Is the quality of accounting information complementary or substitute for other governance mechanisms? : Evidence from the real effects of earnings quality in Japan

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Abstract: The purpose of this study is to analyze the interrelationship between the effects on investment efficiency of accounting information and other governance structures. How they relate is not trivial from the theoretical implication. While one predicts that accounting information is the substitute for other governance tools, the two mechanisms might strengthen each other. I study whether several governance structures mitigating information problems weakens or strengthens the effects of accounting information on investment. Among the governance mechanisms, this study focuses on institutional investors, outside directors, and main bank relationship. I show that the alternative information-problem-mitigating mechanisms influences on the firms' investment efficiency, but the effects are not monotonic. I also find that main bank changes the investment effects of earnings quality, but not institutional ownership and outside directors, by considering their nonlinear effects on investment.

JEL classification:
Keywords: real effects, earnings quality, investment efficiency

1. Introduction

The purpose of this study is to analyze the interrelationship between the effects on investment efficiency of accounting information and other governance structures. How they relate each other is not trivial from the theoretical implication. While one predicts that accounting information is the substitute for other governance tools, the two mechanisms might strengthen each other. I study whether several governance structures mitigating information problems weakens or strengthens the effects of accounting information on investment.

The real effects of accounting information coincides with the effects of "alternative information-problem-mitigating mechanisms". A bulk of study shows that "high-quality" governance mechanism improves firms' efficiency. For instance, institutional investors mitigate information problems through their prior ability to monitor managerial behavior (Bushee 1998; Hartzell and Starks 2003; Chen et al. 2007). Other mechanisms I will discuss are main bank relationship and outside directors. These governance forms improve firms' efficiency by alleviating information and incentive problems. Disclosing high-quality accounting information, managers are able to resolute the two problems. Lots of studies show that earnings attributes (EAs[1]) useful for outsiders decrease information asymmetry in security market and promote monitoring efficiency. Biddle and Hilary (2006) and Biddle et al. (2009) reveal that the useful EAs improve investment efficiency.

Not trivial is, however, the relationship between the effectiveness of accounting information and of other governance mechanisms. Accounting information appears to substitute for other governance mechanisms. If managers are able to improve her firm's efficiency, the effectiveness of accounting would weaken. On the other hand, they might be complementary. Sophisticated investors' behaviors are the signals to others. If the behaviors are based on accounting information, the effects of accounting strengthens through high-quality governance. Theoretical discussion does not conclude how they associate.

Empirical evidence is also mixed. Biddle and Hilary (2006) consider that accounting information is the substitute. They show the evidence that useful EAs improve U.S. firms' investment efficiency, but not Japanese firms'. They infer that Japanese keiretsu and main bank decrease the effects of the accounting information. Observing investment-cash flow sensitivity (ICS), Baik et al. (2010) justify the inference. Nevertheless, a few studies show inconsistent evidence with them. Fujitani (2017) examines the effects of accounting information on over- and under-investment, and finds that useful EAs alleviate them even in recent Japanese firms after controlling the effects of other governance mechanisms including main bank relationship. Beatty et al. (2010) investigates the relationship between the capital structure and the accounting effects. They do not find that bank lending does not weaken them, which is inconsistent with Biddle and Hilary (2006).

Hence, whether the accounting information complements or substitutes for other governance

[1] In this study, "earnings attributes (EAs)" is used interchangeably with "earnings quality".

structures is interesting research question. This study uses the model identifying under- and over- investment firms, and tests how governance mechanisms change the effects of EAs on under- and over-investment. Among the governance mechanisms, I focus on institutional investors, outside directors, and main bank relationship. Using Japanese data, I show that the alternative information-problem-mitigating mechanisms influences on the firms' investment efficiency, but the effects are not monotonic. I also find that main bank changes the investment effects of earnings quality, but not institutional ownership and outside directors, by considering their nonlinear effects on investment. Specifically, main bank is sometimes complement, especially on alleviating under-investment, and sometimes substitute for earnings quality.

This study incorporates three contributions. First, I focus on the relationship between the real effects of accounting information and of the alternative information-problem-mitigating mechanisms. In this sense, this study complements the stream of study on it, such as Baik et al. (2010) and Beatty et al. (2010). However, I sophisticate the tests, for instance I consider the nonlinear effects on investment. In addition, this is the first study the complementary interrelationship between accounting information and governance mechanisms with respect to promoting investment efficiency. Second, I find that non-monotonic effects of governance mechanisms on investment efficiency by the models developed by Biddle et al. (2009). Using the same methodology, Xiao et al. (2017a) and Xiao et al. (2017b) analyze the effects of going public on investment efficiency. This study is close to these studies, but I consider the non-linear relationship in the model and find it. Third, I show explicit evidence on the real effects of accounting information in Japanese economy. Fujitani (2017) is the first study to find the investment effects of earnings attributes by using investment efficiency. This study complements the literature by more strictly controlling governance mechanisms other than accounting information. This contradicts to the results of Biddle and Hilary (2006).

The remainder of this paper proceeds as follows. The next section introduces the theoretical backgrounds, reviews prior literature and constructs hypotheses. Section 3 describes the research design. Section 4 reports the results, and section 5 summarizes the results of robustness tests. Section 6 concludes.

2. Backgrounds and hypotheses

2.1 Theoretical underpinnings

Information and incentive problems worsen the firms' investment efficiency (Fazzari et al. 1988; Hubbard 1998; Stein 2003). These problems are alleviated by the firms' disclosure and financial reporting (Healy and Palepu 2001; Beyer et al. 2010; Bertomeu and Cheynel 2016). Several studies show that the high-quality financial reporting mitigates asymmetric information, and decreases cost of capital (Francis et al. 2004; Francis et al. 2005; Brown and Hillegeist 2007). Thus, the accounting information quality is likely to affect firms' investment behaviors. Accounting researchers show the

evidence of the real effects of earnings around the world (Biddle and Hilary 2006; Biddle et al. 2009; Fujitani 2017).

Accounting information is not the only one solution to information and incentive problems. The problems are settled by alternative mechanisms. Managers are able to deal with incentive problems through several governance mechanisms. Jensen and Meckling (1976, p. 323) suggest bonding mechanisms: auditing by banks or formal controlling systems, such as directors. Banks scrutinize managers when they start lending or re-lending (Diamond 1984; Krasa and Villamil 1992). Directors are able to bond managerial incentives to shareholders' utility by their right to appoint and dismiss managers and their role in monitoring managers (Shleifer and Vishny 1989). Jensen (1986) proposes that debt is a solution to the agency problem. Since managers have discretions over payout, they are able to increase her own utility by not exercise payout. On the other hand, managers have to pay constant interests defined in debt contracts every period. This requirement limits managers' discretions over allocation of earnings, and alleviates agency problem between managers and shareholders. Institutional investors also are important monitoring mechanisms of firms (Bushee 1998; Hartzell and Starks 2003; Chen et al. 2007; Aghion et al. 2013).

Information problems are also alleviated by governance mechanisms other than accounting information. One of the examples is main bank and keiretsu. Main banks and firms in keiretsu group are able to communicate firms through private channel. Hoshi et al. (1991) find that firms in keiretsu groups face less financial constraints than those not in, since keiretsu mitigates information problems. Relationship banks, coincident with main banks, also seem to function in the same way. Bolton et al. (2016) find that relationship banks increase costs in ordinary economic condition, but decreases it in depression as relationship banks are able to collect information on the firms even in depression. Sophisticated investors, such as institutional investors, seem to alleviate information problems through signaling their advanced evaluation on firms to security market (e.g., Ivashina and Sun 2011)[2]. Campbell and Kracaw (1980) discuss that security market is confident in the signals of financial intermediaries since they might hardly have the incentives to mislead other market participants[3]. Overall, managers are able to mitigate information and incentive problems not only by accounting information, but by internal and external governance mechanisms.

[2] Institutional investors are able to use private information their own trading. This causes another serious agency problem, discussed by Bebchuk et al. (2017). I will discuss this point later in my analysis.

[3] However, they point out that information production of financial intermediaries is not able to totally solve information problems: it does not lead to the first best equilibrium (pp. 876-880).

