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What Explains the Idiosyncratic Volatility in the Korean Stock Market?

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Abstract

Using the Fama and French (1993) three-factor model, this paper provides an explanation for the variation of idiosyncratic return in the Korean stock market over the period of 1990-2012. There had been an upward trend until 1999 in idiosyncratic volatility and its trend has been reversed afterwards. Our analysis yields three main results. Firstly, it appears that all four explanatory variables, two fundamentals related variables of the variance of return on equity and a proxy of growth options and two trading volume related variables of trading volume and foreign ownership ratio, explain considerable proportion of idiosyncratic return variation. Most interestingly, foreign investors have stabilizing effect on firm-specific risk in the Korean stock market. Secondly, a firm's characteristics such as size and export orientation exert some influence on idiosyncratic volatility. Lastly, the absolute and relative explanatory powers of the four explanatory variables vary through time and diminish as the sample period ends, implying the need to search for further explanatory variables.

Keywords: Idiosyncratic Volatility, Fama and French Three-Factor Model, Fundamentals Related Variables, Trading Volume Related Variables.

JEL Classification Number: G12

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I. Introduction

Research regarding firm-level stock return volatility has increased, especially through the efforts of Campbell, Lettau, Malkiel, and Xu (2001) who document the upward trend of idiosyncratic volatility in the U.S. stock market from 1960s to 1990s. Since then the efforts to explain idiosyncratic volatility have been galvanized. These studies provide numerous variables explaining the increase of idiosyncratic volatility. Wei and Zhang (2006) show that the higher variance of a firm's profitability measured by the variability of ROE is associated with the higher idiosyncratic volatility. Malkiel and Xu (2003) find that both institutional ownership and earnings growth are positively related with idiosyncratic volatility. In addition, using the option pricing based model of Galai and Masulis (1976), Cao, Simin, and Zhao (2008) find that both the level and variance of market-to-book value, a proxy for growth options are significantly related to idiosyncratic volatility. These studies focus mainly on the time period of increasing idiosyncratic volatility

Beyond the year of 2000, we witness that the trend of idiosyncratic volatility has been reversed. According to Zhang (2010), idiosyncratic volatility and its trend can be explained by two strands of factors – fundamentals related variables and trading volume related variables. Fundamentals related variables include factors that portray a firm's intrinsic value such as return on equity and growth options. On the other hand, there are factors related to trading volume, for instance, stock trading volume, turnover rate, derivative trading, etc..

Such existing literature has primarily focused on the case of industrialized markets. There are several interesting studies that expand their horizon to emerging markets. Since emerging markets possess distinct characteristics, we might assume that it is necessary to consider research hypotheses more adequate in the case of small capitalization market. For instance, the existence of foreign investors would add another important layer of explanation to idiosyncratic volatility. In particular, Pyun, Lee and Nam(2000) find that large trading volume generates high stock return volatility in emerging markets, whereas Li, Nguyen, Pham, and Wei (2011) observe that foreign investors in the emerging markets help to stabilize stock return volatility.

Following the analytical method of Zhang(2010), we contribute to this strand of literature by studying the idiosyncratic risk in the Korean equity market from 1990 to 2012. Although the turning point varies, the trend of idiosyncratic risk in the Korean stock market in our sample period experiences a very similar pattern to the case of international markets reported by existing literature. In the Korean stock market, firm-level risk increased during the period of 1990 through 1999 and declined afterwards. This implies a relatively high level of integration of the Korean stock market with the global market.

In this paper, the conditional three-factor model of Fama and French(1993) is used to estimate the idiosyncratic volatility in the Korean equity market. We examine in detail the relevance of a firm's profitability, growth options, trading volume and foreign ownership to idiosyncratic risk. Next, we divide samples according to size and export orientation characteristics of a firm to investigate the effects of size and export on idiosyncratic volatility. In addition, we estimate the trend in explanatory power of relevant variables changing across time and discuss its implications. To the best of our knowledge, this paper is the first to document the trend and causes of idiosyncratic risk in the Korean stock market over an extensive period of time.

When explaining the idiosyncratic risk in the Korean equity market, our first result is concerned with the relevance of four variables, variance of ROE (*VROE*), a proxy for growth options (*MABA*), trading volume (*VOL*) and foreign ownership ratio (*FHE*). All four variables appear to explain idiosyncratic volatility at a statistically significant level. Variance of ROE holds a positive relationship with idiosyncratic volatility which confirms that uncertainty in the profitability of a firm translates into more idiosyncratic risk. Likewise, firm-level risk increases with large growth options and trading volume. Foreign ownership of Korean stocks has a significantly negative effect on average firm-level risk. This finding asserts the stabilizing effect of foreign investors in the Korean stock market.

Secondly, we find that a firm's characteristics affect the degree in which the four independent variables influence idiosyncratic volatility. In particular, size and export effects are examined. The results confirm that both size and export are two factors that decide the magnitude of the four variables' impact on idiosyncratic volatility. While the role of variance of ROE is comparatively stable across both the sample periods and the group of stocks, growth options and foreign ownership ratio are more explanatory in large companies and major export industries.

Lastly, we also find that the absolute and relative explanatory powers of the variables estimated using a ten-year window change over time. The combined explanatory powers of the variables exhibit a downward trend throughout the sample period. In the early 2000s, *VROE* and *VOL* retain a fairly high explanatory power, but around the end of the sample period, they drop to less than half the previous level. In terms of relative explanatory power, we observe that *FHE* exceeds the other variables.

The remaining sections of the paper proceed as follows: Section II reviews the relevant literature briefly. Section III outlines the methodology and describes the data. Section IV discusses the results. The final section provides concluding remarks.

II. A Brief Review of Relevant Literature

A substantial body of research has analyzed idiosyncratic risk and substantiated its multiple aspects. Earlier papers in this literature include Campbell et al. (2001) who document increasing stock-return volatility over the 1962-1997 period in the United States using the method based on the unconditional version of the capital asset pricing model (CAPM). Iit was idiosyncratic risk particularly which increased during that time period while aggregate market volatility remained the same. This paper fuels continuing debates on idiosyncratic volatility. For example, Brown and Kapadia (2007) suggest that the trend in idiosyncratic volatility is related to stocks that are known to be less mature or riskier firms. Ang, Hodrick, Xing, and Zhang (2006) focus on stocks with higher idiosyncratic return volatility and find that they have lower future return on average. Further still, Irvine and Pontiff (2004) show that a high level of industry turnover prompts future idiosyncratic volatility and return on asset has a negative impact on idiosyncratic volatility. They conclude that increasing competition engenders higher firm-level volatility in the future. More recently, Brandt, Brav, Graham, and Kumar (2009) observe that idiosyncratic volatility dropped to below pre 1990s levels in 2003. This is consistent with the findings of Zhang (2010) who finds that idiosyncratic volatility has reversed the time trend observed in the 1962-1996 period. Our paper is closely related to but distinct from Zhang (2010) who examines the trend and the causes of idiosyncratic return volatility. Zhang (2010) evaluates fundamentals and trading-related variables, and shows that the variation in the earnings and proxies for growth options better explains idiosyncratic volatility than trading-related variables. We also presume that variables can be classified either as fundamentals or trading-related in the case of the Korean stock market, and posit that each variable will play a respective role. In contrast to Zhang (2010), we include other features such as information on foreign investors, an important detail in many emerging stock markets as has been documented by Li et al. (2011). We also consider a firm's characteristics such as size and export orientation. Among papers that document idiosyncratic volatility of many stock markets ours is the first to study the case of the Korean stock market.

There are number of fundamentals factors known to bring about idiosyncratic volatility. Wei and Zhang (2006) find that deteriorating ROE and increasing variance of ROE contribute to the upward trend in idiosyncratic volatility. The authors report that this upward trend was led by newly listed firms, mostly small in size with lower current and past earnings and higher earnings variance. A similar conclusion is drawn by Pastor and Veronesi (2003) who confirm the link between idiosyncratic volatility and variance of a firm's profitability. They find that firm-level risk tends to be higher for firms with high sample variance of firm-level earnings. In the same context, Schwert (2004) investigates the idiosyncratic volatility of NASDAQ stocks from the period of 1973 through 2001. He details firms in high-technology industries with high present value of growth opportunities, and finds that their idiosyncratic risk is above average. Cao et al. (2008) find a positive relationship between growth options and idiosyncratic volatility, and provide concrete evidence that growth-options proxies explain much of the variation in idiosyncratic volatility. We note such profit related characteristics of a firm are also strongly linked to idiosyncratic risk in the case of Korea, and include variance of profitability and growth options in our study.

An attempt to link stock return volatility with trading volume traces back to

Karpoff (1986). Gallant, Rossi and Tauchen (1992) and Jones, Kaul and Lipson (1994) document a strong positive correlation between price changes and trading volume. Similar results have been reported in the case of the Korean equity market by Pyun et al. (2000) that prove a connection between trading volume and the volatility persistence of returns in the Korean equity market. Related to trading volume but unique to emerging stock markets is foreign ownership which constitutes a sizable portion of capitalization in emerging economies. Recently, Li et al. (2011) examine how large foreign ownership in 31 emerging markets affects firm-level stock return volatility. The authors maintain that large foreign ownership has a negative impact on volatility after controlling for endogeneity and the impact of domestic shareholders. This verifies the stabilizing effect of foreign investors in equity markets of emerging economies. Relevant to Li et al. (2011) is Kim and Yoo (2009) who investigate foreigners' investing behavior in the Korean stock market. They find that foreign investors are more prone to be value and long-term investors. This stabilizing effect of foreign ownership is also generally visible in our study, specifically in large-size companies.

