Was Korea's Financial Crisis Self-fulfilling?[*]

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The second generation model, which emphasizes multiple equilibria and self-fulfilling expectations, is distinguished from its predecessors, which emphasize market fundamentals and unique equilibrium. However, a sudden outbreak of vulnerability that is triggered by market panic can also be explained by market fundamentals. This study shows that the Korean crisis was largely triggered by real appreciation, excessive lending, and a lack of adequate reserve protection, while expansionary fiscal and monetary policies as well as capital inflows are less central. Tests for self-fulfilling crisis do not support the relationships among market fundamentals before the crisis. The real appreciation due to a weak yen and a strong won, excessive bank lending, and the mismanagement of foreign reserves led to the Korean crisis.

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1. INTRODUCTION

As the Asian crisis that began in Thailand quickly reached Korea, she inevitably requested for IMF loans on Nov. 21, 1997. At the time, Malaysia and the Philippines did not ask for IMF loans, but they were in no better condition than the crisis-hit countries of Thailand, Indonesia, and Korea. However, the economic depression of these nations did not last long: all of them have shown a remarkable rebound. In particular. Korea recorded double

digit growth in 1999 after negative 6 percent growth in the previous year. This dramatic turnaround provides the momentum to reconsider the causes and cures of the crisis.

Immediately after the crisis, many pointed out the structural problems of the crisis countries. In the case of Korea, many argued that it suffered from crisis due to lax financial supervision and regulation for financial institutions and the significant mismatch in the sources and uses of funds, despite it maintained the sound macro-fundamentals compared to other Asian neighbors.[1] Of course, the dissenting view that investors panic triggered a sudden reversal of capital inflows is also popular.[2] The swift recovery of the Asian economies strengthened the latter view of financial panic due to self-fulfilling expectations. For example, Krugman (1999) switched his position to the self-fulfilling expectations view from market fundamentals view that holds for structural factors such as moral hazard, as he witnessed the spillover of crises (Krugman, 1998).

Studies on currency crises have been vigorously pursued for the past two decades.[3] After the Mexican crisis there was extensive research on the contagion effect that affected many nations.[4] These studies were based on cross-country data and allow us to investigate the general pattern of crisis beyond the experience of an individual country. However, cross country studies cannot properly reveal the characteristics of each individual country, and inter-country comparison is at best limited. The Korean crisis is a unique experience in that Korea had played a major role in the Asian miracle and encountered crisis despite its relatively stable macroeconomic conditions.

This paper investigates empirically the causes of the Korean crisis. The findings are compared with existing studies based on multi-country data to establish relevant insight into the Korean crisis. In section 2, a simple exposition is made to compare a traditional and self-fulfilling currency crisis. Some of the difficulties in empirically identifying either type of model are

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1) Studies such as Krugman (1998), Kaminsky (1998), Park and Choi (1998) emphasize weaknesses in economic structure and market fundamentals as the primary causes of the financial crises in Asia.

2) Radelet and Sachs (1998, 1999), Lee and Lee (1998) and Krugman(1999).

3) In advanced countries, one can refer to Eichengreen, Rose, and Wyplosz (1995), and in case of developing countries to Frankel and Rose (1996) or Sachs, Tornell, and Velasco (1996b). Kaminsky and Reinhart (1996) deal with both cases.

4) Calvo and Reinhart (1995), Eichengreen, Rose, and Wyplosz (1996), and Sachs, Tornell, and Velasco(1996b) are good references.

also pointed out. In section 3, a crisis index is constructed and market fundamentals that can explain the movement in crisis index are introduced. In section 4, the multiple regressions are applied to ferret out market fundamentals followed by the test on the self-fulfilling properties of crisis. In section 5, the same empirical investigations are implemented adopting the logit model to check the robustness of the results in the previous section. The final section concludes the study.

2. MODELS OF CRISIS

Many countries have experienced various types of crises over the decades. Since the patterns of the crises have differed significantly across countries and time, crisis model has also adapted to changing patterns. The first generation model tried to explain crisis by focusing on the fiscal deficit, reflecting the experiences in Latin America where an increased money supply for deficit financing led to a sharp depreciation of domestic currency (Krugman, 1979). However, the EMU crisis in 1992 differed from the Latin American case and engendered the second generation model. Obstfeld (1994) focused on the changing expectations of the market participants for the response of the government when it was caught in conflict among goals in the exchange rate and other macroeconomic objectives. The authority can be forced to change the current policy stance because market participants expect that its policy cannot be sustained. Crisis erupts as market participants expect that policy change is inevitable.

2.1. Model Comparisons

The difference between the first and second generation model lies primarily in the possibility of multiple equilibria. The first generation model stresses the situation in which the authority cannot maintain the fixed level of the exchange rate, as foreign reserves deplete due to weak market fundamentals. However, if the authority cannot defend the exchange rate by using reserves, a typical reaction would be to raise interest rates by reducing the money supply. As market participants expect future depreciation with the depletion of reserves, the cost of maintaining the fixed level of exchange rate increases and the authorities are forced to give up the fixed exchange rate. This expected policy response is missing in the first generation model where the

authority passively responds to the speculative attack. The expected policy changes allow multiple equilibria and set in a self-fulfilling crisis.

