경영학 석사 학위논문

Can Granular Hypothesis Be Applied in Korean Economy?

Granular Hypothesis의 한국 경제 적용 가능성에 대한 실증 연구

2014년 2월

서울대학교 대학원

경영학과 재무금융 전공

오 준 호

Can Granular Hypothesis Be Applied in Korean Economy?

지도 교수 김 우 진

이 논문을 경영학 석사 학위논문으로 제출함
2013년 10월

서울대학교 대학원
경영학과 재무금융 전공
오 준 호

오준호의 경영학 석사 학위논문을 인준함
2013년 12월

위 원 장 ______조 재 호______ (인)

부위원장 ______김 영 진______ (인)

위 원 ______김 우 진______ (인)

Abstract

Junho Oh
College of Business Administration
The Graduate School
Seoul National University

This paper tests whether idiosyncratic shock to large firms can explain GDP fluctuation in Korea using stock return as well as fundamental variables. The results show that large firms' idiosyncratic stock calculated by fundamental variables fails to account for GDP growth when I control for the business cycle and several crisis dummies. In contrast, idiosyncratic shock to large firms derived by the stock return shows robust effect on GDP growth rate. However, the effect does not propagate through the business cycle. This idea might be useful to account for the fluctuation of GDP using stock market information and propose a new perspective for idiosyncratic shock.

Keywords : granular hypothesis, idiosyncratic shock, fundamental value, stock return
Student Number : 2012-20493

Contents

Tables

Figures

1. Introduction

People have thought that idiosyncratic shock is diversified away. However, some scholars have been skeptical about this diversification argument. Merton (1987) stated that idiosyncratic risk raises the expected return in a segmented security market and Shleifer (1997) argued "Idiosyncratic volatility probably matters more, since it cannot be hedged and arbitrageurs are not diversified." Moreover, Ang, Hodrick, Xing, and Zhang (2006) found that monthly stock returns are negatively related to the one-month lagged idiosyncratic volatilities. Challenging Ang' s comment, Fu (2009) showed a positive relationship between the expected stock return and the expected idiosyncratic shock derived by the GARCH model.

Recently, Gabaix (2011) proved that idiosyncratic shock to large firms in the United States could explain the shock to aggregate fluctuation such as GDP growth. He called this view the "Granular hypothesis." This means that at least in fundamentals, idiosyncratic shock is not diversified away and still has the power of influence. Lee (2013) suggested that this Granular hypothesis can be applied to the Korean economy when controlling for the 1998 crisis.

My motivation is that such idiosyncratic shock may be strong in the stock market as well as the fundamental market. Since stock return is a forward-looking measure that incorporates future cash flow and all available information, it is my supposition that the granular effect will strongly appear in the stock market. Although Gabaix empirically tested the granular hypothesis only by fundamental value, I use stock return as well as fundamental values to prove whether the granular hypothesis can be applied to the Korean economy or not.

The results are consistent to my hypothesis. I test the explanatory power of granular residual derived by both the fundamental variables and stock return. Although there is a significant relationship between the granular residual of the fundamental variables and GDP growth when I control for the 1998 crisis dummy, it is very sensitive to the outlier control. If I winsorize idiosyncratic growth rate at 20%, the coefficient of the contemporaneous granular residual is 0.306. However, when I do not control for the outlier, the result becomes insignificant.

In contrast, the explanatory power of the stock return granular residual is strong and robust in any case I consider. The contemporaneous granular residual derived by stock return shows a positive and significant coefficient of 0.199 when a systematic component is induced by rolling regression for 2 years. The result is still significant when I change the rolling period and there even is no outlier control. Compared to the granular residual of the fundamental variables, the stock return granular residual has the stable explanatory power to account for GDP fluctuation. Since using only the 1998 dummy might be too parsimonious, I define a new dummy that incorporates the persistent effect of crisis and the 2008 subprime mortgage event. In that case, the granular residual induced by the fundamental variables fails to explain GDP fluctuation. However, the result of the stock return granular residual is insensitive to the new crisis dummy, which is consistent with my main result.

When I control for the business cycle in the regression of the granular effect by using a coincident composite index, the stock return granular residual is still robust for all cases and has a coefficient around 0.1 and 0.2; meanwhile the fundamental granular residual could not account for the GDP growth. Thus, I conclude that the granular residual derived by the fundamental variables is very sensitive to controlling for the business cycle or the winsorizing criterion. Although the fundamental granular residual has explanatory power for GDP fluctuation when I only control for the crisis dummy and winsorize strictly, the granular residual cannot account for GDP growth when winsorizing is loose and the business cycle variable is included. However, the stock return granular residual shows a fairly robust result whenever I control for the outlier or the business cycle more leniently. Thus, the stock return granular residual is a more stable measure to account for GDP fluctuation in Korea than the fundamental variables.

Finally, I test whether the granular effect is amplified by the business cycle. According to the real business cycle model, temporary positive shock to an economy increases output, consumption, investment, and labor. Moreover, investment generates more available capital in the future. I guess that this propagation process might strengthen the granular effect. However, the interaction term between the boom dummy and the granular residual is insignificant even in the case of stock return. It implies there is no evidence that the granular effect propagates during a boom or recession period.

The contribution of my paper is that my results provide new evidence to those who believe that idiosyncratic shocks are not diversified away and still have influence.

This paper is organized as follows. Section 2 is a literature review. In section 3, I introduce data and methodology to test the granular effect and propose a modified measure that incorporates stock return. Section 4 reports the main results, and section 5 concludes the paper.

2. Literature Review

Traditionally, people have thought that idiosyncratic shock is diversified away. However, some scholars have casted doubt on the diversification of idiosyncratic component. Merton (1987) theoretically proved that idiosyncratic risk raises expected return in segmented security market and Shleifer (1997) argued "Idiosyncratic volatility probably matters more, since it cannot be hedged and arbitrageurs are not diversified." Moreover, Ang, Hodrick, Xing, and Zhang (2006) found that Monthly stock returns are negatively related to the one-month lagged idiosyncratic volatilities. Fu (2009) pointed out that idiosyncratic volatilities might be time varying so that he employed exponential GARCH model to simulate the idiosyncratic volatilities. He found that there was significant positive relation between expected returns and estimated idiosyncratic volatilities.

This point of view have been hotly debated not only in finance but also in macroeconomics. Long and Plosser (1983) proposed that GDP fluctuation could be explained by sectoral idiosyncratic shocks rather than firm shock. Horvath (2000) and Conley and Dupor (2003) showed that aggregate volatility is derived by sector-specific shocks. In addition, Horvath (1998) and Dupor (1999) argued that volatility of N sectors does not decay to $1/\sqrt{N}$.