II. Data and Methodology

1. Data Sources

Data was obtained from Data Guide of FN Guide. The sample consists of all listed stocks either on the KOSPI or the KOSDAQ between January 1, 1990 and May 31, 2012. Stock prices of each company used are of daily frequency. Interest rates, trading volume, market value, and foreign ownership ratio are also of daily frequency. Accounting data such as ROE, asset, and debt are in quarterly basis.

2. Idiosyncratic Volatility

To obtain idiosyncratic volatility estimates, we decompose stock return risk into systemic risk and unsystemic risk. r_{itd} is the excess return on stock *i* on trading day *d* in month *t,* and f_{td} are the daily observations of the systemic factors on trading day *d* in month *t*. ε_{itd} is an error variable of stock *i* on trading day *d* in month *t*.

$$r_{itd} = \alpha_{itd} + \beta'_{itd} f_{td} + \varepsilon_{itd} \tag{1}$$

It necessitates to define systemic factors and to acquire residuals from the regression. The systemic factors used in this paper follow the traditional three-factor model of Fama and French (1993). The three factors refer to market premium, size premium

(SMB, small minus big), and value premium(HML, high minus low).[1]

Residuals are obtained from rolling this regression using a 252-day window. With the daily residuals, we calibrate idiosyncratic volatility by the following formula:

$$IV_{it} = \left[252\left(\frac{\sum_{d=1}^{D_t}\widehat{\varepsilon_{itd}^2}}{D_t}\right)\right]^{1/2} \tag{2}$$

Here the sum of squared residuals is divided by the number of trading days in a month t and annualized to estimate the monthly average idiosyncratic volatility of stock i. Then, we compute the value-weighted average volatility of $IV_{it}s$ to construct the monthly series of idiosyncratic volatility IV_t.

IV_t is categorized into each of the stock exchanges on which they are traded. Four groups of stocks of KOSPI, KOSPI200, KOSDAQ, and all stocks combined are considered. To visually inspect the data, Figure 1 graphs IV_ts of KOSPI, KOSPI200, KOSDAQ, and all stocks. Idiosyncratic volatility trends of KOSPI, KOSPI200, and all stocks share very similar movements during the observation time period. However, KOSDAQ, opened in July of 1996, clearly shows more volatility than other markets in the 2000s despite its co-movement with others in the 1990s. Clearly, there are upward and downward trends of the idiosyncratic volatility in the case of all stocks. A decided upward trend persists throughout the period between January 1990 and December 1999. In the 2000s, the volatility takes a downturn and continues to decrease until the turmoil of the global financial crisis in the fall of 2008. This trend is less visible in KOSDAQ whose volatility seems to meander in fluctuation rather than decline by 2008. This upward and downward trend of the idiosyncratic volatility is remarkably similar to the cases of other stock markets in earlier papers (e.g., see Campbell et al. (2001), Brandt et al. (2010), and Zhang (2010)). Bekaert and Harvey (1997) observe the increase in the correlation between local market returns and the world market returns with the advancement of capital market liberalization and globalization. The Korean stock market is not an exception. We understand that as Korea has gone through stages of deregulation and opened its stock market to global investors, the degree of integration of the Korean stock market in the global market has become fairly high. It seems quite natural that the idiosyncratic volatility in the Korean stock market illustrates a very similar trend to cases of industrialized markets.

Table 1 provides summary statistics on the idiosyncratic volatility studied. It reports mean, standard deviation, minimum and maximum values, as well as skewness and kurtosis for each of the periods. We note that the means and standard deviations of all stocks, KOSPI, and KOSPI200 are almost identical while KOSDAQ has

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[1] Following Fama and French(1993,1996), two size portfolios(50-50) and three value portfolios(30-40-30) are constructed from all stocks listed on both KOSPI and KOSDAQ.

higher means and similar standard deviations.

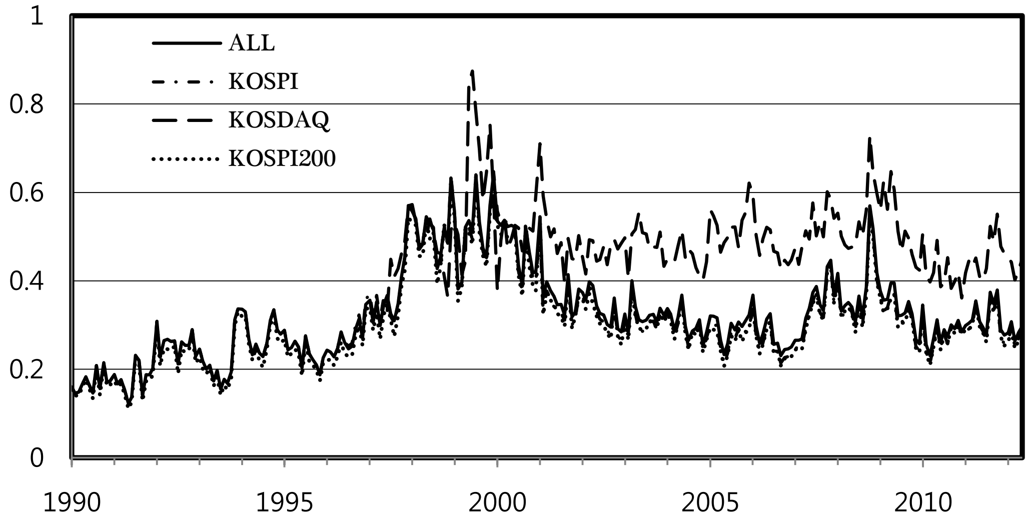

Figure 1. Value-weighted Average Idiosyncratic Volatility.
This figure plots value-weighted average idiosyncratic volatility of ALL stocks, KOSPI, KOSDAQ, and KOSPI200 from January 1990 through May 2012. Idiosyncratic volatility is estimated from the conditional Fama and French three-factor model.

Table 1 Summary Statistics of Idiosyncratic Volatility
This table reports summary statistics of value weighted average idiosyncratic volatility in the Korean equity market. Idiosyncratic volatility is estimated from the conditional Fama and French three-factor model. Subsamples are categorized as all stocks, KOSPI, KOSDAQ, and KOSPI200.

	Mean	STDV	Min	Max	Skewness	Kurtosis
All stocks (No. of firms: 2579)						
1990-2012	0.321	0.103	0.123	0.641	0.812	0.584
1990-1999	0.301	0.130	0.123	0.641	0.986	-0.006
2000-2012	0.338	0.071	0.231	0.570	1.329	1.759
KOSPI (No. of firms: 1066)						
1990-2012	0.313	0.103	0.123	0.647	0.976	0.823
1990-1999	0.301	0.129	0.123	0.647	0.966	-0.018
2000-2012	0.323	0.074	0.212	0.558	1.452	2.169
KOSDAQ (No. of firms: 1513)						
1997-2012	0.497	0.081	0.333	0.875	1.680	4.796
1997-1999	0.537	0.134	0.333	0.875	1.107	0.792
2000-2012	0.489	0.063	0.361	0.728	0.919	1.654
KOSPI200 (No. of firms: 200)						
1990-2012	0.303	0.101	0.110	0.636	0.868	0.623
1990-1999	0.285	0.127	0.110	0.636	1.010	0.007
2000-2012	0.318	0.071	0.207	0.553	1.331	1.894

3. Explanatory Variables

A. Fundamentals Related Variables

We choose the standard deviation of ROE, denoted as *VROE,* and a growth options proxy, denoted as *MABA,* as one of fundamentals related variables. *VROE* is defined as the standard deviation of return on equity which represents a kind of variance in the profitability of a company. Using quarterly ROE data reported in financial statements of each company from 1990 through 2012, *VROE* is constructed. For each firm, the standard deviation of the last 12 quarters of ROE ($VROE_{it}$) is calculated, and then the value-weighted average *VROE*, denoted as $VROE_t$, is obtained[2]. There have been five proxies for growth options widely used in the literature as applied by Cao et al. (2008). The five proxies are an estimate of Tobin's Q, the ratio of the market value to book value of assets (*MABA*), the debt to equity ratio, the ratio of capital expenditures to fixed assets and the present value of growth options. In this paper, we opt for *MABA* ratio to assess market's expectation of growth opportunities. We compute *MABA* as market value of equity plus book value of debt divided by book value of asset. Market value of equity is in daily frequency while asset and debt are in quarterly basis. For each firm, after computing daily $MABA_{itd}$ s, they are averaged by the number of trading days in month *t* ($MABA_{it}$), and then $MABA_{it}$s are value-weighted to obtain $MABA_t$. Figure 2 illustrates $VROE_t$ and $MABA_t$ with the idiosyncratic volatility of KOSPI. $VROE_t$ exhibits somewhat stable volatility between 1990 and 1997, increases in early 1997 and declines after around 2000. Roughly, its visual pattern seems to be in parallel with the idiosyncratic volatility of KOSPI. On the other hand, $MABA_t$ is overall steady except for a short surge around 2000.

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B. Trading Volume Related Variables

We use trading volume, denoted as *VOL*, and foreign ownership ratio, denoted as *FHE*, as trading related variables. VOL_t is the logarithm of the value-weighted average trading volume of month *t* in million wons. As graphed in Figure 3, VOL_t moderately increases until 2000 and thereafter shows a very slow upward movement. For each firm, FHE_{itd} s are calculated from the daily ratio of the number of equity owned by foreigners over the total number of equity. Like other variables, they are monthly averaged and value-weighted to obtain FHE_t.

