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Characteristics of an Innovation Adopter's Network and the Information in a Diffusion Process

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Abstract:

The purpose of this paper is to clarify the information creation activities by innovation adopters and to analyze the contents of that information in the process of innovation diffusion. For the adopter, an innovation has never been used before and, therefore is characterized by a high level of uncertainty for him. In this paper, we assume that there is a relationship —kind of "communities of practice (Lave and Wenger 1991)" —in which innovation adopters are creating information together, considering for example the doctor's networking in the diffusion process for drug A. The information created in that doctor's network, perhaps a research paper, is considered to be important information when other doctors make decisions to adopt that new drug A. Hence, we analyze the content of the paper. As a result of the analysis, in the first half of the diffusion period, research was conducted with groups that included special experts in the field. In the latter period, a group that does not necessarily have experts was conducting research. Regarding the content of information created by the doctor's network, in the first half of the drug diffusion period, research on the early stage of dosing of drug A was conducted, and in the latter period, research on the next stage of dosing, such as side effects, was conducted. We conclude that the doctor's network creates information, and that the content of that information will vary depending on the stage of innovation diffusion.

Keywords
diffusion of innovation, co-authorship network, communities of practice, Qualitative Data Analysis, the pharmaceutical industry

(1) Introduction

Products and services, although excellent, may not enjoy wide popularity. There has been much research and development in the field of management theory. However, there is lack of study on the matter of diffusion.

Christensen (1997) states that people accept new technology, and the resulting theory suggests that people accept new technologies when they reach a satisfactory level in terms of technology use. However, Moore (1991) points out that some high-technology products cannot spread widely.

Rogers (2003) argues that individuals who actively work toward the reduction of

uncertainty in innovation innovate in their decision processes as well. One way to reduce uncertainty of innovation is to test it. If it is not easy, they then try innovation temporarily; "trial by others" (Rogers, 2003, p.177) as an alternative proposal. In the subsequent section, a case study is presented that show how peer information promotes diffusion of innovation.

This study focuses on the innovation adopter's network and its shared information. ITs main objective is the elucidation of mechanism of diffusion by analyzing the adopter's network and their information in the pharmaceutical industry.

(2) Literature review

1. Medical innovation study

Coleman et al. (1966) studied the pattern of diffusion of a new dug. They distinguished a sequence of founts of information pertaining to a new drug by diving them into three sources: primary source, intermediate source, and final source. The highest percentage of the primary source (of information that doctors know a new drug for the first time) was from the details man within a given pharmaceutical company. Likewise, the highest percentage of intermediate source came from the details man. However, the final source, in other words, the information used when making a decision, was different. The highest percentage of the final source was the doctor's colleague. This result showed that doctors had much confidence in existing users. In addition, there was a difference at the time of new drug adoption "between those doctors who were integrated into these network and those who were isolated" (Coleman et al., 1966, p.79). Early adopters were doctors whose networks were enhanced by a colleague who adopted a new drug early, whereas isolated doctors were late adopters. Therefore, doctors reduce the uncertainty of a new drug with organizational power.

2. Clinical information as complementary assets

Teece (1987) mentions that it is necessary to bridge the gap between innovation and problems to provide solutions to customers. Therefore, a few things that fills this gap are "complementary assets," such as distribution and after-sales service. In this paper, we assume that one of the complementary assets of a new drug is clinical information. We presume that the information as complementary assets is one with network externalities (Tsutsui, 2011). Hence, if there are competing products, securing critical mass becomes an immediate necessity in order to be the top drug picked by doctors.

The information as complementary goods strongly promoting the reach of innovation has the characteristics of a network externality.

3. Communities of practice as the parent body of learning

The concept of communities of practice is an effective means to clear the mechanism by which clinical information is generated and shared. The concept of communities of practice, proposed by Lave and Wenger

(1991), is cited in the field of management theory (Brown and Duguid, 1991). Communities of practice are "groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (Wenger et al., 2002, p.4). They presented a case of the Tech Clubs as an example of communities of practices. When Chrysler was changed from a functional structure to product-oriented structure and engineers had to be allocated in separate units. It means that engineers lost a chance to learn from each other. Through these processes, the manager decided to assist in getting engineers to interact with each other. Engineers connected informally under the name of the Tech Clubs.

Similarly, a doctor can become a member of a practice community when obtaining medical knowledge at a medical school. Tsutsui (2011) considered the connection of communities of practice to influence the adoption of a new drug and conducted further research. Tsutsui (2011) assumed that a university hospital was the core element of doctors' communities of practice and examined an adoption rate of a new product in a university-affiliated hospital. As a result of research, an adoption rate of a new product in a university-affiliated hospital was higher than in those that had not adopted the new product.

This paper studies the influence of such communities for learning medical knowledge pertaining to the adoption of a new drug. However, doctors will not be tied down with a university hospital. Therefore, in the next section, I tried to clarify their research connection using co-authored data of the paper.

The logic of this paper is arranged follows. It is assumed that a doctor decides on adopting a new drug based on the information that a trustworthy doctor already uses the drug as part of his new medical supplies. It is assumed that doctors adopt various methods to share information with other doctors, both by personal interaction and participating in workshops.

In this study, we consider papers published in academic journals as important sources of information pertaining to the decision to adopt a new drug, thus, we analyze the paper's data. In many cases, papers are written by multiple authors. Therefore, it is possible to discover a network of doctors who collaborate to write a paper at the time of a new drug's diffusion.

(3) Network analysis of new drug diffusion

1. Data source and analysis methods

The present study focuses on drug A, available on the market since 1999 for the treatment for Alzheimer's disease.

Date were gathered from representative three journals in this field –the *Japanese Journal of Geriatric Psychiatry*, the *Journal of Japanese Society for Dementia Care*, and the *Japanese Journal of Geriatrics*. Then, the authors' data were collected from papers (around 2014) containing the name of drug A (whether having brand name or a generic one) in the title. By recognizing co-authored relationship as communities of

practice that collaborated on writing a paper, research networks were extracted. A total of 146 papers were collected from Ichushi service (http://www.jamas.or.jp/), with total listed authors was 753, and the actual number of authors being 480. Authors with the same family and surnames name were treated as one person.