In some countries such as Korea, a few huge firms account for aggregate economic figures. For example, di Giovanni and Levchenko (2009) reported that Samsung and Hyundai, the first and second largest firm in Korea, account for 35% of exports and 22% of Korean GDP. Canals, Gabaix, Vilarrubia, and Weinstein (2007) found that the top 10 Japanese firms account for 35% of exports in Japan. Since some large firms largely account for aggregate economic statistics in a country, it leads to the question of firm size distribution.

Axtell(2001) proved that U.S. firm size distribution follows Zipfs distribution or power distribution with exponent 1. Based on this argument, Gabaix(2011) suggested that "Idiosyncratic shocks to large firms have the potential to generate nontrivial aggregate shocks that affect GDP, and via general equilibrium, all firms." He called this view as 'Granular hypothesis.' This statement was based on failure of $1/\sqrt{N}$ diversification argument in an economy with a fat-tailed distribution of firm. Moreover, he tested how the idiosyncratic shocks to large firm affect aggregate fluctuation in economy by using granular residual which is calculated by weighted average of idiosyncratic labor productivity growth of top 100 firms. Then he showed that granular hypothesis is true in U.S.

In Korea, Kang et al. (2011) proved that Korean firm size distribution follows Zipf distribution by using the amounts of sales, total assets and capital, and the number of workers as size proxy. It means that size distribution of Korean firms is fat tailed and Granular hypothesis can be applied in Korean economy. Lee(2013) asserted that granular hypothesis is also consistent in Korea when she controled 1998 crisis dummy. She showed that idiosyncratic movements of the top 20 firms in Korea account for 63% of variations in output growth from 1981 to 2011.

3. Data and Methodology

3.1. Data

From Dataguide pro, I obtain data for the number of employees and net sales for all listed firms in KOSPI and KOSDAQ and firms in statutory audit from 1981 to 2012. Different from U.S., both parent company and subsidiary can be listed in Korea. Thus using consolidation financial statement will count the net sales duplicately for firms in the same business group. Hence I basically use non-consolidation financial statement to solve the problem.

In addition, I employ daily return, trading volume, market value data from January 1981 to December 2012. The data include nonfinancial common shares listed on KOSPI. Since I focus on large firms in Korea, considering only KOSPI market may not distort my result. Finally, the real GDP per capita data come from the ECOS in bank of Korea.

I eliminate corporate merger and split events because they can technically influence the net sales and the number of employees. Moreover, I delete events that can influence net sales but are not announced in Dataguide pro.[①]

As Kang et al. (2011) reported, Korean firm size distribution follows Zipf distribution when they focused KOSPI and KOSDAQ companies. Since Axtell(2011) considered data from bureau of labor statistics instead of compustat, I test firm size distribution using data from KOSIS[②] to follow Axtell's implication as close as possible.[③]

Figure 1 shows regression to determine the exponent α of the following power distribution:

$$\Pr[S \geq s_i] = \left(\frac{s_0}{s_i}\right)^{\alpha}, s_i \geq s_0, \alpha \geq 0 \tag{1}$$

① There are several cases that sales data abruptly changes from nonconsolidation criteria to consolidation criteria.
② Korean Statistical Information Service. The site provides overall statistics related to Korean.
③ In year 2011, there are 3,470,034 firms in Korea

$$\ln(f(s_i)) = A - (\alpha + 1)\ln(s_i) \tag{2}$$

where $f(s_i)$ is probability distribution function and $A = \alpha\ln(\alpha s_0)$.

The figure shows that $\alpha = 1.269$. According Gabaix(2011)'s theoretical implication, the idiosyncratic shocks decay at $\frac{1}{N^{1-\frac{1}{\alpha}}} = \frac{1}{N^{0.21}}$ rather than $\frac{1}{\sqrt{N}}$. It means that I can test Granular hypothesis because the Korean firm size distribution is fat-tailed.

3.2. Methodology

3.2.1. Original Granular Residual

Gabaix(2011) defines granular residual like the following:

$$\Gamma_t = \sum_{i=1}^{K} \frac{S_{i,t-1}}{Y_{t-1}} (g_{it} - \overline{g_t}) \tag{3}$$

where Γ_t is granular residual, S_{it} is net sales of firm i in year t, Y_t is aggregate sales in closed economy, equal to $\sum_{i=1}^{N} S_{it}$ g_{it} is productivity growth rate, and $\overline{g_t}$ is the mean of productivity growth rate in portfolio. He define g_{it} as $g_{it} = z_{it} - z_{it-1}$ where

$$z_{it} = ln\frac{sales\ of\ firm\ i\ in\ year\ t}{number\ of\ employees\ of\ firm\ i\ in\ year\ t} \quad (4)$$

z_{it} means labor productivity of firm i. Intuitively, granular residual is the weighted sum of top K firms' idiosyncratic labor productivity. Gabaix(2011) used average growth rate of firms in portfolio as a systematic part. He included the firms in granular residual as top K firms sorted by net sales and considered the effect of shock with respect to large firms on GDP growth by the following model.

$$\text{GDP growth}_t = \alpha_t + \beta_1\Gamma_t + \beta_2\Gamma_{t-1} + \epsilon_t \quad (5)$$

$$\text{GDP growth}_t = \alpha_t + \beta_1\Gamma_t + \beta_2\Gamma_{t-1} + \beta_3\Gamma_{t-2} + \epsilon_t \quad (6)$$

Strictly speaking, since GDP is not the exact sum of sales of each company as Gabaix(2011) implied. Thus someone might be skeptical to use granular residual for explaining GDP fluctuation because it is based on net sales. Nevertheless, granular residual can be easily calculated by observable firm specific data(parsimonious measure) so it is still meaningful. Moreover, unreported test says that total sum of net sales in my sample firm has strict linear relationship with GDP. To be specific, I regress GDP on sum of net sales and the coefficient is 0.6997 and R square is 0.96. Therefore, using sales data could be justified by these two reasons.

Lee(2013) suggests that because there were financial crisis in year 1998, the crisis effect should be considered. Hence, I also test the regression with dummy like following:

$$\text{GDP growth}_{\mathrm{t}} = \alpha_t + \beta_1\Gamma_{\mathrm{t}} + \beta_2\Gamma_{\mathrm{t-1}} + \beta_3\Gamma_{\mathrm{t-2}} + dummy_{1998} + \epsilon_t \qquad (7)$$

where $dummy_{1998}$ equals 1 in year 1998 and 0 otherwise. In section 4.3, I consider more robust crisis dummy such as including 2008 crisis dummy and so on.

Since considering average productivity growth rate as a systematic component might be too naïve, I employ rolling regression using market model.

$$\Gamma_{\mathrm{t}} = \sum_{i=1}^{K} \frac{S_{i,t-1}}{Y_{t-1}} (g_{it} - \widehat{g_t}) \qquad (8)$$

I calculate $\widehat{g_t}$ by rolling regression for 5 years.

$$g_{i,\tau} = \alpha_{j,t} + \beta_{i,m,t} g_{m,\tau} + \epsilon_{i,\tau} \qquad (9)$$

when $g_{i,\tau}$ is labor productivity growth rate or sales growth rate. To check robustness, I also consider rolling regression for 10 years.