[2] In principle, the variance of ROE is calculated with 12 quarters of data. However, if 12 quarter consecutive data is not available, 4 quarters are the minimum time span to compute the variance of ROE at month *t*.

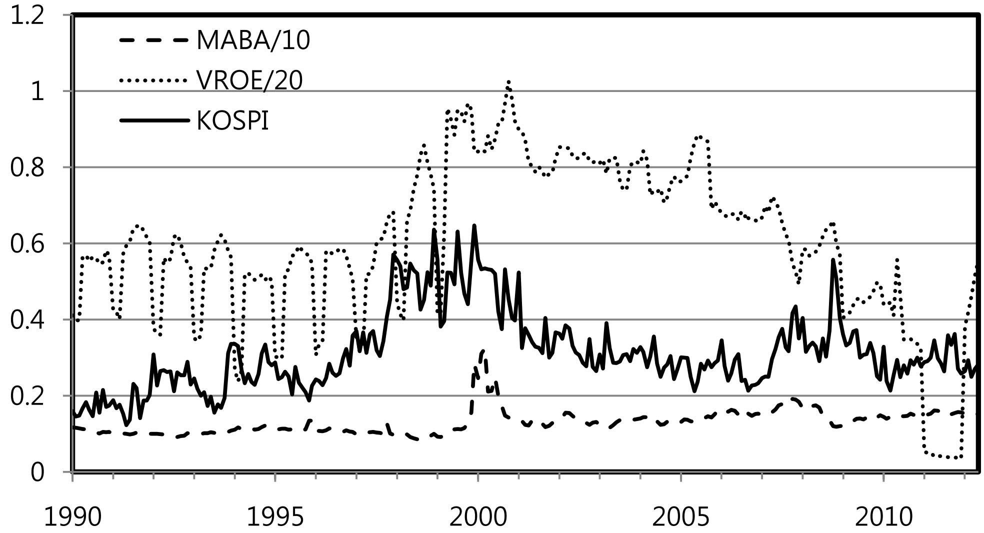

Figure 2. Value-weighted Averages of *MABA* and *VROE*, and the Idiosyncratic Volatility of KOSPI

This figure graphs the value-weighted averages of *MABA* and *VROE*, and the idiosyncratic volatility of KOSPI during the period from January 1990 through May 2012.

Data constituting FHE_t are from January 1 of 2000 to May 31 of 2012. FHE_t of Figure 2 exhibits a steady increase until mid-2004, and declines thereafter. FHE_t increases rapidly and remains high even after the idiosyncratic volatility of KOSPI begins to decline. Seemingly, FHE_t shows opposite movement to the idiosyncratic volatility of KOSPI after 2000.

We give more emphasis on foreign ownership rather than institutional ownership in this paper, taking into account that in the Korean stock market the presence of foreign investors is far more prominent than that of domestic institutional investors. In the Korean stock market, over the period of 2000-2011, individual investors and companies comprised on average of 24% and 21% of market capitalization, respectively. Notably, foreign investors comprised on average of 32%, the largest portion, while institutional investors hold on average of 13%, the smallest portion. This is one of unique facets in the Korean stock market that is clearly different from industrialized markets, in which institutional investors play a critical role.

Table 2 reports summary statistics of the value-weighted averages of explanatory variables. Although not reported here, all the variables used in our estimation are checked for unit root possibility and turn out to be significantly stationary by the augmented Dickey-Fuller test. Also see Appendix Table A for a formal definition of variables.

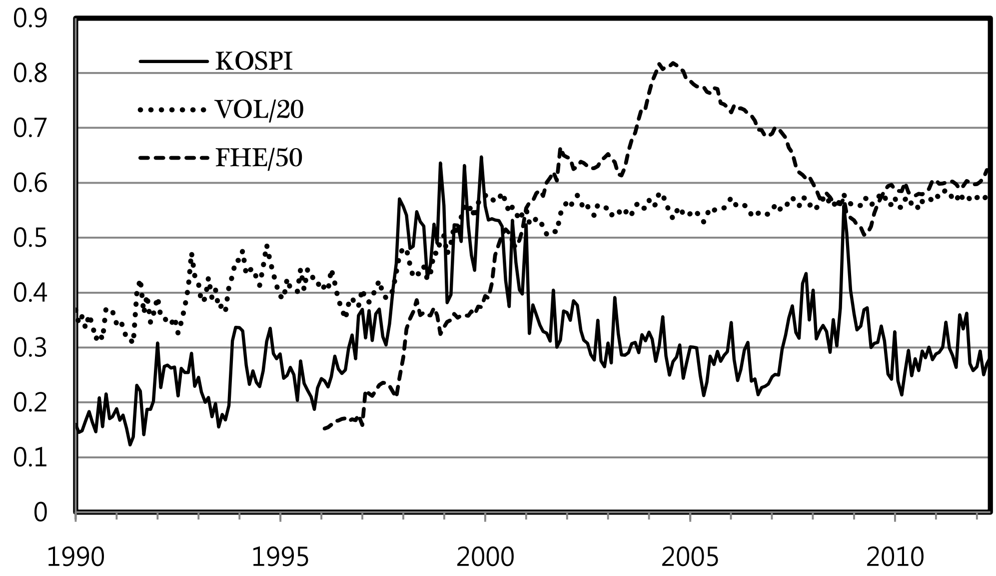

Figure 3. Value-weighted Averages of *VOL*, *FHE* and the Idiosyncratic Volatility of KOSPI.
Figure 3 plots the value-weighted average of *VOL* with the idiosyncratic risk of KOSPI from January 1990 through May 2012. Plots of *FHE* begin from January 1997.

Table 2 Summary Statistics of Explanatory Variables

This table reports descriptive statistics of value-weighted values of explanatory variables based on the Dataguide database.

	Mean	STDV	Min	Max	Skewness	Kurtosis
VROE						
1990-2012	13.42	3.420	6.197	22.44	0.174	-0.342
1990-1999	13.21	2.647	9.958	22.45	1.964	3.009
2000-2012	13.60	3.936	6.197	21.12	-0.344	-1.068
MABA						
1990-2012	1.331	0.337	0.909	3.714	2.762	14.04
1990-1999	1.118	0.219	0.909	2.912	5.124	38.04
2000-2012	1.502	0.317	1.149	3.714	3.900	21.42
VOL						
1990-2012	9.858	1.659	6.147	11.75	-0.642	-1.125
1990-1999	8.247	1.162	6.147	11.48	0.653	0.293
2000-2012	11.16	0.315	10.10	11.75	-0.871	1.189
FHE						
2000-2012	31.68	4.622	19.50	40.90	0.163	-0.235

IV. Results and Discussion

Our results and discussion are presented in five parts. Firstly, the structural break of idiosyncratic volatility is tested. Secondly, univariate regressions for each explanatory variable are run to examine its role in explaining the movements of idiosyncratic volatility. Thirdly, we estimate multivariate regressions with fundamentals related variables and trading volume related variables to examine whether either of them is more contributing in explaining the movements of idiosyncratic volatility. Also, we detail our estimation by splitting the sample into two sub-periods to clarify the explanatory power of independent variables in consideration of the existence of the structural break of idiosyncratic volatility. Fourthly, we confirm that the influence of our four explanatory variables on the idiosyncratic volatility differs depending on a firm's characteristics. In particular, we focus on firm size and export orientation. Lastly, we investigate the explanatory powers of our multivariate regressions that are changing across time and discuss their implications.

1. Tests for Structural Break

Guo and Savickas (2008) document high correlation of average idiosyncratic volatility across G7 countries and find that idiosyncratic volatility from the United States is being transmitted to other countries and vice versa. This finding suggests that idiosyncratic volatility is possibly a pervasive financial variable. With this in mind, we acknowledge the need to test for the structural break of idiosyncratic volatility as some earlier papers have confirmed its existence (see, Brandt et al. (2010) and Zhang (2010)). The following specification provides a convenient way to test the existence of a known structural break.

$$IV_t = a_1 D_{1t} + a_2 D_{2t} + (b_{1t} D_{1t} + b_{2t} D_{2t})t + \varepsilon_t \qquad (3)$$
$$IV_t = a + b_t t + \varepsilon'_t$$

D_{1t} is the dummy variable for January 1990 to December 1999, except in the case of KOSDAQ for June 1997 through December 1999 and D_{2t} is the dummy variable for January 2000 through May 2012. The slope coefficients of b_{1t} and b_{2t} measure movement of idiosyncratic volatility during each of the two sub-periods, respectively, while b_t measures the common trend coefficient for the entire sample period. We estimate the coefficients using the generalized method of moments(GMM) and test the null hypothesis of no structural break using the likelihood ratio test proposed by Andrews and Fair (1987, 1988), denoted as *LR(AF)*. *LR(AF)* tests no structural break, assuming that the error term is autocorrelated with hetroskedasticity. The t-values for slope coefficients are adjusted for autocorrelation and heteroskedasticity using the Newey and West(1987) method with 24 lags.

The results in Table 3 reveal that all the idiosyncratic volatility series have a structural break. All the likelihood ratio tests are highly significant enough to infer that there is a structural break around December 1999. Interestingly enough, in the first sub-sample period, the idiosyncratic volatility shows overwhelming evidence of an upward trend, while there is weak evidence that except for the KOSDAQ, the trend of volatility series takes an opposite direction in the second sub-sample period. All b_{1t} estimates have a positive sign at a 1% level, and all b_{2t} estimates have a negative sign at around 10% level except for the KOSDAQ. The estimates of b_t for the entire period are not significant due to the reversion of the trend. This upward and downward trend of the idiosyncratic volatility in the Korean equity market is similar to cases of other industrialized markets confirmed in earlier papers (e.g., Campbell et al. (2001), Brand et al.(2009), and Zhang(2010)).