When expectations are self-fulfilling, crisis can erupt abruptly, and it is virtually impossible to predict crisis. However, a simple comparison of the two models can create misunderstandings.

First, a crisis associated with structural vulnerability is observationally equivalent to a self-fulfilling crisis. Speculators increase their holdings of foreign currency when they realize that the authority cannot maintain the exchange rate, forcing the abrupt depreciation of currency. The difference is the timing of crisis. While the timing is determined by market fundamentals in the first generation model, it is arbitrarily set according to the self-fulfilling expectations of speculators in the second generation model.

Second, it is very difficult to predict crisis whether it is self-fulfilling or not. As pointed out, the major difference between two models is whether one can pin down the timing of crisis. Even with unique equilibrium of the first generation model that allows one to determine, *ex post facto*, the timing of crisis, predicting it remains very challenging.

Third, those who emphasize the self-fulfilling nature of crisis often assert that the crisis occurs by the speculation, even in the absence of structural problems. However, they miss the important point that the second generation model envisions the triggering mechanism in the presence of structural weaknesses. The model does not suggest that crisis occurs irrespective of market fundamentals, but that the self-fulfilling crisis occurs when the economy enters a crisis zone due to structural weaknesses. The difference is the timing. While the first generation model admits the immediate crisis when the economy enters a crisis zone, the second generation model points out the possibility of crisis at any point of time within the crisis zone.

In this context, Krugman (1996) downplayed the self-fulfilling nature of crisis. He noted that the conflicts among policy objectives do not necessarily ensure a random occurrence of crisis, even if policy is formulated endogenously. He showed that when market participants expect a gradual worsening of market fundamentals, the economy tends to have a unique equilibrium and crisis erupts as soon as the economy heads into a crisis zone. Moreover, Garber (1996) points out the observational equivalence of crisis development between the two models. It is very hard to predict crisis not only because expectations are inherently arbitrary but also expectations about future market fundamentals can change. For instance, if the crisis does not occur when the economy enters the crisis zone, this could be due both to the

arbitrary nature of expectations and changing expectations about the future fundamentals. Therefore the difference between the first and second generation model is not as striking as it might look, since both models allow for the possibilities that crisis can develop when market fundamentals are weakened and that crisis can develop in an abrupt manner. We conduct an empirical investigation into the causes of the Korean crisis from the perspective that economic vulnerability or financial fragility that are the building blocks for the second generation model can be explained by the development of market fundamentals (Kaminsky, 1998).

2.2. Contagion Effect

As the Asian economies recover astonishingly from the crisis, the view that underpins structural weaknesses is losing support in favor of a competing view that stresses investors' panic and the associated withdrawal of funds from the region. During six months around the Asian financial crises, almost 100 billion dollars were withdrawn with a subsequent upheaval of the exchange rate and interest rate. The massive outflows of capital from the region support the view that Korea's problem was not structural but largely attributable to the contagion effect of the crises of the Thai baht, Indonesian rupiah, and Malaysian ringgit. Radelet and Sachs (1999) reaffirmed their position that crisis was mainly triggered by investors' panic rather than weak fundamentals. Krugman who proposed the moral hazard problem in the region (Krugman, 1998) acknowledged the role of contagion (Krugman, 1999).

The contagion effect usually represents the contemporaneous or in-a-series occurrences of crises. Widespread crises in the region can be created by both market fundamentals and self-fulfilling elements. The mere fact that the region suffered from a series of speculative attacks does not support the claim that self-fulfilling expectations are the primary reason for the contagion.

Masson (1998) usefully categorized three contagion effects. First, a monsoonal effect is the influence on developing countries of changes in the economic situation of advanced countries. The developing countries that rely excessively on foreign financing and have weak financial markets are susceptible to common shock originating from the advanced countries. For example, as the U.S. interest rates shot up in the early 1980s, Latin American countries experienced debt crises. Moreover, the weakening of the yen after 1996 and the deep recession in Japan exacerbated the export environment of

Asian countries noticeably.

Second, the spillover effect is related to the change incurred by other countries through trade and financial linkage.[5] For example, when a country in the region devalues its currency, competing nations are forced to depreciate their currencies in order to remain competitive. The financial instability in one country also triggers massive outflow from the region due to heightened risk, extending financial instability to neighboring countries.

Third, the pure contagion effect refers to a situation in which crisis is driven by self-fulfilling expectations that are not directly related to market fundamentals. For example, when a country is hit by a crisis, expectations about future depreciation can develop for those neighboring countries that have no close trade or financial linkages.

Among the three effects, the monsoonal and the spillover effect are related to market fundamentals rather than self-fulfilling expectations. The common shocks of the Japanese slowdown and marked depreciation of the yen can deteriorate the market fundamentals through the trade and financial linkage. Since both the monsoonal and spillover effect explain the transmission mechanism without assuming multiple equilibria, these should be distinguished from a self-fulfilling crisis model with multiple equilibria.

Distinguishing the three types of the contagion effect is difficult. The East Asian regional trade keeps growing to occupy the significant portion of the total trade. Furthermore, the Japanese influence in this region increased after 1985, especially for Korea, as the Japanese yen remained strong up to 1996.[6]

3. CRISIS INDEX AND MARKET FUNDAMENTALS

The Korean crisis occurred in November 1997 when the government decided to ask for IMF loans in the wake of a weakening won and worsening

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5) Crisis models based on trade linkage are Gerlach and Smets (1995) and Eichengreen, Rose, and Wyplosz (1996).