Research was actively conducted twice during 2000 - 2014 (Figure 1). Therefore, we divided the period into two phases: 2000 - 2006 (Phase1) and 2007 - 2014 (Phase 2). The number of papers and authors in each period were 74 and 265, respectively, in Phase 1, and 72 and 256 respectively (41 being published in both phases). There was no significant difference between the number of articles and the number of authors in each periods. Most of the authors are presumed to be doctors as per the names on the paper.

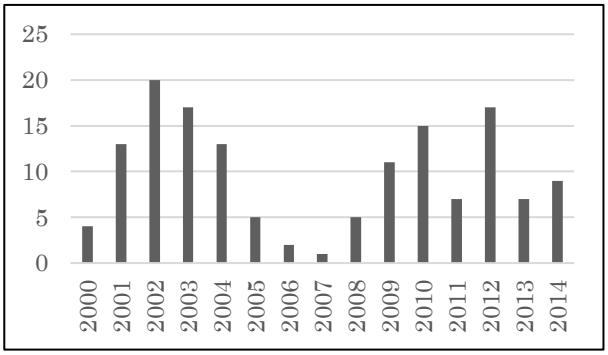

Figure 1, The number of paper per year

Source: Prepared by author.

2. Networks in both periods

The networks of authors in the two periods were defined. The contours were drawn using an m-slice technique in networks based on the method proposed by DeNooy et al. (2005). The following is an example of an m-slice. When there are five articles (paper A is single-authored, papers B, C, D and E are multi-authored) and seven authors (Table 1), Figure 2 may be drawn.

Table 1. Five papers and seven authors

Paper A	1
Paper B	2, 3
Paper C	2, 3, 4
Paper D	3, 4, 5
Paper E	6, 7

Source: Prepared by author.

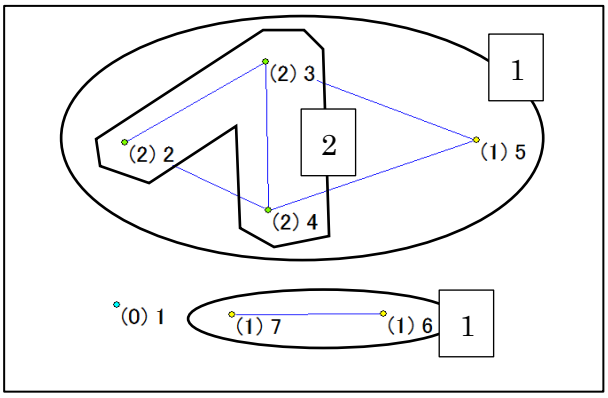

Figure 2. The relation of seven authors

Source: Prepared by author.

In Figure 2, numbers within the curve line are the number of times of co-authorship (n). Authors of papers B, C and D are connected in the big oval of Figure 1. In that oval, there is no joint work experience, yet authors 2 and 5 can connect through authors 3 and 4. Thus, it is possible to draw two networks and an isolated vertex of one person using the m-slice technique.

The respective authors of Phase 1 wrote a total of 74 papers and 72 in Phase 2, drawn from these networks using the aforementioned method. As a result, 35

networks were formed for Phase 1, and 31 for Phase 2. When one regards as the number of the persons who form the network, it becomes clear that a dominant network of Phase 2 is of a larger scale than that of Phase 1 (Table 2).

Table 2. The composition of members of the top three networks

	2000 - 2006	2007 - 2014
1st place	25	48
2nd place	16	21
3rd place	15	17

Source: Prepared by author.

There is no significant difference in the result of the m-slice in phases 1 and 2 (Table 3). The result of m-slice in both phases were a minimum value of 0 and maximum of 9.

Table 3. Result of the m-slice in two phases

m-slice	Number of authors of Phase 1	Number of authors of Phase 2
0	4	7
1	197	188
2	47	52
3	14	2
4	0	3
5	2	0
9	3	4

Source: Prepared by author.

3. Interpretation of network

The insight was provided when I interpreted the network from using the information that got from the interview to the pharmaceutical company.

The interview brought an environmental understanding surrounding the treatment for Alzheimer's disease and the ideas of these researchers. The information obtained from the interview was helpful to understand the influence upon the diffusion of drug A from the list of 480 surveyed authors.

The network was divided such that a person supposed to be influential in the diffusion of drug A was might be included in more than one network or in none of them. As a result, the percentage of networks in which an influential person is included become the Phase 1 percentage, which is higher than Phase 2's (Table 4). Therefore, it appears that the cooperation of an influential person is necessary because of the uncertainty surrounding a new drug's sales. Figure 3 shows that drug A was diffused rapidly within the first 10 years (2000 through 2010). The information that reduces uncertainty and promoted the spread of drug A was considered in the papers included in Phase 1.

Table 4. Percentage of networks where a person influencing the spread of drug A was included

period	The number of network	percentage
2000 - 2006	17	49%(17/ 35)
2007 - 2014	10	32%(10/31)

Source: Prepared by author.

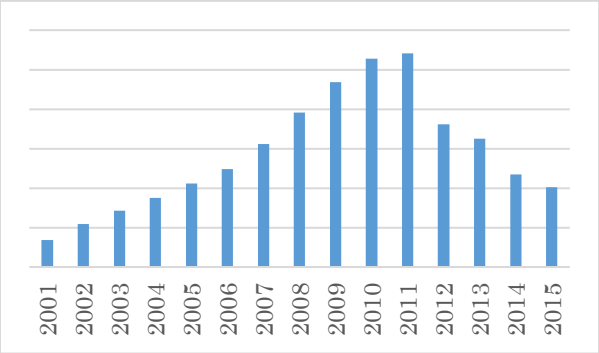

Figure 3. Sales trend of drug

Source: Prepared by author.

In addition, the structure of the top-three network, m-slice, and centricity of each network was considered, but we were not able to find any effective discovery about the diffusion of new drug.

