Table 1 Summary statistics

The present table demonstrates the summary statistics for the full sample period from January 2002 to December 2017. To measure idiosyncratic risk (IVOL), we use the residuals in a regression of each stock's daily return on the three and four factors defined by Fama and French (1993). $IVOL_{t+1}$ is the idiosyncratic risk during the next month. We collect the foreign ownership (FO_t) at the end of calendar month. Book to market ratio (BM_t) is computed by comparing book value to market capitalization. $Ln(Size)_t$is common logarithm of market capitalization at the last day of each calendar month. Leverage (Lev_t) is computed by comparing the total debt to sum of total debt and market capitalization. Age is measured by common logarithm of firm age. We also consider monthly current return of equity (ROE). In Panel A, we report summary statistics which includes the number of samples, mean, median, and standard deviation. The value of summary statistics is computed by time-series average of monthly cross section. In Panel B, we sort months into quintile portfolios based on foreign ownership and compute the average value of idiosyncratic risk.

Panel A. Full sample variable

	Number of stocks	Mean	Median	Std Dev
$IVOL_t$	946	0.02	0.02	0.01
FO_t	946	0.11	0.04	0.15
Firm $size_t$	946	5.23	5.08	0.74
BM_t	946	1.92	1.40	7.39
Lev_t	946	0.57	0.58	0.24
Age_t	946	1.39	1.44	0.22
ROE_t	946	0.01	-0.00	0.14

Panel B. Idiosyncratic risk sorted by foreign ownership quintile

	High	2	3	4	Low
3 factor model estimated $IVOL_t$	0.019	0.020	0.021	0.023	0.027
4 factor model estimated $IVOL_t$	0.018	0.019	0.020	0.022	0.026

Table 2 Foreign ownership and idiosyncratic risk

The present table demonstrates that results of the effect of foreign ownership on idiosyncratic from January 2002 to December 2017. We consider dependent variable as stock i's idiosyncratic risk (IVOL) at month t. We use residuals in a regression of each stock's daily return on the three and four factors defined by Fama and French (1993) and Carhart (1997) as a measure of idiosyncratic risk. Foreign ownership (FO) is foreign investor's ownership at the end of calendar month t-1. We compute the firm size by common logarithm of market capitalization at the last day of each calendar month. Book to market ratio (BM) is computed by comparing the book value of equity to market capitalization. We also adjust the scale of variable multiplied by 10^{-1}. Age indicates the firm age and computed by common logarithm of period of listed on the exchange. Leverage (Lev) is computed by comparing the total debt to sum of total debt and market capitalization. ROE is the monthly current return of equity. Div is the dividend dummy variable that is equal to 1 if the firm paid the dividend in the current year and zero otherwise. For first two columns, we report the regression coefficients using Fama and MacBeth (1973) method. The t-statistics are computed using heteroskedasticity and autocorrelation consistent Newey and West (1987) standard errors. In third column, we re-estimate the regression equation using fixed effect panel regression model with time effect. We compute the t-statistics using white robust standard errors. The asterisks indicate significance at the 1%(***), 5%(**), and 10%(*) levels.

Panel A: Dependent variable is idiosyncratic risk ($IVOL_{i,t}$), estimated by 3 factor model

	(1)	(2)	(3)
Intercept	0.040***	0.039***	
	(26.20)	(19.11)	
$FO_{i,t-1}$	-0.002**	-0.002**	-0.002 **
	(-2.35)	(-2.42)	(-9.95)
$Size_{i,t-1}$	-0.002***	-0.002***	-0.002***
	(-9.56)	(-9.07)	(-31.91)
$BM_{i,t-1}$	-0.002***	-0.002***	-0.001
	(-3.41)	(-3.57)	(-0.23)
$Age_{i,t-1}$	-0.001	-0.001	-0.001***
	(-1.35)	(-1.54)	(-8.60)
$Lev_{i,t-1}$	-0.003***	-0.002***	-0.002***
	(-8.03)	(-4.07)	(-11.26)
$ROE_{i,t-1}$	0.013***	0.013***	0.014***
	(13.60)	(13.55)	(36.87)
$Div_{i,t-1}$	-0.007***	-0.007***	-0.002***
	(-21.10)	(-19.61)	(-79.80)
Industry dummy	N	Y	Y