6) Masson (1998) studied the contagion effect during the Mexican crisis and the recent Asian crisis but found that the multiple equilibria conditions for the pure contagion effect do not hold in Korea and Malaysia which had a relatively low external debt/GDP ratio. Baig and Goldfajn (1998) found the increasing correlations among stock price, exchange rates, and interest rates during the Asian crisis, but this could be due to the monsoonal effect rather than the pure contagion effect.

financial market conditions. Existing literature defines the crisis in two different ways. First, a comprehensive set of standards are applied to define a crisis chronologically.[7]

Second, quantitative indices such as the exchange market pressure is constructed to indicate the severity of a crisis. This study resorts to the latter approach. Because Korea has experienced the crisis for the first time since it launched the export-led growth strategy, the former approach of episode study is impossible for Korea.

It was common practice to monitor abrupt changes in exchange rate associated with sudden changes in capital flows in order to measure the exchange market pressure (Edwards, 1989; Frankel and Rose, 1996). However, preventive measures such as raising interest rates or exhausting foreign reserves to protect exchange rate also exert serious effects on the domestic economy. Eichengreen, Rose, and Wyplosz (1995) measured the exchange market pressure recognizing this chain of events. The so-called Eichengreen-Rose-Wyplosz index is widely applied in empirical investigations, among which Sachs, Tornell, and Velasco (1996b) and Kaminsky, Lizondo, and Reinhart (1997) are notable.

3.1. Crisis Index

We construct the slightly modified Eichengreen-Rose-Wyplosz index. The exchange market pressure (EMP) is defined as the weighted average of won depreciation(Δe), percentage point changes of interest rate(Δ_i) and percentage changes in foreign reserves(Δ_R) from the year earlier. Weights are the inverse of standard deviation of each variable so that volatile series affect the exchange market pressure disproportionately.[8]

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7) Refer to Kaminsky, Lizondo, and Reinhart (1997).

8) The weights are the inverse of unconditional variance. The won depreciation(e) is easured as the percentage depreciation of the won/dollar exchange rate. The yields of the corporate onds of three-year maturity are used. The next section performs sensitivity analysis using conditional variance. Eichengreen, Rose, and Wyplosz (1995) and Kaminsky, Lizondo, and Reinhart (1997) used conditional variance, while Sachs, Tornell, and Velasco (1996b) used unconditional variance.

$$EMP = \frac{1}{s_e} \times \Delta e + \frac{1}{s_i} \times \Delta i - \frac{1}{s_R} \times \Delta R \qquad (1)$$

where s_e, s_i, s_R are standard deviation of $\Delta e, \Delta_i$ and Δ_R respectively.

The Korean monthly data for the years 1989-97 obtained from data base of the Bank of Korea are used for empirical investigation, while most studies on crises use multi-country data. Thus the inherent limitations of this study in using only Korean time series data prevent us from drawing more general conclusion. However, multi-county studies cannot escape from the criticism that they do not offer a study of the Korean crisis because Korea usually occupies very small portion of the whole data set. In this sense, the panel study of the Asian crises cannot be viewed as the study of the Korean crisis. The Korean crisis is very unique in that it was brought about with relatively sound macroeconomic fundamentals as compared to other Asian countries such as Thailand and Indonesia. The concentration into the Korean experience is needed to seek similarities with and differences from existing studies.

The exchange market pressure should be stationary with the percentage transformation of each component. For this purpose, Franses' (1990) method was employed to test the existence of seasonal units roots (Maddala and Kim, 1998). Test results suggest that interest rate, exchange rate, and foreign reserves all have unit roots. It is further verified that the use of Δ_{12} filter is justified in the case of interest rate.

Figure 1 shows the changes in exchange market pressure, which began to increase in 1996 and posted a sharp upturn in early 1997, culminating at the end of 1997 after a brief respite in the middle of 1997. The trend is roughly in line with the public recognition of the probability of crisis. The exchange market pressure was also posted high at the end of 1990. After recording a sizable current account surplus during 1986-89, Korea experienced a sharp turnaround into current account deficit. Interest rates started to climb, increasing exchange market pressure.

Figure 2 exhibits the frequency distribution of exchange market pressure. The frequency increases sharply at interval 9 and 10 but decreases sharply beyond those intervals.