(4) Features of the information regarding the diffusion of drug A: A qualitative data analysis

1. The data source and analysis methods

In this paper, three kinds of qualitative data were analyzed: keywords were given to each thesis, the paper title, and abstract. The keyword was given to each thesis by Ichushi service. For this reason, there is no problem that keyword for giving rules are different for each journal. The paper that appeared in *Japanese Journal of Geriatric Psychiatry* was used based on the title and the abstract. A total of 97 titles and abstracts of papers were used. The titles and abstracts of papers are analyzed using qualitative data analysis software NVivo 11. The keyword can be used to interpret data without using data software because keywords present in-depth classification. The keywords were arranged in the order of frequency and interpreted using information obtained from interviewing pharmaceutical companies.

2. Data Analysis and Findings

2-1.Keyword

A keyword consists of main heading and subheading, e.g., in case of "Alzheimer's disease (pharmacotherapy)," where "Alzheimer's disease" is the main heading and "pharmacotherapy" is the subheading.

The frequency order keyword of each period is compared in 2-1-1. Then, the keyword that appears in either phase is chosen and compared in 2-1-2.

2-1-1 Comparison of frequency of all keywords

In Phase 1, the first keyword was generic name of drug A; second, Alzheimer Disease; third, dementia. In Phase 2, in the first place was "Alzheimer Disease"; second, generic name of drug A; and third, "treatment outcome" (appendix A).

In Phase 1, there are eleven papers with keywords of generic name of drug A whose subheading is "pharmacology"; consequently, we can see that it is focused on research on this new drug.

In Phase 2, since there are papers to which subheading of "complications" is given to "Alzheimer disease" and papers to which subheadings of "adverse effects" are given to generic name of drag A, at this phase, it can be said that research is being conducted to improve the accuracy of medication results.

Although the keyword of "treatment outcome" did not rank within the third rank

in Phase 1, it is the third keyword in Phase 2. As can be seen from here it takes a long time to produce the result of treatment for Alzheimer's disease.

2-1-2 Comparison of frequency keyword (only in either phase)

In addition, keyword that are commonly given in the two periods are excluded, only keyword that are given only to papers in each period are extracted and analyzed.

In Phase 1, it is presumed that the relation between the administration of drug A to patient and the function of the brain is being studied, because keywords indicating names of a part of the brain and a disease occurring in the brain was seen.

With regard to keywords given to the paper in Phase 2, keyword related to adverse effects such as digestive system diseases and anorexia have come to be seen. This suggests that research on the results obtained by administering drug A "settled" to some extent, so it can be inferred that the interest of researchers has shifted to the adverse effects of next concern.

2-2. Title

The title of the thesis was separated in the Phase 1 and the phase and frequency words were picked out using a qualitative data analysis tool (NVivo 11). The characters and words were widely defined so that the frequency of their appearance was high (Figure 4). Words like Alzheimer, dementia, disease, type, name of drug A were established as prohibited terminologies because these words are general words frequently appearing in the papers on Alzheimer's disease.

Figure 4. Frequency word in the title in Phase 1

Source: Prepared by author.

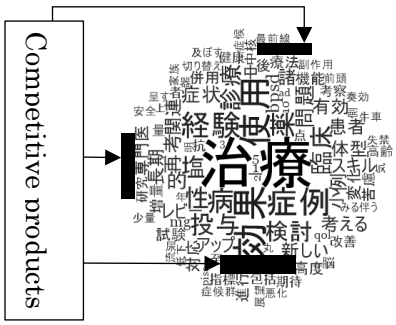

Figure 5. Frequency word in the title in Phase 2

Source: Prepared by author.

Comparison of figures 4 and 5 gave us the next discovery.

The word having the highest degree of frequency in Phase 1 was "medication "(middle of Figure 4). The context of the word–medication–was the report that facilitated beginning to prescribe drug A and the effect of the prescription of drug A, and consideration of whether drug A is prescribed. The context of the word "therapeutics" (the lower one of Figure 4) was the consideration of therapeutics

strategy and administration of drug affairs.

The word having the highest degree of frequency in Phase 2 was “therapeutics” (middle of Figure 5). The context of the word “therapeutics” was the effect of administration of drug to patient on disease. Additionally, the other Alzheimer’s disease curatives on market since 2011 are shown in Figure 5. The new drugs sold from other companies are competitors to drug A at the same time as these drugs are able to be used together. Therefore, some papers on switching from drug A to new drugs, other papers on the results of combined use with drug A have also been reported.

2-3 Abstract

Frequent terms of the two phases of the abstract were analyzed using a qualitative data analysis tool (NVivo 11).

The most frequently appearing word in Phase 1 was “group” (middle of Figure 6). The context of the word medication was the report that divided part of the data among treatment group and non-treatment group and analyzed the condition. The word that has the second highest degree of frequency in Phase 1 was “medication” (the lower one of Figure 6). The context of the word medication was reported, which is as a result of the patient who took drug A for the first time.

The word having the highest degree of the frequency in Phase 2 was “therapeutics” (middle of Figure 7).

The context of therapeutics was varied. The word having the second highest degree of frequency in Phase 2 was “group” (the lower one of Figure 7). The context of the word group was the article in which the patient’s data are classified by various factors (e.g., group to which the drug was given and group to which the drug was not given, high-dose group and low-dose group, young group and the over-80 group), and it was thus compared and examined.

Figure 6. Frequency word in the abstract in Phase 1

Source: Prepared by author.

Figure 7. Frequency word in the abstract in Phase 2

Source: Prepared by author.

(5) Finding and explanation for findings

From network analysis and qualitative data analysis, the following findings were determined about the doctor’s network of and the contents of the information created by that network during the period of diffusion of drug A period.

When the diffusion period is divided into two stages, in the Phase 1, many of the research group on drug A is participating specialists who are influential in the diffusion process. On the one hand, the reason is assumed that specialists were indispensable to the research group on the period where large uncertainty of drug A exists. On the other hand, in Phase 2, there are many groups that specialists do not participate in. In those periods, diversity within the research theme increasing is considered.

It was assumed that a research foundation was established during Phase 1, and various studies bloomed as a result of Phase 2.