Table 3.
Trends and Tests for Structural Break of Idiosyncratic Volatility

This table presents the results of the Andrew and Fair(1987, 1988) test for testing the existence of a known structural break. The entire sample period is for all stocks, KOSPI and KOSPI200 from January 1990 to May 2012, while in the case of KOSDAQ, the sample period is from June 1997 to May 2012. D_{1t} is a dummy variable for the period of January 1990-December 1999 (for KOSDAQ, for the period of June 1997-December 1999) and D_{2t} for the period of January 2000-May 2012. b_t represents the slope coefficient for the entire period. The *t*-values for slope coefficients are adjusted for autocorrelation and heteroskedasticity using the Newey and West(1987) method with 24 lags. *LR(AF)* proposed by Andrews and Fair(1987,1988) is the likelihood ratio test for no structural break, assuming that the error term is autocorrelated and heteroskedastic. *LR(AF)* follows the χ^2 distribution with 2 degrees of freedom asymptotically. .

$$IV_t = a_1D_{1t} + a_2D_{2t} + (b_{1t}D_{1t} + b_{2t}D_{2t})t + \varepsilon_t$$

$$IV_t = a + b_tt + \varepsilon'_t$$

Stocks	b_{1t}	b_{2t}	b_t	$LR(AF)$
All	0.00313	-0.00066	0.00037	302.55
	(6.31)***	(-1.88)*	(1.57)	(.000)***
KOSPI	0.00312	-0.00068	0.00028	302.37
	(6.59)***	(-1.83)*	(1.19)	(.000)***
KOSDAQ	0.00901	-0.00019	-0.0003	45.48
	(6.12)***	(-0.74)	(-1.13)	(.000)***
KOSPI200	0.00301	-0.00061	0.00035	276.79
	(5.98)***	(-1.75)*	(1.56)	(.000)***

Note: The numbers in parentheses below the *b* estimates are the Newey and West *t*-values adjusted for autocorrelation and heteroskedasticity. The numbers in parentheses below the *LR(AF)* statistics are their right-tail *p*-values. *, **, *** indicate statistical significance at 10%, 5% and 1%, respectively.

2. Univariate Regressions

In this section, we endeavor to examine the legitimacy of each explanatory variable in explaining the idiosyncratic volatility in the Korean equity markets by running univariate regressions of the idiosyncratic volatility on each explanatory variable. $VROE_{t-1}$, $MABA_{t-1}$, VOL_{t-1} and FHE_{t-1} are used as explanatory variables. The regression equations of interest for each explanatory variable are as follows:

$$IV_t = (a_{x1}D_{1t} + a_{x2}D_{2t}) + (b_{x1}D_{1t} + b_{x2}D_{2t})X_{t-1} + \varepsilon_t \tag{4}$$
$$IV_t = a_x + b_xX_{t-1} + \eta_t$$
$$\hat{\eta}_t = (a_{1t}D_{1t} + a_{2t}D_{2t}) + (b_{1t}D_{1t} + b_{2t}D_{2t})t + \xi_t$$

where X is *VROE, MABA, VOL*, or *FHE*. D_{1t} equals 1 for t of January 1990 to December 1999 and 0 of January 2000 to May 2012. D_{2t} equals 1 minus D_{1t}. The first equation of (4) takes a structural break into account while the second equation of (4) considers no structural break. To be a reasonable explanatory variable, the sign of the slope coefficient estimates should be identical in both sub-periods. Also, to validate the stable relationship between the explanatory variable and the idiosyncratic volatility, the magnitudes of the slope coefficient estimates should not be much different in both sub-periods. In addition, the residuals from the second equation are regressed on time variable to ensure if each explanatory variable is adequate in explaining the idiosyncratic volatility by itself, irrespective of the trend reversion of idiosyncratic volatility. If the time variable appears significant in the regression of the residuals, it suggests further multivariate analysis is necessary.

Table 4 reports this baseline analysis of each variable. In Panel A of this table, *VROE* holds a positive relationship with the idiosyncratic volatility. Namely, if the variance of ROE increases (decreases), the volatility is likely to trend upward (downward). Although in the second sub-period slope coefficients estimates appear to be statistically very weak, the estimates of the two sub-periods and the entire period for that matter have equal positive signs. However, *LR(AF)* shows that a structural break exists, and a time trend clearly remains in the regression of the residuals of the first sub-period.

Table 4.
Univariate Regressions of Idiosyncratic Volatility

This table reports univariate regressions of idiosyncratic volatility on each explanatory variable. Value-weighted average idiosyncratic risk, IV_t, is regressed on $VROE_{t-1}$, $MABA_{t-1}$ or VOL_{t-1} over the entire period of January 1990 through May 2012 and the two sub-periods of January 1990-December 1999 and January 2000-May 2012, respectively. FHE_{t-1} is used only for the period of January 2000-May 2012. Residuals obtained from the regression of IV_t on $VROE_{t-1}$, $MABA_{t-1}$ or VOL_{t-1} over the entire period of January 1990-May 2012 are regressed on time variable, t. D_{1t} is a dummy variable for the period of January 1990-December 1999 (for KOSDAQ, for the period of June 1997-December 1999) and D_{2t} for the period of January 2000-May 2012. The t-values for slope coefficients are adjusted for autocorrelation and heteroskedasticity using the Newey and West(1987) method with 24 lags. *LR(AF)* proposed by Andrews and Fair(1987,1988) is the likelihood ratio test for no structural break, assuming that the error term is autocorrelated and heteroskedastic. *LR(AF)* follows the χ^2 distribution with 2 degrees of freedom asymptotically

$$IV_t = (a_{x1}D_{1t} + a_{x2}D_{2t}) + (b_{x1}D_{1t} + b_{x2}D_{2t})X_{t-1} + \varepsilon_t$$

$$IV_t = a_x + b_xX_{t-1} + \eta_t$$

$$\hat{\eta}_t = (a_{1t}D_{1t} + a_{2t}D_{2t}) + (b_{1t}D_{1t} + b_{2t}D_{2t})t + \xi_t$$

Panel A. *VROE*

Stocks	b_{VROE1}	b_{VROE2}	b_{VROE}	*LR(AF)*	b_{1t}	b_{2t}
ALL	0.0228	0.0039	0.0093	44.56	0.0028	0.0003
	(3.93)***	(1.42)	(2.05)**	(.000)***	(7.87)***	(0.59)
KOSPI	0.0222	0.0040	0.0089	36.92	0.0028	0.0002
	(3.92)***	(1.37)	(1.98)**	(.000)***	(8.16)***	(0.40)
KOSDAQ	0.0225	0.0026	0.0051	37.68	0.0076	0.0003
	(4.19)***	(1.81)*	(2.20)**	(.000)***	(5.70)***	(1.47)
KOSPI200	0.0223	0.0034	0.0088	45.17	0.0027	0.0002
	(3.93)***	(1.26)	(1.95)*	(.000)***	(7.32)***	(0.59)

Panel B. *MABA*

Stocks	b_{MABA1}	b_{MABA2}	b_{MABA}	*LR(AF)*	b_{1t}	b_{2t}
ALL	-0.0952	0.1082	0.0860	5.02	0.0031	-0.0006
	(-0.34)	(4.30)***	(1.54)	(.081)*	(5.99)***	(-2.55)**
KOSPI	-0.0988	0.1211	0.0769	8.22	0.0031	-0.0006
	(-0.36)	(4.49)***	(1.32)	(.016)**	(6.27)***	(-2.42)**
KOSDAQ	0.3429	-0.0081	-0.0232	21.68	0.0091	-0.0002
	(4.38)***	(-0.50)	(-1.19)	(.000)***	(5.83)***	(-0.80)
KOSPI200	-0.1092	0.1078	0.0818	6.06	0.0030	-0.0005
	(-0.41)	(4.54)***	(1.50)	(.048)**	(5.72)***	(-2.37)**

Panel C. *VOL*

Stocks	b_{VOL1}	b_{VOL2}	b_{VOL}	*LR(AF)*	b_{1t}	b_{2t}
ALL	0.0825	0.0249	0.0267	92.96	0.0025	-0.0008
	(5.95)***	(0.71)	(2.86)***	(.000)***	(5.52)***	(-2.25)**
KOSPI	0.0809	0.0306	0.0226	97.60	0.0026	-0.0008
	(6.00)***	(0.84)	(2.30)**	(.000)***	(5.89)***	(-2.13)**

KOSDAQ	0.0861	-0.0081	0.0044	62.31	0.0086	-0.0002
	(9.50)***	(-0.32)	(0.47)	(.000)***	(5.95)***	(-0.80)
KOSPI200	0.0802	0.0296	0.0255	92.05	0.0024	-0.0007
	(5.87)***	(0.85)	(2.85)***	(.000)***	(5.26)***	(-2.11)**

Panel D. *FHE*

Stocks	b_{FHE}	b_t
ALL	-0.0088	-0.0007
	(-2.96)***	(-4.22)***
KOSPI	-0.0093	-0.0007
	(-2.83)***	(-4.17)***
KOSDAQ	-0.0018	-0.0002
	(-1.00)	(-0.74)
KOSPI200	-0.0087	-0.0006
	(-3.05)***	(-4.02)***

Note: The numbers in parentheses below the *b* estimates are the Newey and West *t*-values adjusted for autocorrelation and heteroskedasticity. The numbers in parentheses below the *LR(AF)* statistics are their right-tail *p*-values. *, **, *** indicate statistical significance at 10%, 5% and 1%, respectively.