2.2 Prior literature and hypotheses

Governance mechanisms alleviating information asymmetry other than accounting information[4], alternative information-problem-mitigating mechanisms hereafter[5], might relate to the effects of accounting information on firm's investment decision. One possibility is that the alternative information-problem-mitigating mechanisms shrink the importance of accounting information. For instance, Biddle and Hilary (2006) find that earnings quality mitigates firm's financial constraints in US, but it does not in Japan. They infer that:

> (A) ccounting quality should have a smaller effect on investment efficiency in countries where bank financing and *keiretsu* are important sources of capital than in countries where equity is a dominant source of capital, because capital suppliers in credit-based economies have alternative avenues for reducing information asymmetry. (Biddle and Hilary 2006, p. 976)

Beatty et al. (2010) test whether how a firm funds changes the strength of the effects of earnings quality on investment or not. According to Biddle and Hilary's (2006) discussion, firms mainly funding from banks are able to restrict asymmetric information through the private communication with the banks or banks' monitoring. For those firms, accounting information does not seem to be important. On the other hand, accounting information plays incremental role in firms mainly funding from arm's length capital resource, since they do not have the private channel. Thus, I expect that accounting information and alternative information-problem-mitigating mechanisms are substitute. The empirical evidence is mixed. Baik et al. (2010) find that

The other possibility is that the alternative information-problem-mitigating mechanisms increase the importance of accounting information. Chen et al. (2011) find the evidence consistent with this expectation. When banks evaluate firm's repayment capacity, they might use accounting information. Thus, the earnings quality, the proxy of accounting information quality, might affect investment in firms funding from banks than in those not doing. Using private firms in emerging countries, they find that the effects of earnings quality on investment efficiency are stronger as firms depend more on banks. Prior studies do not provide the conclusive evidence on how accounting information and other governance mechanisms associates each other.

Among the alternative information-problem-mitigating mechanisms, I focus on three governance mechanisms. First, main bank is one of the solutions to alleviate information and incentive problems. Those two problems are mitigated by the private communication channel which main banks

[4] Becht et al. (2003) is worth referring for comprehensive survey on corporate governance and agency problems (asymmetric information).
[5] I follow Beatty et al. (2010) when using this terminology.

have (e.g., Hoshi and Kashyap 1990; Hoshi et al. 1990; Hoshi et al. 1991; Kang and Shivdasani 1995). Based on these studies, Biddle and Hilary (2006) infer that main banks substitute for accounting information.

H1: The strength of firm-main bank relationship changes the investment effects of earnings quality.

Second, institutional investors are likely to alleviate asymmetric information. They are able to monitor managerial decision from long-term perspective. Bushee (1998) discussed that institutional investors decrease the managerial incentives on myopic behavior. Then, he hypothesizes and finds that institutional investors prevent managers from cutting R&D expenses in order to beat and meet benchmark earnings. Hartzell and Starks (2003) find that institutional investors mitigate agency problem by changing manager's compensation scheme. Aghion et al. (2013) also show that institutional ownership promotes R&D investment and patent. They hypothesize institutional investors are able to discipline ``lazy managers'' by their forces to influence on managerial careers. Such effects of institutional investors monitoring on investment might weaken the effects of accounting information.

On the other hand, considering that institutional investors utilize accounting information, institutional ownership appears to strengthen its effects. Since institutional investors focus on long term performance, they pay much attention to signals from managers. Thus the behavior of institutional investors reflect accounting information. Then, the behavior becomes the reliable signals to other investors (Campbell and Kracaw 1980). The effects of institutional investors help accounting information spread out over the security market. While the two predictions on institutional investors are opposite signs, I summarize them as follows:

H2: The power of institutional investors changes the investment effects of earnings quality.

Third, internal governance also alleviates asymmetric information. Outside directors are the representative of investors to monitor the managerial behavior. Outside directors do not have the interests to build the manager's empire, so they seem to monitor managers more effective than insiders. In particular, Japanese government recently promotes firms to introduce outside directors in order to increase transparency by revising Japanese Corporate Acts and announcing Japanese version of Corporate Governance Code. However, outside directors also face asymmetric information. They do not have the same information as the insider does. Thus, when they monitor managers, they might collect information from accounting information. If so, the information quality determines their monitoring quality, thus accounting information and outside directors are complementary. I summarize the discussion as:

H3: The power of outside directors changes the investment effects of earnings quality.

In the previous discussion, I assume the governance effects on investment are monotonic. However, several previous studies imply that they are nonlinear (He and Tian 2013; Sapra et al. 2014; Bolton et al. 2016; Bebchuk et al. 2017). For instance, Bebchuk et al. (2017) discuss that the agency problems of institutional ownership. They point out that the concentration of ownership of institutional ownership raises the agency problems. Bolton et al. (2016) analyze the costs and benefits of relationship banking. They show that while relationship banking is costly in stable economic condition, is less costly in economic crisis. On the other hand, several studies provide the evidence on the advantages of governance systems. Overall, I expect that the effectiveness of the each governance mechanism increases with their power, and then shrinks after a threshold. Thus, this study tests the nonlinearity of governance effects as preliminary analysis. In addition, I consider the non-monotonic effects when investigating the relationship between the investment effects of earnings quality and the governance mechanisms.

H4a: The effects of governance mechanisms on investment are not monotonic.

H4b: The interrelationship between the effects of accounting information and of the alternative information-problem-mitigating mechanisms is not monotonic.

3. Research design

3.1 Over- and under-investment

I follow Biddle et al.'s (2009) model when identifying over- and under-investment (*over* and *under*) firms (model (1)). They define over- and underinvestment with unexpected components of investment. They regress *investment* (inv) at period t on lagged *sales growth* (sg), then define as "*unexpected investment* (ue_inv)" the deference between the estimated level of investment and the realized value. The lagged sales growth is the proxy of investment opportunity.

$$inv_{i,t} = \alpha_0 + \alpha_1 sg_{i,t-1} + \varepsilon_{1,i,t} \quad (1)$$

I also define the absolute value of the unexpected components of investment ($ab[ue\_inv]$) as investment efficiency. This increases with the multitude of the unexpected components of investment, which indicate inefficient levels. To test the robustness of the main analysis, I also use Goodman et al.'s (2014) model and Chen et al.'s (2011) model (their definitions are described in Appendix).

3.2 Earnings attributes

I use a proxy of earnings quality (eq), which is defined as the weighted average indicator for the principal components of 4 earnings attributes. The 4 attribute are persistence, predictability, smoothness, and accruals quality of earnings, which prior studies discuss that are useful characteristics of earnings to investors (Francis et al. 2004; Francis et al. 2008).

Earnings persistence (per) equals coefficient in AR1. Using 10 year data from t-9 through t, I estimate AR1 and define per as the coefficient on previous year earnings. Predictability (pre) is standard deviation of residuals calculated from AR1. Using 10 year data from t-9 through t, I estimate AR1 and define pre as the standard deviation of the residuals in each year. Earnings smoothness (smo) equals vol divided by cash flow volatility (vcf). Earnings smoothed through accruals are disperse less than cash flow. Thus, I define smo as 10 year earnings standard deviation (vol) scaled by 10 year cash flow standard deviation (vcf). Accruals quality (maq) equals one developed by McNichols (2002). Dechow and Dichev (2002) model regresses accruals (acc) on previous and former cash flow (cf), and define the 5 year standard deviation of residuals as accruals quality. McNichols (2002) add several control variables in order to avoid omitted variable problem. I estimate McNichols' (2002) model by running separated industry-year regressions. Then, I take standard deviation of residuals in each firm.

Before estimating the principal components of the 4 earnings attributes, I take the signs of all the earnings attributes except for persistence and smoothness. By this operation, the 4 variables increase with the usefulness of the earnings. The definitions of each earnings attribute are described in Appendix.

3.3 The alternative information-problem-mitigating mechanisms

I use three variables representing governance mechanisms. One is firms' relationship to their main bank. Japanese Banking Acts permits banks to hold firms' stock. Thus, I aggregate into one index both the percentage debt lending from the main bank and its shareholdings. The aggregated main bank variable (*main*) is calculated from the weights estimated by principal components analysis. This indicator increases with the strength of firm-main bank relationship. Institutional ownership (*inst*) equals the percent of their shareholdings to whole issued stocks, which represents the power of institutional investors' monitoring. *inst* increases with their monitoring. Outside directors (*outd*) represents the power of outside directors in a firm. This equals the percent of outside directors to whole directors. This increases with the strength of their monitoring.