The forgoing hypothesis about the transition of the above research contents was demonstrated in the result of a qualitative analysis. As a result of the qualitative analysis of the article dealing with drug A, the research carried out in Phase 1 was a research before the start of the administration of drug A to patient or immediately after starting its administration. In Phase 2, the following two points were clarified. One can see that research on comparing and combining competitive drug competitor and drug A is conducted. Secondly, in Phase 2, there are many reports of side effects. In short, the research accumulated in Phase 1 was the basis of Phase 2's research.

As mentioned (2)-2, information serving as a complementary asset promoting diffusion innovation has the strong characteristic a network externality. Therefore, it is necessary to acquire critical mass quickly when there is a competitive product. Because competitive product was not released at the time of release in drug A, it was not threatened by a competitive product. However, it is necessary to thoroughly inform doctors even when the products excellent.

In fact, according to *Nikkei Medical*, in the year when drug A was released, there is a description that points out that drug's "batting average" is 20%, that is, there was a tendency to underestimate. If a customer feels that the degree of product uncertainty is high, even if it is a superior product functionally, and even in the absence of conspicuous competition, building complementary assets called *user information* is necessary for products to diffuse widely.

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Appendix A

Table of top three keywords

	2000～2006（74 papers）			2007～2014（72 papers）		
	Keyword	Sub Headings	Number pf time	Keyword	Sub Headings	Number pf time
1st	generic name of drug A(total 90 times)	therapeutic use	68	Alzheimer Disease (total 110 times)	drug therapy	56
		pharmacology	11		diagnosis	21
		adverse effects	10		complications	11
		No subheading	1		Prognosis	7
					diagnostic imaging	4
					radionuclide imaging	3
					rehabilitation	2
					Radiography	1
					genetics	1
					chemically induced	1
					therapy	1
					etiology	1
					prevention and control	1
2nd	Alzheimer Disease (total 78 times)	drug therapy	48	generic name of drug A (total 100 times)	therapeutic use	76
		diagnosis	8		adverse effects	20
		radionuclide imaging	8		pharmacology	4
		prognosis	6			
		complications	4			
		diagnostic imaging	3			
		No subheading	1			
3rd	Dementia (total 19 times)	drug effects	13	treatment outcome	No subheading	25
		complications	2			
		prognosis	2			
		No subheading	1			
		radionuclide imaging	1			

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Organizational Design in Modern Firms and the Role of Corporate Management: Relationships of Organizational Change with Trust and Creative Capacity

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Abstract

This study seeks to determine whether employees' trust in management and the company itself has any effects on organizational change. In particular, this seeks to reveal its effects on organizational design changes undertaken in response to a major strategic challenge facing companies today: how to stimulate innovation and creative capacity.

The results of analysis demonstrate that institutional changes in an organization influences employee trust in management, which in turn acts to mediate the effectiveness of organizational changes. Initiatives that involve what this study identified as "comprehensive change" can raise trust in management, avoiding morale problems and helping companies to unleash their creative capacity. On the other hand, so-called "cost-cutting, flattening change" risks damaging employee trust in management and can bring about severe morale problems.

These findings suggest the importance of integration in organizational design and emphasize the essential roles for corporate management in the development of healthy social structures and relationships in the businesses.

Key words: Organizational design, morale, complementarity, trust, creative capacity

(1) Study Background and Purpose

Discontinuous change in the modern business environment has forced many companies to reconsider their organizational design. Initiatives to review traditional organizational designs and explore new ones are spreading in Japanese firms as well. A business organization can be understood as an instrumental system configured to achieve a unique objective. From this perspective, we can conclude that the institutional transformations in Japanese firms today correspond to attempts to accomplish strategic tasks more effectively in the face of environmental turbulence. Let us assume that businesses today face the dual challenge of how to innovate in order to generate added value discernible to customers, and how to unleash their organization's creative capacity to deliver that innovation. In this light, organizational change in the modern era can be interpreted as a technical challenge: what kind of organizational design(s) should businesses choose to effectively encourage employees to innovate and to

deploy this creative capacity?

However, business organizations consist of two layers, corresponding to their technical structure and their social structure. Businesses can only improve the effectiveness and efficiency in technical terms by "genuine fostering in their employees a will to work" through ensuring "development of healthy social structures and relationships in the business" (Mohri, 1965, p. 21). Viewing organizational design as a mere technical problem limits our understanding to only one side of the story. While organizational design indeed has technical aspects, it must also be recognized as a social issue: i.e., how to ensure "development of healthy social structures and relationships in the business" to instill in employees this "will to work".

Many problems are known to occur during the organizational change process, including decreased willingness to work, uncooperative attitudes, and low morale due to resistance or opposition to the change process, or simply confusion, among employees and managers alike. This paper refers to these inclusively as "morale problems" associated with organizational change. Dealing with morale problems means addressing "social structures and relationships in the business", which often determine the success or failure of organizational changes. Management is tasked with the important responsibility of solving them in their role as the "designers" of an organization (Roberts, 2004, p. 12).

In interpersonal relationships, when ensuring the intentions and behavior of other people are appropriate comes with certain risks and when the achievement of interests of an individual may depend on another person, trust is essential in these case. Trust can be defined as "a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another" (Rousseau et al., 1998, p. 395). Odaka identified "trust" in work colleagues, managers, and supervisors as essential components of organizational morale (Odaka, 1981, pp. 390-391). Accordingly, "trust" in an organization and management should be essential for dealing with morale problems associated with organizational change.

Executing organizational changes is associated with high risk: while the effects are felt throughout the whole firm, there is no guarantee the efforts will be successful. The mere presence of risk can generate anxiety and confusion among employees, which in turn can easily trigger serious morale problems. Accordingly, protecting employee morale by promoting coordination and collaboration within the organization in order to improve cohesion is indispensable to the success of organizational changes.

This means that organizational change demands leadership as well, to "offer direction and then motivate others to believe and to follow" (Roberts, 2004, p. 284). Whether leadership can succeed or not would seem to depend on the level of trust employees and managers alike have in their company and its management personnel. This is because trust in a company and its management are necessary prerequisites to overcoming the morale problems associated with organizational changes and ensuring those changes take root, serving as a basis for the legitimacy of corporate leadership and a foundation for their support.

