An Equity Market Perspective of the Korean Financial Crisis

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ABSTRACT

We examine the movement of Korean stock prices before and after the 1997 financial crisis. In contrast to the case of Japan documented by Hamao, Mei and Xu (2005), we find an increase in firm-level volatility. The results appear to derive from government efforts to restructure the corporate sector, specifically Chaebol firms, immediately after the market crash.

Keywords: Idiosyncratic risk; Financial crisis

JEL classification: G01, G15

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1. Introduction

This paper investigates the dynamics of the Korean stock market during the period 1992 to 2004. Near the end of 1997, Korea experienced a financial crisis and an ensuing stock market crash. However, the market recovered surprisingly quickly and broke the previous record high after six years. Several years before this crisis, Japan experienced its own crash in 1990. However, for twelve years after the stock market bubble burst, the Japanese economy suffered prolonged stagnation. Hamao, Mei and Xu (2007, henceforth HMX) reported a large decrease in firm-level volatility and turnover after Japan's market crash. They argue that this may impede Japan's capital formation process by making it difficult for both investors and managers to separate high quality from low quality firms. We examine both market and firm-specific volatility movements in the Korean equity market before and after the Korean crisis to determine whether there is a notable difference between Japan and Korea.

In recent years, there has been much research about market and firm-specific volatility. Campbell, Lettau, Malkiel and Xu (2001, henceforth CLMX) show that average firm-specific volatility in U.S. stock markets has increased over the last few decades. This is puzzling because the U.S. economy stabilized during that period. Moreover, firm-specific risk increased over time, while market volatility remained basically unchanged.

Increasing firm-specific risk has attracted the attention of many researchers around the

world. Similar to Campbell, Lettau, Malkiel and Xu (2001), Kearney and Potì (2006) have documented a rise in firm-specific volatility in European equity markets during the period 1974 to 2004. However, Kearney and Potì (2006) found that market risk is trended upwards in Europe and thus correlations are not trended downwards. In the Japanese equity market, HMX have present evidence opposing that from U.S. and European markets. The main features of the Japanese stock market in the post-crash era are an increase in market volatility, a fall in firm-level volatility, and an increasing explanatory power (R^2) of the market model. HMX argue that this unique phenomenon led to economic stagnation in Japan for roughly a decade after the 1990 crash. In the U.S. market, CLMX document that firm-level volatility moves counter-cyclically. During recessions, this will make it easier for investors to distinguish low quality from high quality firms and thus encourage "cleansing recessions." The Japanese equity market, however, experienced a reduction in firm-level volatility during the recession period. This will lead to the failure of effective resource reallocation.

In contrast to the case of Japan, we have found decreasing market volatility and increasing firm-level volatility after Korea's financial crisis. Firm-level volatility increased in the early post-crisis period and decreased to the original level in the late post-crisis period. We also found that highly leveraged firms had high firm-specific volatility in the post-crisis period. When dividing samples into Chaebol and Non-Chaebol firms, we document that economic

performance among Chaebol firms was closely correlated even after the financial crisis. Firms in the regulated industries also showed low firm-specific volatility in the post-crisis period. This result supports the claim that government efforts to restructure Chaebols helped reduce firm-specific volatility, which had increased in the post-crisis period.

This paper is organized as follows. Section 2 describes the data and methodology used. In Section 3, the dynamics of market-wide and firm-specific volatilities are presented. We further investigate firm-specific volatility and other economic variables in Section 4. Concluding remarks are offered in Section 5.

2. Data and methodology

2.1 Sample and data

We divide the sample period into three groups. First is a pre-crisis period from February 1992 to November 1997; second is an early post-crisis period from December 1997 to December 2001; the last is a late post-crisis period from January 2002 to December 2004. We examine all stocks listed on the Korean Stock Exchange (KSE). Monthly data on individual stock returns are gathered from the Korean Securities Research Institute (KSRI) based on the CRSP's data classification. Stock trading volume and annual financial statements

are obtained from the KIS-Value. Short-term interest rates are measured by yield on 91-day Certificates of Deposit (CD). The numbers of stocks in each sub-period are 693 in the pre-crisis period, 769 in the early post-crisis and 703 in the late post-crisis period.