3.4 Models

To test the effects of earnings quality and the alternative information-problem-mitigating

mechanisms, I use the models developed by Biddle et al. (2009). If these mechanisms mitigate investment efficiency, they decrease investment levels in over-investment firms and increase them in under-investment firms. Considering opposite relationship between the two groups, Biddle et al. (2009) develop the model:

$$\begin{aligned} inv_{i,t} = {} & \eta_0 + \eta_1 eq_{i,t-1} + \eta_2 eq_{i,t-1} * over_{i,t} + \eta_3 \boldsymbol{gov}_{i,t-1} \\ & + \eta_4 \boldsymbol{gov}_{i,t-1} * over_{i,t} + \eta_5 over_{i,t} + \delta \cdot \boldsymbol{Z} + \boldsymbol{year}_t + \boldsymbol{industry}_I + \varepsilon_{5,i,t} \end{aligned} \tag{2}$$

This model regresses investment on earnings quality ($eq_{i,t-1}$), governance variables ($\boldsymbol{gov}$), and the interactions between them and indicator ($over_{i,t}$), which equals one if a firm includes over-investment group. Independent variables also include control variables ($\boldsymbol{Z}$) and industry ($\boldsymbol{industry}_I$) and year fixed ($\boldsymbol{year}_t$) effects. The subscripts i, t, and I depicts firm i, period t, and industry I, respectively. The hypothesis indicates that η_1 and η_3 are positive, and $\eta_1 + \eta_2$ and $\eta_3 + \eta_4$ are negative. The former prediction corresponds with the hypothesis regarding under-investment, and the latter does with that on over-investment.

As the preliminary analysis, I investigate how the alternative information-problem-mitigating mechanisms affects investment efficiency, monotonic or non-linear. I decompose the effects of the mechanisms into two: the firms with greater strength of them than the median or the mean values. Then I add the indicators to model (2) and observe whether the coefficients change across the groups. If the difference is significant, H4 is supported: the effects are not monotonic.

$$\begin{aligned} inv_{i,t} = {} & \pi_0 + \pi_1 eq_{i,t-1} + \pi_2 eq_{i,t-1} * over_{i,t} + \pi_3 eq_{i,t-1} * \boldsymbol{gov}_{i,t-1} \\ & + \pi_4 eq_{i,t-1} * over_{i,t} * \boldsymbol{gov}_{i,t-1} + \pi_5 \boldsymbol{gov}_{i,t-1} \\ & + \pi_6 \boldsymbol{gov}_{i,t-1} * over_{i,t} + \pi_7 over_{i,t} \\ & + \delta \cdot \boldsymbol{Z} + \boldsymbol{year}_t + \boldsymbol{industry}_I + \varepsilon_{5,i,t} \end{aligned} \tag{3}$$

To test the relationship between the investment effects of earnings quality and the governance mechanisms, I add the interaction term between governance variables and earnings quality (model (3)). However, if the governance effects are nonlinear, I am not able to isolate it by model (3). Thus I also run the model by entangling the sample into two: the firms with greater strength of them than the median or the mean values. The coefficients in interest are π_3 and π_4. They are positive if the relationship is complementary, and negative if substitute.

4. Results

4.1 Sample and descriptive statistics

The sample of the models to estimate ue_inv and to calculate EAs consists of firms reporting financial statements in March under J GAAP. Since several variables need 9 prior and one former

periods' data, the initial sample covers the period from 2001 through 2015. I exclude financial and utility firms (Nikkei Medium Classification Industry Code [NKILM] 47-52 and 65-69), I winsorize each variable at the 1% and 99% levels.

In main analysis, I winsorize each variable at the 1% and 99% levels. The final sample used in the main analysis consists of 11,515 firm-year observations. All the data are obtained from Nikkei NEEDS Financial Quest 2.0 and Nikkei NEEDS Cges.

[Table 1]

Table 1 reports sample distribution with respect to year and industry. Industry classifications are Nikkei Medium Classification Industry Code (2-digit code, [NKILM]). In table 2, I show descriptive statistics of variables used in the analyses. No variable takes extraordinary level, because of sampling requirement. All variables are defined in Appendix. Table 3 shows a Spearman/Pearson correlation matrix of the variables. I also check that VIF of every variable in each model is less than 4.0. Multicollinearity does not seem to be serious issue.

[Table 2]
[Table 3]

4.2 Preliminary analyses

Before examining the interrelationship between earnings quality and other governance mechanisms, I investigate how the governance mechanisms influence on investment efficiency. In particular, I focus on whether their relationship is monotonic or not (H4a). To test the non-monotonicity, I decompose the effects of the governance mechanisms into two, the effects in firms with them more than median and with them less than it.

[Table 4]

Table 4 shows the results of the analysis. The first column reports the results of the baseline model testing the direct effects of three governance mechanisms. I just report partial derivatives with respect to those variables in the table. The coefficient on main bank is significantly positive in under-investment firms, and is significantly negative in over-investment firms. The coefficient on institutional ownership is significantly positive in under-investment firms, and is not statistically significant in over-investment firms. Outside directors negatively relate to investment in under-investment firms, and positively relate in under-investment firms. Overall, main bank and institutional ownership alle-

viate under-investment, and main bank main bank mitigate over-investment. Outside directors, however, adversely impact investment inefficiency.

The second to forth columns show the results of the models testing nonlinearity of the effects of the governance mechanisms. In the second column, I decompose the effects of main bank into two: the firms with greater strength of their relationship to their main bank than the median and otherwise. The coefficients on *main* in firms with the less strength are significantly consistent with the expectation, not otherwise. The results in the first column seem to derive from those firms. In the third column, I decompose the effects of institutional investors into two: the firms with the larger institutional ownership than the median and otherwise. Only in firms with stronger institutional investors' power than the median, the coefficient on institutional ownership is significantly positive in under-investment firms. The forth column shows the results when entangling the effects of outside directors into two: the firms with the stronger outside directors' power than the mean and otherwise. Since the median value of *outd* is zero, I separate firms based on its mean value (Table 3). From this results, I find that the coefficients derived in the first column are from the firms with the stronger outside directors' power.

[Table 5]

To observe the comprehensive results, I include all the decomposed operationalization into one model. Table 5 reports the result. According to VIFs of the model, multicollinearity does not seem serious problem (untabulated). All the results are consistent with the results in Table 4. Overall, main bank promotes investment efficiency in firms with the greater strength of relationship to the firms, and so do institutional investors in firms with larger ownership. Outside directors do not promote investment efficiency, but they worsen it in firms with greater power. Those results support H4a: the relationship between investment efficiency and governance mechanisms is nonlinear.

4.3 Main analysis

Table 6 reports the results of the model adding earnings quality. This model coincides with Biddle et al. (2009) and its subsequent studies. Earnings quality positively relates to investment in under-investment firms, and negatively relates in over-investment. The coefficients on main bank, institutional ownership, and outside directors do not change from the previous models. Consistent with Fujitani (2017), I confirm that earnings quality promotes firm's investment efficiency by using Japanese data. In addition, this results indicate that earnings quality and the other governance mechanisms have incremental effects on investment. However, we are not able to observe the interrelationship between the investment effects of earnings quality and of the other governance mechanisms.

[Table 6]

[Table 7]

To test the interrelationship, I add the interaction term between earnings quality and the alternative information-problem-mitigating mechanisms to the model. Since the preliminary tests suggest that the investment effects of governance mechanisms are not monotonic, I also decompose the sample into two groups as do in the preliminary analyses. Table 7 reports the results of the tests investigating the effects of main bank on the investment effects of earnings quality. The first column shows the results of the analysis using pooled sample. The interactions are not statistically significant. Considering the nonlinear effects of main bank, I decompose the sample into two based on median values of *main*. In the second and third columns, I report the results when using firms with less than and greater than the median, respectively. In the second column, the effects of earnings quality is significantly consistent with my expectation in under-investment firms, the interaction is significantly positive in under-investment firms. In the third column, the coefficient on earnings quality in over-investment firms is significantly negative, and those on the interaction are not significant. The difference of the coefficient on earning quality between the second and the third columns is significant in under-investment firms, but insignificant in over-investment. Overall the results support H1. However, since the findings are complicated, I discuss the interpretation in 4.4.

[Table 8]

In Table 8, I report the results of the investigation the effects of institutional investors on the investment effects of earnings quality. The first column shows the results of the analysis using whole sample. The interactions are not statistically significant. Considering the nonlinear effects of institutional ownership on investment, I decompose the sample into two based on median values of *inst*. The second and third columns report the results when using firms with less than and greater than the median, respectively. The direct effects of institutional ownership on investment are consistent with the previous analyses. In the second column, the effects of earnings quality is significantly consistent with my expectation in under-investment firms, and the interaction is not statistically significant. In the third column, neither the coefficients on earnings quality nor on the interaction are statistically significant. The difference of the coefficient on earning quality between the second and the third columns is not significant. Thus, institutional investors do not change the effects of earnings quality on investment efficiency: H2 is not supported.