Organizational trust is also essential to

enabling innovation and unleashing the creative capacity of a company. Bellah et al. write that "the productivity of a high-tech company resides in the quality of its workforce, in the competence and responsibility of individuals, but also, critically, in the trust they have in each other to nurture creativity and innovation", and that companies need "persons who trust each other and genuinely enjoy working together" (Bellah et al., 1991, p. 94). This claim implies that individuals within an organization need to form trusting relationships with each other in order for a given organizational design to successfully stimulate its employees to innovate and unleash their creative capacity.

This study is an attempt to address the issues defined above. Namely, it seeks to determine whether employees' trust in management and the company itself has any effects on organizational change. In particular, it seeks to reveal its effects on organizational design changes undertaken in response to a major strategic challenge facing companies today: how to stimulate innovation and creative capacity.

(2) Preceding Research

1. Organizational Change and Morale Problems at Japanese Firms

Since the 1990s, Japanese firms have attempted to transform their organizational structures in various ways to adapt to rapid changes in business environments. However, few studies have endeavored to clarify the actual results of these transformations, nor their impacts or positive effects. Moreover, it is rarely obvious how the organizational changes in Japanese firms in recent years relate to the modern, strategic challenge of stimulating innovation and unleashing an organization's creative capacity, nor how morale problems associated with these changes relate to their success or failure.

One study whose findings bear significance on this research topic is that of Inoue (2004). Inoue analyzed the so-called "selection and concentration" strategies adopted by Japanese electronics and information-related companies, and how they were complemented by organizational changes such as hierarchical flattening, decentralization of authority, subcontracting, and departmental consolidation. He found that measures such as cost-cutting, subcontracting, and reductions of business scale were compatible with the pursuit of "efficiency" (typified by cost-cutting). He also found, however, their efforts to externalize business and reduce scale acted to inhibit their "effectiveness" (e.g. in creating market value).

One of his observations on companies' "selective withdrawal" in particular is very interesting and relevant to the research problem at hand: corporate readiness to externalize business operations actually lowered employee morale, reducing their "commitment and tenacity to work", and impeded their ability to solve problems creatively to generate innovative products and services (Inoue, 2004, 102). Inoue's findings reveal that while modern Japanese firms have made considerable changes to their operational structures, those same changes have led to their own inextricable problems. At the same time, they suggest that morale issues due to certain kinds of organizational change can hinder companies from exercising their full creative capacity. The present study seeks to investigate such

morale problems from the perspective of organizational trust.

2. Trust in Japanese Firms

Trust has become an interdisciplinary topic, with research efforts spanning different disciplines such as economics, psychology, and sociology. Japanese organizational research is no exception. In one study, Hino focused on the relationship between "leaders" and "followers" in an organization. Along with determining several factors necessary for the formation of trust in leaders among followers, he revealed that this formation was crucially necessary for leadership to function (Hino, 2010). Another study, directly relevant to this study's research problem, is that of Tatsumichi, who conducted a survey of employees of Japanese firms looking at changes in their attitudes towards their company and management personnel. Based on the results, he claimed that in the midst of recent reforms in personnel systems, that "a 'chasm' of some kind seems to have formed between employees and their company, and moreover between them and management" (Tatsumichi, 2006, p.285). His findings suggest that the trusting relationships between employees and their companies and managers may have incurred some damage in Japanese firms as they continue to evolve and implement organizational changes.

The relation between institutional transformations in Japanese firms and organizational trust was also analyzed by Miyamoto: specifically, as the relation between recent corporate governance reforms and employee trust. Finding unexpectedly high support among employees for shareholder-oriented governance, Miyamoto attributed it to be mediated by their trust in management. In his words: "Employees support managerial behaviors intended to increase shareholder value as their trust in management grows. Conversely, their support for shareholder value-centric management falls as their trust in management decreases" (Miyamoto, 2008, pp.99-100). Miyamoto's research demonstrates that employee attitudes, and particularly their trust in their managers and the company itself, are important factors to consider during management reforms and organizational changes, as the perspectives of organizational members can crucially impact their potential for success. Building on this body of work, the present study hypothesizes that the success and effectiveness of organizational changes intended to facilitate innovation and unleash the creative capacity of firms are mediated by trust among members of the organization.

(3) Theoretical Framework and Variable Configuration

The theoretical framework of Whittington and Pettigrew's "innovative forms of organizing" was adopted to guide this study's variable configuration and analysis. These scholars argued that dramatic changes in business environments, such as the transition to the globalized economy and the knowledge-based economy, encouraged modern enterprises to introduce "innovative forms of organizing". Along with real examples in European firms, they showed how different forms had complementary effects within organizations. Their analysis demonstrated how "complementarities" are essential to their successful introduction, and that companies could

suffer harm by failing to achieve mutual complementarity between disparate organizing forms, calling this phenomenon "the dangers of partial change" (Whittington et al., 1999). Whittington and Pettigrew's research provides us with a useful framework for conceptualizing and analyzing structural and process changes in modern business organizations, as well as their effects, in a comprehensive way.

Variables in the present study were configured to match the dimensional configuration of related research on innovative forms of organizing, so as to capture structural and process changes in the same framework. To operationalize the variables, new scale items were created to capture real organizational changes underway in Japanese businesses today. The following were set up as o*rganizing forms-related variables*: *hierarchical flattening*, *strategic decentralization*, *operational decentralization*, *project-based organizational structures*, *downsizing*, *IT investment*, *communications and systems integration*, *strategic restructuring*, and *outsourcing*[1].

Two other variables, corresponding to *creative activities* and creative *achievements*, were set up to examine another important factor: the relationship of organizational changes with innovation and creative capacity. For the former, employees would be asked to what extent their organization carried out initiatives and efforts aimed at creative results. For the latter, they would be asked to what extent their organization produced real, tangible creative results. These were both subjective measures in the sense that their scores depended on the individual perceptions of respondents: thus, the variables were termed *Subjective Creative Activities* and *Subjective Creative Achievements*[2].