2.2 Model specifications

To estimate firm-specific volatility, we employ the following market model:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{m,i}(R_{M,i} - R_{f,t}) + \varepsilon_{i,t},$$

where $R_{i,t}$, $R_{M,t}$ and R_f are the individual stock return, the value-weighted market return and the risk-free rate at month *t*, respectively. We compute firm-specific volatility $\sigma_{i,IV}$ as the root mean square of residuals from the market model.

Additionally, we compute an individual stock's total volatility $\sigma^2_{i,TV}$ following a modified approach, as suggested by Xu and Malkiel (2003). The individual stock's total volatility $\sigma^2_{i,TV}$ and market volatility are computed, respectively, by:

$$\sigma^2_{i,TV} = \hat{Var}_t(R_{i,t}) = \sum_{k=1}^{\tau} \omega_k (R_{i,t+1-k} - \mu_{i,t})^2,$$

$$\sigma^2_{M} = \hat{Var}_t(R^M_t) = \sum_{k=1}^{\tau} \omega_k (R^M_{t+1-k} - \mu^M_t)^2,$$

where $\mu_{i,t} = \sum_{k=1}^{\tau} \omega_k R_{i,t+1-k}$, $\mu^M_t = \sum_{k=1}^{\tau} \omega_k R^M_{t+1-k}$ and τ represent the window's length. For weights ω_k, we use geometrically declining weights ($e^{-\alpha k}$), as proposed by Foster and Nelson (1999), with $\sum_{k=1}^{\tau} \omega_k = 1$. The optimal α and τ have a relationship of $\tau \times \alpha = \sqrt{3}$,

where $\tau = 12$.

As HMX suggest, the total aggregate volatility σ_{TV}^2 is calculated by value weighting an individual stock's total volatility $\sigma_{i,TV}^2$. The aggregate firm-specific volatility σ_{IV}^2 is computed as the total aggregate volatility σ_{TV}^2 less the market volatility.

3. Dynamics of market and firm-specific volatilities

3.1 Summary statistics

We first plot the Korea Composite Stock Price Index (KOSPI) and trading volume on a weekly basis. The KOSPI fell sharply in November 1997 when the Korean government officially requested a rescue package from the International Monetary Fund. Since then, the market index rose a bit and decreased again to a 20-year record low in May 1998.

We present key statistics for the three sample periods in Table 1. Panel A of Table 1 contains the median, mean and standard deviation of each variable and Panel B presents the tests of significance for the difference between the early post-crisis period and other periods. The first column in Panel A shows market volatility which can be roughly measured by standard deviation of R_M. It increased in the early post-crisis period from 0.072 to 0.131 and then decreased to 0.076 in the late post-crisis period. The second and third columns provide the

results of the market model estimation for individual stocks. We note that the cross-sectional variation of firm betas ($\beta_{i,CAPM}$) increased from 0.389 to 0.484, while the mean of R^2 increased from 25.8% to 29.0% in the early post-crisis period and dropped (25%) in the late post-crisis period. This early increase in explanatory power indicates that the co-movement of the whole market and individual stocks increased after the financial crisis. The increase in R^2 is statistically significant as show in Panel B.

The fourth column in Panel A shows individual stocks' firm-specific component of volatility ($\sigma_{i,IV}$) measured by mean squared residuals. We notice that mean firm-specific volatility jumped from 0.112 to 0.221 in the early post-crisis period, which is a 97.3% increase. The difference is more drastic when we compared the standard variation of firm-specific. The deviation of firm-specific volatility shows a 289% increase in the post-crisis pried from 0.038 and 0.148. Panel B shows the differences in both mean and standard variation are statistically significant. This is in contrast to results obtained in the Japanese market as reported by HMX, who find that a sharp fall in both the mean and the variation of firm-specific volatility in the cash period.