Figure 1   Exchange Market Pressures
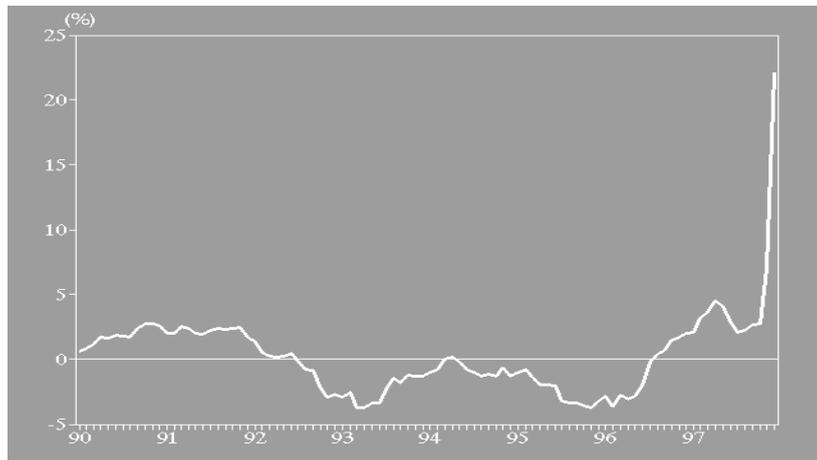
Figure 2   Frequency Distribution of Exchange Market Pressure
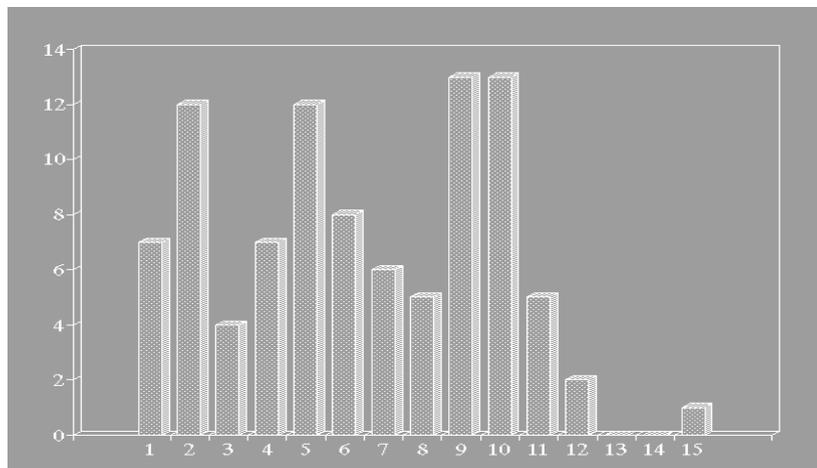
Note: The vertical scale is the frequency. The horizontal axis is the
exchange market pressure divided into 15 intervals.

3.2. Market Fundamentals

Among a sizable set of market fundamentals that can explain the economic crisis the twenty variables were selected in view of data availability and crisis predictability. [9]

The real sector variables are: 1) terms of trade, 2) industrial inventory/shipment, 3) Korean stock price index (KOSPI), 4) current account/GDP, 5) real effective exchange rate, 6) trade balance/trade amount, 7) export concentration (exports of five major items/total exports), 8) export amount, 9) capital account/GDP.

The financial sector variables are: 10) foreign reserves, 11) foreign liabilities/foreign assets at commercial banks, 12) loans in foreign currency, 13) net foreign liabilities/total deposits at commercial banks, 14) domestic credit/GDP, 15) M2 multiplier, 16) excess M1 supply,[10] 17) M2/foreign reserve, 18) foreign liablities/total liabilities at monetary institutions, 19) Standard & Poor's sovereign credit ratings,[11] 20) devaluation pressure from Asian neighbors (weighted average of the real effective exchange rates of Thailand, Indonesia, the Philippines, Malaysia, Taiwan, and Hong Kong).[12]

4. EMPIRICAL ANALYSIS OF THE KOREAN CRISIS

4.1. Determinants of the Crisis

We now investigate the link between exchange market pressure and market fundamentals. Since the financial sector is largely blamed for the crisis, the financial variables are under close scrutiny.

We can find the determinants for a crisis by regressing the exchange market pressure on the market fundamentals and selecting those variables that have

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9) They have low noise-to-signal ratio in predicting the Korean crisis when the leading indicator approach was applied (Park and Choi, 1998).

10) The money demand is assumed to be a function of GDP, CPI inflation and time trend.

11) Standard & Poor's classifies national ratings into 22 categories. Korea's rating worsened dramatically after October 1997 and was subsequently classified as unfit for investment.

12) The data base of the Bank of Korea is the source of most data. The real effective exchange rate data of the Morgan Stanley are used. The ratio of the short-term external debt/total external debt was not included because the data were not available on a monthly basis only after 1998.

Table 1 Determinants of the Korean Crisis

	current (1)	6-month moving average (2)	current (3)	6-month moving average (4)
Constant	-1.150(-9.55)	-0.765(-4.61)	-1.391(-11.55)	-1.187(-7.26)
REER	0.032(1.87)	-0.075(-3.44)	0.057(3.35)	-0.054(-2.20)
Domestic Credit/GDP	0.123(5.54)	0.131(4.37)	0.144(6.35)	0.189(5.95)
M2/reserves	0.113(17.45)	0.119(13.66)	0.118(17.60)	0.126(12.89)
S&P ratings	0.716(3.36)	1.271(5.15)		
Adjusted R^2	0.89	0.83	0.88	0.78

Note: 1) All explanatory variables are expressed as percentage change from a year earlier. The estimation period is from January 1990 until December 1997. t-values are inside the parentheses.

2) Moving average covers the present and five previous months.

the right signs and are significant. If we assume that crisis follows the traditional pattern, the exchange market pressure as the representative of the crisis severity can be expressed as a function of market fundmentals. As explained earlier, even when the crisis arises due to self-fulfilling expectations, it retains its relationship with market fundamentals until the economy enters the crisis zone. Afterwards the relationship can change.

