84.53)	15.56(11.25,24.26)	1.15(0.82,5.11)	3.70(2.61,8.89)
	48	77.91(67.02,83.26)	16.89(12.20,26.08)	1.31(0.94,5.60)	3.90(2.73,9.46)
TOT	4	0.26(0.23,2.03)	98.10(94.21,98.46)	0.40(0.29,2.88)	1.23(0.90,3.65)
	12	1.18(0.87,8.35)	95.90(86.22,96.79)	0.68(0.50,4.41)	2.24(1.62,6.82)
	18	1.07(0.78,9.79)	95.79(84.35,96.70)	0.76(0.56,4.79)	2.38(1.70,7.46)
	24	0.82(0.62,10.55)	96.13(83.57,96.94)	0.74(0.55,4.94)	2.30(1.66,7.64)
	36	0.69(0.56,13.16)	96.68(81.71,97.28)	0.65(0.47,5.01)	1.98(1.45,7.65)
	48	0.61(0.49,15.72)	96.99(79.56,97.59)	0.59(0.42,5.09)	1.82(1.32,7.77)
REX	4	0.37(0.34,1.85)	10.13(7.45,14.84)	86.39(80.90,89.26)	3.11(2.25,5.86)
	12	1.73(1.32,9.28)	19.13(14.29,26.41)	71.50(61.80,77.00)	7.64(5.48,12.97)
	18	8.07(6.01,19.25)	22.17(16.77,29.63)	61.50(50.80,68.58)	8.25(6.01,13.94)
	24	20.12(15.19,32.21)	23.82(18.19,31.31)	47.82(38.22,56.48)	8.23(6.01,14.04)
	36	41.06(32.49,51.74)	24.35(18.46,32.12)	27.16(20.72,36.22)	7.42(5.37,13.34)
	48	48.71(38.61,58.87)	24.62(18.50,32.90)	19.66(14.53,28.57)	7.02(5.03,13.17)
ID	4	5.10(4.42,7.75)	8.58(6.65,12.72)	54.92(51.21,57.33)	31.40(28.85,34.53)
	12	8.74(7.11,14.99)	10.23(8.22,14.91)	51.44(46.23,54.23)	29.59(26.73,32.62)
	18	12.32(10.13,20.64)	10.58(8.55,15.52)	48.86(42.60,51.79)	28.24(24.87,31.28)
	24	16.12(13.23,26.24)	11.00(8.89,16.23)	46.07(38.89,49.15)	26.81(22.93,29.88)
	36	19.76(16.07,32.85)	11.65(9.40,17.54)	43.21(34.45,46.65)	25.37(20.57,28.48)
	48	20.08(16.31,34.51)	11.71(9.44,17.95)	42.96(33.27,46.42)	25.24(19.87,28.32)

Note (1) Numbers in parentheses are estimated one standard error band around the point estimate, obtained from a Monte Carlo simulation of normal random drawings (500 times) from the distribution of reduced-form VAR coefficients. Initial decomposition matrix was used to generate impulses based on randomly drawn coefficients.
(2) V/E : Variables Explained
(3) M/A : Months Ahead

[Table 3] Continued

(3) Variance Decomposition of 24- and 48-month Forecast Error: Various Orderings

Variables explained	Months Ahead	By shocks to ID	CI	TOT	REX
ID	24	66.65	14.83	11.01	7.51
	48	61.98	19.09	11.85	7.08
CI	24	0.17	84.10	14.53	1.20
	48	0.04	80.23	18.47	1.27
TOT	24	5.42	1.67	92.13	0.78
	48	5.31	0.84	93.24	0.61
REX	24	36.73	29.81	31.48	1.97
	48	11.40	58.33	29.84	0.42

Variables explained	Months Ahead	By shocks to REX	ID	TOT	CI
REX	24	44.93	0.61	28.08	26.38
	48	15.49	0.14	30.10	54.26
ID	24	46.86	25.10	13.61	14.43
	48	43.59	23.38	14.51	18.51
TOT	24	0.12	15.95	80.86	3.07
	48	0.09	15.81	82.53	1.57
CI	24	0.01	0.76	17.59	81.64
	48	0.11	0.67	21.75	77.47