3.2 Dynamics of market and firm-specific volatility

To investigate volatility over time, we plot the 12-month moving average of both the

monthly market volatility and the aggregated firm-specific volatility. As Figure 2 shows, market-wide volatility increased rapidly in late 1997 and peaked in early 1998. It then experienced a decreasing trend. In the mean time, aggregate firm-specific volatility peaked first in early 1998 and then fluctuated during the next year. It began decreasing in Feb. 2000 and reverted to its original level in about a year. In short, firm-level volatility increased in the early post-period and then decreased in the late post-period, while stock market volatility in Korea has trended downwards over the years.

Next, we examine the explanatory power of the market model. The dispersion between market volatility and firm-specific volatility implies an increase in the R^2. The R^2 is estimated based on the market model using the previous 24 months of monthly return data in a way similar to HMX. In Figure 3, we can see that R^2s peaked from early 1998 to 2000 when dispersion between the market-wide and firm-specific volatility was greatest.

4. Firm-specific volatility and its determinants

In this section, we investigate how an individual firm-specific volatility is associated with some characteristics of the Korean economy in order to find what drives the Korean stock market to behave differently from the Japanese one in terms of individual stock's firm-specific volatility. We focus on two main features: leverage and Chaebol firms.

4.1 Firm-specific volatility and leverage

Firms with high debt are generally considered to be highly exposed to default risk and thus associated with high firm-specific volatility. Before the Korean financial crisis, the prevailing belief was that firms had a high leverage rate due to optimism about economic growth and easy lending. Even the government intervened in banks' lending decisions to encourage loans and expand firms' investment. Thus, an association between firm-specific volatility and leverage was weaker before the financial crisis.

As previously noted, in the post-crisis period Korean stock market showed the large increase in firm's firm-specific volatility in contrast to Japanese case. If this is due to the process of resource allocation during recessions, we can conjecture that the leverage positively affects the upward trend of firm-specific volatility.

4.2 Firm-specific volatility and Chaebol firms

We now investigate whether post-crisis volatility movements are related to differences in economic performance between firms that belong to Chaebol, Korean conglomerates, and firms that do not. Immediately after the crisis, the Korean government initiated a restructuring plan, mainly targeting Chaebol firms. Among all, the Korean

government actively supported a “Big Deal” project targeted the top five largest Chaebols, including Daewoo, Hyundai, LG, Samsung and SK. This policy required them to swap businesses in key industries to alleviate chronic excess capacity, which was one of the key factors responsible for the crisis. The seven major industries targeted by the "Big Deal" were the semiconductor, petrochemical, automobile, aerospace, shipping, oil refining, and electronics industries.

In addition, the government commenced debt-to-equity conversion project to reduce the level of debts in Chaebol firms. The Financial Supervisory Commission required the big five Chaebol groups to lower their debt-to-equity ratio below 200 percent through inducement of foreign capital and other self-rescue efforts.

First of all, the government informed ordinary investors about facing problems of Chaebol firms as it targeted Chaebol firms. As a result, investors learned that the government would not give any more favor for Chaebol firms in economic and financial policies. Thorough Chaebols’ restructuring efforts after the financial crisis, outside investors could better distinguish which firm was good or bad. For those reasons, firm-specific volatility in the post-crisis period is expected to increase higher in Chaebol firms compared to Non-Chaebol firms. In addition, we expect that the positive effect of leverage on firm-specific volatility would be more prominent for Chaebol firms.