Table 1 shows the standard regression results.[13] Among the twenty fundamentals, real effective exchange rate of the Korean won, domestic credit/GDP, M2/reserves and Standard & Poor's credit ratings turned out to be statistically significant.[14] The expansion in domestic credit, reduction in foreign reserves or worsening in the credit ratings increase the exchange market pressure. However, depreciation of the real exchange rate is shown to increase the market pressure at the current period, contrary to the expectations. Since this can be attributable to the lag structure between market fundamentals and the market pressure, 3-, 6-, and 12-month moving average of each explanatory variable are tried. With 6-month moving average each

13) The heteroscedasticity and serial correlation are not corrected in the standard regression. But the logit analysis will be done later.

14) Korea's credit rating by the Standard and Poor's improved from A+(class 5) to AA-(class 4) in May 1995, but deteriorated to A+ in October 1997. A rise in the rating variable represents a rise in the class number, namely a worsening in credit ratings.

variable had the expected sign and became significant.

It is noteworthy that the three variables of the real exchange rate, domestic credit/GDP and M2/reserve are chosen among the twenty market fundamentals as the most influential for the Korean crisis. This coincides with the study of Sachs, Tornell, and Velasco (1996b) based on a sample of the twenty emerging market economies that had crises. They found that the three variables play the key role in the process leading to the financial crisis and that the financial crises in emerging markets are self-fulfilling. The next section tests whether the Korean crisis is self-fulfilling, following their test method.

4.2. Tests of Self-fulfilling Crisis

Since the crucial difference between the first and the second generation model is the existence of the multiple equilibria. we must set up a multiple equilibrium model and empirically investigate whether the conditions for multiple equilibria hold. Masson (1998) builds the simplified external debt model of multiple equilibrium exchange rates to assure the satisfaction of the multiple equilibrium condition in the Asian crisis. This test has merits in that it is based on the specific multiple equilibrium model. But it is also limited in that the test is confined to the specific multiple equilibrium model among the many.

Sachs, Tornell, and Velasco (1996b) and Eichengreen, Rose, and Wyplosz (1996) performed the less decent but convenient dummy test for the self-fulfilling crisis, recognizing that the relationship between the exchange market pressure and the market fundamentals can change in the crisis zone.

The dummy variable is defined according as the crisis zone is defined. It is natural to assume that the economy enters the crisis zone when the exchange market pressure exceeds a certain threshold, $ì + kó$ (where k is a multiplicative constant, $ì$ the sample mean of EMP, and $ó$ the standard deviation of EMP). Figure 3 illustrates two crisis zones. When k=1.5, the crisis zone covers only four months of March, April, May, and November in 1997. When k=1.1, it covers February to November except for July and August in 1997 and three months of October, November, and December in 1990.

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Figure 3 Exchange Market Pressures
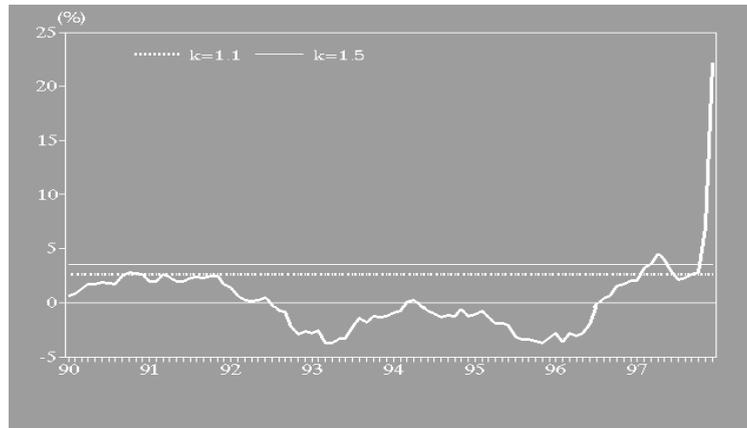
Table 2 Tests of Self-fulfilling Properties of the Korean Crisis

	EMP dummy 1	EMP dummy 2	EMP dummy 3	M2/ Reserves Dummy	M2/ Reserves Dummy	Real Effective Exchange Rate Dummy	Domestic Credit/ GDP Dummy
Constant	-0.78	-0.74	-0.76	-0.51	-1.30	-1.05	-0.78
	(-3.98)	(-4.08)	(-4.24)	(-2.79)	(-5.61)	(-6.61)	(-5.39)
Real Effective	-0.07	-0.08	-0.07	-0.15	-0.14		0.01
Exchange Rate	(-2.83)	(-3.59)	(-2.92)	(-6.99)	(-4.65)		(0.31)
Domestic Credit /GDP	0.11	0.11	0.11	0.13	0.25	0.06	
	(2.43)	(2.93)	(3.24)	(3.65)	(5.11)	(2.03)	
M2/Reserves	0.12	0.11	0.12	0.17		0.13	0.12
	(13.60)	(13.07)	(13.63)	(9.31)		(14.52)	(13.00)
S&P Ratings	1.15	1.31	1.14	1.15	2.00	1.39	1.06
	(3.11)	(3.67)	(3.32)	(3.71)	(4.81)	(5.05)	(3.26)
Dummy	0.92	3.41	8.15	0.42	2.65	-0.08	1.53
	(0.08)	(1.17)	(0.50)	(0.33)	(4.66)	(-0.14)	(5.22)
REER × Dummy	-1.33	-0.30	0.05	0.24	0.18		-0.18
	(-1.51)	(-0.97)	(0.09)	(4.16)	(2.94)		(-4.28)
Domestic Credit/ GDP× Dummy	-0.28	-0.38	-1.28	0.02	-0.13	0.25	
	(-0.19)	(-1.29)	(-0.47)	(0.27)	(-1.87)	(2.80)	
M2/Reserves ×Dummy	0.30	0.15	0.50	-0.12		-0.06	0.04
	(0.85)	(0.73)	(0.47)	(-2.77)		(-2.55)	(1.80)
S&P Ratings ×Dummy	1.08	0.10	0.00	0.13	-0.77	-0.32	0.26
	(1.19)	(0.19)	(0.00)	(0.31)	(-1.39)	(-0.44)	(0.60)
Adjusted R^2	0.84	0.84	0.83	0.89	0.81	0.85	0.86