[Table 9]

Table 9 shows the results of the tests on the effects of outside directors on the investment

effects of earnings quality. The first column shows the results of the analysis using whole sample. The interactions are not statistically significant. Considering the nonlinear effects of outside directors on investment, I decompose the sample into two based on mean values of *outd*. The second and third columns report the results when using firms with less than and greater than the median, respectively. The investment effects of outside directors are consistent with the previous analyses. In the second column, the effects of earnings quality is significantly consistent with my expectation, and the interaction is not significant. In the third column, the coefficients on earnings quality are consistent with my expectation in over-investment firms, and those on the interaction are insignificant. The difference of the coefficient on earning quality between the second and the third columns is not significant. This evidence does not support H3.

4.4 More discussion on main bank and earnings quality

In order to interpret the results more deeply, I plot the interrelationship between the effects of main bank and earnings quality in the second column of Table 7. Figure 1 plots how the effects of earnings quality change with the strength of firm-main bank relationship. In under-investment firms, the relationship increases the effects of earnings quality. This is consistent with complementary hypothesis. On the other hand, the relationship increases in over-investment firms: which is consistent with the substitute hypothesis.

[Figure 1]

[Figure 2]

Figure 2 plots how the effects of main bank change with earnings quality. In under-investment firms, earnings quality increases the coefficients of main banks. This is consistent with complementary hypothesis. On the other hand, the coefficients on main bank are significantly negative in the middle of the levels of earnings quality in over-investment firms. Overall, the interrelationship between earnings quality and main bank is mixed: sometimes complementary and sometimes substitute.

5. Robustness tests

To confirm the robustness of main tests, I change the definitions of the variables and reexamine the models. I change the specification of the model estimating expected investment levels. In main analysis, ue_inv is calculated by model (1). However, this modified model can make differences in the results of main analysis. To check the robustness in terms of the first stage, I define ue_inv by using models developed by Chen et al. (2011) and by Fujitani (2017). Almost all the results are consistent with main analysis. In both results, the coefficients on earnings quality are significant and consistent with my expectation.

6. Conclusion

I analyze the interrelationship between the effects of accounting information and of other governance mechanisms on investment efficiency by using Japanese data, where banking governance is thought to be dominant. This study focuses on main bank, institutional ownership, and outside directors as the alternative information-problem-mitigating mechanisms. I find that those governance mechanisms affect investment efficiency, but the effects are not monotonic. Considering this nonlinear effects, I find that main bank changes the effects of earnings quality on investment. The relationship is sometimes complementary, especially on alleviating under-investment, and sometimes substitutional.

This study is not able to answer why Biddle et al. (2009) do not observe the significant effects of earnings quality on investment efficiency in Japan. However, I show that their discussion is too simple to describe the complicated picture of accounting information and governance mechanisms. For complete explanation, future research should more focus on the reason of the results this study derives.

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Table 1. Sample distribution

	2010	2011	2012	2013	2014	2015	Total
Foods	81	78	79	76	80	76	470
Textile Products	37	35	39	38	36	37	222
Pulp & Paper	18	18	0	18	18	18	90
Chemicals	157	160	160	158	156	153	944
Drugs	35	36	35	36	37	32	211
Stone, Clay & Glass Products	48	47	46	45	45	44	275
Iron & Steel	45	47	48	45	43	43	271
Nonferrous Metal & Metal Products	95	92	93	88	87	87	542
Machinery	185	184	177	174	177	177	1,074
Electric & Electronic Equipment	208	212	202	198	194	195	1,209
Motor Vehicles & Auto Parts	76	76	73	73	70	70	438
Precision Equipment	35	35	34	36	33	33	206
Other Manufacturing	70	67	70	66	69	67	409
Construction	132	128	127	123	127	121	758
Wholesale Trade	209	207	212	211	215	208	1,262
Retail Trade	79	83	82	80	79	79	482
Real Estate	30	34	40	36	37	37	214
Railroad Transportation	27	27	28	27	27	27	163
Trucking	31	31	31	31	30	31	185
Warehousing & Harbor Transportation	32	33	33	34	34	32	198
Services	311	315	311	316	322	317	1,892
Total	1,941	1,945	1,920	1,909	1,916	1,884	11,515

Each year depicts each fiscal year ending in March. For instance, the column "2010" shows the number of observations reporting financial statement ending in March 2010. Industry classifications are Nikkei Medium Classification Industry Code (2-digit code, [NKILM])

Table 2.descriptive statistics

variables	mean	median	sd	min	1st Q	3rd Q	max
inv	0.0566	0.0434	0.0537	0	0.0193	0.0766	0.6074
ue_inv	-0.0015	-0.0096	0.0425	-0.0758	-0.0273	0.0151	0.1788
per_ni	0.4173	0.4432	0.3222	-0.5634	0.2222	0.6325	1.2358
pre_ni	-0.0244	-0.0203	0.0166	-0.0841	-0.0319	-0.0124	-0.0028
smo_ni	-0.5986	-0.5562	0.3090	-1.5771	-0.7890	-0.3620	-0.0992
maccq_ni	-0.0214	-0.0168	0.0165	-0.0988	-0.0267	-0.0106	-0.0031
eq	0.0025	0.2638	1.2848	-5.9350	-0.6809	0.9338	2.4327
inst	0.1421	0.0857	0.1544	0	0.0104	0.2347	0.6001
outd	0.1049	0	0.1352	0	0	0.1667	0.5714
mbnk	0.2224	0.1972	0.2340	0	0	0.3594	1
mbnk_sh	0.0208	0.0199	0.0180	0	0	0.0382	0.0497
main	0.0000	-0.0619	1.0851	-1.4890	-0.8657	0.8188	3.4535
$cf_{i,t}$	0.0731	0.0704	0.0648	-0.1127	0.0358	0.1079	0.2693
$cash_{i,t-1}$	2.2961	0.5149	7.0632	0.0183	0.2419	1.2152	53.6364
$q_{i,t-1}$	0.7115	0.5468	0.6385	0.0159	0.3903	0.7643	4.1081
$vsg_{i,t-1}$	0.1219	0.0884	0.1180	0.0068	0.0464	0.1531	0.6913
$vinv_{i,t-1}$	0.0328	0.0226	0.0327	0.0018	0.0125	0.0407	0.1879
$neg_{i,t-1}$	0.1178	0	0.3224	0	0	0	1

All observations falling in the top or bottom 0.5 % with respect to each variable are winsorized. All variables are defined in Appendix.

Table 3.
correlation coefficient

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)	*inv*		0.7360	-0.0213	-0.1830	-0.1821	0.0445	-0.1479	0.2448	0.1088
(2)	*ue_inv*	0.8479		-0.0247	-0.0436	-0.0289	0.0340	-0.0204	0.1755	0.0527
(3)	*per_ni*	-0.0370	-0.0291		0.0856	-0.2098	0.1141	0.0745	0.0958	-0.0340
(4)	*pre_ni*	-0.1658	-0.0892	0.0953		0.5564	0.4780	0.9175	0.0199	-0.0559
(5)	*smo_ni*	-0.1058	-0.0208	-0.1855	0.4657		0.0106	0.6491	-0.0968	0.0388
(6)	*maccq_ni*	-0.0409	-0.0324	0.1318	0.4918	-0.0344		0.6215	0.1181	-0.0640
(7)	*eq*	-0.1485	-0.0717	0.0978	0.9253	0.5907	0.6703		0.0198	-0.0453
(8)	*inst*	0.1823	0.1253	0.0812	0.0108	-0.1184	0.1070	0.0115		0.1490
(9)	*outd*	0.1171	0.0797	-0.0409	-0.0793	0.0427	-0.1191	-0.0791	0.1547	
(10)	*mbnk*	-0.0544	-0.0374	-0.0373	-0.0084	0.0068	-0.0208	-0.0127	-0.1872	-0.0862
(11)	*mbnk_sh*	-0.1118	-0.0690	0.0000	0.2229	0.0166	0.2046	0.2121	-0.1131	-0.1951
(12)	*main*	-0.1083	-0.0693	-0.0243	0.1398	0.0153	0.1198	0.1299	-0.1957	-0.1833
(13)	$cf_{i,t}$	0.2446	0.1861	0.0339	-0.0387	-0.0520	-0.0051	-0.0401	0.1253	0.0628
(14)	$cash_{i,t-1}$	-0.0398	-0.0627	-0.0838	-0.2043	0.0663	-0.2770	-0.2061	-0.0900	0.1477
(15)	$q_{i,t-1}$	0.0918	0.0535	0.0192	-0.0555	-0.0309	-0.0637	-0.0663	0.1302	0.0928
(16)	$vsg_{i,t-1}$	0.0278	0.0111	-0.1492	-0.4265	-0.1384	-0.3898	-0.4517	0.0221	0.0217
(17)	$vinv_{i,t-1}$	0.2525	0.1844	-0.0472	-0.2117	0.0211	-0.2663	-0.2199	-0.0232	0.0982
(18)	$neg_{i,t-1}$	-0.0483	-0.0299	0.0062	-0.2389	-0.0367	-0.1937	-0.2234	-0.0902	-0.0081