I use real GDP growth rate, and I subtract CPI (Consumer Price index) growth rate from $\widehat{\epsilon_{i,\tau}}$ to control inflation rate.

3.2.2. Granular Residual Derived by Stock Return

I define granular residual using stock as a weighted sum of top K firms' idiosyncratic stock return.

$$\Lambda_{\mathrm{t}} = \sum_{i=1}^{K} \frac{S_{i,t-1}}{Y_{t-1}} (r_{it} - \hat{r_t}) \tag{10}$$

where $\mathrm{r_{it}}$ is stock return of firm i at month t. I calculate $\hat{r_t}$ by using two factor model proposed by Durnev, Morck, and Yeung (2004).

$$r_{i,j,\tau} = \alpha_{j,t} + \beta_{j,i,m,t} r_{m,\tau} + \beta_{j,i} r_{i,\tau} + \epsilon_{i,j,\tau} \tag{11}$$

$r_{i,\tau}$ means industry return with 2 digit code and $r_{m,\tau}$ means market return. Each industry should have at least five firms. To calculate beta, I use rolling regression for two and three years. To check robustness, I also obtain beta from regression for all period. Then and after calculating granular residual with stock, I regress equation (12).

$$\text{GDP growth}_{\mathrm{t}} = \alpha_t + \beta_1 \Lambda_{\mathrm{t}} + \beta_2 \Lambda_{\mathrm{t-1}} + \beta_3 \Lambda_{\mathrm{t-2}} + \epsilon_t \tag{12}$$

When I consider crisis dummy as Lee(2013)'s implication, I include dummy variable to equation (13).

$$\text{GDP growth}_{\mathrm{t}} = \alpha_t + \beta_1 \Lambda_{\mathrm{t}} + \beta_2 \Lambda_{\mathrm{t-1}} + \beta_3 \Lambda_{\mathrm{t-2}} + dummy_{1998} + \epsilon_t \tag{13}$$

4. Empirical Result

4.1. Testing Original Granular Residual in Korea

Table 1 shows explanatory power of granular residual which is calculated by sales growth and labor productivity growth. I obtain granular residual of top 10 firms and top 20 firms respectively and estimate the coefficient using equation (5) and (6). Overall, there is no significant result in this table and the R square is low. Thus, without any control variable, granular residual cannot explain the movement of GDP growth.

On the other hand, Lee(2013) reports that granular residual has an explanatory power when controlling crisis dummy. Table 2 shows the result of Lee's implication.[④] Since Lee(2013) controls outlier by winsorizing idiosyncratic growth rate $\widehat{\epsilon_{it}} = (g_{it} - \widehat{g_t})$ at 20% as Gabaix(2011) does, I report 20% winsorized result in Panel A of Table 2.[⑤]

The result in Panel A shows that granular effect might exist in Korea with controlling crisis dummy. The coefficient of

---

④ My dataset is different from Lee(2013)'s because she used her own dataset from bank of Korea.

⑤ Winsorizing $\widehat{\varepsilon_{it}}$ at $x\%$ means that if $|\widehat{\varepsilon_{it}}| > x$, then $\widehat{\varepsilon_{it}} = sign(x)$.

contemporaneous granular residual Γ_t is 0.306 in case of equation (5) and and 0.308 when I additionally include Γ_{t-2} in aforementioned regression(equation (6)). It implies that 1 percent of idiosyncratic shock to large firms can affect contemporaneous GDP growth rate at amount of 0.3%. Moreover, the coefficient of crisis dummy is negative and significant for all case. Trivially, the result shows that 1998 crisis negatively influences on GDP growth. Since R square is also high, the granular residual with crisis dummy has explanatory power on GDP growth.

Panel B of table 2 shows 50 percent winsorized result. The result is similar to the case of Panel A, but the coefficient of Γ_t significantly decreases. In addition, when I do not winsorize the idiosyncratic growth rate(Panel C), the magnitude of coefficient greatly drops and even become insignificant if I use equation (6). Therefore, the explanatory power of granular residual with crisis dummy is sensitive to outlier control.

In fact, unreported test shows that average 45 percent of idiosyncratic labor productivity growth data is winsorized by such 20 percent rule. In other words, among top 20 sales firms, idiosyncratic labor productivity growth to 9 firms is modified and it is possible that some data are dramatically changed. Thus, such changed data may leads to biased result.

4.2. Granular Residual Derived by Stock Return

Table 3 reports explanatory power of granular residual which is derived by stock return. I consider top 10 firms to obtain granular residual by equation (10). When calculating $\hat{r}_t$, I use equation (11) with rolling period 2 years in Panel A and 3 years in Panel B. Both Panel A and Panel B show that granular residual derived by stock return has significant relationship with GDP growth rate. The coefficients of Λ_t , Λ_{t-1} , and Λ_{t-2} shows that 1 percent contemporaneous idiosyncratic stock return shock to large firms affects fluctuation of GDP growth at amount of 0.2 percent. Moreover, GDP growth is influenced by big firms' idiosyncratic stock return in previous year and two years ago. Hence, the idiosyncratic stock return explains the GDP fluctuation well and the effect is persistent for two years.

For robustness check, I also calculate $\hat{r}_t$ from beta induced by period from 1981 to 2012. The result is reported in Panel C and basically similar to other results.

I report the result in Table 4 when I control crisis dummy in equation (11). As I mention that winsorizing might be dangerous, I control outlier more carefully. I winsorize idiosyncratic stock return at 1 percentile and 99 percentile, but the result is basically insensitive to such control. As you see in the Panel A of Table 4, the contemporaneous granular residual derived by stock return significantly affects GDP growth although the significance of first lag and second lag granular residual disappear. Compared to granular residual of fundamental variables (Table 2), explanatory power of granular residual of stock return is better because the R square is higher (0.70) than that of fundamental variables (0.44~0.56).

For robustness check, I also consider case when beta is derived by the all sample period(Panel B). Although the magnitude of coefficient and R square somewhat drop, contemporaneous granular residual still has significant effect on GDP growth.

4.3. Granular Residual and Crisis Dummy

Crisis dummy in equation (7) might be too parsimonious to explain all crisis in Korea. There is subprime mortgage crisis in 2008 and this incident greatly affects the Korean business cycle. Moreover, such crisis effect might be persistent for several years. Therefore, I solve the above two question by considering several specification for crisis dummy.

To solve the former implication, I also set value 1 in year 2008 as well as in year 1998. Secondly, I define crisis dummy as 4 implication to control persistent shock of crisis as follows:

(A): Crisis=1 when year 1997, 1998, 1999 & 2007, 2008, 2009.