Panel B: Dependent variable is idiosyncratic risk ($IVOL_{i,t}$), estimated by 4 factor model

	(1)	(2)	(3)
Intercept	0.039***	0.038***	

	(26.67)	(19.77)	
$FO_{i,t-1}$	-0.001**	-0.002**	-0.002***
	(-2.24)	(-2.33)	(-9.35)
$Size_{i,t-1}$	-0.002***	-0.002***	-0.002***
	(-10.74)	(-10.30)	(-35.82)
$BM_{i,t-1}$	-0.002***	-0.002***	-0.000
	(-3.39)	(-3.544)	(-0.157)
$Age_{i,t-1}$	-0.001	-0.000	-0.001***
	(-1.20)	(-1.37)	(-8.53)
$Lev_{i,t-1}$	-0.003***	-0.002***	-0.002**
	(-8.37)	(-4.18)	(-11.36)
$ROE_{i,t-1}$	0.013***	0.013***	0.014***
	(14.06)	(14.00)	(36.14)
$Div_{i,t-1}$	-0.007***	-0.007***	-0.007***
	(-21.13)	(-19.65)	(-80.17)
Industry dummy	N	Y	Y

Table 3 Granger causality test

Following Boehmer and Kelley (2009), we exploit granger causality test using time series regression. Using vector autoregressive model, we estimate time series regression for each stocks which having monthly observations over the past five years, at least. To check direction of causality between idiosyncratic risk and foreign ownership, dependent variables are considered foreign ownership and idiosyncratic risk in first difference form, respectively. Foreign ownership (FO) is foreign investor's ownership at the end of calendar month t-1.Idiosyncratick risk is estimated using Fama and French' three factor model. We compute the firm size by common logarithm of market capitalization at the last day of each calendar month. Book to market ratio (BM) is computed by comparing the book value of equity to market capitalization at the last day of each calendar month. Leverage (Lev) is computed by comparing the total debt to sum of total debt and market capitalization. All independent variables are expressed as value lagged by one month. Δ indicates change during current month. We report the average coefficients along with *standard t-test.* The value in parenthesis is p-value. ***, **, and * indicate t-values of 1%, 5%, 10%, respectively.

Panel A: Dependent variable is a monthly change in idiosyncratic risk (ΔIV)

Intercept	Lag_ΔFO	Lag_ΔIV	Lag_ΔSize	Lag_ΔBM	Lag_ΔLev	Lag_ΔROE
0.009***	-0.076***	-0.093***	-0.028***	-0.007	-0.005	0.012***
(0.00)	(0.00)	(0.00)	(0.00)	(0.22)	(0.46)	(0.00)

Panel B: Dependent variable is a monthly change in foreign ownership (ΔFO)

0.001	0.184***	-0.011*	0.022***	-0.01	0.011	-0.003
(0.88)	(0.00)	(0.07)	(0.01)	(0.48)	(0.14)	(0.31)

Table 4 Information based explanation

In this table, we examine the information based explanation. First, we examine the relation between equity mispricing, foreign ownership, and idiosyncratic risk. We consider three measures for equity mispricing. Mispricing 1 is based on the comparison of industry peer groups (Doukas, Kim, and Pantzalis (2011)). Mispricing 2 and 3 are based on the model of Rhodes-Kropf, Robinson, and Viswanathan (2005). Specifically, using regression equation (5) and (6), we construct mispricing 2 and 3, respectively. The regression is estimated cross sectionally in each month. After that we can calculate the firm specific error using fitted value. In case of regression (6), Firm specific error is defined as $M_{i,t} - (\alpha_{i,t} + \sum_{i=1}^{4} \beta_{i,t})$. The degree of mispricing is computed by time series average value of cross sectional firm specific error. We estimate coefficient of the regression of future idiosyncratic risk on foreign ownership, including interaction variable between foreign ownership and mispricing. The results are reported from first to third column. In column (4), we examine the relation between foreign ownership and idiosyncratic risk adding analyst coverage. As a measure of analyst coverage, we use the number of analyst who issued earnings forecast for a stock during the given calendar year. To adjust the scale of variable, we take the logarithm of one plus number of analyst. To consider industry effect, every regression includes industry dummy variable. Newey and West (1987) robust *t-statistics* are reported in parentheses. ***, **, and * indicate t-values of 1%, 5%, 10%, respectively.

