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Abstract

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those of the IMF or IMF policy. Working Papers describe research in progress by the author(s) and are
published to elicit comments and to further debate.

The objective of this paper is to provide a retrospective assessment of our ability to have
predicted the impact of the 1997 crisis on the Korean corporate sector. We perform some
simple stress tests on the aggregate balance sheets and income statements of the corporate
sector to determine what could have been foreseen before the onset of the crisis. Our results
show that data available in mid-1997 clearly showed that the corporate sector was very
sensitive to various shocks, particularly interest rate shocks. Had stress tests been performed
at the time, they would have revealed that the corporate sector was highly vulnerable to
adverse economic developments. Our findings suggest that close surveillance of corporate
sector balance sheets can play a useful role in understanding potential financial
vulnerabilities.

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I. INTRODUCTION

A rich literature has developed to explain the factors and underlying conditions that swept Korea into the Asian financial crisis.[2] Most studies of the Korean economy have identified the core of the problem as an overleveraged corporate sector and a poorly supervised financial sector with little commercial orientation. Pomerleano (1998a, 1998b) shows that the countries that experienced the most disruption to their corporate sectors during the Asian crisis had pre-existing weaknesses in their balance sheet structures. Nam and Jinn (2000) show that most of the Korean firms that went bankrupt in 1997–98 had shown signs of financial distress long before the crisis. Claessens, Djankov, and Lang (1998) and Claessens, Djankov, and Ferri (1999) provide evidence for the vulnerabilities in corporate financial structures since the early 1990s.

The various postmortems of the Asian crisis have highlighted the failure of many analysts (including the IMF) to understand the magnitude of corporate and financial sector weaknesses, which became evident once the crisis erupted. The report of the Independent Evaluation Office of the IMF (2003, p. 11) notes that "potential vulnerabilities were in varying degrees identified in IMF surveillance but their seriousness or their implications were not adequately appreciated." The report went further to recommend that IMF surveillance "should be oriented toward looking for points of vulnerability, and developing and analyzing stress test scenarios, rather than toward simply trying to predict the future."

The question that arises then is whether information available at the time of the crisis, if analyzed more closely, could have aided our understanding of how the corporate sector would be impacted by the severe macroeconomic turbulence that occurred. Would stress tests really have been that revealing? This paper aims to answer this question for Korea by performing some simple stress tests on corporate sector data that were available before the crisis broke out. More specifically, we consider the question of whether stress tests of the corporate sector performed on data available at the time of the crisis provide useful information on vulnerabilities and an accurate forecast of what actually happened to corporate balance sheets. The methodological approach we use to stress test the corporate sector is similar to Heytens and Karacadag (2001) and Goldman Sachs (1998, 2000) who use the interest coverage ratio of the corporate sector to make inferences about their ability to meet their financial commitments.

The paper is organized as follows. Section II begins with a brief description of the corporate sector in Korea before the crisis. Section III outlines the simple stress testing techniques that are applied to publicly available corporate sector data in Korea and compares the exante predictions of the stress tests with actual outcomes. Section IV draws some conclusions about

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[2] Lane and others (1999) and Chopra and others (2002), among others, review the origins of the twin currency and financial sector crisis in Korea and discusses the strategy followed in responding to the crisis. Lindgren and others (1999) review the experience of Indonesia, Korea, and Thailand, and contrast it with that of Malaysia and the Philippines.

the usefulness of this methodological approach in assessing corporate and financial sector vulnerabilities and for surveillance more generally.

II. THE KOREAN CORPORATE SECTOR BEFORE THE CRISIS[3]

Prior to the crisis in 1997–98, the Korean corporate sector was characterized by significant conglomeration and concentrated ownership, with complex cross-ownership linkages between affiliated companies. Conglomeration dated back to government policies in the 1960s that promoted heavy and chemical industries as a development model, with industrial conglomerates (chaebol) actively supported via directed policy lending at low interest rates. This model created a culture of risk sharing between the government and the private sector that discouraged the financial sector from improving its risk assessment and monitoring capabilities. This culture was also nourished by a history of government bailouts that created further incentives for risk taking. With the exception of two cases in 1985 and 1996, no large corporates or nationwide banks were allowed to fail until 1997.

Poor corporate governance, coupled with concentrated corporate ownership and conglomeration, provided incentives for financial excesses by owners without due attention to profitability and shareholder value.[4] Conglomerates made extensive use of cross-company guarantees, which acted as soft budget constraints in the weaker affiliates and obscured the true financial condition of the affiliated companies and the group. These complex linkages allowed a nontransparent governance culture to flourish, and allowed the owners to exercise control while risking little of their own capital in the process. Inadequate accounting and disclosure rules, in turn, helped mask the magnitude and nature of risks that were being taken.