4.3 Models

We conduct a cross-sectional regression of firm-specific volatility against leverage, Chaebols and other control variables about the firms traded in Korea Exchange (KRX) from 1996 to 2001. Then, whole six year period is divided into three periods; 1996 to 1997, 1998 to 1999 and 2000 to 2001. For each two year period, we calculate the average of monthly firm-specific volatility for an individual stock ($iv_{i,t}$). The change between current and previous averaged idiosyncrasy volatility (*iv_ch*) are used as dependent variables. The regression model is given as follows:

$$iv\_diff_{i,t} (\text{or } iv\_ch_{,i,t}) = Post + LnLev_{i,t} + Post \times LnLev_{i,t} + ROA_{i,t} + LnEmp_{i,t} + Age_{i,t}$$

$$iv\_diff_{i,t} (\text{or } iv\_ch_{i,t}) = Post + LnLev_{i,t} + Post \times LnLev_{i,t} + Chaebol_{i,t} + Post \times Chaebol_{i,t}$$

$$+ Post \times LnLev_{i,t} \times Chaebol_{i,t} + ROA_{i,t} + LnEmp_{i,t} + Age_{i,t}$$

Leverage (*LnLev*) is obtained by the logarithm of the book value of long-term debt divided by market values of equity and *Post* is a dummy variable equal to 1 in the post-crisis period. Another key variable, *Chaebol* is a dummy variable for firms which listed in the top thirty Chaebol groups announced by the Korea Fair Trade Commission. Then, we consider several control variables. Return-on-equity (ROA) is included to control for the fundamental effects following Wei and Zhang (2006). The log of the number of employment (*LnEmp*) is used as size proxy. Finally, the year counted since the foundation date (*Age*) is included in

order o control for the characteristics of newly listed stocks as suggested by Brown and Kapadia (2007). The definition of variables used is presented in Table 2. All dependent variables are obtained at the beginning of period t.

As shown in the first column of Table 3, the coefficient of the leverage variable (*LnLev*) is positive and significant. When the *Post* and its interaction variables are added in the next model, however, the coefficient of *LnLev* becomes close to zero in the pre-crisis period. Instead, the coefficient of leverage variable in the post-crisis period (*Post* × *LnLev*) turns out to be positive and significant. The coefficients shift to be positive after the financial crisis, implying that higher leveraged firms have higher firm-specific volatility.

The coefficient of *Chaebol* dummy variable included in the third column is insignificant in the pre-crisis period but it turns out to be positive and significant in the post-crisis period (*Post* × *Chaebol*). This indicates that the government's effort to restructure the Chaebol firms contributed to an increase in firm-specific volatility after crisis. In addition, the increasing effect of leverage on firm-specific volatility becomes stronger for *Chaebol* firms as shown in the positive coefficient of *Post* × *Chaebol* × *LnLev*.

On the basis of the regression result, we can conjecture that the leverage positively affects the upward trend of firm-specific volatility in the post-crisis period and the positive relation between firm-specific volatility and the leverage is stronger in *Chaebol* firms.

5. Conclusion

We examine the movement of Korean stock prices before and after the financial crisis. In contrast to the case of Japan, we find decreasing market volatility and increasing firm-level volatility after Korea's financial crisis. Firm-level volatility increased for about two years in the post-crisis period and then decreased to the original level in the late post-crisis period.

From cross-sectional regressions, we find that highly leveraged firms have a large increase in firm-specific volatility in the post-crisis period. When a dummy variable for Chaebol firms introduced, Chaebol firms show the significant increase in firm-specific volatility in the post-crisis period. Moreover, the positive relation between leverage and firm-specific volatility is stronger for Chaebol firms. This result supports the claim that the government's efforts to restructure Chaebol contributed to accelerating the process of cleansing the recession, which had increased firm-specific volatility in the post-crisis period.