Variables explained	Months Ahead	By shocks to REX	CI	ID	TOT
REX	24	44.93	26.11	2.18	26.78
	48	15.49	54.94	1.45	28.11
CI	24	0.01	83.72	0.54	15.72
	48	0.11	79.60	0.56	19.73
ID	24	48.86	14.81	25.31	13.03
	48	43.59	19.01	23.57	13.82
TOT	24	0.12	0.89	17.46	81.53
	48	0.09	0.62	16.38	82.91

Variables explained	Months Ahead	By shocks to CI	REX	ID	TOT
CI	24	82.46	1.27	0.54	15.72
	48	77.91	1.81	0.56	19.73
REX	24	20.12	50.92	2.18	26.78
	48	48.71	21.73	1.45	28.11
ID	24	16.12	45.54	25.31	13.03
	48	20.08	42.52	23.57	13.82
TOT	24	0.82	0.19	17.46	81.53
	48	0.61	0.11	16.38	82.91

Variables explained	Months Ahead	By shocks to ID	REX	TOT	CI
ID	24	66.65	5.31	13.61	14.43
	48	61.98	5.00	14.51	18.51
REX	24	36.73	8.81	28.08	26.38
	48	11.40	4.23	30.10	54.26
TOT	24	5.42	10.65	80.86	3.07
	48	5.31	10.60	82.53	1.57
CI	24	0.17	0.60	17.59	81.64
	48	0.04	0.74	21.75	77.47

Table 4 reports the *F*-tests for the significance of blocks of lags. The *F*-tests are not sensitive to the ordering of the variables because no orthogonalization of the innovations is done when the system is estimated. The information in Table 4 confirms that capital inflows Granger-caused the real exchange rate whereas the causality-relations did not go the other way. None of the *F*-values but for capital inflows is significant when the dependent variable is the real exchange rate. On the other hand, the *F*-value for the real exchange rate is insignificant in capital inflow equation. However, the *F*-value for the terms of trade is significant in the equation. This is consistent with the previous finding that the loss in the predictive power of capital inflows with respect to itself is due to the terms of trade. All in all, the empirical results based on both the bivariate and four-variable models show that the causal direction ran from capital inflows to the real exchange in Korea during the period under examination.

[Table 4] *F*-test of Blocks of Lags: Four-variable Model

Dependent variable	Independent variable			
	CI	TOT	REX	ID
CI	1.04×10^6(0.00)	2.55(0.06)	0.79(0.50)	1.05(0.38)
TOT	0.48(0.70)	1.93(0.13)	0.10(0.96)	0.47(0.70)
REX	5.77(0.00)	2.37(0.08)	1.65(0.19)	1.79(0.16)
ID	4.41(0.00)	2.47(0.07)	2.25(0.09)	5.04(0.00)

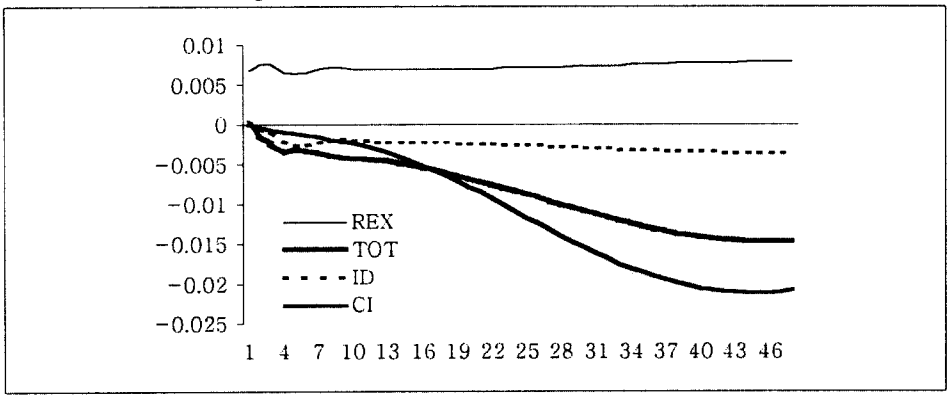
Note: Numbers in parentheses are significance levels at which the null hypothesis of all lagged values of independent variables being jointly zero is rejected.