		(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1)	*inv*	-0.0677	-0.0850	-0.0982	0.2812	-0.1906	0.2275	0.0048	0.3194	-0.0656
(2)	*ue_inv*	-0.0416	-0.0320	-0.0513	0.1639	-0.1482	0.1003	-0.0011	0.1715	-0.0394
(3)	*per_ni*	-0.0445	-0.0089	-0.0359	0.0430	-0.0323	0.0342	-0.1470	-0.0327	0.0066
(4)	*pre_ni*	0.0232	0.2007	0.1344	-0.0642	-0.2279	-0.1125	-0.4260	-0.2307	-0.2257
(5)	*smo_ni*	0.0068	0.0177	0.0158	-0.0760	-0.0111	-0.0945	-0.1574	-0.0651	-0.0543
(6)	*maccq_ni*	0.0216	0.1773	0.1191	0.0142	-0.2856	-0.0308	-0.3481	-0.1542	-0.1872
(7)	*eq*	0.0244	0.1979	0.1320	-0.0587	-0.2483	-0.1184	-0.4322	-0.2174	-0.2163
(8)	*inst*	-0.1932	-0.0930	-0.1800	0.1443	-0.0523	0.2252	0.0414	-0.0091	-0.1133
(9)	*outd*	-0.1053	-0.1876	-0.1854	0.0544	0.0365	0.1510	0.0006	0.0660	-0.0233
(10)	*mbnk*		0.2214	0.7547	-0.0403	-0.1513	0.0170	0.0049	0.0555	0.0270
(11)	*mbnk_sh*	0.1775		0.7821	-0.1241	-0.1419	-0.0785	-0.0580	-0.1368	-0.0034
(12)	*main*	0.7673	0.7673		-0.1060	-0.1640	-0.0476	-0.0316	-0.0556	0.0156
(13)	$cf_{i,t}$	-0.0392	-0.1143	-0.1000		-0.0610	0.1880	-0.0764	0.1895	-0.2106
(14)	$cash_{i,t-1}$	-0.0924	-0.1906	-0.1844	0.0095		-0.1471	0.1256	-0.2407	0.0329
(15)	$q_{i,t-1}$	-0.0057	-0.0186	-0.0158	0.0871	0.0160		0.0105	0.2139	-0.0309
(16)	$vsg_{i,t-1}$	0.0200	-0.0800	-0.0391	-0.0608	0.1039	0.0265		0.1044	0.1748
(17)	$vinv_{i,t-1}$	0.0483	-0.1679	-0.0779	0.1117	-0.0245	0.1182	0.1783		0.0541
(18)	$neg_{i,t-1}$	0.0330	-0.0030	0.0196	-0.2119	0.0374	-0.0164	0.1500	0.0752	

Pearson correlation coefficients are reported at the lower left diagonal matrix, and Spearman correlation coefficients are reported at the lower right diagonal matrix. All observations falling in the top or bottom 0.5 % with respect to each variable are winsorized. All variables are defined in Appendix.

Table 4. The effects of Governance mechanisms
(Obs=11,515)

		baseline		main		inst		outd	
variables	pred	COEFFs	S.E.	COEFFs	S.E.	COEFFs	S.E.	COEFFs	S.E.
under-investment									
dinv/dmain									
full	+	0.002a	0.0004			0.002a	0.0004	0.002a	0.0004
<*median*				**0.004a**	**0.0008**				
>*median*				**0.000**	**0.0006**				
dinv/dinst									
full	+	0.012a	0.0033	0.012a	0.0033			0.011a	0.0033
<*median*						**0.024**	**0.0171**		
>*median*						**0.013a**	**0.0034**		
dinv/doutd									
full	+	-0.014a	0.0031	-0.013a	0.0031	-0.014a	0.0031		
<*median*								**0.036**	**0.0194**
>*median*								**-0.014a**	**0.0031**
over-investment									
dinv/dmain									
full	-	-0.003a	0.0008			-0.003a	0.0008	-0.003a	0.0008
<*median*				**-0.008a**	**0.0023**				
>*median*				**0.000**	**0.0014**				
dinv/dinst									
full	-	-0.002	0.0058	-0.001	0.0058			-0.001	0.0059
<*median*						**0.006**	**0.0483**		
>*median*						**0.007**	**0.0081**		
dinv/doutd									
full	-	0.034a	0.0076	0.033a	0.0076	0.033a	0.0076		
<*median*								**-0.019**	**0.0269**
>*median*								**0.042a**	**0.0129**
controls									
$over_{i,t}$		0.054a	0.0015	0.048a	0.0026	0.055a	0.0020	0.055a	0.0015
$cf_{i,t}$		0.073a	0.0101	0.072a	0.0100	0.073a	0.0101	0.073a	0.0100
$cash_{i,t-1}$		0.000	0.0001	0.000	0.0001	0.000	0.0001	0.000	0.0001
$q_{i,t-1}$		-0.001	0.0007	-0.001	0.0007	-0.001	0.0007	-0.001	0.0007
$vsg_{i,t-1}$		0.002	0.0052	0.002	0.0052	0.002	0.0052	0.002	0.0052
$vinv_{i,t-1}$		0.197a	0.0235	0.196a	0.0236	0.196a	0.0234	0.196a	0.0236
$neg_{i,t-1}$		-0.003b	0.0012	-0.003a	0.0012	-0.003a	0.0012	-0.003b	0.0012
year/industry		yes		yes		yes		yes	
C.R.S.E.		yes		yes		yes		yes	
other interactions		yes		yes		yes		yes	
AdjR		0.5202		0.5211		0.5203		0.5205	

b and a indicate significance at the 5 and 1% levels, respectively, using a two-tailed test. Coefficients on *eq* and ***gov*** variables are partial derivatives with respect to them in each group. "***year/industry***" indicates whether each model includes year and industry fixed effects or not. "***C.R.S.E***" indicates whether standard errors are clustered by firm (Petersen 2009; Cameron and Miller 2015).

Table 5. The full-model

	full-model	
variables	COEFFs	S.E.
under-investment		
dinv/dmain		
<*median*	**0.004a**	**0.0009**
>*median*	**0.000**	**0.0006**
dinv/dinst		
<*median*	**0.025**	**0.0171**
>*median*	**0.010a**	**0.0035**
dinv/doutd		
<*median*	**0.037**	**0.0191**
>*median*	**-0.015a**	**0.0032**
over-investment		
dinv/dmain		
<*median*	**-0.007a**	**0.0023**
>*median*	**-0.001**	**0.0014**
dinv/dinst		
<*median*	**0.016**	**0.0484**
>*median*	**0.008**	**0.0081**
dinv/doutd		
<*median*	**-0.014**	**0.0271**
>*median*	**0.039a**	**0.0128**
controls		
$over_{i,t}$	0.050a	0.0031
$cf_{i,t}$	0.073a	0.0100
$cash_{i,t-1}$	0.000	0.0001
$q_{i,t-1}$	0.000	0.0007
$vsg_{i,t-1}$	0.002	0.0052
$vinv_{i,t-1}$	0.195a	0.0236
$neg_{i,t-1}$	-0.003a	0.0012
year/industry	yes	
C.R.S.E.	yes	
other interactions	yes	
AdjR	0.5214	
obs	11,515	

b and a indicate significance at the 5 and 1% levels, respectively, using a two-tailed test. Coefficients on *eq* and ***gov*** variables are partial derivatives with respect to them in each group. "***year/industry***" indicates whether each model includes year and industry fixed effects or not. "***C.R.S.E***" indicates whether standard errors are clustered by firm (Petersen 2009; Cameron and Miller 2015).