	(1)	(2)	(3)	(4)
Intercept	0.040***	0.0388***	0.0387***	0.0350***
	(18.84)	(19.75)	(19.96)	(25.36)
$FO_{i,t-1}$	-0.0018**	0.0008	0.0013	-0.0060***
	(-2.50)	(0.47)	(0.72)	(-3.93)
$Mispricing1_{t-1}$	-0.0011***			
	(-7.94)			
$Mispricing2_{t-1}$		0.0001		
		(0.77)		
$Mispricing3_{t-1}$			0.0001	
			(0.99)	
$I(FO * Mispricing\ 1)_{t-1}$	-0.0008*			
	(-1.69)			
$I(FO * Mispricing\ 2)_{t-1}$		-0.0005*		
		(-1.87)		
$I(FO * Mispricing\ 3)_{t-1}$			-0.0006**	
			(-2.11)	
$Analyst_{t-1}$				0.0010***
				(4.85)
$I(FO * Analyst)_{t-1}$				0.0050***

				(3.31)
$Size_{i,t-1}$	-0.0020***	-0.001****	-0.0019***	-0.0020***
	(-9.46)	(-9.09)	(-9.10)	(-11.76)
$BM_{i,t-1}$	-0.0001***	-0.0002***	-0.0002***	-0.0000***
	(-2.69)	(-3.58)	(-3.58)	(-3.10)
$Age_{i,t-1}$	0.0001	-0.0005	-0.0005	-0.0000
	(0.45)	(-1.55)	(-1.54)	(-1.25)
$Lev_{i,t-1}$	-0.0042***	-0.0019***	-0.0019***	-0.0030***
	(-8.43)	(-4.14)	(-4.15)	(-4.40)
$ROE_{i,t-1}$	0.0131***	0.0132***	0.0013***	0.0150***
	(13.78)	(13.57)	(13.56)	(11.64)
$Div_{i,t-1}$	-0.0070***	-0.0072***	-0.0072***	-0.0060***
	(-20.33)	(-19.63)	(-19.67)	(-23.31)

Table 5 Governance, foreign ownership, and idiosyncratic risk

In this table, we examine the relationship between foreign ownership and idiosyncratic risk in different corporate governance environment. To measure the degree of corporate governance, we employ the corporate evaluate score. Korea Corporate Governance Service (KCGS) provide the corporate evaluate score for each stock. The corporate evaluate scores are computed by reflecting degree of shareholder protection, activity of board of directors, corporate disclosure, audit systems, and profit sharing. In Panel A, we present the time series average of monthly cross sectional mean and standard deviation of foreign ownership and idiosyncratic risk in next month. We examine the relationship between foreign ownership and idiosyncratic risk in different governance environment and report the regression coefficients. Gov is the dummy variable which takes 1 if the stock i belongs to poor governance group, and zero otherwise. $I(FO_{i,t} * Gov)$ is interaction variable between foreign ownership and governance dummy variable. The result is reported in first column of Panel B. To enhance the robustness of test, we conduct the subsample analysis. Due to limitation of sample, the analysis using corporate evaluate score covers the period from 2011 to 2017. To consider industry effect, every regression includes industry dummy variable. All analyses included the industry dummy variable. Newey and West (1987) robust *t-statistics* are reported in parentheses. ***, **, and * indicate t-values of 1%, 5%, 10%, respectively.