Panel B presents the slop coefficients estimates of *MABA* which show apparently less coherent with idiosyncratic volatility than those of *VROE*. The signs of the slope coefficient estimates of the two sub-periods are not consistent meaning *MABA* is less capable of catching the reversed trend of idiosyncratic volatility. Except for the KOSDAQ, the estimates for the first sub-period are not significant, while the estimates for the second sub-period are highly significant. The slope coefficients estimates of *MABA* over the entire period are not significant for all groups. The slope coefficients estimates of time variable in the regression of the residuals appear significant in both sub-periods, while their signs are positive and negative for the first and second period, respectively.

Panel C investigates trading volume variable in relation to the idiosyncratic volatility. The slope coefficients estimates of *VOL* are all significantly positive for the first sub-period, but insignificant for the second sub-period. The hypothesis of no structural break is rejected at the 0.01 level. The regressions of residuals under the constraint of no structural break indicate that trend component clearly remains in both sub-periods except for the second sub-period of KOSDAQ. For all groups, the residuals contain a positive trend for the first sub-period and a negative trend for the second sub-period.

Since foreign ownership data are available from January 2000, we omit structural break test and the sub-periods analysis for *FHE*. Panel D shows that *FHE* exerts a negative effect on the idiosyncratic volatility for the period of January 2000-May 2012 at the significance level of 1% except for the KOSDAQ. This finding indicates that if foreigners hold more equities of a firm, it causes a decrease in its idiosyncratic volatility. Except for the KOSDAQ, the residual regressions exhibit very significantly the presence of time trend.

In general, all explanatory variables independently influence the idiosyncratic volatility over the observed time span. The slope coefficients of *VROE, MABA,* and *VOL* have positive values and of FHE, negative. For *VROE, MABA and VOL*, we observe that the extent of influence that each variable has on the idiosyncratic volatility reduces as shown in their estimates of the two sub-periods. The residuals of all the explanatory variables contain trend component which implies that none of each explanatory variable individually is sufficient to explain the variation of the idiosyncratic volatility.

3. Multivariate Regressions

In this section, multivariate regressions are employed to compare the explanatory power of fundamentals related factors and trading volume related factors. Firstly, we specify the regression equations as follows:

$$IV_t = a + b^*_{VROE} VROE_{t-1} + b^*_{MABA} MABA_{t-1} + \eta_t \qquad (5)$$
$$\hat{\eta}_t = a + b^{**}_{VOL} VOL_{t-1} + \varepsilon_t$$
$$\hat{\eta}_t = a + b^{**}_{FHE} FHE_{t-1} + \varepsilon_{t'}$$

The idiosyncratic risk is regressed on fundamentals related variables, and then the residuals are regressed on each of the trading volume related variables. If the idiosyncratic volatility is fully explained by the former two explanatory variables and there are no additional variation in the idiosyncratic risk to be explained by the latter explanatory variable, then the estimated b^{**} will be insignificant. In succession, we switch the role of fundamentals related variables and trading volume related variables. The sample period for ALL, KOSPI and KOSPI200 is the period of January 1990 through May 2012, but for KOSDAQ, it is the period of January 1997 to May 2012. The regressions including *FHE* cover the period of January 2000 through May 2012.

Table 5 reports the results of the multivariate regressions of idiosyncratic volatility aimed to compare the explanatory power of fundamentals related variables and trading volume related variables. As shown in Regression A, the slope estimates of *VROE* are significantly positive in all groups while those of MABA are not statistically significant. The regressions of residuals on each of the trading volume related variables show that the slope estimates of FHE are significantly negative for all groups and those of *VOL* are positively significant for KOSPI and KOSDAQ only. In Regression B where the roles of fundamentals related variables and trading volume related variables are switched, except for KOSDAQ, the slope estimates of *FHE* are significantly negative while those of *VOL* are significantly negative.

Table 5

Multivariate Regressions of Idiosyncratic Volatility:

Fundamentals Related Variables versus Trading-volume Related Variables

This table reports the results of the multivariate regressions of idiosyncratic volatility aimed to compare the explanatory powers of fundamentals related variables and trading volume related variables. Idiosyncratic risk is regressed on fundamentals related variables, and then the residuals are regressed on each of the trading volume related variables. We repeat the same method, switching the role of fundamentals related variables and trading volume related variables. The values of adjusted R^2 are also reported. The sample period for ALL, KOSPI and KODPI200 is the period of January 1990 through May 2012, but for KOSDAQ,, the period is January 1997 through May 2012. The regressions including *FHE* are run over the period of January 2000 through May 2012. The *t*-values for slope coefficients are adjusted for autocorrelation and heteroskedasticity using the Newey and West(1987) method with 24 lags.

Regression A:

$$IV_t = a + b^*_{VROE}VROE_{t-1} + b^*_{MABA}MABA_{t-1} + \eta_t$$

$$\hat{\eta}_t = a + b^{**}_{VOL}VOL_{t-1} + \varepsilon_t$$

$$\hat{\eta}_t = a + b^{**}_{FHE}FHE_{t-1} + \varepsilon'_t$$

Stocks	b^*_{VROE}	b^*_{MABA}	$adjR^2$	b^{**}_{VOL}	b^{**}_{FHE}
ALL	0.0086	0.0722	0.1924	0.0307	-0.0079
	(2.20)**	(1.37)		(1.48)	(-7.22)***
KOSPI	0.0083	0.0636	0.1670	0.0352	-0.0085
	(2.11)**	(1.19)		(1.86)*	(-7.40)***
KOSDAQ	0.0050	-0.0201	0.0816	0.0286	-0.0028
	(2.12)**	(-0.97)		(2.01)**	(-1.66)*
KOSPI200	0.0081	0.0688	0.1771	0.0332	-0.0078
	(2.07)**	(1.33)		(1.57)	(-6.71)***

Regression B:

$$IV_t = a + b^*_{VOL}VOL_{t-1} + b^*_{FHE}FHE_{t-1} + \eta_t$$

$$\hat{\eta}_t = a + b^{**}_{VROE}VROE_{t-1} + \varepsilon_t$$

$$\hat{\eta}_t = a + b^{**}_{MABA}MABA_{t-1} + \varepsilon'_t$$

Stocks	b^*_{VOL}	b^*_{FHE}	$adjR^2$	b^{**}_{VROE}	b^{**}_{MABA}
ALL	-0.0070	-0.0089	0.3396	0.0054	0.0519
	(-0.31)	(-3.01)***		(5.76)***	(5.72)***
KOSPI	-0.0027	-0.0093	0.3439	0.0056	0.0601
	(-0.12)	(-2.85)***		(5.69)***	(6.57)***
KOSDAQ	-0.0152	-0.0020	0.0097	0.0024	-0.0146
	(-0.62)	(-1.27)		(1.75)*	(-0.77)
KOSPI200	-0.0018	-0.0088	0.3352	0.0050	0.0501
	(-0.08)	(-3.04)***		(5.41)***	(5.79)***

Note: The numbers in parentheses below the *b* estimates are the Newey and West *t*-values adjusted for autocorrelation and heteroskedasticity. *, **, *** indicate statistical significance at 10%, 5% and 1%, respectively.

The regressions of residuals show that *VROE* turns out to be a legitimate variable, but *MABA* does not after controlling trading volume related variables. From these two regression panels, both *VROE* and *FHE* appear to be effective and stable in explaining the idiosyncratic volatility. In terms of adjusted R^2, it could be said that trading volume related variables have higher explanatory power than fundamentals related variables in explaining the variation of idiosyncratic risk. However, based on our results, we infer tentatively that in the Korean equity market, trading volume related variables such as *FHE* provide reasonable explanation to the variation of idiosyncratic risk as well as fundamentals related variables such as *VROE*.

We further explore the relationship between idiosyncratic volatility and four explanatory variables with the following two sets of regression equations:

$$IV_t = a + b_{VROE}VROE_{t-1} + b_{MABA}MABA_{t-1} + b_{VOL}VOL_{t-1} + \eta_t \quad (6)$$
$$\hat{\eta} = a_{FHE} + b_{FHE}FHE_{t-1} + \xi_t$$
$$\hat{\eta} = (a_{1t}D_{1t} + a_{2t}D_{2t}) + (b_{1t}D_{1t} + b_{2t}D_{2t})t + \xi_t$$

$$IV_t = a + b_{VROE}VROE_{t-1} + b_{MABA}MABA_{t-1} + b_{VOL}VOL_{t-1} + b_{FHE}FHE_{t-1} + \eta_t \quad (7)$$
$$\hat{\eta} = a_t + b_t t + \xi_t$$

Bearing in mind the prominent presence of foreign investors in the Korean stock market, we bring attention to the role of *FHE* in equations (6), along with equations (7) which include all four explanatory variables. Regression A reports the linear relationship of *VROE, MABA,* and *VOL* altogether with idiosyncratic risk using the data January 1990 through May 2012. It appears that both *VROE* and *VOL* are statistically valid at the 5% or 10% levels for all groups, while *MABA* gives statistically very weak evidence as a valid explanatory variable only for KOSDAQ. As expected, the signs of the slope coefficients estimates of all three explanatory variables are consistent for all groups. We then regress the residuals on *FHE* and time trend, respectively. Particularly, the slope coefficient estimates of *FHE* on the residuals are significantly negative rendering the explanatory power of *FHE* compelling. Also, we find that the time trend exerts significantly its influence on the residuals over the first sub-period. Adding *FHE* as an additional explanatory variable, the prominent role of *FHE* is confirmed in explaining the variation of the idiosyncratic volatility. As shown in Regression B of Table 6, except for KOSDAQ, the slope coefficients estimates of *FHE* have highly significant negative values. This means that *FHE* exerts a stabilizing effect on the idiosyncratic volatility. The outcome substantiates the results of Regression A. The value of adjusted R^2 almost doubles verifying the importance of *FHE* in explaining the idiosyncratic volatility in the Korean stock market over the period of January 2000 through May 2012. Interestingly enough, it appears that in this case the time trend does not exert influence on the residuals.