In addition, this study used scale items adopted by Tatsumichi (2006) and Miyamoto (2008) to measure employees' trust in management and their organization. Along with directly measuring whether or not "management is trusted", Tatsumichi's scale measures factors like whether an employee's "company is completely devoted to its employees, even when their performance is bad", and whether "employees are valued". The scale allows users to measure employees' positive expectations of the intentions and behavior of their corporate management, as well as their company overall. Thus, it was incorporated in the present study in the variable *Trust in Management*[3].

(4) Survey Overview and Data Used in Analysis

Two approaches were necessary to describe and understand the actual operations of firms in terms of the underlying organizational structures and processes controlling them. First, to learn how different individuals

[1] There is insufficient space to describe the items composing each variable. Suffice to say, the variables had sufficiently high internal consistency for analysis purposes (the lowest reliability coefficient observed for any variable was 0.793, for "outsourcing").

[2] *Subjective Creative Activities* consisted of 5 items such as "My company develops new products and services ahead of our competitors", while *Subjective Creative Achievements* consisted of 3 items such as "My company has increased the number of new products and services offered in the past 2 years". Their respective reliability coefficients were 0.934 and 0.831.

[3] The reliability coefficient of this variable based on Tatsumichi's scale ietms was 0.920.

within organizations perceive those structures and processes as 'social realities' in their workplace; second, to determine the perceptions and expectations of management, as well as an organization itself, by its constituent members.

To this end, a survey was administered to general employees and management personnel employed in different departments in a variety of organizations. The survey was administered through the internet in January 2014 to general employees and managerial personnel working at private companies in Japan[4].

Sampling bias, specifically in terms of respondent attributes, in a problem that has been identified with internet surveys, and could not be avoided in this study. However, problems have also been noted for conventional surveys, such as difficulties in retrieval: the internet survey methodology was adopted based on a decision to prioritize data collection. In addition, the survey was administered to individuals, based on the study's motive of understanding organizational realities from the perspective of individual employees: this meant sample representativeness was another potential issue with the data. Nevertheless, this method was still deemed suitable for the study, given the dual objectives of determining various organizational members' perspectives about corporate management and company overall, and understanding their 'organizational realities' as the real social environment experienced by individuals within their organization. In addition, readers should also keep in mind that since data about organizational structural characteristics, perceptions of management, and creative activities and achievements were all collected from the same individuals, the potential for common method bias cannot be completely eliminated.

In total, 300 responses were collected; 186 were analyzed after excluding individuals who responded "Unknown" to questions about the capital and sales of their firm. Compared with national averages, a somewhat greater proportion of respondents were employed in the manufacturing industry, and a greater proportion at large enterprises (although there was no shortage of employees of small and medium enterprises). Further, many respondents worked in sales or R&D departments, and many were clerical workers; however, there also many individuals in professional occupations. Other notable characteristics of the sample included the fact that over 40% were senior officials (i.e., designation of "Chief/Head" or higher), and a somewhat high number over 40 years old.

The effects of industry type, company size, department, and managerial staff (yes/no) were controlled for in analysis by inserting these factors as control variables.

(5) Analysis Results

1. Derivation of Organizational Change Patterns

Two major characteristics of organiza-

[4] This survey was conducted as part of a 2009 Strategic Research Foundation Grant-aided Project for Private Universities from the Ministry of Education, Culture, Sports, Science and Technology: *Practical Research on Intelligently Designed Enterprises and Organizations and Personnel Development Techniques Built by Business Creators*.

tional changes in Japanese firms were apparent based on whether and to what extent each of the specific organizing forms described above were confirmed by respondents:

1) Firms tended to implement changes to a project-based organizational structure, focusing on company-wide cost reductions and reviewing their businesses and operations;

2) Firms tended to emphasize rigorous review of the responsibilities of operational managers, along with information sharing, cooperation, and support within the organization. However, they seldom implemented approaches such as strategic or operational decentralization, hierarchical flattening, disestablishing or closing departments, or reducing the number of management personnel or official positions.

However, we know from the work of Inoue, Whittington and others that organizing forms are more effective when introduced in a mutually complementary way, rather than separately. Assuming this holds true here, we can imagine that organizing forms are put into practice in certain combinations or 'units', and further that these units tend to follow certain patterns. This study derived these 'patterns' via principal component analysis, in an attempt to determine the major trends underlying institutional transformations in Japan.

Two principal components were extracted in the analysis (PC1 and PC2:Table 1).

Table 1. PCA Findings for Organizing Forms

Organizing Form Variable	PC1	PC2
hierarchical flattening	**0.728**	**0.492**
strategic decentralization	**0.895**	-0.149
operational decentralization	**0.848**	-0.270
project-based organizational structures	**0.786**	-0.211
downsizing	**0.655**	**0.599**
IT investment	**0.796**	**-0.376**
communications and systems integration	**0.762**	**-0.477**
strategic restructuring	**0.866**	0.110
outsourcing	**0.596**	**0.578**
eigenvalue	5.416	1.456
percentage of variance	60.175	16.175
cumulative variance	60.175	76.35

PC1 exhibited high factor loadings and positive correlations for all organizing form-related variables. Given that all organizing forms are promoted in a comprehensive manner in this change pattern, we can term this component *Comprehensive Change*. PC2, on the other hand, showed high factor loadings and positive correlations for organizing forms such as hierarchical flattening, downsizing, and outsourcing, but negative loadings for IT investment and communications and systems integration. In other words, this change pattern was characterized by the reduction of both business cost and operational scope, with an accompanying increase in external procurement, while failing to maintain investments in IT and efforts at intra-firm integration. Accordingly, we can term this component *Cost-cutting, Flattening Change*. The above

analysis revealed the existence of two patterns in organizational changes: *Comprehensive Change* and *Cost-Cutting, Flattening change*.

2. Relationship of Creative Capacity with Organizational Change and Trust in Management

The study next sought to analyze how firms' utilization of their creative capacity related to these organizational change patterns, and moreover how trust in management affected this relationship. According to our hypothetical framework outlined above, institutional transformations inevitably generate resistance, confusion, and opposition within an organization. However, the present of trust in a firm's management can avoid the consequent dysfunction and diminished morale, allowing these transformations to take hold and effect. In short, organizational change is presumed to be mediated by trust in management, which influences the consequences of any institutional change: its effects should be especially strong on organizational changes aimed at liberating the creative capacity of a firm.