(B): Crisis=1 when year 1996, 1997, 1998, 1999, 2000 & 2006, 2007, 2008, 2009, 2010.

(C): Crisis=1 when year 1997, 1999 & 2007, 2009.

Crisis=2 when year 1998, 2008.

(D): Crisis=1 when year 1996, 2000 & 2006, 2010.

Crisis=2 when year 1997, 1999 & 2007, 2009

Crisis=3 when year 1998 & 2008

The implication (A) and (C) mean that crisis effect exist around 1 years as well as 1998 and 2008. Similarly, the implication (B) and (D) imply that crisis effect exist around 2 years centered at crisis year. Finally, (C) and (D) have a meaning that the nearer the crisis years, the stronger crisis effect.

Table 5 shows explanatory power of granular residual derived by fundamental variable with new crisis dummy. In this table, crisis implies new crisis dummy employed by the 4 implication. Overall, there is no significant coefficient and it means that fundamental granular residual is very sensitive to control other variables and cannot explain GDP fluctuation well. Although the R square is reasonably high(around 60%), it might be driven by the regression structure that includes many independent variables.

In case of stock return granular residual, all Λ_t is significant and positive. Moreover when I obtain systematic component from regression for all period (Panel B of Table 6), all Λ_t, Λ_{t-1}, and Λ_{t-2} are significant and positive.

It is interesting that interaction term crisis$\times \Lambda_t$ in Panel B is significant and negative. It seems to be contradicted that 1 percent idiosyncratic increase in top sales firms affect GDP growth at the amount of −0.4 percent (=0.092−0.495) when a country falls crisis. It can be interpreted as following. Firstly, my sample is relatively small (yearly data from 1981 to 2012) and secondly, GDP falls dramatically when crisis year. Hence, although there is positive shock to large firms, GDP should be decreased so that relationship between granular residual and GDP growth become negative.

4.4. Granular Residual and Business Cycle

In this section, I include control variables to indicate the business cycle. I use Coincident Composite Index(CCI) as a proxy of business cycle. Table 7 and Table 8 report the explanatory power of granular residual when I control Coincident Composite Index (CCI) itself. The variable 'cycle' means CCI. Table 7 shows that there is no significant relationship between GDP growth and granular residual of fundamental variables. It means that granular residual derived by fundamental variable cannot account for GDP fluctuation when I control business cycle. Only cycle variable is significant and positive so it implies business cycle deeply influences GDP fluctuation.

Finally, I test whether the granular effect is amplified by business cycle. According to real business cycle model, temporary positive shock to economy increases output, consumption, investment, and labor. Moreover, investment generates more available capital in the future. I guess that this propagation process might strengthen granular effect. I define boom dummy as 1 when CCI increases and 0 otherwise. The table 9 reports the explanatory power of granular residual derived by sales growth and labor productivity with controlling boom dummy. As you see Panel A of Table 9, the granular residual of sales growth could not account for GDP growth because R squares are low and there is no significant coefficient. In case of labor productivity growth (Panel B), Γ_{t-2} significantly affects GDP growth. However, there is no significant result of interaction term between granular residual and boom dummy. Although the boom×Γ_t is statistically significant, the main variable Γ_t is not significant. When I control recession dummy which has value 1 when CCI decreases and otherwise, the coefficients of independent variable I describe in Table 9 have exactly opposite sign to those of boom dummy. In brief, GDP fluctuation could not be explained by granular residual derived by fundamental variable well.

In contrast, the coefficients of granular residual derived by stock return with respect to GDP growth rate are still significant. When I obtain systematic part by rolling regression over the period 2 years (Panel A), coefficients of Λ_t are positive and significant for most cases although the significance move from Λ_t to Λ_{t-1} and Λ_{t-2} when I control interaction term with second lag granular residual. It means that contemporaneous granular residual of stock return well explains the GDP fluctuation. Moreover, as you see Panel B, the result is still robust when I obtain systematic component from the regression of all sample period.

I note that most boom dummies in Table 10 are positive and significant. It shows that when business cycle gets better, GDP growth also increases. However, such relation is very weak in the case of fundamental variables reported in Table 9. It may be due to the noise of fundamental data in Korea.

Similar to the case of Table 5 and Table 6, the granular residual derived by stock return, especially contemporaneous term, well explains GDP growth rate. Compared to Table 4 and Table 6, the magnitude of coefficient is also stable. Moreover, granular residual of stock return have higher explanatory power than that of fundamental variable because all contemporaneous coefficient is significant and R square is also higher.

However, all the interaction term is insignificant even in stock return granular residual. It implies the granular effect does not strengthen so that there is no evidence that granular effect propagates in boom or recession period.

In conclusion, the granular residual derived by fundamental variables is very sensitive to controlling business cycle or winsorizing criterion. Although Panel A and B of Table 2 shows that fundamental granular residual has significant effect on GDP growth, the results of Panel A of Table 2, Table 5 and Table 7 cast doubt on the stability of explanatory power. In contrast, stock return granular residual shows fairly robust result whenever I control outlier more leniently or business cycle as I reported in Table 6 and Table 8. Thus, stock return granular residual is more stable measure to account for GDP fluctuation in Korea than that of fundamental variables.

5. Conclusion

I test on Gabaix(2011)'s granular hypothesis by using fundamental variables and stock returns. Although there is a significant relationship between granular residual of fundamental variable and GDP growth when I control 1998 crisis dummy, it is very sensitive to the outlier control. Moreover, fundamental granular residual fails to explain GDP fluctuation when I include business cycle variable or new crisis dummy. In contrast, stock return granular residual shows fairly robust result whenever I control outlier more leniently or two cases of business. Thus, I conclude that stock return granular residual is more stable measure to account for GDP fluctuation in Korea than that of fundamental variables. However, I could not find the evidence that granular effect propagates in the boom or recession period. I believe that my results provides new evidence to propose a different point of view for the idiosyncratic shock.

Reference

Ang, Andrew, et al. "The cross-section of volatility and expected returns." *The Journal of Finance* 61.1 (2006): 259−299.

Axtell, Robert L. "Zipf distribution of US firm sizes." *Science* 293.5536 (2001): 1818−1820.

Canals, Claudia, et al. *Trade patterns, trade balances and idiosyncratic shocks*. " la Caixa", 2007.

Chan, Louis KC, Yasushi Hamao, and Josef Lakonishok. "Fundamentals and stock returns in Japan." The Journal of Finance 46.5 (1991): 1739−1764.

Chun, Hyunbae, et al. "Creative destruction and firm−specific performance heterogeneity." *Journal of Financial Economics* 89.1 (2008): 109−135.

Chun, Hyunbae, Jung−Wook Kim, and Randall Morck. "Varying heterogeneity among US firms: facts and implications." Review of Economics and Statistics 93.3 (2011): 1034−1052.