Impulse Responses

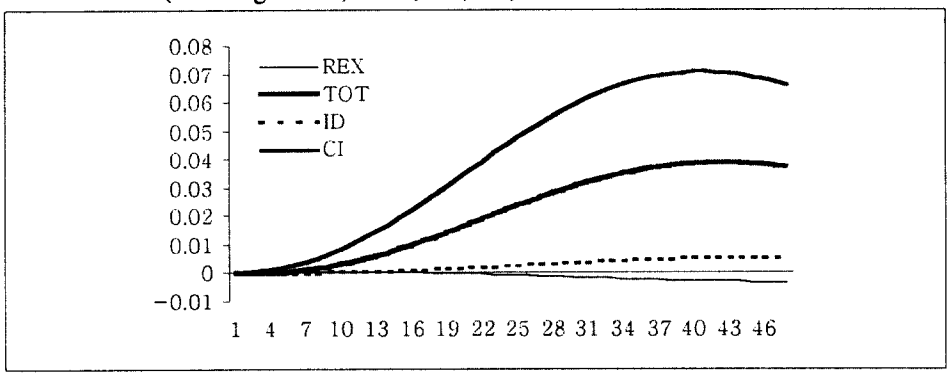
Figure 2-1 and Figure 2-2, respectively, plot the impulse responses in the level of the real exchange rate and capital inflows to a one standard deviation shock to each endogenous variable with the corresponding ordering of the variables in the first panel of Table 3. Figure 2-1 shows that a positive capital inflow shock has a strongest downward pressure on the real exchange rate. Its permanent effect is 0.021 percent decrease in the real exchange rate. The real exchange rate negatively responses to positive shocks to the terms of trade and interest rate differentials. As the terms of trade improve and interest rate differentials get higher, the foreign exchange will be abundant, thereby appreciating the real exchange rate. Figure 2-2 depicts the impulse responses of capital inflows to a one standard deviation shock to each endogenous variable. It clearly shows that capital inflows are most significantly influenced by their own shocks. The permanent effect is 0.08 percent increase. Although capital inflows rightly response to the shocks to the real exchange rate, the permanent effect amounts to only 0.003 percent decrease, which also confirms that the effects on capital inflows of innovations in the real exchange rate are negligible. As expected, capital inflows increase in response to a positive shock to interest rate differentials. However, one puzzling finding is that capital inflows respond positively to shocks to the terms of trade. One conjecture that can be advanced is that an improvement in the terms of trade makes the total export revenue less than import payments because of unfavorable price elasticity of domestic commodities.

Figure 3-1 and Figure 3-2, respectively, plot the impulse responses of the real exchange rate and capital inflows with the corresponding ordering of the variables in the second panel of Table 3. Although a little differs in magnitude, the patterns of the impulse responses are the same as Figure 2-1 and Figure 2-2. Thus, the explanations given to Figure 2 can be applied to Figure 3. Shocks to capital inflows are mainly responsible for the appreciation of the real exchange rate while the effects of innovations in the real exchange rate on capital inflows are negligible.