The mediating effects of trust in management were analyzed according to the procedure of Baron and Kenny (1986). Several models were constructed:

1) Independent variables = *Comprehensive Change* and *Cost-Cutting, Flattening Change* (i.e., their principal component scores); dependent variable = *Trust in Management* (Model 1);

2) Independent variables = *Comprehensive Change* and *Cost-Reducing, Flattening Change*; dependent variable = *Subjective Creative Activities* (Model 2) or *Subjective Creative Achievements* (Model 4);

3) Independent variables = *Comprehensive Change*, *Cost-Reducing, Flattening Change*, and *Trust in Management*; dependent variable = *Subjective Creative Activities* (Model 3) or *Subjective Creative Achievements* (Model 5).

Three things needed to be shown for the mediating effects of trust in management to be confirmed: in 1), organizational change patterns needed to affect trust in management; in 2), organizational change patterns needed to affect firms' creative capacity; and in 3), trust in management needed to affected firms' creative capacity, *and* the effect of organizational change patterns on firms' creative capacity needed to be *smaller* than in 2) (Baron and Kenny, 1986, p.1177).

The results for Model 1 in Table 2 demonstrate that comprehensive change increases trust in management, while cost-cutting, flattening change decreases it.

Moreover, trust in management mediated the effects of both types of change pattern on both creative activities (Models 2, 3) and creative achievements (Models 4, 5). Besides, the value of adjusted R square is higher in mediation models (Models 3 and 5) than in models without mediator (Models 2 and 4). This suggests that mediation models explain the effect of organizational change on firms' creative capacity better than otherwise.

Table 2. Mediation Analysis Findings for Trust in Management

Dependent Variable	Trust in Management	Subjective Creative Activities	Subjective Creative Activities	Subjective Creative Achievements	Subjective Creative Achievements
	Model 1	Model 2	Model 3	Model 4	Model 5
Comprehensive Change	.587**	.583**	.365**	.538**	.271**
Cost-cutting, Flattening Change	-.452**	-.278**	-.102	-.199**	.016
Trust in Management			.374**		.457**
R^2	.647	.532	.591	.479	.562
Adj. R^2	.563	.418	.486	.354	.451
F value	7.687**	4.693**	5.633**	3.829**	5.055**
VIF	1.123-2.419	1.141-2.403	1.127-2.803	1.126-2.380	1.130-2.834
N	157	155	153	156	154

*† p < .1, * p < .05, ** p < .01*

(6) Conclusions and Future Challenges

The study findings demonstrate that institutional changes in an organization influences employee trust in management, which in turn acts to mediate the effectiveness of these changes. Initiatives that involve what this study identified as *comprehensive change*—i.e., promoting intra-firm integration, decentralization, and IT investment alongside flattening and outsourcing—can raise trust in management, avoiding morale problems and helping companies to unleash their creative capacity. Whereas, so-called *cost-cutting, flattening change* risks damaging employee trust in management and can bring about severe morale problems. Put another way, the consequences of an institutional change seem to depend on the contents of the change itself. Poorly configured change can damage trust in management, and trigger resistance, confusion, and the loss of working motivation within an organization. However, if the change embodies certain specific characteristics, confidence in management will be strengthened, and the effects of the change potentiated. Along with alluding to the importance of *integration* in organizational design—the *big-picture* perspective that takes into account the entire situation of an enterprise—the findings suggest that *the development of healthy social structures within businesses* serve to complement and effectuate institutional changes. Corporate management shoulder essential roles in the task of designing an organization: they must not only foster trust in management among company employees, but also ensure the development of healthy social structures and relationships within the firm, which can serve as a foundation for smooth collaboration. This fact must be acknowledged today anew.

This study nonetheless has a few limitations. For one, “trust”, “morale”, and other constructs fundamental to the study hypothe

sis were not directly measured or analyzed. New theoretical and empirical investigations of these constructs are necessary. Second, mediation analysis does not reveal anything about the cause-effect relationship of a phenomenon. Case studies and other methods should be adopted to help elucidate the causality of the relationships identified here. Third, the survey methodology meant that sample representativeness could not be ensured, and common method bias could not be controlled for. Additionally, the priority placed on effective data collection was inextricably associated with limitations on the data available for analysis, suggesting the study method could use improvement. Readers should proceed with caution to avoid generalizing the study findings in an over-simplistic way. New investigations should be conducted to improve on this study's weaknesses and validate its findings.

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Regulation FD, Analysts' Information Acquisition, and the Public Goods Problem

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Abstract

Analysts collect their own information to improve the precision of their earnings forecast. However, once the Regulation Fair Disclosure (FD) takes effect and information includes the aspect of public goods, individual analysts are expected to begin free-riding on information acquired by other analysts. This paper develops a model in which analysts decide whether or not to collect costly information, and an investor predicts earnings based on the analysts' behavior. The findings of this paper include, under Regulation FD, as the number of analysts grows, the motivation to collect information becomes weaker, and analysts depend on public information only. Further, without Regulation FD, an increase in the number of analysts has a nonnegative effect on the investor's predictive ability. Finally, under Regulation FD, the investor's predictive ability is at a low level compared to a case without the Regulation. It is noteworthy that Reg FD, which intends to improve the information environment surrounding security market participants, has these unintended consequences.

Keywords

Earnings forecast, Forecast accuracy, Regulation FD, Free-rider, Public information

(1) Introduction

Mitigation of the information asymmetry among security market participants is seen as major purpose of disclosure regulation. The Regulation Fair Disclosure (hereafter "Reg FD"), which was enacted in 2000 in the United States, prohibits firms from privately disclosing important information to select investors or analysts without simultaneously disclosing the same information to the public. As a result, enactment of Reg FD has banned so-called selective disclosure, which comprises that firms transmit material information only to particular participants. Further, a regulation with the same effect as Reg FD will be introduced in Japan in the near future. The purpose of this paper is to

investigate the effect of Reg FD on analysts' information acquisition and the investor's predictive ability.