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Table 1 Summary Statistics

Panel A. Key statistics for a pre-crisis period and post-crisis periods

	R_M	$\beta_{i,CAPM}$	R^2_{CAPM}	$\sigma_{i,IV}$	turnover
pre-crisis: Mar.1991 - Nov.1997					
Median	-0.027	0.848	0.241	0.108	0.021
Mean	-0.018	0.849	0.258	0.112	0.031
S.D	0.072	0.389	0.125	0.038	0.031
post-crisis(early): Dec.1997 - Dec.2001					
Median	-0.031	0.743	0.274	0.182	0.014
Mean	-0.007	0.804	0.290	0.221	0.018
S.D	0.131	0.484	0.159	0.148	0.014
post-crisis(late): Jan.2002 - Dec.2004					
Median	0.002	0.721	0.231	0.108	0.010
Mean	0.0001	0.768	0.253	0.130	0.025
S.D	0.076	0.524	0.144	0.083	0.047

Panel B. Test of significance

		$\beta_{i,CAPM}$	R^2_{CAPM}	$\sigma_{i,IV}$	$\sigma_{i,IV}$	turnover	turnover
		S.D.	Mean	Mean	S.D.	Mean	S.D.
Mean (pre) – Mean (early post)	t-statistic		-4.288	-18.756		10.3821	
S.D.(pre) / S.D.(early post)	F-statistic	0.6443			0.066		4.647
	p-value	0.000	0.000	0.000	0.000	0.000	0.000
Mean(early) – Mean(late post)	t-statistic		4.700	14.386		-4.281	
S.D.(early) / S.D.(late post)	F-statistic	0.8524			3.172		0.095
	p-value	0.0305	0.000	0.000	0.000	0.000	0.000

We perform t-tests for means and F tests for variances of variables for for the difference between the early post-crisis period and other periods