The key financial weaknesses that resulted from this structure were the high and increasing level of leveraging and declining profitability. Claessens, Djankov, and Lang (1998) report that Korea had the highest debt-to-equity ratios and the lowest real return on assets in a cross-country study that included nine Asian countries, Germany, and the United States for 1988–96 (Tables 1 and 2). The buildup of leverage was attributable to the financing of rapid investment and the associated acquisitions of fixed assets, especially in 1995–96, which failed to generate sufficient profits and led to an increasing servicing cost on accumulated debt. The combination of poor profitability and high leverage made the corporate sector extremely vulnerable to any adverse developments. This vulnerability peaked in 1996–97.

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[3] Various postmortems of the Korean crisis amply demonstrate the corporate sector weaknesses that became evident when the crisis unfolded. Here we will suffice with a brief summary.

[4] See Gobat (1998) and Nam and others (1999) for a discussion of corporate governance practices in Korea and the ownership structure of the corporate sector.

Table 1. Return on Assets for Nine Asian Countries, Germany, and the United States
(In percent, medians, real local currency)

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1988-96
Hong Kong	5.1	5.3	4.9	4.8	4.5	3.8	3.9	3.9	4.1	4.6
Indonesia	n.a.	n.a.	9.4	9.1	8.6	7.9	7.4	6.2	6.5	7.1
Japan	5.7	5.4	4.6	4.7	4.8	4.5	4.1	3.8	3.6	4.1
Korea	**4.4**	**3.9**	**4.1**	**4.0**	**3.9**	**3.6**	**3.4**	**3.6**	**3.1**	**3.7**
Malaysia	5.4	5.6	5.4	6.2	6.0	6.5	6.3	6.1	5.6	6.3
Philippines	n.a.	n.a.	n.a.	7.1	6.4	8.1	8.5	6.8	8.4	7.9
Singapore	4.9	4.5	4.2	3.9	5.2	4.6	4.5	3.9	4.0	4.4
Taiwan	n.a.	n.a.	n.a.	5.1	6.2	6.5	6.8	6.5	6.6	6.7
Thailand	10.8	11.0	11.7	11.2	10.2	9.8	9.3	7.8	7.4	9.8
United States	4.7	4.8	5.1	4.9	5.2	5.4	5.3	5.2	5.2	5.3
Germany	5.3	5.5	5.5	5.7	5.6	5.2	5.1	4.9	5.0	4.7

Source: Claessens, Djankov, and Lang (1998).

Table 2. Leverage for Nine Asian Countries, Germany, and the United States
(In percent, means)

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1988-96
Hong Kong	1.8	2.3	1.8	2.0	1.8	1.8	2.3	2.0	1.6	1.9
Indonesia	n.a.	n.a.	n.a.	1.9	2.1	2.1	1.7	2.1	1.9	2.0
Japan	3.0	2.8	2.9	2.0	2.0	2.1	2.2	2.4	2.4	2.3
Korea	**2.8**	**2.6**	**3.1**	**3.2**	**3.4**	**3.6**	**3.5**	**3.8**	**3.5**	**3.5**
Malaysia	0.7	0.8	1.0	0.6	0.6	0.7	1.0	1.1	1.2	0.9
Philippines	n.a.	n.a.	n.a.	0.8	1.2	1.2	1.1	1.2	1.3	1.1
Singapore	0.8	0.9	0.9	0.9	0.9	1.1	0.9	1.0	1.0	0.9
Taiwan	n.a.	n.a.	n.a.	0.7	0.9	0.9	0.9	0.8	0.8	0.8
Thailand	1.6	1.9	2.2	2.0	1.8	1.9	2.1	2.2	2.4	2.0
United States	0.8	0.8	0.9	1.0	1.1	1.1	1.1	1.1	1.1	1.0
Germany	1.5	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.5

Source: Claessens, Djankov, and Lang (1998).

III. STRESS TESTING THE CORPORATE SECTOR

The previous section described the vulnerability of the corporate sector as a result of its high leverage and low profitability. While this seems obvious in hindsight, what is not so obvious is whether the data available at the time could have provided useful information to quantify this vulnerability. In this section we attempt to answer this question by using simple stress tests on aggregated corporate sector data that were available prior to the outbreak of the crisis. Our objective is to verify the hypothesis that surveillance of the corporate sector would

have been worthwhile, because the information available at the time had enough predictive power to warrant its consideration.

A. Development of Scenarios

The first thing that must be established is what was known at the time of the crisis, and what were reasonable expectations about the likely size of potential shocks. In other words, if we were to perform stress tests prior to the crisis, what data would have been available, and what would have been reasonable assumptions to make concerning the size of shocks to use? The second question that must be answered is what is our yardstick: to what actual outcomes should we compare our hypothetical results?

**When did we have balance sheets information?**

In the summer of 1997, when the crisis spread to Korea (Figure 1), the only comprehensive balance sheet data available on the Korean corporate sector were data for end–1996 (which became available in August 1997). Thus, in the absence of other data, we can use data on 1996 balance sheets as a proxy for the state of the corporate sector at the end of 1997. This assumption would tend to underestimate the extent of fragility in the Korean corporate sector, because cash flows and exposures of many industries deteriorated further during the course of the year.