Table 6. Model (2)

		eq-baseline model	
	pred	COEFFs	S.E.
$\partial inv/\partial eq$			
under-investment	+	0.002a	0.0004
over-investment	-	-0.005a	0.0009
$\partial inv/\partial main$			
under-investment	+	0.001a	0.0004
over-investment	-	-0.002a	0.0008
$\partial inv/\partial inst$			
under-investment	+	0.012a	0.0032
over-investment	-	0.000	0.0057
$\partial inv/\partial outd$			
under-investment	+	-0.012a	0.0030
over-investment	-	0.031a	0.0076
controls			
$over_{i,t}$		0.054a	0.0015
$cf_{i,t}$		0.070a	0.0100
$cash_{i,t-1}$		0.000	0.0001
$q_{i,t-1}$		-0.001	0.0007
$vsg_{i,t-1}$		-0.005	0.0054
$vinv_{i,t-1}$		0.188a	0.0229
$neg_{i,t-1}$		-0.004a	0.0012
year/industry		yes	
C.R.S.E.		yes	
AdjR		0.528	
obs		11,515	

This table reports the results obtained by: $inv_{i,t} = \eta_0 + \eta_1 eq_{i,t-1} + \eta_2 eq_{i,t-1} * over_{i,t} + \eta_3 \boldsymbol{gov}_{i,t-1} + \eta_4 \boldsymbol{gov}_{i,t-1} * over_{i,t} + \eta_5 over_{i,t} + \delta \boldsymbol{Z} + \boldsymbol{year}_t + \boldsymbol{industry}_I + \varepsilon_{5,i,t}$.
b and a indicate significance at the 5 and 1% levels, respectively, using a two-tailed test. Coefficients on *eq* and ***gov*** variables are partial derivatives with respect to them in each group. "***year/industry***" indicates whether each model includes year and industry fixed effects or not. "***C.R.S.E***" indicates whether standard errors are clustered by firm (Petersen 2009; Cameron and Miller 2015). All the other variables are defined in Appendix.

Table 7. Model (3):
Main banks and earnings quality

		pooled		main<med		main>med	
	pred	COEFFs	S.E.	COEFFs	S.E.	COEFFs	S.E.
$\partial inv/\partial eq$							
under-investment	+	0.002a	0.0004	0.004a	0.0011	0.001	0.0008
over-investment	-	-0.005a	0.0009	-0.003	0.002	-0.003b	0.0015
$(\partial inv/\partial eq)*(\partial inv/\partial main)$							
under-investment	?	**0.000**	**0.0003**	**0.002b**	**0.0009**	**0.000**	**0.0006**
over-investment	?	**0.001**	**0.0006**	**0.002**	**0.0018**	**-0.001**	**0.0012**
$\partial inv/\partial main$							
under-investment		0.001a	0.0004	0.003b	0.0012	0.000	0.0007
over-investment		-0.002a	0.0008	-0.005b	0.0022	0.000	0.0014
$\partial inv/\partial inst$							
under-investment		0.012a	0.0033	0.010b	0.0044	0.015a	0.0044
over-investment		0.001	0.0058	0.004	0.0076	-0.002	0.008
$\partial inv/\partial outd$							
under-investment		-0.012a	0.0029	-0.013a	0.0039	-0.010b	0.0041
over-investment		0.031a	0.0076	0.022b	0.0096	0.045a	0.0118
controls							
$over_{i,t}$		0.053a	0.0015	0.050a	0.003	0.049a	0.0024
$cf_{i,t}$		0.071a	0.01	0.080a	0.0131	0.057a	0.0143
$cash_{i,t-1}$		0.000	0.0001	0.000	0.0001	-0.000a	0.0001
$q_{i,t-1}$		-0.001	0.0007	-0.001	0.0011	-0.001	0.0007
$vsg_{i,t-1}$		-0.005	0.0053	-0.005	0.0084	-0.006	0.0055
$vinv_{i,t-1}$		0.187a	0.0228	0.207a	0.0274	0.145a	0.0355
$neg_{i,t-1}$		-0.004a	0.0012	-0.003	0.002	-0.005a	0.0013
year/industry		yes		yes		yes	
C.R.S.E.		yes		yes		yes	
AdjR		0.5283		0.5250		0.5255	
obs		11,515		5,758		5,757	

This table reports the results obtained by: $inv_{i,t} = \pi_0 + \pi_1 eq_{i,t-1} + \pi_2 eq_{i,t-1} * over_{i,t} + \pi_3 eq_{i,t-1} * \boldsymbol{gov}_{i,t-1} + \pi_4 eq_{i,t-1} * over_{i,t} * \boldsymbol{gov}_{i,t-1} + \pi_5 \boldsymbol{gov}_{i,t-1} + \pi_6 \boldsymbol{gov}_{i,t-1} * over_{i,t} + \pi_7 over_{i,t} + \delta \cdot \boldsymbol{Z} + \boldsymbol{year}_t + \boldsymbol{industry}_I + \varepsilon_{5,i,t}$.
b and a indicate significance at the 5 and 1% levels, respectively, using a two-tailed test. Coefficients on *eq* and ***gov*** variables are partial derivatives with respect to them in each group. "***year/industry***" indicates whether each model includes year and industry fixed effects or not. "***C.R.S.E***" indicates whether standard errors are clustered by firm (Petersen 2009; Cameron and Miller 2015).

Table 8. Model (3): Institutional investors and earnings quality

		pooled		inst<med		inst>med	
		COEFFs	S.E.	COEFFs	S.E.	COEFFs	S.E.
$\partial inv/\partial eq$							
under-investment	+	0.002a	0.0005	0.002b	0.0007	0.000	0.0011
over-investment	-	-0.005a	0.0012	-0.005a	0.0016	-0.004	0.002
$(\partial inv/\partial eq)*(\partial inv/\partial inst)$							
under-investment	?	**-0.001**	**0.0025**	**0.016**	**0.0153**	**0.003**	**0.004**
over-investment	?	**0.001**	**0.0045**	**-0.019**	**0.0431**	**-0.004**	**0.0064**
$\partial inv/\partial inst$							
under-investment		0.012a	0.0032	0.040b	0.018	0.005	0.0052
over-investment		0.000	0.0056	0.033	0.0485	0.005	0.0079
$\partial inv/\partial main$							
under-investment		0.001a	0.0004	0.001b	0.0004	0.002b	0.0007
over-investment		-0.002a	0.0008	-0.002	0.0012	-0.003a	0.001
$\partial inv/\partial outd$							
under-investment		-0.012a	0.003	-0.011a	0.0036	-0.014a	0.0049
over-investment		0.031a	0.0077	0.042a	0.0136	0.024a	0.0083
controls							
$over_{i,t}$		0.054a	0.0015	0.053a	0.0023	0.050a	0.0027
$cf_{i,t}$		0.070a	0.01	0.064a	0.0139	0.076a	0.0137
$cash_{i,t-1}$		0.000	0.0001	0.000	0.0001	0.000	0.0001
$q_{i,t-1}$		-0.001	0.0007	-0.001	0.0011	0.000	0.0008
$vsg_{i,t-1}$		-0.005	0.0053	-0.002	0.0072	-0.009	0.0077
$vinv_{i,t-1}$		0.187a	0.0229	0.198a	0.0317	0.167a	0.0267
$neg_{i,t-1}$		-0.004a	0.0012	-0.004a	0.0015	-0.003	0.002
year/industry		yes		yes		yes	
C.R.S.E.		yes		yes		yes	
AdjR		0.5279		0.5135		0.5267	
obs		11,515		5,759		5,756	

This table reports the results obtained by: $inv_{i,t} = \pi_0 + \pi_1 eq_{i,t-1} + \pi_2 eq_{i,t-1} * over_{i,t} + \pi_3 eq_{i,t-1} * \boldsymbol{gov}_{i,t-1} + \pi_4 eq_{i,t-1} * over_{i,t} * \boldsymbol{gov}_{i,t-1} + \pi_5 \boldsymbol{gov}_{i,t-1} + \pi_6 \boldsymbol{gov}_{i,t-1} * over_{i,t} + \pi_7 over_{i,t} + \delta \cdot \boldsymbol{Z} + \boldsymbol{year}_t + \boldsymbol{industry}_I + \varepsilon_{5,i,t}$.
b and a indicate significance at the 5 and 1% levels, respectively, using a two-tailed test. Coefficients on *eq* and ***gov*** variables are partial derivatives with respect to them in each group. "***year/industry***" indicates whether each model includes year and industry fixed effects or not. "***C.R.S.E***" indicates whether standard errors are clustered by firm (Petersen 2009; Cameron and Miller 2015).