Conley, Timothy G., and Bill Dupor. "A spatial analysis of sectoral complementarity." *Journal of Political Economy* 111.2 (2003): 311−352.

David, Alexander, and Pietro Veronesi. What ties return volatilities to price valuations and fundamentals?. No. w15563. National Bureau of Economic Research, 2009.

Di Giovanni, Julian, and Andrei A. Levchenko. "International trade and aggregate fluctuations in granular economies." *University of Michigan, Research Seminar in International Economics, Working Paper*. Vol. 585. 2009.

Dupor, Bill. "Aggregation and irrelevance in multi−sector models." *Journal of Monetary Economics* 43.2 (1999): 391−409.

Durnev, Art, Randall Morck, and Bernard Yeung. "Value-enhancing capital budgeting and firm-specific stock return variation." *The Journal of Finance* 59.1 (2004): 65-105.

Gabaix, Xavier. "The granular origins of aggregate fluctuations." *Econometrica* 79.3 (2011): 733-772.

Fu, Fangjian. "Idiosyncratic risk and the cross-section of expected stock returns." *Journal of Financial Economics* 91.1 (2009): 24-37.

Horvath, Michael. "Cyclicality and sectoral linkages: Aggregate fluctuations from independent sectoral shocks." *Review of Economic Dynamics* 1.4 (1998): 781-808.

Horvath, Michael. "Sectoral shocks and aggregate fluctuations." *Journal of Monetary Economics* 45.1 (2000): 69-106.

Kang, Sang Hoon, et al. "Changes of firm size distribution: The case of Korea." Physica A: Statistical Mechanics and its Applications 390.2 (2011): 319-327.

Lee, Mihye. "Can Idiosyncratic Shocks to Firms Explain Macroeconomic Fluctuations? *Working paper* (2013): 1-17

Long Jr, John B., and Charles I. Plosser. "Real business cycles." *The Journal of Political Economy* (1983): 39-69.

Merton, Robert C. "A simple model of capital market equilibrium with incomplete information." *The Journal of Finance* 42.3 (1987): 483-510.

Morck, Randall, et al. "The stock market and investment: is the market a sideshow?." Brookings Papers on Economic Activity 1990.2 (1990): 157-215.

Shleifer, Andrei, and Robert W. Vishny. "The limits of arbitrage." *The Journal of Finance* 52.1 (1997): 35-55.

국문 초록

본 연구에서는 한국 내 몇몇 거대 기업들에 대한 기업고유의 쇼크가 GDP에 유의한 영향을 미칠 수 있는지 여부를 주식 수익률과 펀더멘털 변수를 이용하여 테스트하였다. 그 결과 경기 순환 및 금융 위기 더미를 통제할 경우, 펀더멘털 변수에 의해 계산된 거대 기업의 기업고유 쇼크는 GDP 성장률을 잘 설명하지 못하였다. 반면, 주식 수익률에 의해 유도된 거대 기업들에 대한 기업고유의 쇼크는 GDP 성장률에 유의한 영향을 미치는 것으로 나타났다. 한편 이러한 효과는 경기 순환을 통해 전파되지는 않는 것으로 보였다. 본 연구는 주식 시장의 정보를 이용하여 GDP의 변동을 설명하는데 유용할 수 있으며 기업고유의 쇼크에 대한 새로운 관점을 제시한다.

주요어 : 알갱이 가설(granular hypothesis), 기업고유의 쇼크, 펀더멘털 변수, 주식 수익률

학　번 : 2012-20493

Table 1
Explanatory power of granular residual

This table reports explanatory power of granular residual with respect to Korea GDP growth from January 1981 to December 2012. $\boldsymbol{\Gamma_t}$, $\boldsymbol{\Gamma_{t-1}}$ and $\boldsymbol{\Gamma_{t-2}}$ are granular residuals in year t, t−1, and t−2, respectively. The granular residuals are calculated by equation (3) when g_{it} is sales growth (panel A) and when g_{it} is labor productivity growth (panel B). I consider firms which have top 10 sales and top 20 sales among the sample firms in year t. The dependent variable is Korea real GDP growth in year t. N is the number of observation, and R^2 and adjusted R^2 are reported. t−statistics are reported in parentheses. ***, **, and * denote significance of the parameter estimates at the 0.01, 0.05, 0.10 levels, respectively. If the number of observation is 30, critical values are 2.75 (0.01 level), 2.042 (0.05 level), 1.697 (0.1 level), respectively.

	Panel A: sales growth				**Panel B: labor productivity**			
	Top 10 firms		Top 20 firms		Top 10 firms		Top 20 firms	
Intercept	0.094*** (8.25)	0.090*** (7.69)	0.092*** (7.87)	0.088*** (7.30)	0.086*** (7.58)	0.081*** (6.97)	0.086*** (7.18)	0.081*** (6.51)
$\boldsymbol{\Gamma_t}$	0.094 (1.47)	0.059 (0.83)	0.114 (1.63)	0.078 (1.02)	0.038 (0.65)	-0.002 (-0.03)	0.044 (0.68)	0.008 (0.12)
$\boldsymbol{\Gamma_{t-1}}$	0.031 (0.49)	0.019 (0.30)	0.025 (0.35)	0.008 (0.12)	0.060 (1.05)	0.046 (0.81)	0.058 (0.91)	0.041 (0.62)
$\boldsymbol{\Gamma_{t-2}}$		0.065 (0.92)		0.072 (0.95)		0.090 (1.47)		0.089 (1.32)
N	31	30	31	30	31	30	31	30
$\mathbf{R^2}$	0.10	0.12	0.11	0.13	0.06	0.12	0.06	0.11
Adj. $\mathbf{R^2}$	0.03	0.01	0.05	0.03	-0.01	0.02	-0.01	0.00

Table 2
Explanatory power of granular residual with crisis dummy

This table reports explanatory power of granular residual with respect to Korea GDP growth from January 1981 to December 2012 when controlling 1998 crisis. Γ_t, Γ_{t-1}, and Γ_{t-2} are granular residuals in year t, t−1, and t−2, respectively. The granular residuals are calculated by equation (3) when g_{it} is labor productivity growth. I consider firms which have top 20 sales among the sample firms in year t. Crisis means crisis dummy with 1 in year 1998 and 0 otherwise. Idiosyncratic labor productivity growth rate is winsorized at 20% in Panel A and 50% in Panel B respectively. Also, I report the result with no winsorized idiosyncratic growth rate in Panel C. The dependent variable is Korea GDP growth in year t. N is the number of observation, and R^2 and adjusted R^2 are reported. t−statistics are reported in parentheses. ***, **, and * denote significance of the parameter estimates at the 0.01, 0.05, 0.10 levels, respectively. If the number of observation is 30, critical values are 2.75 (0.01 level), 2.042 (0.05 level), 1.697 (0.1 level), respectively.