What did we know about shocks?

The next question to consider is the size of shocks to be applied to the available data (1996 balance sheets). One approach that is often used in stress testing is to use previous historical episodes to calibrate the size of shocks.[5] Applying this approach to the Korean corporate sector has some limitations, because of structural changes that occurred in this period in the Korean corporate sector and in monetary and financial policies, including capital account liberalization. However, it is a reasonable starting point to consider recent history in determining the size of shocks to apply in a stress test, despite the limitations mentioned above.

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[5] See Blaschke and others (2001) for a discussion of the benefits and costs of using historical versus hypothetical scenarios.

Figure 1. Timeline of Korean Crisis, 1996–1998
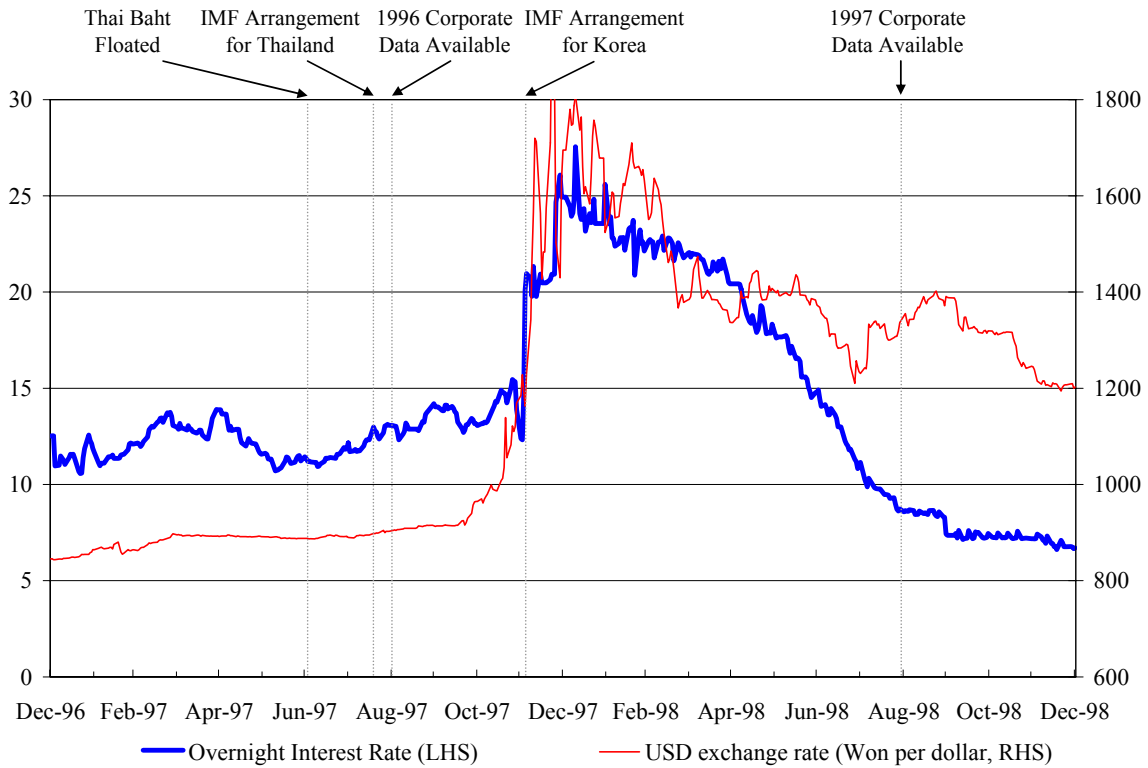
Sources: Bank of Korea; Lindgren and others (1999); and IMF (2003).

Table 3 shows the changes in annual averages for market interest rates, the exchange rate, and corporate operating income for the period 1990–98. Annual averages are used because the corporate sector data is based on annual balance sheets. Even though balance sheets show the position at the end of the calendar year, using changes in end-of-year interest rates or exchange rates is not strictly appropriate, because debt contracts (and their associated interest rates and exchange rates) are negotiated throughout the year and so will have varying interest rates and exchange rates.[6]

Once the magnitude of observed changes is established, the next step is to consider which numbers to use. A stress test can be based on either the largest observed change, or on a particular historical episode. For example, a stress test could be conducted using the largest observed changes for each variable, even if the maximum change of the individual variables did not all occur in the same year. We can see from Table 3 that the maximum observed changes during the 1990–96 period did not all occur in the same year; the largest change in

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[6] Ideally, a measure of the interest rate facing corporate sector borrowers such as the lending rate charged by banks would provide a more realistic measure of the actual change in interest costs faced by corporations (instead of using the overnight call rate and yield on corporate bonds) but detailed data on lending rates was unavailable for the entire period.

interest rates occurred in 1991, in exchange rates in 1992, and in operating income in 1993. Using this approach can be considered a "worst-case" scenario, because the largest observed changes did not occur simultaneously. A shortcoming of this approach is that the observed changes may not be internally consistent, because the inherent dynamics of the economy and financial system may cause offsetting changes in different economic variables.