Panel A: Mean and standard deviation of foreign ownership and future idiosyncratic risk in different governance environment

	Corporate evaluate score				
	High		Low		
	Mean	Standard deviation	Mean	Standard deviation	Difference in means
$FO_{i,t}$	0.127	0.005	0.065	0.131	0.062***
					(40.39)[1]
$IVOL_{i,t+1}$	0.018	0.003	0.022	0.003	-0.004***
					(-7.82)

Panel B: Foreign ownership and idiosyncratic risk in different governance environment

	(1)	(2)	
		High	Low
Intercept	0.0287***	0.0252***	0.0311***
	(18.24)	(9.26)	(13.38)
$FO_{i,t-1}$	-0.0001	-0.0023***	-0.0034***
	(-0.07)	(-2.86)	(-4.14)
$GOV_{i,t-1}$	0.0011***		
	(6.17)		
$I(FO_{i,t} * GOV_{i,t-1})$	-0.0039***		
	(-0.68)		

[1] Report the sample t-statistics with null hypothesis is mean equal to zero

$Size_{i,t-1}$	-0.001***	-0.0005	-0.0011***
	(-4.78)	(-1.05)	(-3.49)
$BM_{i,t-1}$	-0.0002***	-0.0002	-0.0003***
	(-4.17)	(-1.19)	(-3.65)
$Age_{i,t-1}$	-0.001***	-0.0019***	-0.0006***
	(-5.18)	(-5.04)	(-2.24)
$Lev_{i,t-1}$	-0.002***	-0.0008	-0.0023***
	(-4.51)	(-1.33)	(-3.25)
$ROE_{i,t-1}$	0.016***	0.0092***	0.0167***
	(16.01)	(6.67)	(17.18)
$Div_{i,t-1}$	-0.006***	-0.0023***	-0.0062***
	(-28.42)	(-7.32)	(-18.66)

Table 6 Event study (idiosyncratic risk response after block holding announcement of foreign activist investor)

Using data from Data Analysis and Retrieval Transfer (DART) in Financial Supervisory Service (FSS), I manually collect the block holding announcement of foreign investors who declare their share acquisition to influence in management. All announcements are categorized into buying and selling announcement. Sample period is January 2005 to December 2015. The present paper defines above foreign investors as foreign activists and hypothesizes that idiosyncratic risk will decrease after the buying announcement of foreign activists if foreign activists enhance the monitoring. The ordinary least square model is specific as follows:

$$IVOL_{i,t} = \alpha_{i,t} + \sum_{n=0}^{6} \gamma_n \delta_{n,i,t} + \sum_{t=1}^{12} \lambda_t + \sum_{q=1}^{Q} \eta_t + \varepsilon_{i,t}$$

where δ_0 is a binary variable taking a value 1 if the time t is announcement month. δ_1 is a binary variable that takes a value 1 if the time t is one month later a foreign activist's block holding announcement. We set n up to 6, considering the event period up to 6 month later. The coefficient γ captures that effect on idiosyncratic risk. To consider time effect, we include the calendar month dummy variable, λ which taking a value of 1 for month t. η is the industry dummy taking 1 for industry q, and zero otherwise. We use 11 industries from the two-digit Korea SIC code. In order to address selection bias, we re-estimate using propensity score matching method. We match the stocks using firm characteristics, such as firm size, book to market ratio, liquidity, leverage, current return, and leverage. The results of matched sample are reported in Panel B. The coefficients are estimated using standard errors clustered at firm level. ***, **, and * indicate t-values of 1%, 5%, 10%, respectively.