Table 6.
Multivariate Regressions of Idiosyncratic Volatility:
All Explanatory Variables

This table presents the results of two regression models. Regression A reports the linear relationship of *VROE, MABA,* and *VOL* altogether with idiosyncratic risk. We then regress the residuals on *FHE* and time trend, respectively. Regression B measures the impact of *VROE, MABA, VOL*, and *FHE* altogether with idiosyncratic risk. Also, the residuals are regressed on time trend. The values of adjusted R^2 are reported. The sample period for ALL, KOSPI and KOSPI200 is the period of January 1990 through May 2012, but for KOSDAQ, the period of January 1997 through May 2012. The regressions including *FHE* cover the period of January 2000 through May 2012. Dummy variables are included in the time trend regression of the residuals where D_{1t} has 1 for the period of January 1990- May 1999 and D_{2t} has 1 for the period of January 2000-May 2012. The *t*-values for slope coefficients are adjusted for autocorrelation and heteroskedasticity using the Newey and West(1987) method with 24 lags.

Regression A. $IV_t = a + b_{VROE}VROE_{t-1} + b_{MABA}MABA_{t-1} + b_{VOL}VOL_{t-1} + \eta_t$

$\hat{\eta} = a_{FHE} + b_{FHE}FHE_{t-1} + \xi_t$

$\hat{\eta} = (a_{1t}D_{1t} + a_{2t}D_{2t}) + (b_{1t}D_{1t} + b_{2t}D_{2t})t + \xi_t$

Stocks	T	b_{VROE}	b_{MABA}	b_{VOL}	$adjR^2$	b_{FHE}	b_{t1}	b_{t2}
ALL	1990	0.0075	-0.0046	0.0234	0.2682	-0.0100	0.0023	-0.0000
	-2012	(2.10)**	(-0.07)	(2.36)**		(-6.94)***	(6.42)***	(-0.05)
KOSPI	1990	0.0074	0.0040	0.0182	0.2115	-0.0103	0.0024	-0.0000
	-2012	(2.00)**	(0.06)	(1.72)*		(-6.15)***	(6.88)***	(-0.08)
KOSDAQ	1997	0.0056	-0.0505	0.0212	0.1080	-0.0027	-0.0056	0.0002
	-2012	(2.11)**	(-1.70)*	(1.85)*		(-2.13)**	(-4.12)***	(0.98)
KOSPI200	1990	0.0070	-0.0047	0.0224	0.2490	-0.0087	0.0022	-0.0000
	-2012	(1.98)**	(-0.07)	(2.35)**		(-3.04)***	(6.06)***	(-0.04)

Regression B. $IV_t = a_x + b_{VROE}VROE_{t-1} + b_{MABA}MABA_{t-1} + b_{VOL}VOL_{t-1} + b_{FHE}FHE_{t-1} + \eta_t$

$\hat{\eta}_t = a_t + b_t t + \xi_t$

Stocks	T	b_{VROE}	b_{MABA}	b_{VOL}	b_{FHE}	$adjR^2$	b_t
ALL	2000	0.0063	0.0415	0.0244	-0.0084	0.5298	-0.0001
	-2012	(4.10)***	(1.87)*	(0.97)	(-5.25)***		(-1.10)
KOSPI	2000	0.0064	0.0527	0.0255	-0.0086	0.5444	-0.0001
	-2012	(4.05)***	(2.33)**	(0.97)	(-4.96)***		(-1.23)
KOSDAQ	2000	0.0042	-0.0435	0.0304	-0.0033	0.0724	0.0001
	-2012	(2.66)***	(-1.22)	(1.18)	(-1.53)		(0.30)
KOSPI200	2000	0.0058	0.0416	0.0258	-0.0082	0.5010	-0.0001
	-2012	(3.81)***	(1.96)*	(0.98)	(-5.02)***		(-1.17)

Note: The numbers in parentheses below the *b* estimates are the Newey and West *t*-values adjusted for autocorrelation and heteroskedasticity. *, **, *** indicate statistical significance at 10%, 5% and 1%, respectively.

Unlike earlier papers corroborating a strong effect of growth options on the idiosyncratic volatility in industrialized stock markets, our evidence suggests that such presence of growth options is very weak in the Korean stock market (e.g. Chan, Lakonishok, and Sougiannis(2001), Apendjinou and Vassalou(2004), and Cao et al.

(2007)). Moreover, the role of *MABA* is less consistent as shown in the Table 6. Since the regression of idiosyncratic volatility on *VROE*, *MABA*, *VOL*, and *FHE* is confined to the period from January 2000 through May 2012, we repeat our analysis of *VROE, MABA,* and *VOL* to investigate the role of *MABA* in explaining the idiosyncratic risk in detail using the two subsamples. Table 7 reports the slope coefficients estimates of *VROE, MABA,* and *VOL* for each subsample. According to the results of Table 7, though the slope coefficients estimates of *MABA* are highly significant in both sub-periods excluding KOSDAQ, they have different signs. In the first sub-period, *MABA* exerts a negative influence on idiosyncratic volatility but in the second sub-period the sign turns positive. This means that when stock is overpriced it helps reduce idiosyncratic volatility, as seen in the period of January 1990-May 2000, but after 2000, the market perceives more idiosyncratic risk for overpriced stock. In the second sub-period, *MABA* plays a far greater role than *VROE* and *VOL* in terms of the magnitude of slope coefficients estimates. It is also observed that the slope coefficients estimates of *VROE* are reduced in magnitude and the *VOL* effect also wanes. Yet, the explanatory power of all the three explanatory variables altogether has decreased as observed in the value of adjusted R^2 which becomes almost half in the 2000s. As shown in Regression B of Table 6, it seems that *FHE* fills the gap in the 2000s.

Table 7.
Multivariate Regressions of Idiosyncratic Volatility:
By sub-sample periods

This table shows the regression results of idiosyncratic risk on *VROE, MABA* and *VOL* altogether for each of the sub-sample periods. We regress the idiosyncratic volatility IV_t on $VROE_{t-1}$, $MABA_{t-1}$ and VOL_{t-1} during the period of 1990-1999 and 2000-2012. D_{x1} is a dummy variable for the period of January 1990-December 1999 and D_{x2}, for the period of January 2000-May 2012. The *t*-values for slope coefficients are adjusted for autocorrelation and heteroskedasticity using the Newey and West(1987) method with 24 lags.

$$IV_t=(a_{x1}D_{1t} + a_{x2}D_{2t}) + (b_{VROE1}D_{1t} + b_{VROE2}D_{2t})VROE_{t-1} + (b_{MABA1}D_{1t} + b_{MABA2}D_{2t})MABA_{t-1} + (b_{VOL1}D_{1t} + b_{VOL2}D_{2t})VOL_{t-1} + \varepsilon_t$$

Stocks	b_{VROE1}	b_{VROE2}	b_{MABA1}	b_{MABA2}	b_{VOL1}	b_{VOL2}	$adjR^2_1$	$adjR^2_2$
ALL	0.0113	0.0044	-0.2912	0.1025	0.0751	0.0136	0.63	0.28
	(6.46)***	(2.64)***	(-3.04)***	(3.19)***	(9.90)***	(0.32)		
KOSPI	0.0108	0.0045	-0.2920	0.1150	0.0740	0.0145	0.61	0.31
	(6.09)***	(2.66)***	(-2.92)***	(3.41)***	(9.54)***	(0.33)		
KOSDAQ	0.0129	0.0034	0.0314	-0.0194	0.0598	0.0261	0.50	0.03
	(2.96)***	(2.13)**	(0.26)	(-0.71)	(13.77)***	(0.91)		
KOSPI200	0.0111	0.0039	-0.3000	0.1014	0.0732	0.0152	0.63	0.27
	(6.75)***	(2.45)**	(-3.33)***	(3.30)***	(10.24)***	(0.36)		

Note: The numbers in parentheses below the *b* estimates are the Newey and West *t*-values adjusted for autocorrelation and heteroskedasticity. *, **, *** indicate statistical significance at 10%, 5% and 1%, respectively.

From our results so far, we might infer that all the four explanatory variables in consideration exert a quite significant influence on the idiosyncratic volatility of the Korean stock market although the magnitude of their influence varies over time. *VROE* largely outweighs the other explanatory variables in its importance and consistency, having a positive relationship with the idiosyncratic volatility and sufficiently providing reasonable explanation irrespective of the trend reversion of idiosyncratic volatility as well. This view is consistent with the conventional wisdom that investors are known to shy away from stocks with high variance of profitability. In the case of *MABA*, its role becomes manifest as observed in the subsample analysis. During the period of January 1990-December 1999, a high level of *MABA* helps to stabilize idiosyncratic volatility, but over the period after 2000, the high level of *MABA* translates into a high level of idiosyncratic volatility as observed in Cao et al.(2007).