	Panel A: 20%		**Panel B: 50%**		**Panel C: No control**	
Intercept	0.054*** (5.46)	0.045*** (3.71)	0.052*** (5.88)	0.042*** (4.38)	0.062 (10.33)	0.060 (9.90)
Γ_t	0.306** (2.18)	0.308** (2.16)	0.214*** (2.58)	0.212*** (2.62)	0.101*** (2.34)	0.071 (1.57)
Γ_{t-1}	0.060 (0.45)	0.073 (0.56)	0.051 (0.69)	0.036 (0.51)	0.053 (1.34)	0.043 (1.10)
Γ_{t-2}		0.179 (1.33)		0.136* (1.93)		0.056 (1.38)
Crisis	-0.148*** (-4.41)	-0.149*** (-4.53)	-0.166*** (-4.86)	-0.165*** (-5.09)	-0.160*** (-4.85)	-0.150*** (-4.64)
N	31	30	31	30	31	30
R^2	0.44	0.48	0.49	0.56	0.50	0.54
Adj. R^2	0.38	0.39	0.44	0.49	0.45	0.46

Table 3
Explanatory power of granular residual derived by stock return

This table reports explanatory power of granular residual derived by stock return with respect to Korea GDP growth from January 1981 to December 2012. Λ_t, Λ_{t-1}, and Λ_{t-2} are granular residuals derived by stock return in year t, t−1, and t−2, respectively. The granular residuals with stock return are calculated by equation (10) and rolling period is 2 years, 3years and for all period. I consider firms which have top 10 sales among the sample firms in year t. The dependent variable is Korea GDP growth in year t. N is the number of observation, and R^2 and adjusted R^2 are reported. t−statistics are reported in parentheses. ***, **, and * denote significance of the parameter estimates at the 0.01, 0.05, 0.10 levels, respectively. If the number of observation is 30, critical values are 2.75 (0.01 level), 2.042 (0.05 level), 1.697 (0.1 level), respectively.

	Panel A: Rolling over 2 years		**Panel B: Rolling over 3 years**		**Panel C: For all period**	
Intercept	0.088*** (9.64)	0.084*** (9.30)	0.088*** (8.36)	0.078*** (7.42)	0.102 (11.36)	0.099 (13.41)
Λ_t	0.266*** (3.28)	0.190** (2.22)	0.265*** (2.57)	0.242*** (2.53)	0.156** (2.03)	0.122* (1.92)
Λ_{t-1}	0.149* (1.88)	0.186*** (2.40)	0.140 (1.51)	0.246*** (2.39)	0.110 (1.43)	0.164*** (2.59)
Λ_{t-2}		0.175** (2.15)		0.216*** (2.52)		0.229*** (3.62)
N	31	30	31	30	31	
R^2	0.31	0.42	0.21	0.38	0.16	0.47
Adj. R^2	0.26	0.34	0.15	0.30	0.09	0.40

Table 4

Explanatory power of granular residual derived by stock return controlling crisis dummy

This table reports explanatory power of granular residual with stock return when controlling crisis dummy with respect to Korea GDP growth from January 1981 to December 2012. Λ_t, Λ_{t-1}, and Λ_{t-2} are granular residuals derived by stock return in year t, t−1, and t−2, respectively. The granular residuals with stock return are calculated by equation (10) and rolling period is 2 years and for all period. I consider firms which have top 10 sales among the sample firms in year t. Crisis means crisis dummy with 1 in year 1998 and 0 otherwise. The dependent variable is Korea GDP growth in year t. N is the number of observation, and R^2 and adjusted R^2 are reported. t−statistics are reported in parentheses. ***, **, and * denote significance of the parameter estimates at the 0.01, 0.05, 0.10 levels, respectively. If the number of observation is 30, critical values are 2.75 (0.01 level), 2.042 (0.05 level), 1.697 (0.1 level), respectively.

	Panel A: Rolling over 2 years		**Panel B: For all period**	
Intercept	0.057*** (11.71)	0.055*** (10.84)	0.107*** (13.18)	0.103*** (15.07)
Λ_t	0.199*** (4.78)	0.173*** (3.76)	0.151** (2.23)	0.126** (2.20)
Λ_{t-1}	0.128*** (3.06)	0.141 (3.30)	0.152** (2.20)	0.188*** (3.25)
Λ_{t-2}		0.051 (1.15)		0.191*** (3.23)
Crisis	-0.130*** (-5.37)	-0.126*** (-5.14)	-0.133*** (-2.93)	-0.010*** (-2.58)
N	31	30	31	30
R^2	0.68	0.70	0.37	0.58
Adj. R^2	0.65	0.65	0.29	0.52

Table 5
Explanatory power of granular residual derived by fundamental variable with new crisis dummy

This table reports explanatory power of granular residual with stock return when controlling crisis dummy with respect to Korea GDP growth from January 1981 to December 2012. Γ_t, Γ_{t-1} and Γ_{t-2} are granular residuals in year t, t−1, and t−2, respectively. The granular residuals are calculated by equation (3) when g_{it} is sales growth (panel A) and when g_{it} is labor productivity growth (panel B). I consider firms which have top 10 sales among the sample firms in year t. crisis means new crisis dummy defined in section 4.3. I consider firms which have top 10 sales firms among the sample firms in year t. The dependent variable is Korea real GDP growth in year t. N is the number of observation, and R^2 and adjusted R^2 are reported. t-statistics are reported in parentheses. ***, **, and * denote significance of the parameter estimates at the 0.01, 0.05, 0.10 levels, respectively. If the number of observation is 30, critical values are 2.75 (0.01 level), 2.042 (0.05 level), 1.697 (0.1 level), respectively.

	Panel A: sales growth				**Panel B: labor productivity growth**			
	(1)	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**
Intercept	0.068*** (11.52)	0.070*** (8.69)	0.067*** (10.95)	0.069*** (10.10)	0.066*** (11.11)	0.068*** (9.28)	0.066*** (11.37)	0.068*** (10.19)
Γ_t	0.050 (1.21)	0.050 (0.95)	0.045 (1.05)	0.053 (1.16)	0.066 (1.68)	0.065 (1.43)	0.066* (1.74)	0.066 (1.57)
Γ_{t-1}	0.025 (0.68)	0.028 (0.60)	0.025 (0.67)	0.036 (0.89)	0.042 (1.20)	0.038 (0.91)	0.042 (1.22)	0.036 (0.94)
Γ_{t-2}	0.050 (1.23)	0.058 (1.08)	0.054 (1.27)	0.055 (1.19)	0.041 (1.13)	0.047 (1.04)	0.042 (1.19)	0.055 (1.29)
crisis	0.024 (0.89)	-0.027 (-1.04)	0.021 (0.92)	-0.002 (-0.17)	-0.054** (-2.26)	-0.011 (-0.68)	-0.051** (-2.37)	-0.011 (-1.31)
crisis $\times \Gamma_t$	-0.563*** (-3.77)	-0.296* (-1.90)	-0.286** (-2.24)	-0.161** (-2.34)	-0.195* (-1.74)	-0.353*** (-3.49)	-0.014 (-0.16)	-0.100** (-2.66)
crisis $\times \Gamma_{t-1}$	-0.944*** (-3.05)	-0.157 (-1.11)	-0.579** (-2.20)	-0.159* (-1.71)	0.303** (2.42)	0.072 (0.82)	0.256** (2.10)	0.052 (1.10)
crisis $\times \Gamma_{t-2}$	0.555** (2.61)	0.201 (1.06)	0.263 (1.30)	0.065 (0.76)	-0.526* (-2.09)	0.072 (0.80)	-0.489* (-2.00)	-0.028 (-0.42)
N	30	30	30	30	30	30	30	30
R^2	0.63	0.42	0.60	0.56	0.65	0.54	0.67	0.60
Adj. R^2	0.50	0.22	0.46	0.41	0.54	0.39	0.56	0.47