Table 3. Historical Context for Shocks, 1990–1998

	1990	1991	1992	1993	1994	1995	1996	1997	1998
End-December changes, in percentage points [1]									
Call rate [2]	0.8	2.6	-2.4	-2.3	0.3	0.1	0.0	0.8	1.8
Bond yield [3]	1.3	2.4	-2.7	-3.6	0.3	0.9	-1.9	1.5	1.7
Exchange rate [4]	5.4	3.6	6.5	2.8	0.2	-4.0	4.3	18.1	47.7
Operating income [5]	---	-13.1	-3.5	-21.5	0.5	-3.5	-8.7	32.7	-19.8
Maximum observed changes, in percentage points [6]									
Call rate [2]	3.9	2.6	2.6	-2.3	0.3	1.3	0.0	2.1	5.0
Bond yield [3]	1.3	2.9	2.1	-3.1	0.3	1.7	0.4	1.5	4.8
Exchange rate [4]	5.4	6.1	6.7	6.3	2.7	-0.2	4.3	18.1	59.5

Source: Bank of Korea *Economic Statistics System*. Available via the internet: http://ecos.bok.or.kr/EIndex_en.jsp.

1/ For call rate and bond yield: average of monthly figures for 12 months to December, less corresponding figure for previous year. For exchange rates, percentage change in average of monthly figures for 12 months to December over corresponding figure for previous year. For any monthly average series X, the change in the annual average is: $Average(X_t, X_{t-1}, \ldots X_{t-11}) - Average(X_{t-12}, X_{t-13}, \ldots X_{t-23})$. For exchange rates, the percentage change in averages is used instead:
$$100 * \left[\left(Average(X_t, X_{t-1}, \ldots X_{t-11}) \big/ Average(X_{t-12}, X_{t-13}, \ldots X_{t-23}) \right) - 1 \right].$$
2/ Overnight call rate.
3/ Yield on corporate bonds (AA-, 3 Year).
4/ Average Won/Dollar rate.
5/ Percentage change in total operating income for all industries in Bank of Korea's *Financial Statement Analysis* database. Series break in 1995.
6/ Largest value observed during the year ending December for average of monthly figures for previous 12 months, less corresponding figure for previous year. For example, if the March 1992 figure (average of monthly figures for April 1991 through March 1992, less average of monthly figures for April 1990 through March 1991) was the largest change for 1992, then that figure would be selected instead of the number for any other month during 1992. For call rate and bond yield: average of monthly figures for previous 12 months, less corresponding figure for previous year. For exchange rates, percentage change in average of monthly figures for previous 12 months over corresponding figure for previous year.

Another approach to calibrating the size of shocks is to use the actual changes observed during one particular year. Looking at Table 3, we can see that 1991 was a particularly turbulent year, with quite large changes observed in interest rates and in operating income. Using a specific historical episode as a benchmark has much appeal, because it reflects

changes in the economy that actually occurred, and takes into account the interaction of the variables. We use both approaches and compare the results.

The final step in developing scenarios is to determine a yardstick against which our results can be compared. As the crisis in Korea occurred late in the year (with most of the rise in interest rates and the exchange rate occurring in December 1997), we would expect that much of the impact would not register in the balance sheets of the corporate sector until well into 1998. Since we are using annual data, we will express our results in terms of a one-year impact. Thus, the best measure of the actual impact of the crisis in Korea on corporate sector balances sheets can be derived by comparing end–1998 balance sheets with end–1997.

B. Description of the Data Set

The database underlying the corporate sector analysis was extracted from the Bank of Korea's *Financial Statement Analysis*,[7] a regular survey of corporate sector balance sheets and income statements. The database consists of annual financial statement information for 1995–2003 for a sample of Korean industries (12 separate industries at the one digit SIC level, plus additional data for 21 manufacturing industries at the two digit SIC level). The database covers approximately 37,000 companies (2000–02), including all publicly traded companies, those companies with more than W 2 billion in sales, the top five companies in each industry by sales, and a stratified random sample of smaller companies. The data for any given year are typically published by the Bank of Korea in August of the following year. For instance, the data for end–1996 balance sheets were available in August 1997.

The main shortcoming of using the Bank of Korea database is the fact that it is based on industry averages, and thus the potential impact of weak firms is averaged out in the aggregation process. However, the database does allow a great deal of disaggregation, and the bias introduced by using industry averages will tend to lower the proportion of distressed debt.

C. How Did We Do It? Crunching the Numbers

The sensitivity of the corporate sector to various macroeconomic risks (interest rate, foreign currency, and income risks) was calculated by estimating the direct impact of different shocks on key balance sheet items and ratios. We used 1996 data as the base, under the assumption that they are the best proxy for end–1997 balance sheets. Then, using the largest shocks observed over the past six years, we compared the shocked balance sheets with the actual outcomes observed at the end of 1998, as discussed above.