Note: 1) EMP dummy 1 for Jan. to Dec. of 1997, EMP dummy 2 for EMP $\geq i +1.1\acute{o}$, EMP dummy 3 for EMP $\geq i +1.5\acute{o}$.

2) M2/reserves dummy for the upper 30%, real effective exchange rate for the lower 25%, domestic credit/GDP dummy for the upper 20%.

Table 2 reports the results of the dummy test. The EMP dummy 1 to 3 are defined according to the exchange market pressure. The EMP dummy 1 covers the year of 1997. The EMP dummy 2 corresponds to the case of k=1.1 (EMP $\ge \mu +1.1\sigma$) in Figure 3 and the EMP dummy 3 to k=1.5 (EMP $\ge \mu +1.5\sigma$), respectively. The dummy is combined with each explanatory variable including the constant term to capture changes in the investor behavior in the crisis zone. All EMP dummy variables combined with each explanatory variable turned out insignificant, implying that the relationship between the market fundamentals and the exchange market pressure did not change even after the Korean economy entered the crisis zone. The regression results in Table 2 do not support the claim that the Korean crisis are self-fulfilling.

It is also possible to define the crisis zone by the critical range of explanatory variables rather than that of the dependent variable. In Table 2 the critical range of the M2/reserves, real effective exchange rate, and domestic credit/GDP was set to the upper 30%, the lower 25%, and the upper 20%, respectively, in consideration of R^2. These dummies combined with each explanatory variable are also insignificant and, if significant, the signs are contrary to expectations. Even if we delete the significant but wrong-signed dummy-combined variables, the remaining dummy-combined variables are still insignificant

In sum, we could not find concrete evidence for self-fulfilling properties for the Korean crisis. The results in Table 2 certainly contrast with those of Sachs, Tornell, and Velasco (1996b) who found the self-fulfilling properties in the financial crises of the emerging market economies. But other studies such as Masson (1998) point out the lack of evidence for self-fulfilling characteristics in the Korean case, although the Asian crises are contageous. Since Korea occupies only a small portion in cross-country panel data, we must be very cautious not to extend the cross-country study results straightforward to the Korean crisis.

4.3. Test of Other Determinants

The previous section underscored the importance of real exchange rate, domestic credit/GDP and M2/reserves as the determinants of the Korean crisis. However, the alternative hypotheses on the crisis can be adressed to attest other fundamental variables. We examine here whether the often-mentioned causes for the crisis such as fiscal deficit, monetary expansion, capital inflows, and current account deficit can explain the Korean crisis additionally.

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Table 3 Tests of Other Determinants

	Fiscal balance/ GDP	M2 growth rate	Excess Money Supply (M1)	Capital Balance/ GDP	Current Balance/ GDP	Devaluation of neighbors
Coefficient (t-value)	0.047 (0.316)	0.108 (1.607)	-0.059 (-3.572)	-0.001 (-0.596)	-0.358 (-6.694)	0.009 (0.156)
Adjusted R^2	0.83	0.83	0.85	0.83	0.89	0.83

Note: All variables are 6-month moving average of the percentage change from the year earlier.

4.3.1. Fiscal deficit and monetary expansion

Macroeconomic instability as a result of expansionary monetary and fiscal policy has been emphasized as the root cause of currency crisis. The domestic boom under the expansionary policy worsens the current account and fuels inflationary pressure, resulting in the increased probability of devaluation. But the loose macroeconomic policy cannot explain the Korean crisis because Korea maintained the sound macroeconomic stance. When the fiscal balance/GDP and M2 growth rate are added to the equation (2) in Table 1, they turn out insignificant as shown in Table 3. The excess M1 supply defined as in Section 3 is significant but has the wrong sign.

4.3.2. Current and capital account

The currency crisis is closely related to the balance of payments crisis. The excessive capital inflows or massive current account deficit could create crisis through various channels. Soon after Korea joined OECD, capital inflows increased rapidly and current account deficit widened. Many claim that Korea's capital account liberalization associated with its joining the OECD stimulated capital inflows that would be reversed to lead to the crisis.

The evidence is that the capital account cannot explain the Korean crisis in addition to the three key determinants. Despite the fact that the crisis was associated with the reversal of capital inflows, the capital account did not have additional explanatory power.

In contrast, current account/GDP seems to explain the crisis, but we should note that the inclusion of current account/GDP variable make the real exchange rate insignificant.