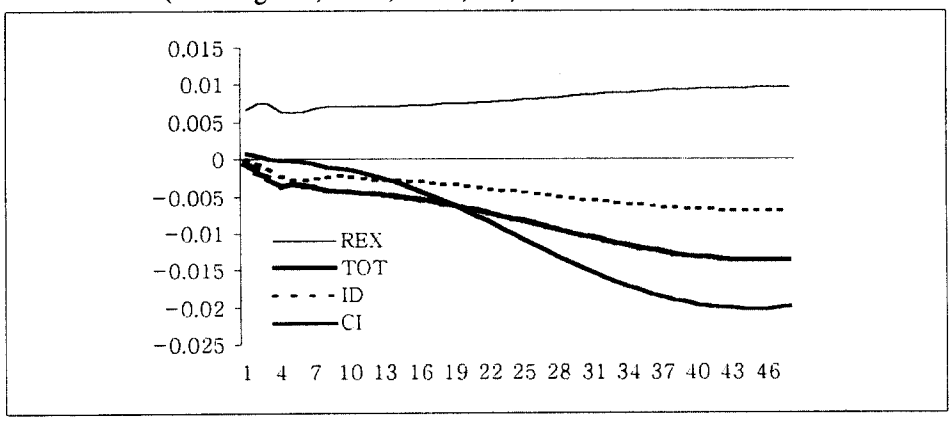
[Figure 2-1] Impulse Responses of Real Exchange Rate
(Ordering: REX, TOT, ID, CI)



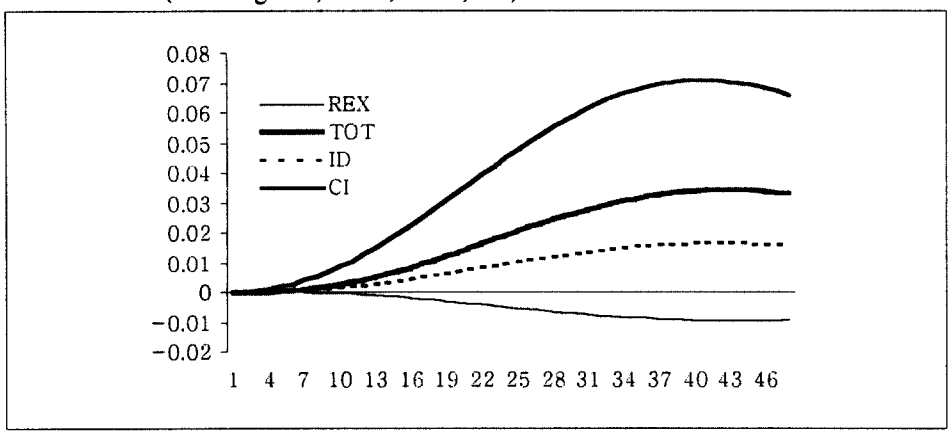
[Figure 2-2] Impulse Responses of Capital Inflow
(Ordering: REX, TOT, ID, CI)



[Figure 3-1] Impulse Responses of Real Exchange Rate
(Ordering: CI, TOT, REX, ID)



[Figure 3-2] Impulse Responses of Capital Inflows
(Ordering: CI, TOT, REX, ID)



All in all, the estimation results show that capital inflows are close to being exogenous with respect to the real exchange rate, and the real exchange rate is Granger-caused by capital inflows.

Ⅳ. CONCLUDING SUMMARY

This study investigated the causality-relations between the inflow of foreign capital and the real exchange rate in Korea for the period 1990:01 - 1997:10 using the bivariate and four-variable vector autoregression models. It is important to identify what comes first for the highly indebted capital recipient countries that are experiencing the cumulated current account deficits. If capital inflows result in an appreciation of the real exchange rate, which in turn deteriorates the current account, a foreign exchange crisis can occur when this inflow of foreign capital is abruptly halted. On the other hand, if the causal direction goes the other way, nominal exchange rate policy for domestic price stabilization causes the real exchange rate to appreciate, which results in the current account deterioration. This will motivate the capital inflows. Therefore, a crisis can originate if all lending to a country in question is virtually cut.

The empirical results show that the causal direction went from the inflow of foreign capital to the real exchange rate in Korea for the period 1990:01 - 1997:10. It has been commonly thought that the current account deficits have motivated foreign capital inflows. However, the current account deficits were a result, not a cause of capital inflows. This finding suggests that the timing and extent of domestic capital market liberalization are important lessons for Korea and other highly indebted capital recipient countries.

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