Table 6

Explanatory power of granular residual derived by stock return with new crisis dummy

This table reports explanatory power of granular residual with stock return when controlling crisis dummy with respect to Korea GDP growth from January 1981 to December 2012. Λ_t, Λ_{t-1}, and Λ_{t-2} are granular residuals derived by stock return in year t, t−1, and t−2, respectively. The granular residuals with stock return are calculated by equation (10) and rolling period is 2 years and for all period. I consider firms which have top 10 sales among the sample firms in year t. Crisis means new crisis dummy and defined in section 4.3. I consider firms which have top 10 sales firms among the sample firms in year t. The dependent variable is Korea real GDP growth in year t. N is the number of observation, and R^2 and adjusted R^2 are reported. t−statistics are reported in parentheses. ***, **, and * denote significance of the parameter estimates at the 0.01, 0.05, 0.10 levels, respectively. If the number of observation is 30, critical values are 2.75 (0.01 level), 2.042 (0.05 level), 1.697 (0.1 level), respectively.

	Panel A: Rolling over 2 years				**Panel B: For all period**			
	(A)	**(B)**	**(C)**	**(D)**	**(A)**	**(B)**	**(C)**	**(D)**
Intercept	0.058*** (8.06)	0.054*** (5.23)	0.059*** (9.12)	0.059*** (7.06)	0.068*** (12.23)	0.064*** (9.41)	0.070*** (13.75)	0.067*** (11.39)
Λ_t	0.156** (2.44)	0.170** (2.11)	0.155** (2.70)	0.153** (2.27)	0.092** (2.10)	0.132** (2.44)	0.091** (2.26)	0.122** (2.60)
Λ_{t-1}	0.111* (1.94)	0.130 (1.65)	0.113** (2.22)	0.126* (1.91)	0.106** (2.35)	0.114** (2.25)	0.101** (2.45)	0.105** (2.37)
Λ_{t-2}	0.055 (0.96)	0.077 (1.06)	0.050 (0.99)	0.056 (0.92)	0.101** (2.14)	0.100** (2.03)	0.100** (2.31)	0.098** (2.21)
crisis	-0.039** (-2.23)	-0.009 (-0.59)	-0.030** (-2.18)	-0.012 (-1.62)	-0.036** (-2.45)	-0.023 (-1.63)	-0.023** (-2.31)	-0.013** (-2.19)
crisis $\times \Lambda_t$	-0.058 (-0.20)	-0.003 (-0.017)	-0.093 (-0.61)	-0.005 (-0.06)	-0.495** (-2.08)	-0.316** (-2.52)	-0.204 (-1.33)	-0.189** (-2.38)
crisis $\times \Lambda_{t-1}$	-0.184 (-0.59)	-0.116 (-0.81)	-0.008 (-0.03)	-0.087 (-0.91)	-0.285 (-1.20)	-0.161 (-0.99)	0.017 (0.10)	-0.057 (-0.66)
crisis $\times \Lambda_{t-2}$	0.273 (0.72)	0.050 (0.26)	0.300 (1.23)	0.068 (0.63)	0.234 (1.45)	0.213 (1.54)	0.236 (1.60)	0.115 (1.65)
N	30	30	30	30	30	30	30	30
R^2	0.61	0.43	0.69	0.59	0.66	0.62	0.71	0.70
Adj. R^2	0.48	0.23	0.58	0.44	0.54	0.50	0.61	0.60

Table 7
Explanatory power of granular residual derived by fundamental variable with business cycle

This table reports explanatory power of granular residual with respect to Korea GDP growth from January 1981 to December 2012. $\mathbf{\Gamma_t}$, $\mathbf{\Gamma_{t-1}}$ and $\mathbf{\Gamma_{t-2}}$ are granular residuals in year t, t−1, and t−2, respectively. The granular residuals are calculated by equation (3) when g_{it} is sales growth (panel A) and when g_{it} is labor productivity growth (panel B). I consider firms which have top 10 sales among the sample firms in year t. Cycle is coincident composite index variable. The dependent variable is Korea real GDP growth in year t. N is the number of observation, and R^2 and adjusted R^2 are reported. t−statistics are reported in parentheses. ***, **, and * denote significance of the parameter estimates at the 0.01, 0.05, 0.10 levels, respectively. If the number of observation is 30, critical values are 2.75 (0.01 level), 2.042 (0.05 level), 1.697 (0.1 level), respectively.

	Panel A: sales growth		**Panel B: labor productivity growth**	
Intercept	-0.923** (-2.52)	-0.894** (-2.42)	-1.022*** (-2.79)	-0.967** (-2.70)
Γ_t	0.041 (0.90)	0.021 (0.40)	0.035 (0.83)	0.009 (0.20)
Γ_{t-1}	0.005 (0.10)	0.000 (0.00)	0.055 (1.33)	0.049 (1.20)
Γ_{t-2}		0.047 (0.91)		0.067 (1.55)
Cycle	0.010** (2.69)	0.010** (2.59)	0.011*** (2.96)	0.010*** (2.87)
N	31	30	31	30
R^2	0.24	0.27	0.30	0.36
Adj. R^2	0.15	0.15	0.21	0.25

Table 8
Explanatory power of granular residual derived by stock return with business cycle

This table reports explanatory power of granular residual with stock return when controlling crisis dummy with respect to Korea GDP growth from January 1981 to December 2012. Λ_t, Λ_{t-1}, and Λ_{t-2} are granular residuals derived by stock return in year t, t−1, and t−2, respectively. The granular residuals with stock return are calculated by equation (10) and rolling period is 2 years and for all period. I consider firms which have top 10 sales among the sample firms in year t. Cycle is coincident composite index variable. The dependent variable is Korea GDP growth in year t. N is the number of observation, and R^2 and adjusted R^2 are reported. t−statistics are reported in parentheses. ***, **, and * denote significance of the parameter estimates at the 0.01, 0.05, 0.10 levels, respectively. If the number of observation is 30, critical values are 2.75 (0.01 level), 2.042 (0.05 level), 1.697 (0.1 level), respectively.