4.3.3. Devaluation of neighbors

As the Asian crises erupted in a chain, beginning with the Thailand and

ending in Korea, the Korean crisis could be understood as the result of the contagion from the Thai Baht crisis. The devaluation in one country forces the devaluation of the neighboring country when two countries compete in the third market. Hence the crisis in one country can spread out to the region.

To check for the domino effect of the devaluation of the neighboring Asian countries on the Korean economy, we added the pertinent variable, i.e., fundamental variable of number (20) in section 3. Table 3 shows that it is insignificant. The devaluation of currencies of other Asian countries with the speculative attack do not directly aggravate the foreign exchange market in Korea.

4.4. Sensitivity Analysis

The crisis index has been defined in equation (1) using the unconditional variance as weights. However, the crisis index can change very sensitively with the usage of alternative weights. We check the robustness of the previous results using conditional variance in place of unconditional variance.

It is assumed that the won depreciation ($\ddot{A}e$), percentage point changes of interest rate ($\ddot{A}i$), and percentage changes in foreign reserves ($\ddot{A}R$) from the year earlier follow the AR-ARCH process. The order of AR and ARCH process was estimated to be one, respectively. Then the conditional variance of each AR(1)-ARCH(1) process is calculated. Figure 4 shows the alternative exchange market pressure as the wighted sum of the conditional variance. The

Table 4 Regression with the Alternative Exchange Market Pressure

	Current	6-month moving average	Current	6-month moving average
Constant	-2.89(-5.98)	-1.64(-2.87)	-3.61(-8.49)	-2.94(-5.36)
REER	0.09(1.38)	-0.25(-3.38)	0.16(2.66)	-0.19(-2.27)
Domestic Credit/GDP	0.32(4.04)	0.34(3.25)	0.38(4.80)	0.51(4.82)
M2/Foreign Reserve	0.37(15.86)	0.39(13.05)	0.38(16.23)	0.41(12.55)
S&P Ratings	2.16(2.82)	3.93(4.64)		
Adjusted R^2	0.86	0.80	0.85	0.76

Note: 1) Explanatory variables are percentage change from the previous year.
   2) Sample period: January 1990-December 1997.
   3) Inside the parentheses are t-values.

Figure 4 Alternative Exchange Market Pressures
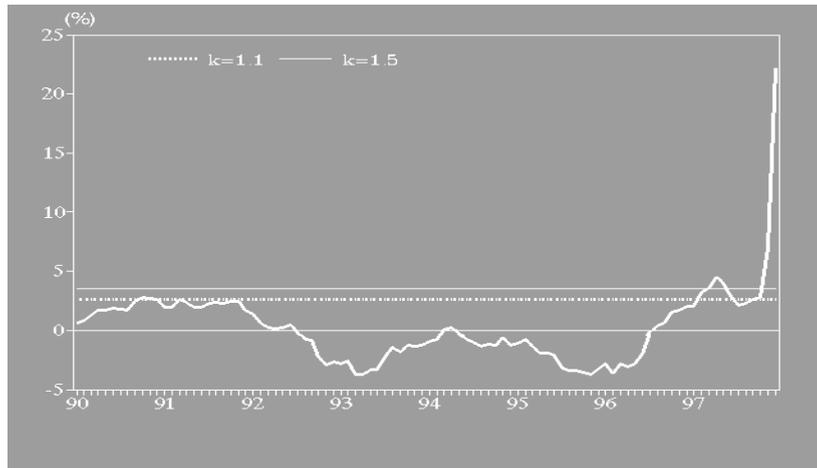
Note: Exchange market pressure 1 uses the unconditional variance, while
exchange market pressure 2 uses conditional variance.

new index varies widely. For example, the exchange market pressure in
December 1997 is measured over 70% using the conditional variance
compared to 20% using the unconditional variance.

Despite the volatility of the newly constructed market pressure, the
variables such as real exchange rate, domestic credit/GDP, M2/foreign
reserves and S&P credit rating continue to be an important set, as shown in
Table 4.

5. LOGIT ANALYSIS

So far we have relied on the exchange market pressure to investigate the
properties of the Korean crisis. However, such quantitative crisis index has its
own drawbacks that the false measurement of the severity of the crisis distorts
the nature of the crisis. Furthermore, the frequency distribution of the
exchange market pressure in Figure 2 is inappropriate for the standard
regression. Therefore we follow the qualitative approach using a dummy
variable instead of quantifying the degree of the crisis.

The exchange market pressure y_t^* is a function of the fundamental

variables x_t. It is equal to 1 if it exceeds the threshold value $\boldsymbol{q}$ and 0, otherwise. It is also assumed that the probability of crisis $\Pr(y_t = 1)$ is the logistic function of $\boldsymbol{a} + \boldsymbol{b}x_t - \boldsymbol{q}$.

$$y_t^* = \boldsymbol{a} + \boldsymbol{b}x_t + u_t \tag{2}$$
$$y_t = 1, \ if \ \ y_t^* \geq \boldsymbol{q}.$$
$$y_t = 0, \ \ otherwise$$

$$Also, \ \Pr(y_t = 0) = \frac{1}{1 + \exp(\boldsymbol{a} + \boldsymbol{b}x_t - \boldsymbol{q})}$$

$$\Pr(y_t = 1) = \frac{\exp(\boldsymbol{a} + \boldsymbol{b}x_t - \boldsymbol{q})}{1 + \exp(\boldsymbol{a} + \boldsymbol{b}x_t - \boldsymbol{q})}$$