Table 9. Model (3):
Outside directors and earnings quality

		pooled		outd<mean		outd>mean	
		COEFFs	S.E.	COEFFs	S.E.	COEFFs	S.E.
$\partial inv/\partial eq$							
under-investment	+	0.001a	0.0005	0.001b	0.0006	0.002	0.0011
over-investment	-	-0.005a	0.001	-0.005a	0.0011	-0.006b	0.0026
$(\partial inv/\partial eq)*(\partial inv/\partial outd)$							
under-investment	?	**0.002**	**0.002**	**-0.012**	**0.0155**	**-0.001**	**0.0033**
over-investment	?	**-0.001**	**0.0059**	**0.026**	**0.0259**	**0.002**	**0.0106**
$\partial inv/\partial outd$							
under-investment		-0.012a	0.0029	0.033	0.0203	-0.015a	0.0052
over-investment		0.031a	0.0077	-0.022	0.0296	0.039a	0.0134
$\partial inv/\partial main$							
under-investment		0.001a	0.0004	0.001a	0.0005	0.001b	0.0006
over-investment		-0.002a	0.0008	-0.003a	0.0009	-0.002	0.0014
$\partial inv/\partial inst$							
under-investment		0.011a	0.0033	0.014a	0.0046	0.008	0.0044
over-investment		0	0.0058	0.005	0.0072	-0.002	0.0089
controls							
$over_{i,t}$		0.054a	0.0015	0.054a	0.0017	0.051a	0.0035
$cf_{i,t}$		0.070a	0.0101	0.068a	0.0118	0.071a	0.0162
$cash_{i,t-1}$		0	0.0001	0	0.0001	0	0.0001
$q_{i,t-1}$		-0.001	0.0007	0	0.0009	-0.001	0.001
$vsg_{i,t-1}$		-0.005	0.0054	-0.003	0.007	-0.007	0.0079
$vinv_{i,t-1}$		0.188a	0.0229	0.204a	0.0293	0.173a	0.0333
$neg_{i,t-1}$		-0.004a	0.0012	-0.004a	0.0013	-0.004b	0.0021
year/industry		yes		yes		yes	
C.R.S.E.		yes		yes		yes	
AdjR		0.5279		0.5336		0.5147	
obs		11,515		6,605		4,910	

This table reports the results obtained by: $inv_{i,t} = \pi_0 + \pi_1 eq_{i,t-1} + \pi_2 eq_{i,t-1} * over_{i,t} + \pi_3 eq_{i,t-1} * \boldsymbol{gov}_{i,t-1} + \pi_4 eq_{i,t-1} * over_{i,t} * \boldsymbol{gov}_{i,t-1} + \pi_5 \boldsymbol{gov}_{i,t-1} + \pi_6 \boldsymbol{gov}_{i,t-1} * over_{i,t} + \pi_7 over_{i,t} + \delta \cdot \boldsymbol{Z} + \boldsymbol{year}_t + \boldsymbol{industry}_I + \varepsilon_{5,i,t}$.
b and a indicate significance at the 5 and 1% levels, respectively, using a two-tailed test. Coefficients on *eq* and ***gov*** variables are partial derivatives with respect to them in each group. "***year/industry***" indicates whether each model includes year and industry fixed effects or not. "***C.R.S.E***" indicates whether standard errors are clustered by firm (Petersen 2009; Cameron and Miller 2015).

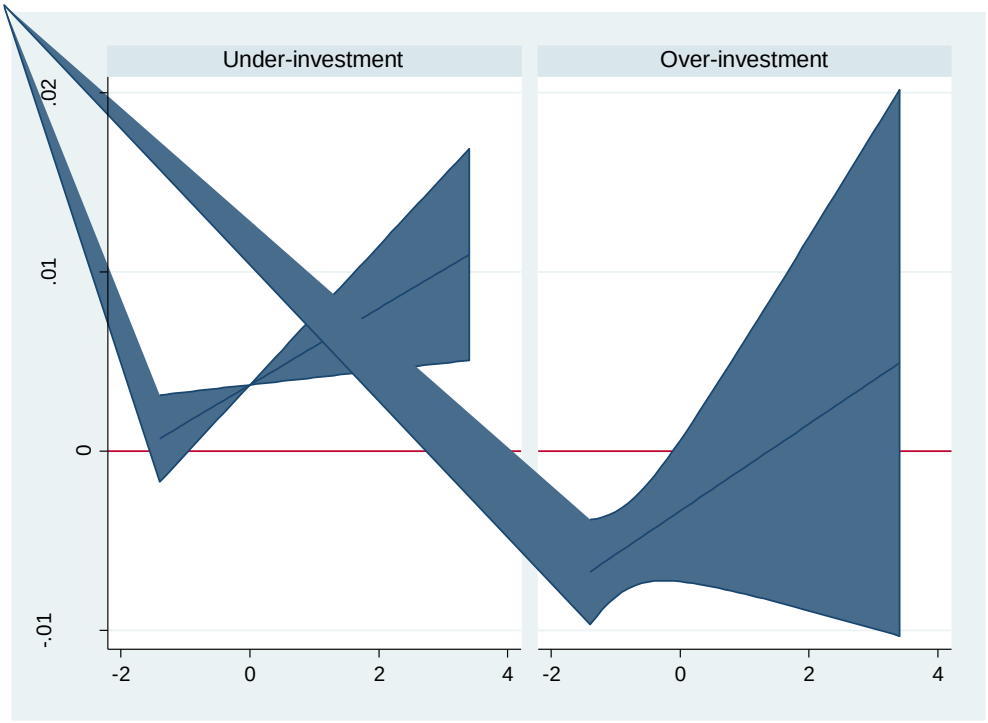

Figure 1. The change in the earnings quality effects on investment. This figure presents how the marginal effects of earnings quality (*eq*) estimated model (3) vary with the strength of main bank relationship in firms with less than the median. The x axis presents the values of *main*, and the y axis presents the marginal effects of earnings quality on investment. The left panel reports the changes in under-investment firms, and the right panel does in over-investment firms. The plotted region describes the confidence at 95% levels. The line in the region presents the estimated coefficients. The estimated model is: $inv_{i,t} = \pi_0 + \pi_1 eq_{i,t-1} + \pi_2 eq_{i,t-1} * over_{i,t} + \pi_3 eq_{i,t-1} * \boldsymbol{gov}_{i,t-1} + \pi_4 eq_{i,t-1} * over_{i,t} * \boldsymbol{gov}_{i,t-1} + \pi_5 \boldsymbol{gov}_{i,t-1} + \pi_6 \boldsymbol{gov}_{i,t-1} * over_{i,t} + \pi_7 over_{i,t} + \delta \cdot \boldsymbol{Z} + \boldsymbol{year}_t + \boldsymbol{industry}_I + \varepsilon_{5,i,t}$.

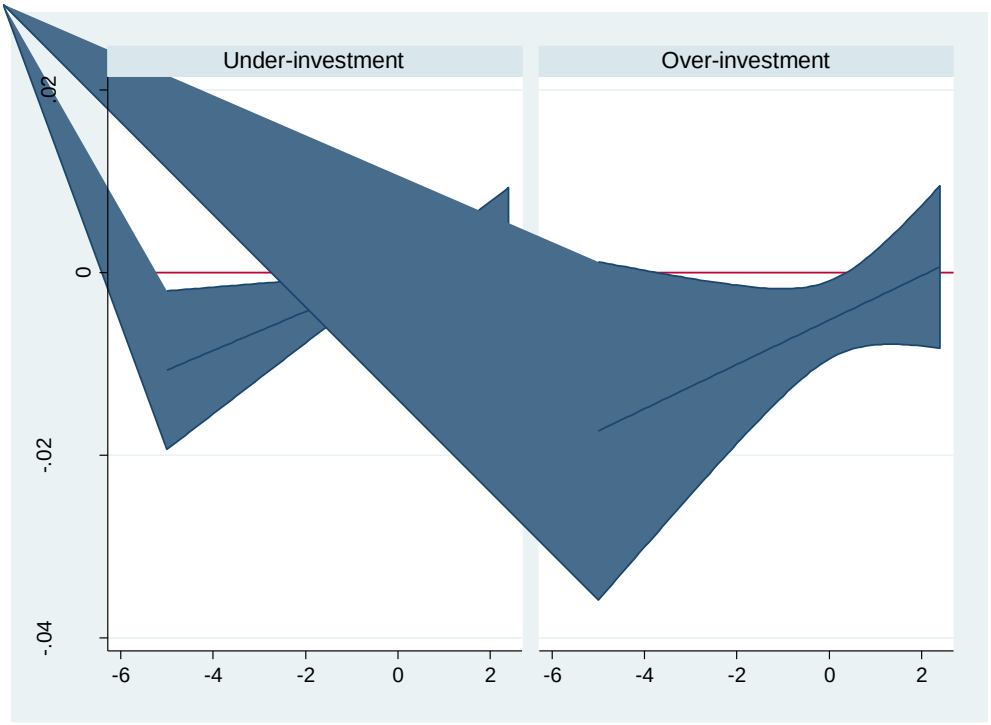

Figure 2. The change in the main bank effects on investment. This figure presents how the marginal effects of the strength of main bank relationship (*main*) estimated model (3) vary with the strength of main bank relationship in firms with less than the median. The x axis presents the values of *eq*, and the y axis presents the marginal effects of the main bank relationship on investment. The left panel reports the changes in under-investment firms, and the right panel does in over-investment firms. The plotted region describes the confidence at 95% levels. The line in the region presents the estimated coefficients. The estimated model is: $inv_{i,t} = \pi_0 + \pi_1 eq_{i,t-1} + \pi_2 eq_{i,t-1} * over_{i,t} + \pi_3 eq_{i,t-1} * \boldsymbol{gov}_{i,t-1} + \pi_4 eq_{i,t-1} * over_{i,t} * \boldsymbol{gov}_{i,t-1} + \pi_5 \boldsymbol{gov}_{i,t-1} + \pi_6 \boldsymbol{gov}_{i,t-1} * over_{i,t} + \pi_7 over_{i,t} + \delta \cdot \boldsymbol{Z} + \boldsymbol{year}_t + \boldsymbol{industry}_I + \varepsilon_{5,i,t}$.