Trading volume hitherto known to create more market volatility in stock market also applies to idiosyncratic volatility. *VOL* stands out as a useful variable in that it confirms a positive relationship between trading volume and the idiosyncratic volatility, even though in the 2000s its role subsides. What deserves a particular notice is the foreign ownership ratio since it comprises one-third of the market capitalization of the Korean stock market. The slope coefficient estimates of *FHE* clearly show that the foreign ownership ratio has a negative relation with idiosyncratic volatility excluding KOSDAQ in the 2000s. These results are in line with the findings of previous studies such as Kim and Yoo (2009), and Li et al. (2011), which support that foreign investors are committed investors with long-term perspective, rather than speculative investors. In terms of the identity of foreign investors, Li et al.(2011) maintains that nonfinancial investors have a tendency to stabilize stock return volatility unlike financial investors. Since the year of 2000, the Korean government has allowed foreigners' large ownership of Korean stocks, thus successfully attracting committed foreign investors whose main interest is a company's fundamental performance rather than a short term speculative pursuit of profit. Furthermore, we observe that the slope coefficients estimates related to KOSDAQ oftentimes appear insignificant. While Schwert (2002) verifies the link between growth options and individual risk of NASDAQ, our evidence leads to suggest that the idiosyncratic volatility of KOSDAQ cannot be aptly explained as much as KOSPI can either by fundamentals related variables or trading volume related variables.

4. Effects of Size and Export on Idiosyncratic Volatility

We hypothesize that a firm's individual characteristics change the way our explanatory variables affect its idiosyncratic volatility. In this section, we focus mainly on two possible features, namely firm size and export orientation, and examine their relation to the firm-level idiosyncratic volatility.

A. Size Effect

In terms of capitalization on the last day of May 2012, stocks are sorted into groups based on their size. The largest and smallest 500 company groups among all stocks listed on KOSPI and KOSDAQ are formed. Also, the largest and the smallest 30% company groups are formed for each of KOSPI and KOSDAQ. Each idiosyncratic volatility series is regressed on the four explanatory variables to capture size effect on idiosyncratic volatility for the period of January 2000-May 2012.

The results in Table 8 provide interesting evidence. The *b* estimates of *VROE* of Big 500 and Small 500 are positive and statistically significant, but idiosyncratic volatility of small companies are more influenced by it as observed in terms of the magnitude of estimates. On the other hand, *MABA* and *FHE* have a statistically significant relation to idiosyncratic volatility only in the group of big companies. Also, our results indicate that *MABA* and *FHE* do not play major roles in explaining the idiosyncratic volatility of small companies. In addition, we observe that the adjusted R^2 of the small companies group is much lower than that of the big companies group.

If we observe KOSPI and KOSDAQ individually, there are more implications for size effect. In the KOSPI market, the idiosyncratic volatility of the smallest 30% company group is much more influenced by the variance of ROE than the largest 30% company group. This result implies that investors are more sensitive when small companies in KOSPI do not display consistent profit record. In the KOSPI market, the slope coefficient estimate of *MABA* is significantly positive only for the largest 30% group, while *FHE* provides significantly negative estimates for both groups. On the other hand, in the KOSDAQ market, all the four explanatory variables are significant in explaining the idiosyncratic volatility, only for the largest 30% group. However, *MABA* plays a negative role in contrast to our previous result shown in Regression B of Table 6, implying that if large companies in KOSDAQ are excessively priced, the level of idiosyncratic volatility is reduced as investors perceive less risk. All the four explanatory variables do not play any significant role in explaining the idiosyncratic volatility for small companies in KOSDAQ. Here, we should point out that KOSDAQ is comprised of high-tech companies and newly start-ups. We observe that the adjusted R^2 values of both groups in KOSDAQ are much lower than those of both groups in KOSPI, implying that a careful search for additional explanatory variables particularly for KOSDAQ remains necessary.

Table 8.
Multivariate Regressions of Idiosyncratic Volatility
By Firm-size

This table reports the regression results of size effect on idiosyncratic volatility. The largest and the smallest 500 company groups among all stocks listed on KOSPI and KOSDAQ are formed Also, we form the largest and smallest 30% company groups for each of KOSPI and KOSDAQ,. Each idiosyncratic volatility series is regressed on the four explanatory variables to capture size effect on idiosyncratic volatility for the period of January 2000-May 2012. The *t*-values for slope coefficients are adjusted for autocorrelation and heteroskedasticity using the Newey and West(1987) method with 24 lags.

$$IV_t = a_x + b_{VROE}VROE_{t-1} + b_{MABA}MABA_{t-1} + b_{VOL}VOL_{t-1} + b_{FHE}FHE_{t-1} + \varepsilon_t$$

Stocks	b_{VROE}	b_{MABA}	b_{VOL}	b_{FHE}	$adjR^2$
All:					
Big500	0.006	0.040	0.029	-0.008	0.5034
	(3.84)***	(1.87)*	(1.12)	(-5.09)***	
Small500	0.008	0.082	0.056	-0.002	0.2969
	(3.17)***	(1.36)	(1.49)	(-0.59)	
KOSPI	0.006	0.049	0.027	-0.008	0.5182
(largest 30%)	(3.79)***	(2.20)**	(1.03)	(-4.92)***	
KOSPI	0.016	0.059	0.048	-0.009	0.4934
(smallest 30%)	(5.63)***	(1.29)	(1.36)	(-2.36)**	
KOSDAQ	0.004	-0.066	0.036	-0.005	0.0923
(largest 30%)	(2.82)***	(-2.66)*** (1.78)*		(-2.94)***	
KOSDAQ	0.004	0.059	0.056	0.001	0.0818
(smallest 30%)	(1.03)	(0.80)	(1.07)	(0.19)	

Note: The numbers in parentheses below the *b* estimates are the Newey and West *t*-values adjusted for autocorrelation and heteroskedasticity. *, **, *** indicate statistical significance at 10%, 5% and 1%, respectively.

B. Export Effect

Since Korea has had a successful export-driven growth, the preponderance of stocks in export industries in the Korean economy is quite certain. We conjecture that a different interpretation of the four explanatory variables can be deduced for companies of export industries in comparison with those of the other industries. To check this possibility, we form the company group of six major export industries, including textile, chemical, machine, ICT[3], steel, automobile.[4] Each idiosyncratic

[3] ICT industry includes electronic components, computers, communication equipments.

[4] For a detailed analysis for six major export industries of Korea, refer to S-H Min, H-S Shin, J-M Lee, and S.H. Lee(2011).

volatility series is regressed on the four explanatory variables respectively to identify the effect of export orientation characteristics of companies for the period of January 2000-May 2012.

As shown in Table 9, we find that the role of *FHE* and *MABA* is more pronounced in export industries than the other industries, whereas *VROE* is consistently valid throughout all groups. Companies of the major export industries listed on KOSPI have a significantly positive estimate of *MABA* while the slope coefficient estimate of *FHE* triples the magnitude of other industries' estimate. Due to the effective role of growth option and foreign ownership ratio, the values of adjusted R^2 are much higher for export industries than the other industries.

Table 9.
Multivariate Regressions of Idiosyncratic Volatility:
Export Industries versus Other Industries

This table reports the regression results of export effect on idiosyncratic volatility. Idiosyncratic volatility is divided into two groups of major export industries and the others. Major export industries of Korea include textile, chemical, steel, machine, ICT and automobile. Each idiosyncratic volatility series is regressed on the four explanatory variables respectively to identify the effect of export orientation characteristics of companies for the period of January 2000-May 2012. The *t*-values for slope coefficients are adjusted for autocorrelation and heteroskedasticity using the Newey and West(1987) method with 24 lags.

$$IV_t = a_x + b_{VROE}VROE_{t-1} + b_{MABA}MABA_{t-1} + b_{VOL}VOL_{t-1} + b_{FHE}FHE_{t-1} + \varepsilon_t$$

Stocks	b_{VROE}	b_{MABA}	b_{VOL}	b_{FHE}	$adjR^2$
All stocks:					
Export Industries	0.006	0.043	0.010	-0.011	0.5754
	(3.63)***	(1.77)*	(0.39)	(-6.76)***	
Other Industries	0.006	0.040	0.035	-0.006	0.4178
	(3.89)***	(1.53)	(1.37)	(-3.34)***	
KOSPI:					
Export Industries	0.006	0.056	0.007	-0.012	0.6006
	(3.64)***	(2.33)**	(0.24)	(-6.65)***	
Other Industries	0.006	0.026	0.039	-0.004	0.3344
	(4.16)***	(1.08)	(1.65)	(-2.49)**	

Note: The numbers in parentheses below the *b* estimates are the Newey and West *t*-values adjusted for autocorrelation and heteroskedasticity. *, **, *** indicate statistical significance at 10%, 5% and 1%, respectively.

5. Change in Explanatory Power

Lastly, we investigate the change in the absolute and relative explanatory powers of four explanatory variables. This is a relevant concern because it is plausible that the relative role of our explanatory variables would change as time flows. To check this possibility, firstly, R^2 of each explanatory is calculated with a window of the past 10 years of all stocks. The plots of our results are illustrated in Panel (a) and (b) of Figure 4. In the beginning of 2000, R^2s of *VROE* and *VOL* start at a fairly high level, but steadily diminish to less than 0.1 by around 2005 and continue to dwindle between 0.0 and 0.2. However, R^2 of *FHE* exhibits a different pattern. Around 2010, its explanatory power is relatively higher than that of any other variables, but afterwards shows a steep decrease. The absolute explanatory power of *MABA* is low relative to other variables and shows little fluctuation compared to the others. In general, the absolute explanatory power of each of all four variables exhibits downward trend, although R^2 of *FHE* appears relatively somewhat higher than those of the others.