Panel A-1: Buying announcement

	α	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6
Coefficient	0.0401***	0.0006	-0.0009	-0.0008	-0.0007	-0.0019**	-0.0017**	-0.0016**
t-statistics	(42.74)	(0.68)	(-1.13)	(-0.96)	(-0.86)	(-2.27)	(-2.47)	(-2.26)
Observation	1589							

Panel A-2: Selling announcement

	α	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6
Coefficient	0.0452***	0.0024**	0.0008	0.0008	-0.0001	0.0012	-0.0001	-0.0005.
t-statistics	(31.89)	(2.14)	(0.78)	(0.71)	(-0.12)	(1.00)	(-0.05)	(-0.45)
Observation	1118							

Panel B-1: Buying announcement (propensity score matching sample)

	α	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6
Coefficient	0.0391***	0.0008	0.0000	-0.0002	-0.0003	-0.0012	-0.0006	-0.0002
t-statistics	(742.4)	(1.04)	(0.02)	(-0.24)	(-0.41)	(-1.49)	(-0.80)	(-0.25)
Observation	1589							

Panel B-2: Selling announcement (propensity score matching sample)

	α	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6
Coefficient	0.0395***	0.0005	-0.0001	0.0006	-0.0002	-0.0003	0.0025	-0.0001
t-statistics	(749.5)	(0.44)	(-0.07)	(0.40)	(-0.13)	(-0.26)	(1.54)	(-0.09)
Observation	1118							

Table 7 Portfolio diversification effect

The excess standard deviation is computed by the difference between the monthly standard deviation of individual stock and the monthly standard deviation of a value weighted market index. The monthly standard deviation is computed each month from daily data within month. We use the Korea composite stock price index (KOSPI) as a market index. In Panel A, we report the time series average of excess standard deviation for each quintile portfolio that sorted by foreign ownership. In Panel B, we report the time series average of portfolio's excess standard deviation. We construct the five portfolios that containing randomly selected stocks from two to thirty stocks. FO indicates the percentage of foreign ownership at the last day of calendar month. ***, **, and * indicate p-values of 1%, 5%, 10%, respectively.

Panel A. Average excess standard deviation

	High	2	3	4	Low
Excess standard deviation	0.119***	0.128***	0.134***	0.155***	0.186***

Panel B. Excess standard deviation against number of stock and foreign ownership

	Number of stocks				
	2	5	10	20	30
FO > 10%	0.67***	0.28***	0.08***	-0.03*	-0.07***
FO > 5%	0.79***	0.28***	0.07***	-0.03	-0.10***
FO < 5%	1.03***	0.49***	0.17***	0.01	-0.04
FO < 1%	1.17***	0.56***	0.25***	0.04	-0.05

Table 8 Analysis using alternative idiosyncratic risk measure

To ensure the robustness of analysis, we use alternative measures of idiosyncratic risk. First, we examine the effect of foreign ownership on expected idiosyncratic risk. Following Fu (2009), we use the exponential GARCH (1, 1) models to estimate expected idiosyncratic risk. The explicit functional forms are as follows: For the regression, we require the firms to have at least 60 months of observations. The analysis period is January 2005 to December 2017. The regression result is reported in column (1). Second, we estimate idiosyncratic risk as logistic transformation of ratio between idiosyncratic risk and total risk, by $\log(\frac{(1-R^2)}{R^2})$. The R^2 value obtained from the three factor model (Fama and French (1993)). The analysis period using idiosyncratic risk relative to total risk is January 2002 to December 2017. The regression result is reported in column (2). As a control variable, we include the firm size (Size), book to market ratio (BM), firm age (Age), return on equity (ROE), leverage (Lev), and dividend dummy (Div). All regressions include industry dummy variable. Newey and West (1987) robust t-statistic are reported in parentheses. ***, **, and * indicate t-values of 1%, 5%, 10%, respectively.

	(1)	(2)
Intercept	0.069	3.098***
	(1.63)	(22.13)
$FO_{i,t-1}$	-1.871**	0.313**
	(-2.16)	(8.14)
$Size_{i,t-1}$	-0.408	-0.335***
	(-0.77)	(-12.54)
$BM_{i,t-1}$	8.767	-0.044**
	(1.37)	(-2.37)
$Age_{i,t-1}$	6.921	0.013
	(1.21)	(0.61)
$Lev_{i,t-1}$	-7.486	-0.257***
	(-1.24)	(-7.54)
$ROE_{i,t-1}$	-20.103	0.375***
	(-1.01)	(7.21)
$Div_{i,t-1}$	-3.165	-0.006
	(-1.16)	(-0.40)