Each shock is assumed to have an immediate impact through the income statement, affecting interest expenses and earnings before interest, taxes, depreciation, and amortization

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[7] Details of the *Financial Statement Analysis* are available on the Web site of the Bank of Korea at http://www.bok.or.kr/template/eng/default/public/index.jsp?tbl=tbl_FM0000000066_CA0000001012.

(EBITDA). Figure 2 shows how the various shocks are incorporated into the calculations of EBITDA, while Figure 3 shows a stylized version of the balance sheet and income statement items used in the stress tests. The pre-shock EBITDA is derived as the sum of ordinary income plus interest expenses plus depreciation and amortization. Ordinary income can be further broken down into operating income plus nonoperating income less nonoperating expenses. EBITDA can then be shocked by applying adjustments to interest income, interest expenses, gains and losses on foreign exchange transactions and translations, and operating income, based on the following three main risks:

- For *interest rate risk*, interest income was shocked by increasing the average interest rate earned on interest-bearing assets (cash, marketable securities, and investment securities), with separate effects for short-term and long-term rates. Interest expenses were shocked by increasing the average interest rate paid on short-term and long-term borrowings, assuming no change in credit spreads, again with separate interest rate shocks for short- and long-term borrowing.[8]

- For *foreign exchange rate risk*, the impact of a change in the exchange rate was estimated by applying a shock to the net gain on foreign currency transactions and foreign currency translations.[9]

- For *earnings risk*, the impact of a change in the income of the corporate sector was estimated by assuming a decline in operating income (defined as sales less cost of sales less selling and administrative expenses).

The impact of the different shocks on the debt-servicing capacity of the corporate sector can be compared to baseline levels using the interest coverage ratio (ICR), a standard ratio used by analysts to understand the debt-servicing capacity of a firm. The results are expressed in terms of the uncovered debt ratio (UDR), the proportion of all industry debt for which the EBITDA do not adequately cover the interest payments on that debt. The UDR measure provides a proxy for the underlying credit quality of the corporate sector. The exact definition of UDR used in this paper is the proportion of total industry debt for which the interest coverage ratio (ICR $\equiv$ EBITDA to interest expenses) is less than 0.75. If the ICR of an industry is below the threshold, all of the debt of that industry is classified as "uncovered."

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[8] Credit spreads were expressed as the ratio of the interest rate on borrowings for each industry relative to the weighted average interest rate on borrowings for all industries (weighted by the stock of debt). The shock to interest rates was then multiplied by this credit spread ratio to arrive at the new interest rate for each industry, thus preserving the existing credit spread structure. This procedure could potentially understate the impact of an increase in interest rates for the highly leveraged companies, because these companies could face an even larger increase in interest rates if spreads increased.

[9] A shock on the stock of foreign currency exposures of the corporate sector would have provided more accurate estimates, however these data were not available in the Bank of Korea database.

The UDR is simply the sum of all such "uncovered" debt, as a percentage of the total debt outstanding for all industries.[10]