Appendix1. Variable definitions

A1.1 Investment

Investment level ($inv_{i,t}$) is net investment in tangibles, intangibles and R&D projects. Tangibles investment equals the change in *property, plant and equipment* [B01063] from t-1 through t pluses its *depreciation* and its *impairment*. Intangibles investment equals the change in intangibles [B01076] pluses its *depreciation* and its *impairment*. R&D investment is *cash outflow on research and development* [H01033]. I use sum of depreciation, amortization, and impairment with regard to tangibles and intangibles ([H01005] and [H01009]).

A1.2 Earnings attributes

Earnings used in the following definitions is *earnings before taxes and special items* [D01066] (Data source: FQ).

Earnings volatility ($vol_{i,t}$) is the standard deviation of 10 years earnings from period t-9 to period t, all scaled by the average of *total assets* (computed as the average of *total assets* [B01110] at the beginning and the end of t). To represent the ease to predict future earnings, I add negative sign (Data source: FQ).

Earnings persistence ($per_{i,t}$) is the AR1 coefficient $\phi_1^{i,t}$ in regression model: $ear_{i,t} = \phi_0^{i,t} + \phi_1^{i,t} ear_{i,t-1} + \tau_{i,t}$, using data from t-9 through t. Ear is scaled by the average of *total assets* (computed as the average of *total assets* [B01110] at the beginning and the end of t) (Data source: FQ).

Earnings predictability ($pre_{i,t}$) is the 9-year standard deviation of residuals from AR (1) model: $ear_{i,t} = \phi_0^{i,t} + \phi_1^{i,t} ear_{i,t-1} + \tau_{i,t}$, using data from t-9 through t. Ear is scaled by the average of *total assets* (computed as the average of *total assets* [B01110] at the beginning and the end of t) (Data source: FQ).

Smoothness ($smo_{i,t}$) is *earnings volatility* ($vol_{i,t}$) divided by *cash flow volatility* ($vcf_{i,t}$), all divided by the average of *total assets* (computed as the average of *total assets* [B01110] at the beginning and the end of t). To represent the ease to predict future earnings, I add negative sign (Data source: FQ).

Dechow and Dichev's (2002) accruals quality ($acq_{i,t}$) is the 5-year standard deviation of residuals from the following regression model: $acc_{i,t} = \psi_0 + \psi_1 cfo_{i,t-1} + \psi_2 cfo_{i,t} + \psi_3 cfo_{i,t+1} + v_{i,t}$, from t-4 through t. $acc_{i,t}$ and $cfo_{i,t}$ are respectively accruals and cash flow components of earnings, defined at section A1.3. All variables are scaled by the average of *total assets* (computed as the average of *total assets* [B01110] at the beginning and the end of t). This regression model is estimated by running separated industry-year regressions. To represent the ease to predict future earnings, I add negative sign.

McNichols' (2002) accruals quality ($maq_{i,t}$) is the 5-year standard deviation of residuals from the following regression model: $acc_{i,t} = \chi_0 + \chi_1 cfo_{i,t-1} + \chi_2 cfo_{i,t} + \chi_3 cfo_{i,t+1} + \chi_4 sg_{i,t} +$

$\chi_5 ppe_{i,t} + \omega_{i,t}$, from t-4 through t. $acc_{i,t}$ and $cfo_{i,t}$ are respectively accruals and cash flow components of earnings. $sg_{i,t}$ is sales growth from t-1 through t, and $ppe_{i,t}$ is capital intensity at t. All variables are defined at section A1.3, and scaled by the average of *total assets* (computed as the average of *total assets* [B01110] at the beginning and the end of t). This regression model is estimated by running separated industry-year regressions. To represent the ease to predict future earnings, I add negative sign.

Aggregate indicator of EAs ($agg2_{i,t}$) is the estimated principal components of 4 EAs including $per_{i,t}$, $pre_{i,t}$, $smo_{i,t}$, and $maq_{i,t}$. The eigenvalues of the indicators are 0.0748, 0.7171, 0.4576, 0.5203, respectively.

A1.3 Other variables

Accruals ($acc_{i,t}$) is computed by the items on balance sheet: $(\Delta ca_{i,t} - \Delta cash_{i,t}) - (\Delta cl_{i,t} - \Delta std_{i,t} - \Delta tp_{i,t}) - dep_{i,t}$. $\Delta ca_{i,t}$ is the change in *current asset* [B01021] from t-1 through t. $\Delta cash_{i,t}$ is the change in *cash and cash equivalents* [B01022]. $\Delta cl_{i,t}$ is the change in *current liabilities* [C01021]. $\Delta std_{i,t}$ is the change in *debt included in current liabilities* [C01026]. $\Delta tp_{i,t}$ is the change in *total taxes payable*, which is sum of *income taxes payable* [C01040], *accrued business office taxes* [C01041], and *accrued consumption taxes* [C01042]. $dep_{i,t}$ is *depreciation* [H01005]. All variables are divided by the average of *total assets* (computed as the average of *total assets* [B01110] at the beginning and the end of t) (Data source: FQ).

Assets growth ($ag_{i,t}$) is the change in *total assets* [B01110] from t-1 through t, all scaled by *total assets* at t-1 (Data source: FQ).

Capital intensity ($ppe_{i,t}$) equals property, plant and equipment [B01063] at t scaled by total assets [B01110] at t (Data source: FQ).

Cash flow from operation ($cfo_{i,t}$) equals the difference between *earnings* and *accruals* ($acc_{i,t}$). *Earnings* equals *operating income* [D01029] on profit and loss statement. All variables are divided by the average of *total assets* (computed as the average of *total assets* [B01110] at the beginning and the end of t) (Data source: FQ).

Cash flow volatility ($cfv_{i,t}$) equals the standard deviation of *cash flow from operation* ($cfo_{i,t}$) over 10 years, from t-9 through t (Data source: FQ).

Cash holdings ($cash_{i,t}$) equals *cash and cash equivalents* [B01022] divided by the average of total assets (computed as the average of *total assets* [B01110] at the beginning and the end of t) (Data source: FQ).

Firm's age ($age_{i,t}$) is the difference between *the year at t* and *the actual year of foundation* [PRMTD1] (Data source: FQ).

The ratio of *institutional investor* ($inst_{i,t}$) equals the sum of stock held by foreign investors, trust accounts and special life insurance accounts, all divided by total stock traded in equity market

(Data source: Cges).

Main banks ($main_{i,t}$) equals the the estimated principal components of two variables with respect to firm-bank relationship, including debt dependence of the main bank and the percent of main bank's shareholding. The eigenvalues of the indicators are 0.7071 and 0.7071, respectively (Data source: Cges).

Return on assets ($roa_{i,t}$) equals operating income [D01029] scaled by the average of *total assets* (computed as the average of *total assets* [B01110] at the beginning and the end of t) (Data source: FQ).

Sales growth ($sg_{i,t}$) equals the change in *sales* [D01021] from t-1 through t, all scaled by *sales* at t-1 (Data source: FQ).

Sales growth volatility ($sgv_{i,t}$) equals the standard deviation of *sales growth* ($sg_{i,t}$) over 10 years, from period t-9 through period t. (Data source: FQ).

The proxy of *tobin's q* ($q_{i,t}$) is the sum of *market value of equity* and *book value of liabilities*, scaled by *book value of equity* [B01110]. *Market value of equity* equals firm's stock price [MXCLOSE] times *its number traded* in equity market. *The number of traded stocks* equals the sum of *the number of stock issued* [A01057] at the end of period t, and the number of treasury stocks [A01058]. *Book value of liabilities* is the sum of *long-term loans and bonds* [C01058], and *short-term loans and bonds* [C01026] (Data source: FQ).

Appendix 2. Other specifications of the model estimating efficient investment