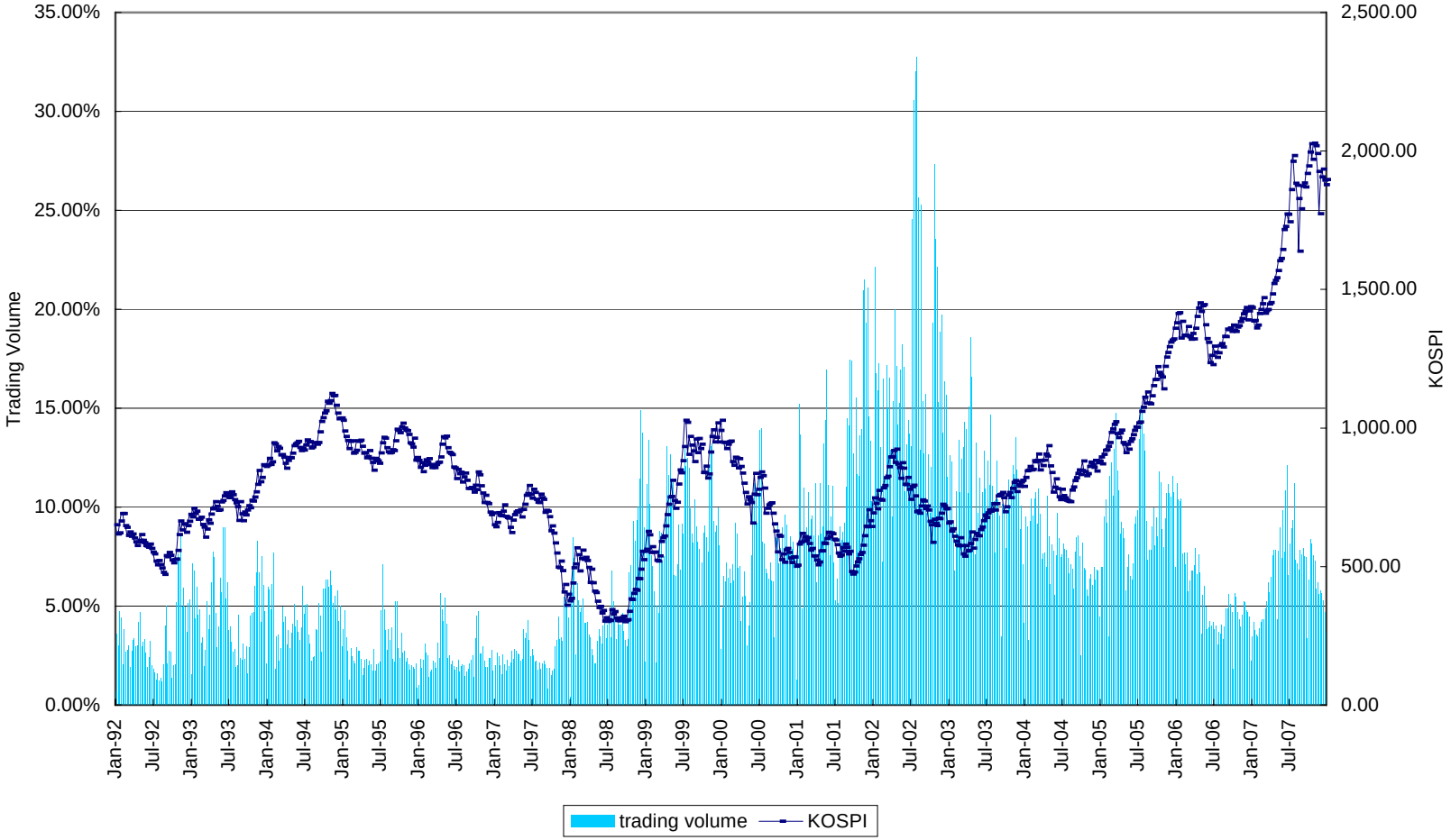
Table 2 Description of variables

Variables	Definitions
$iv_{i,t}$	The average of monthly firm-specific volatilities of firm i over period t
$iv_{i,t}\_ch$	A rate of mean change of the firm-specific volatility from period t-1 to the period t, $c\_iv_{i,t} = \frac{iv_{i,t} - iv_{i,t-1}}{iv_{i,t-1}}$
$LnLev_{i,t}$	Leverage of firm i is obtained by Log (book value of long-term debt/ market values of equity) at the beginning of period t
$Chaebol_{i,t}$	A dummy variable equal to 1 if a firm i belongs to Chaebol group and 0 otherwise at the beginning of period t
$Post_{i,t}$	A dummy variable equal to 1 in the post-crisis period, from year 1998 to 2001
$ROA_{i,t}$	Return on assets firm i, calculated by dividing operating earrings by total assets at the beginning of period t
$LnEmp_{i,t}$	Log of the number of firm i's employment shown in 1,000 persons at the beginning of period t
$Age_{i,t}$	The age of the firm i counted from the year it was established at the beginning of period t

Table 3 Cross-sectional regressions

	(1)	(2)	(3)
Dep. Variable =	$iv_{i,t}\_ch$	$iv_{i,t}\_ch$	$iv_{i,t}\_ch$
Constant	1.615***	0.208	0.244
	(10.14)	(0.638)	(0.724)
$LnLev_{i,t}$	0.147***	-0.005	-0.005
	(7.953)	(-0.133)	(-0.117)
$Post_{i,t}$		1.637***	1.328***
		(4.852)	(3.724)
$Post_{i,t} \times LnLev_{i,t}$		0.155***	0.113**
		(3.545)	(2.509)
$Chaebol_{i,t}$			-0.031
			(-0.270)
$Post_{i,t} \times Chaebol_{i,t}$			1.730***
			(4.852)
$Post_{i,t} \times Chaebol_{i,t} \times LnLev_{i,t}$			0.260***
			(5.202)
$ROA_{i,t}$	-1.576***	-1.444***	-1.551***
	(-5.491)	(-5.177)	(-5.598)
$LnEmp_{i,t}$	-0.014	0.016	0.021
	(-0.528)	(0.645)	(0.757)
$Age_{i,t}$	-0.005**	-0.007***	-0.008***
	(-1.977)	(-2.760)	(-3.057)
N	1085	1085	1085
Adj. R^2	0.1237	0.1759	0.1940

Significance levels: *** 1%, ** 5%, * 10%



Figur

e 1. Korea Composite Stock Price Index (KOSPI) and trading volume

Figure 2 Annualized market and firm-specific volatilities

Figure 3. Average R^2