Figure 2. Derivation of EBITDA

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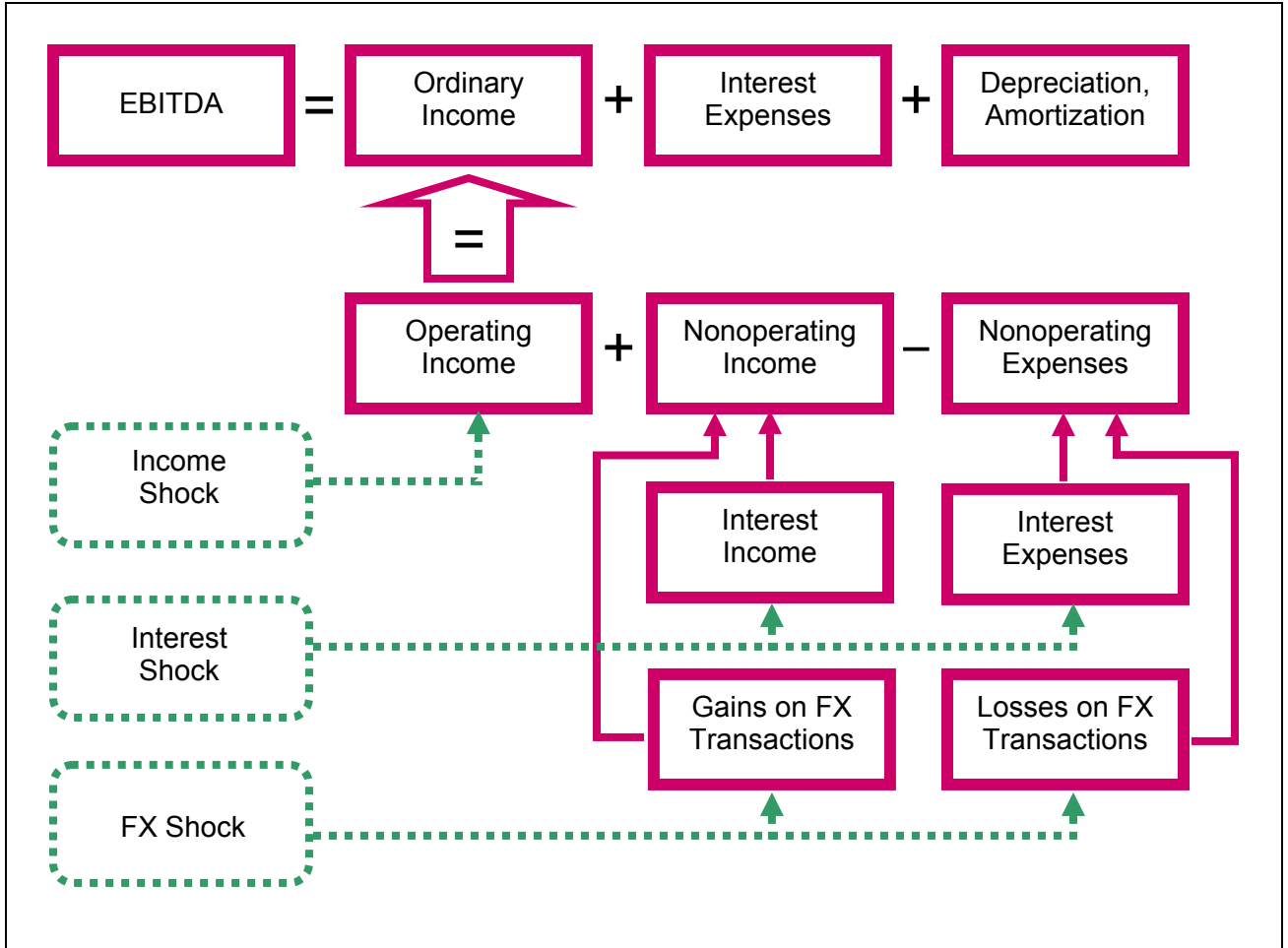
[10] A threshold of 0.75 was used instead of the standard cutoff point of 1.0, because calibration exercises performed separately by the authors provided greater explanatory power in mapping interest coverage ratios to nonperforming loan data. Changing the threshold from 0.75 to 0.5 or 1.0 did not change the results qualitatively.

Figure 3. Balance Sheet Calculations

	Interest Rate Shock	Foreign Exchange Shock	Operating Income Shock

BALANCE SHEET

Code	Item
111	Current assets
1111	Quick assets
11111	Cash and cash equivalents
11112	Marketable securities
11113	Trade receivables
11114	Other quick assets
1112	Inventories
112	Non-current assets
1121	Investments
11211	Investment securities
1122	Tangible assets
1123	Intangible assets
11231	Development costs
11	Total assets
121	Current liabilities
1211	Trade payables
1212	Short-term borrowings from banking institutions
1213	Current maturities of long-term borrowings
1214	Current maturities of bonds payable
1215	Other short-term borrowings
1216	Other current liabilities
122	Long-term liabilities
1221	Bonds payable
1222	Long-term borrowings from banking institutions
1223	Other long-term borrowings
1224	Liabilities provisions
1225	Other long-term liabilities
123	Stockholders' equity
12	Total liabilities and stockholders' equity

INCOME STATEMENT

Code	Item
21	Sales
22	Cost of sales
23	Gross profit or loss
241	Selling and administrative expenses
24101	Salaries
24102	Retirement allowance
24103	Other employee benefits
24104	Utilities
24105	Taxes and dues
24106	Rent
24107	Depreciation
24108	Entertainment
24109	Advertising
24110	Ordinary research and development expenses
24111	Insurance
24112	Transportaion, cargo handling, and packing
24113	Bad debt expense
24114	Amortization of intangible assets
241141	Amortization of development costs
24115	Other selling & administrative expenses
24	Operating income or loss
251	Non-operating income
25101	Interest income
25102	Dividend income
25103	Gain on foreign currency transactions
25104	Gain on foreign currency translation
25105	Gain on valuation of marketable securities
25106	Gain on disposition of investments/tangible assets
25107	Other non-operating income
252	Non-operating expenses
25201	Interest expenses
25202	Loss on foreign currency transacions
25203	Loss on foreign currency translation
25204	Loss on valuation of marketable securities
25205	Loss on disposition of investments/tangible assets
25206	Other non-operating expenses
25	Ordinary income or loss
261	Extraordinary gains
262	Extraordinary losses
26	Income or loss before income tax expense
271	Income tax expense
27	Net income or loss

Investment assets multiplied by increase in interest rates (separate calculations for short and long term) to show change in interest income

Debts multiplied by increase in interest rates (separate calculations for short and long term) to show change in interest expenses.

Net gain on foreign currency transactions and translations multiplied by change in exchange rate.

Operating income shocked directly.