Next, the values of partial R^2 are also measured to examine the relative explanatory power of four explanatory variables. Idiosyncratic volatility of all stocks is first regressed on *VROE* and the values of R^2 are obtained using the moving window of the past 10 years. Then, the residuals from this rolling regression are regressed on *MABA*, and likewise, the value of R^2 is calculated. This is the partial R^2 of *MABA* conditioned on *VROE*, denoted as $R^2_{MABA|VROE}$. Switching the roles of *VROE* and *MABA*, the partial R^2 of *VROE* conditioned on *MABA*, denoted as $R^2_{VROE|MABA}$, is obtained. Panel (c) of Figure 4 confirms the earlier univariate finding that *VROE* is relatively more fitting than *MABA* of the fundamentals related variables. The partial R^2 of *VROE* conditioned on *MABA*, $R^2_{VROE|MABA}$ shares a similar movement to the R^2 of *VROE*, and is much higher than $R^2_{MABA|VROE}$. $R^2_{MABA|VROE}$ remains low, but temporarily increases between mid 2009 to early 2010. However, as the data approaches 2012, the absolute and relative explanatory power of *VROE* and *MABA* drop substantially. Panel (d) reports the value of R^2 of all the four variables. While the aggregate explanatory power of the four variables is trending downward, the increase in explanatory power when *FHE* is added can be noticed.[5]

[5] Although the results for KOSPI and KOSPI200 are omitted, the plots of R^2 and partial R^2 for KOSPI and KOSPI200 are almost identical to those for the case of all stocks illustrated in Figure4.

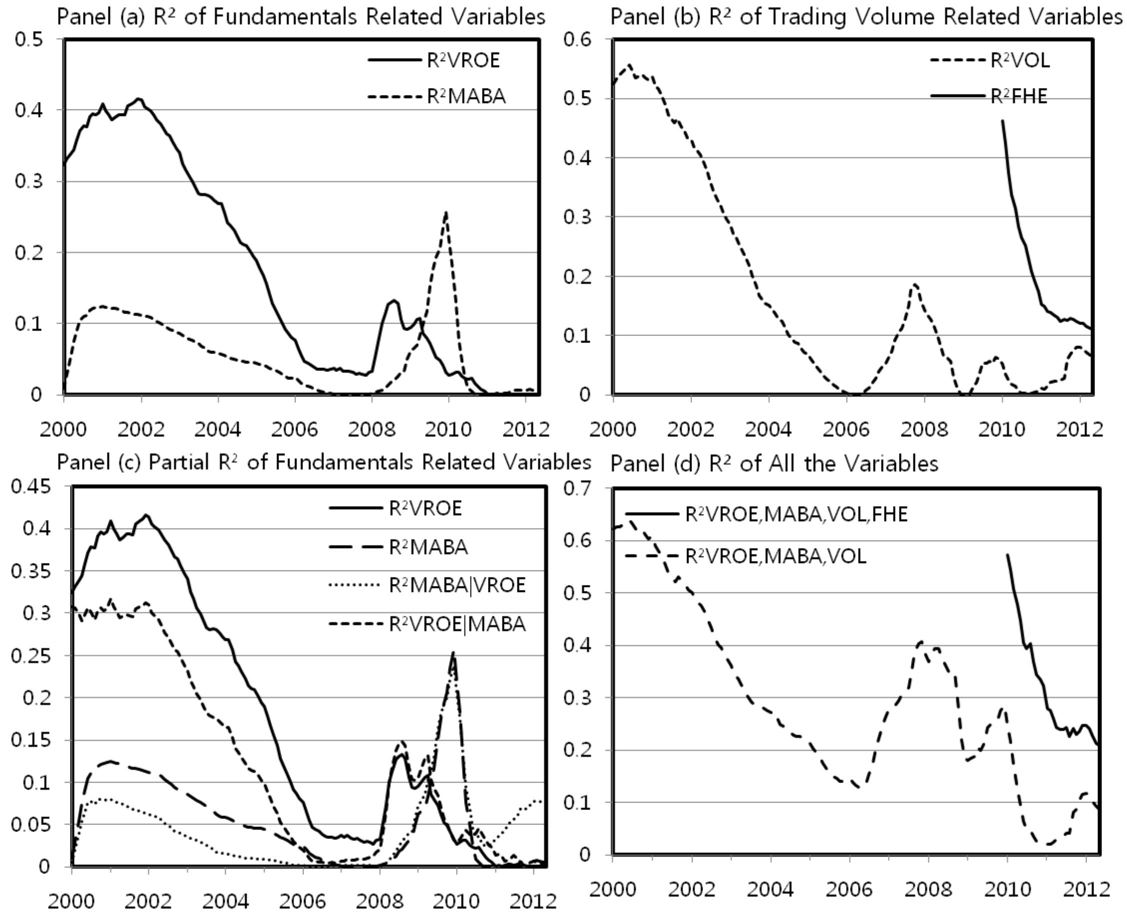

Figure 4. Explanatory Power of Explanatory Variables.

This figure plots the change of R^2 of the regressions of idiosyncratic volatility on each explanatory variable over time. Partial R^2 is also computed from the residual of the regression in which a conditioned variable is first regressed on. The value of R^2 and the partial R^2 are obtained from the regressions using the moving window of the past 10 years.

IV. Concluding Remarks

In this paper, we investigate various features of idiosyncratic volatility in the Korean stock market, one of largest emerging economies in the past two decades. The firm level idiosyncratic volatilities in the Korean stock market are estimated using the three-factor model of Fama and French(1993) over the time span of January 1990 through May 2012. Firstly, we obtain the firm level daily conditional idiosyncratic volatilities with the moving window of 252 days, and then value-weighted them to calculate the firm level monthly conditional idiosyncratic volatilities. The monthly value weighted idiosyncratic volatilities are regressed on the four explanatory variables for the groups of stocks using the generalized method of moments(GMM) to examine what explains the idiosyncratic volatility in the Korean stock market. We find that in the Korean stock market, the upward trend of the idiosyncratic volatility over the 1990s is reversed around 2000 to the downward trend throughout the 2000s. This is similar to the trend of idiosyncratic volatility observed in industrialized economies, reflecting a global interdependence. While in the case of industrialized economies Zhang(2010) maintains that fundamentals related variables better explain the trend of idiosyncratic volatility than trading volume related variables, we observe that in the Korea stock market both strands of variables reasonably contribute to explain the variation of idiosyncratic risk.

One of the major findings in this paper is that variance of ROE (*VROE*), a proxy of growth options (*MABA*), trading volume (*VOL*) and foreign ownership ratio (*FHE*) altogether explain considerable proportions of idiosyncratic return variation. It appears that on the whole *VROE*, *MABA, VOL* are positively related to the idiosyncratic volatility while *FHE* is negatively related. While the role of foreign ownership ratio is most prominent over the period of January 2000 through May 2012, volatility of return on equity was consistently effective over the entire period of January 1990 through May 2012, irrespective of the trend reversion of idiosyncratic volatility. Interestingly enough, the role of growth options strengthens and the effect of trading volume wanes in 2000s. In terms of adjusted R2 value, the explanatory power of the four explanatory variables for KOSPI and KOSPI200 reaches about 0.54 and 0.50, respectively, over the period of January 2000 through May 2011. However, as illustrated in Figure 4 plotting the changes of R^2 values calculated from the rolling regressions using the window of the past 10 years, the explanatory power of the four explanatory variables on the idiosyncratic volatility decreases considerably as time passes.

In addition, conjecturing that a firm's characteristics might be reflected on the contribution of the four explanatory variables on the idiosyncratic volatility, we focus mainly on size in terms of capitalization and export orientation in particular among firm characteristics. We observe that regardless of size and export features, *VROE* is a consistently effective explanatory variable across all groups. Additionally, the effects of *MABA* and *FHE* are more prominent in idiosyncratic risk of large companies and the group of export industries than small companies and the group of the other industries.

Although our findings shed little light on the trend and causes of idiosyncratic volatility in the Korean stock market beyond the past two decades, there remains further necessary researches. As previously mentioned, the diminishing explanatory power of the four explanatory variables throughout the sample period requires us to search for other latent explanatory variables needed to clarify the unexplained variation of idiosyncratic volatility. Furthermore, a comparative investigation of idiosyncratic volatility across emerging stock markets might be a stimulating subject in the future to understand in greater detail the effect of the deepening interdependence of global financial markets.

Appendix

Table A: Data Definitions

Volatility and Factors	
Idiosyncratic volatility	Standard deviation of residual stock return from a Fama-French (1993) three-factor regression based on daily data
Market premium	Market return minus risk free rate
SMB	Return of the portfolio of small stocks minus return of the portfolio of big stocks (50-50)
HML	Return of the portfolio of stocks that have high book-to-market ratio minus return of the portfolio of stocks that have low book-to-market ratio. (30-40-30)
Explanatory Variables	
VROE	Variance of ROE over the past three years
MABA	Market value of equity plus book value of debt divided by book value of asset
VOL	Log of daily trading volume of a stock in won
FHE	Daily foreign ownership ratio of a stock

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