This approach is called the logit analysis. The previous analysis implicitly assumes that the higher the exchange market pressure, the more probable the crisis. In the logit analysis the probability of the crisis is assumed to increase with the exchange market pressure in a logistic function. The coefficients are estimated using the maximum likelihood estimation method. [15]

The threshold $\boldsymbol{q}$ can be determined with reference to Figure 3 in which two crisis zones are shown. Table 5 shows the estimation results when the threshold is set at k=1.1 ($\boldsymbol{q}$ =2.57%). The three key variables of real exchange rate, domestic credit/GDP, and M2/reserves are significant with logit specification, but the real exchange rate has the wrong sign even with six-month moving average specification. Instead of the real exchange rate variable, the Korean stock price index (KOSPI) turned out to be significant and have the right sign. The KOSPI replaces the real exchange rate in the logit model prabably because it is closely related with the yen/dollar exchange rate and current account balance.

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15) The logit model is typically used for panel studies but it is used for the time series analysis in the paper. In this case serial correlation can be a problem. However, one can obtain the consistent estimator following Robinson (1982) or Grether and Maddala (1982).

Table 5 Estimation Results of the Logit Model (k = 1.1)

	Contant	Domestic Credit/ GDP	REER	KOSPI	M2/Foreign Reserve	McFadden R^2
6-month moving average	-10.31 (-3.15)	0.59 (3.33)	0.33 (2.07)		0.18 (2.25)	0.55
	-13.59 (2.48)	0.43 (2.69)		-0.32 (-2.09)	0.18 (1.32)	0.64
Contemp oraneous	-31.68 (2.03)	1.78 (2.06)	1.12 (1.86)		0.58 (1.84)	0.84
	-15.50 (2.48)	0.67 (2.55)		-0.23 (-2.14)	0.26 (1.82)	0.68

Table 6 Test of the Self-fulfilling Properties of the Korean Crisis (logit model)

	M2/ Foreign Reserve Dummy	M2/ Foreign Reserve Dummy	KOSPI Dummy	Domestic Credit/ GDP Dummy
Constant	-17.081 (-2.325)	-14.770 (-2.889)	-8.569 (-3.549)	-13.371 (-2.048)
KOSPI	0.188 (0.488)	0.125 (0.426)		-0.342 (-2.026)
Domestic Credit/GDP	1.272 (1.278)	1.633 (1.952)	0.759 (2.722)	
M2/Foreign Reserve	0.665 (1.153)		0.0612 (0.713)	0.216 (1.017)
Kospi × Dummy	-0.624 (-1.373)	-0.651 (-1.634)		-0.144 (-0.665)
Domestic Credit / GDP × Dummy	-0.868 (0.363)	-1.193 (-1.593)	-0.464 (-1.756)	
M2 / Foreign Reserve × Dummy	-0.432 (-0.856)		0.264 (2.111)	0.094 (0.446)
McFadden R^2	0.72	0.68	0.59	0.66

Note: Domestic credit/GDP for the upper 20%, the KOSPI dummy for the lower 25%, and M2/foreign reserves dummy for the upper 30%.

Table 7 Test of the Significance of Other Fundamentals (logit model)

	Fiscal balance/ GDP	M2 growth rate	Excess money supply(M1)	Capital account/ GDP	Current account/ GDP	Devaluation of neighbors
coefficient (*t*-value)	1.615 (1.331)	0.6752 (0.902)	-0.2839 (-0.952)	0.0039 (0.609)	0.7271 (1.644)	0.3402 (1.599)
McFadden R^2	0.67	0.65	0.65	0.64	0.69	0.69

Note: All variables are 6-month moving averages.

We also tested on the self-fulfilling properties of the Korean crisis in the logit specification. The EMP dummy cannot be used in the logit model specified in equation (2) because the dependent variable is also the EMP dummy variable. Thus only the explanatory variable dummies are used in Table 6. The estimation results do not support the self-fulfilling story of the Korean crisis, since the explanatory variables combined with dummy are insignificant or have wrong sign.

Finally, we performed the significance test on the other fundamental variables such as fiscal balance/GDP, M2 growth rate, excess M1 supply, capital account/GDP, current account/GDP, and devaluation of neighbors with specification of the logit model. Again these variables turned out to be insignificant under the qualitative crisis index and the crisis probability of the logistic function.

6. CONCLUSION

This paper carried out empirical research on the causes of the Korean crisis and found that the Korean crisis was not self-fulfilling. The excessive lending and insufficient foreign reserves coupled with real appreciation mostly explains the crisis. The dummy test on the self-fulfilling properties of the crisis did not support the hypothesis that the Korean crisis was largely caused by the self-fulfilling expectations. The sharp depreciation of the Baht and other Asian currencies during the second half of 1997 did not exert the contagious effect on the Korean crisis.

The evidence is that excessive lending at financial institutions and mismanagement of foreign reserves as well as real appreciation or the

sluggish stock market heighten economic vulnerability. These fundamental weaknesses remain the primary cause of the Korean crisis.

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