We use the UDR as a proxy for the underlying credit quality of the corporate sector. While a rise in the UDR does not necessarily imply a crisis, a sharp rise is a useful indicator of widespread corporate distress that would be likely to have a serious impact on bank earnings and profitability. Indeed, other authors have found a close correspondence between low levels of interest coverage and increased probability of default or bankruptcy, which justifies its use as an indicator of corporate distress.[11]

D.   What Did Stress Tests Show?

The results of the stress tests suggest that corporate balance sheet information available in mid-1997 would have provided a good indication of the likely impact of the crisis on the corporate sector. Had stress tests been performed at the time with data available in August 1997, they would have revealed that the corporate sector was highly vulnerable to adverse economic developments, even plausible ones such as a repeat of the 1991–92 tightening.

Figure 4 tabulates the UDR ratio obtained from applying the worst-case scenario and a repeat of 1991 to 1996 data on corporate balance sheets. Under the worst-case scenario (largest shocks for each variable observed over the previous seven years, 1990–96) the UDR would have increased by almost 37 percentage points from its end-1996 level. Similarly, if the 1991 interest rate increases were replayed, it would have resulted in a similar increase in the UDR by 34 percentage points over the end–1996 level.

Figure 4. Effect of Shocks on Uncovered Debt Ratio, Actual Versus Projected
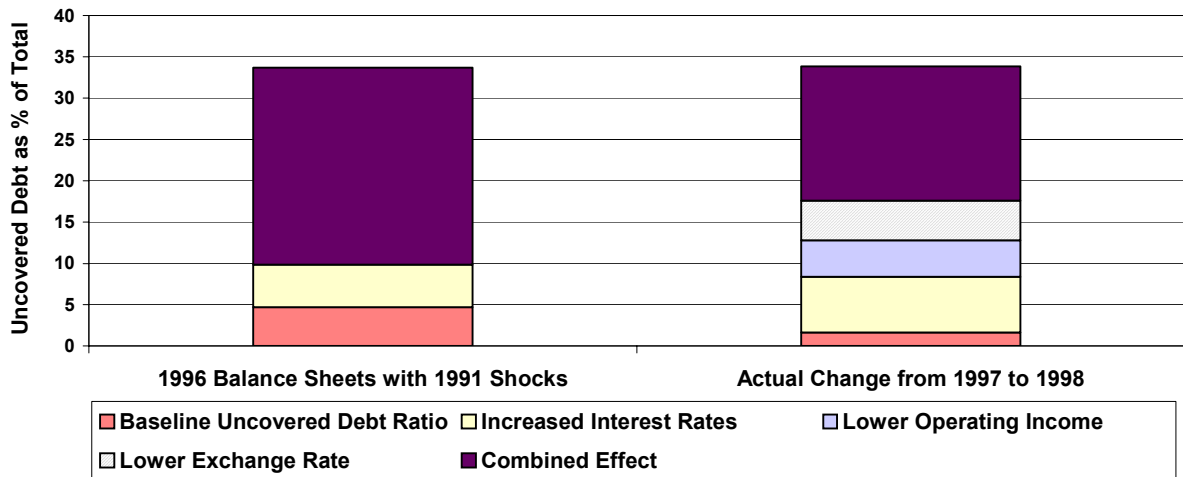
Source: Authors calculations.

Table 4 shows that the main vulnerability of the corporate sector was as a result of a sharp rise in interest rates. A rise in rates similar to that observed in 1991 would be sufficient to cause the UDR to rise by over a third. This is almost identical to what happened from end-

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[11] See Nam and Jinn (2000) for evidence for Korea, and Altman and Narayan (1997) and Glen (2004) for broader international evidence.

1997 to end-1998. While care must be taken in interpreting these numbers, the results certainly suggest that data available at the onset of the crisis could have provided useful information on the vulnerability of the corporate sector to an interest rate shock, as well as a reasonably accurate prediction of the likely distress in the corporate sector under plausible scenarios.

Table 4. Stress Test Results

Impact on 1996 Balance Sheets (Change in UDR)	Interest Rate Shock	Operating Income Shock	FX Shock	Combined Effect [3/]
Using Worst Case Shocks [1/]:	5.2	0.0	0.0	36.6
Using 1991 Shocks [2/]:	5.2	0.0	0.0	33.7
Memo: Actual Change from 1997 to 1998 [4/]	6.8	4.4	4.8	33.8

Source: Authors calculations.

1/ Assumes an increase in short and long rates of 2.6 p.p. and 2.4 p.p., respectively; a decrease in operating income of 21.5 percent; and an increase in the Won/Dollar rate of 6.5 percent; equivalent to the largest negative shocks observed during 1990-1996.
2/ Assumes an increase in short and long rates of 2.6 p.p. and 2.4 p.p., respectively; a decrease in operating income of 13.1 percent; and an increase in the Won/Dollar rate 3.6 percent; equivalent to actual changes observed in 1991.
3/ The combined effect differs from the sum of the separate effects, depending on the proportion of industries near the ICR threshold. If many industries are close to the threshold, a single shock may not be enough to push them over the threshold, but combined shocks may be enough to push many over the threshold.
4/ The combined effect shows the actual change in the UDR from 1997 to 1998, while the separate effects for interest, operating income, and fx shocks are calculated using 1997 balance sheets and the actual size of the changes observed in 1998. These included an increase in short and long rates of 1.8 p.p and 1.7 p.p, respectively; a decrease in operating income of 19.8 percent; and an increase in the Won/Dollar rate of 47.7 percent.