	Panel A: Rolling over 2 years		**Panel B: For all period**	
Intercept	-0.749** (-2.39)	-0.696** (-2.22)	-0.999*** (-3.06)	-0.762** (-2.47)
Λ_t	0.187*** (3.27)	0.163** (2.68)	0.140*** (2.79)	0.110** (2.34)
Λ_{t-1}	0.076 (1.40)	0.090 (1.63)	0.055 (1.11)	0.082* (1.77)
Λ_{t-2}		0.067 (1.15)		0.124** (2.60)
Cycle	0.008** (2.56)	0.007** (2.37)	0.011*** (3.24)	0.008** (2.67)
N	31	30	31	30
R^2	0.48	0.51	0.41	0.54
Adj. R^2	0.42	0.42	0.34	0.46

Table 9
Explanatory power of granular residual derived by fundamental variable with boom dummy

This table reports explanatory power of granular residual with respect to Korea GDP growth from January 1981 to December 2012. $\mathbf{\Gamma_t}$, $\mathbf{\Gamma_{t-1}}$ and $\mathbf{\Gamma_{t-2}}$ are granular residuals in year t, t−1, and t−2, respectively. The granular residuals are calculated by equation (3) when g_{it} is sales growth (panel A) and when g_{it} is labor productivity growth (panel B). I consider firms which have top 10 sales among the sample firms in year t. Boom means boom dummy which has value 1 if coincident composite index increases from the previous year and 0 otherwise. The dependent variable is Korea real GDP growth in year t. N is the number of observation, and R^2 and adjusted R^2 are reported. t−statistics are reported in parentheses. ***, **, and * denote significance of the parameter estimates at the 0.01, 0.05, 0.10 levels, respectively. If the number of observation is 30, critical values are 2.75 (0.01 level), 2.042 (0.05 level), 1.697 (0.1 level), respectively.

	Panel A: sales growth				**Panel B: labor productivity growth**			
Intercept	0.049*** (4.35)	0.049*** (4.22)	0.048*** (4.21)	0.047** (3.76)	0.047*** (4.13)	0.049*** (4.43)	0.043*** (3.88)	0.040*** (3.38)
Γ_t	0.032 (0.63)	0.017 (0.29)	0.005 (0.09)	-0.034 (-0.34)	0.006 (0.12)	-0.025 (-0.55)	-0.027 (-0.57)	-0.064 (-1.27)
Γ_{t-1}	-0.002 (-0.34)	0.008 (0.13)	-0.008 (-0.17)	-0.024 (-0.29)	0.051 (1.11)	0.050 (0.97)	0.042 (0.96)	0.018 (0.33)
Γ_{t-2}			0.061 (1.11)	0.109 (0.61)			0.088* (1.87)	0.174* (1.70)
boom	0.022 (1.48)	0.020 (1.18)	0.023 (1.52)	0.020 (1.11)	0.023 (1.58)	0.011 (0.67)	0.025* (1.82)	0.019 (1.20)
boom $\times \Gamma_t$		0.098 (0.69)		0.125 (0.74)		0.304* (2.09)		0.323* (1.82)
boom $\times \Gamma_{t-1}$		-0.048 (-0.42)		0.000 (0.00)		-0.031 (-0.32)		0.005 (0.05)
boom $\times \Gamma_{t-2}$				-0.051 (-0.27)				-0.161 (-1.35)
N	31	31	30	30	31	31	30	30
R^2	0.10	0.12	0.15	0.17	0.13	0.27	0.24	0.36
Adj. R^2	0.00	-0.07	0.01	-0.10	0.03	0.12	0.12	0.15

Table 10
Explanatory power of granular residual derived by stock return with boom dummy

This table reports explanatory power of granular residual with stock return when controlling crisis dummy with respect to Korea GDP growth from January 1981 to December 2012. Λ_t, Λ_{t-1}, and Λ_{t-2} are granular residuals derived by stock return in year t, t−1, and t−2, respectively. The granular residuals with stock return are calculated by equation (4) and rolling period is 2 years and for all period. I consider firms which have top 10 sales among the sample firms in year t. Boom means boom dummy which has value 1 if coincident composite index increases from the previous and 0 otherwise. The dependent variable is Korea real GDP growth in year t. N is the number of observation, and R^2 and adjusted R^2 are reported. t−statistics are reported in parentheses. ***, **, and * denote significance of the parameter estimates at the 0.01, 0.05, 0.10 levels, respectively. If the number of observation is 30, critical values are 2.75 (0.01 level), 2.042 (0.05 level), 1.697 (0.1 level), respectively.

	Panel A: Rolling over 2 years				**Panel B: For all period**			
Intercept	0.040*** (4.02)	0.041*** (3.79)	0.037*** (3.76)	0.029** (2.29)	0.045*** (4.36)	0.048*** (5.32)	0.043*** (4.00)	0.047*** (4.85)
Λ_t	0.197*** (3.25)	0.168* (1.98)	0.159** (2.50)	0.101 (1.13)	0.145** (2.62)	0.110** (2.21)	0.150* (1.93)	0.136* (1.97)
Λ_{t-1}	0.095 (1.64)	0.077 (0.86)	0.113* (1.98)	0.195* (1.79)	0.047 (0.86)	0.079 (1.62)	-0.040 (-0.41)	0.050 (0.53)
Λ_{t-2}			0.095 (1.60)	0.298* (1.77)		0.146*** (2.97)		0.210* (2.00)
boom	0.021* (1.70)	0.018 (1.28)	0.023* (1.86)	0.031* (1.97)	0.029** (2.14)	0.023* (1.90)	0.030** (2.16)	0.023* (1.87)
boom $\times \Lambda_t$		0.068 (0.54)		0.097 (0.72)			-0.011 (-0.10)	-0.051 (-0.50)
boom $\times \Lambda_{t-1}$		0.033 (0.28)		-0.083 (-0.62)			0.129 (1.09)	0.051 (0.45)
boom $\times \Lambda_{t-2}$				-0.239 (-1.32)				-0.084 (-0.70)
N	31	31	30	30	31	30	31	30
R^2	0.41	0.42	0.47	0.51	0.29	0.48	0.33	0.52
Adj. R^2	0.34	0.29	0.38	0.34	0.20	0.39	0.18	0.36

Figure 1
Fat−tailed test in Korean firms

The figure shows regression to determine the exponent α of power distribution as I mention on equation (1). The x−axis is number of employees in log scale, and y−axis is frequency of correspond number of firms in log scale. Regression equation is reported beside the line and R^2 means R square.