Do these results indicate that a crisis might have been imminent or more likely in 1997 than in other years? Some of the vulnerability indicators shown in Table 1 suggest that the corporate sector was vulnerable even prior to 1997. So why didn't a crisis occur earlier? To answer this question we can look at how the sensitivity to shocks evolved over time. Figure 5 shows the estimated impact of a "1991-sized" shock on the uncovered debt ratio of the corporate sector from 1995 to 2002.[12] We can see from this figure that the underlying vulnerability was more pronounced in 1997 than in either 1995 or 1996. But this does not mean that we could have predicted the crisis or that a crisis was more likely, as stress tests and sensitivity measures are not amenable to crisis prediction. Ultimately, it was the dramatic reversal of external conditions, which had been largely favorably until late 1997, that

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[12] Assuming the same shocks as the 1991 scenario described in Table 4.

precipitated the crisis. What we can say from the results presented here is that underlying vulnerabilities were very high, and thus any significant shock would have been likely to precipitate widespread distress in the corporate sector.

Figure 5. Sensitivity to Shocks, 1995–2002
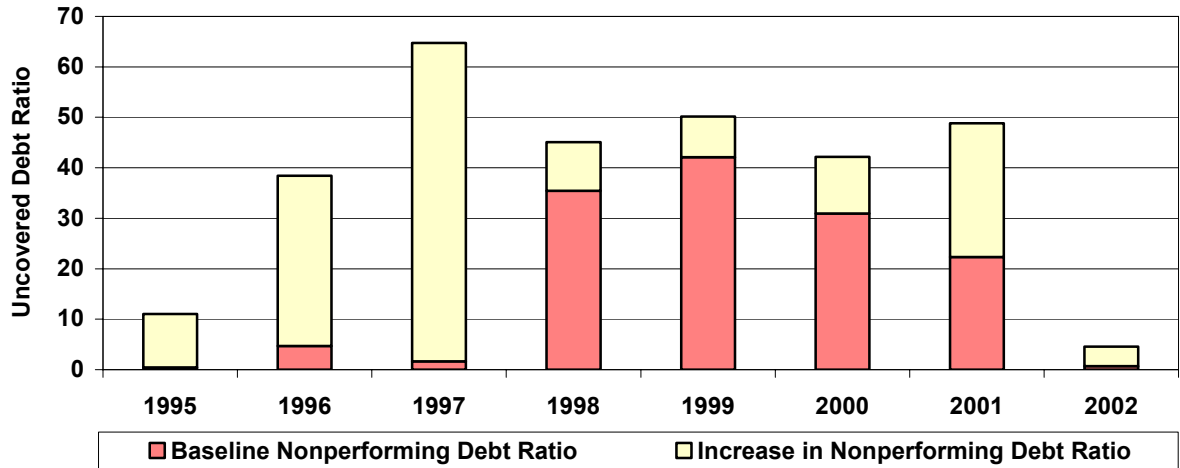
Source: Author's calculations.

IV. CONCLUSIONS AND LESSONS FOR SURVEILLANCE

The simple stress tests conducted in this paper suggest that the scale of corporate sector distress that occurred in the wake of the crisis in Korea could have been foreseen in mid-1997. With the wisdom of hindsight, this result is hardly surprising, because the corporate sector was highly leveraged and unprofitable, and these pre-existing vulnerabilities have been well documented, albeit expost.[13] Our results suggest that stress tests could have provided useful information about the vulnerability of the corporate sector in 1997 to adverse developments, particularly interest rate shocks. This information, when combined with knowledge about the financial sector, could have helped to raise awareness of the fragility of the situation in late 1997.

Stress tests do not show the likelihood of a particular set of shocks, but they do show the sensitivity of a particular set of balance sheets should the shock occur. Thus, while it is not possible exante to predict the likelihood of the severe shocks experienced during the crisis (particularly for the exchange rate), it is reasonable to assume that a set of shocks that were similar in magnitude to those experienced in 1991 could have happened again.

The results presented in this paper suggest that an analysis of corporate sector balance sheets can provide timely and useful information on the extent of vulnerabilities in an economy. Stress tests alone are not sufficient to determine the true extent of financial vulnerabilities,

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[13] See for example, IMF (2003) for a discussion of the role of surveillance in the Korean case.

nor do they provide information on the timing or likelihood of crises. However, they can be a useful tool in understanding the magnitude of balance sheet imbalances and their sensitivity to macroeconomic developments, even with outdated data. As such, they have a useful role to play as an additional tool in the surveillance toolkit.

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