There are abundant prior researches that empirically inquire how Reg FD affected analysts and investors. Concerning analysts, enactment of Reg FD has (1) increased (or decreased) the number of analysts who follow the firm (Irani and Karamanou 2003; Mohanram and Sunder 2006; Gomes et al. 2007); (2) rendered analysts' information acquisition active (or inactive) (Mohanram and Sunder 2006; Janakiraman et al. 2007; Mensah and Yang 2008; Kross and Suk 2012; Hahn and Song 2013); and (3) improved (or worsened) the precision of analysts' forecasts(Irani and Karamanou 2003; Heflin et al. 2003; Bailey et al. 2003; Agrawal et al. 2006; Francis et al. 2006; Mohanram and Sunder 2006; Gomes et al. 2007; Srinidhi et al. 2009; Kross and Suk 2012). With respect to investors, enactment of Reg FD has (1) changed (or not changed) their information environment (Heflin et al. 2003; Francis et al. 2006; Ahmed and Schneible 2007) and (2) reduced (or expanded) information asymmetry among investors (Eleswarapu et al. 2004; Chiyachantana et al. 2004; Gomes et al. 2007; Sidhu et al. 2008; Duarte et al. 2008; Chen et al. 2010). These prior studies do not necessarily come to the same conclusion. On the contrary, some opposing results are presented.

Arya et al. (2005) investigate Reg FD analytically. Their model, which includes two analysts and a representative investor, reveals the following. First, if the firm discloses information to all players (two analysts and an investor), an information cascade will arise among them so that the investor's predictive ability will worsen. Second, if the information is offered to only one analyst (in other words, the firm issues a selective disclosure), cascade formation may be restrained and the investor is better off. Lastly, under Reg FD, the firm may decide not to disclose information intentionally in order to improve the investor's predictive ability.

The work of Arya et al. (2005) is closely related to this paper. Both studies pay attention to the nature of the influence of Reg FD on analysts and investors. They differ in the following point: Arya et al. (2005) is concerned with the information cascade caused by Reg FD, while this study focuses on a particular phenomenon, namely that Reg FD renders information a public good. Therefore, Arya et al. (2005) see analysts as rational decision-makers, but they do not consider the strategic interactions of analysts. On the other hand, this study sees analysts as strategic agents who rationally expect other agents' incentive. In particular, the study pays attention to the motivation of analysts to be free-riders in information collection. In general, most firms are covered by multiple analysts. Therefore, to gain deeper insight into analysts' decision-making, a study of their behavior in the presence of rivals is needed. As mentioned above,

a model is developed to examine the influence of Reg FD on analysts' information collection and the investor's predictive ability, while taking analysts' strategies into account.

The paper is organized as follows. Section 2 presents the model and derives an equilibrium. Section 3 shows the comparative statics and discusses the case where Reg FD is not enforced. Section 4 concludes.

(2) Model

There are n analysts and a representative investor who are forecasting the firm's forthcoming earnings. The variable n is a positive integer and larger than one. The forthcoming earnings of the firm, which are denoted by θ, are the realization of a random variable $\tilde{\theta}$, where $\tilde{\theta} \sim N(0, 1/\omega)$. Note that tilde ("~") represents a random variable.

All analysts and the investor obtain public information (or signals) $\tilde{y}$ released by the firm at no charge. Assume that public information $\tilde{y}$ is represented by:

$$\tilde{y} = \tilde{\theta} + \tilde{\eta},$$

where $\tilde{\eta}$ represents the prediction error and $\tilde{\eta} \sim N(0, 1/\alpha)$. Managers' initial earnings forecast, which is made public (so-called "management forecast"), illustrates $\tilde{y}$.

Analysts can extract additional (private) information (or signals) with an effort from manager, and c_i denotes the cost of effort incurred by analyst i. Assume that signal $\tilde{x}$ is represented by:

$$\tilde{x} = \tilde{\theta} + \tilde{\varepsilon},$$

where $\tilde{\varepsilon}$ represents the prediction error and $\tilde{\varepsilon} \sim N(0, 1/\beta)$. One of the examples of $\tilde{x}$ is the manager's own prospect, which is not expressed in the management forecast. To avoid being pursued as responsible for the wrong prediction, this study assumes that the manager will not venture to release his prospect voluntarily. However, if he is interviewed by analysts, he will reveal it in a passive manner. The cost of acquiring $\tilde{x}$, which is dependent on the ability to extract information from the manager, differs among analysts. Suppose that each analyst observes his c_i, but cannot know another analyst's cost. He only knows that another analyst's cost is a random variable that is uniformly distributed in $[0,1]$. [1] Meanwhile, the investor does not have access to a manager, and he cannot obtain $\tilde{x}$ on his own. Assume that $\tilde{\theta}$, $\tilde{\eta}$, and $\tilde{\varepsilon}$ are mutually independent.[2]

To begin with, the analysts' behavior is considered. According to the so-called projection theorem, an analyst, who has observed y and x, will expect

[1] Because there is no reason to specify the distribution of c_i a priori, it is assumed that c_i distributes uniformly on $[0,1]$. Alternatively, even if the distribution function of c_i is assumed to be a monotone increasing function that is continuous on $[0,1]$, the main results (except for Corollary 1) remain unchanged. For convenience, it is assumed that c_i is a uniformly distributed random variable on $[0,1]$.

[2] Due to the release of signals y or x, a firm may incur proprietary costs. However, the decision-making of disclosure by firms is beyond the scope of this work, since proprietary cost is not considered in this model.

that $\tilde{\theta}$ is represented by:

$$\mathrm{E}(\tilde{\theta}|y,x) = \frac{\alpha y + \beta x}{\omega + \alpha + \beta} \quad (1)$$

In this case, the variance of the prediction error is represented by $1/(\omega+\alpha+\beta)$. In contrast, when an analyst does not collect additional information, he can observe only y, and his conditional expectation is represented by:

$$\mathrm{E}(\tilde{\theta}|y) = \frac{\alpha y}{\omega + \alpha} \quad (2)$$

The variance of the prediction error is represented by $1/(\omega+\alpha)$. Assume that, after the formation of expectation, the analysts release their forecast simultaneously, but without communication among them. In this paper, it is assumed that sales of signal x to other analysts are prohibited.[3] In addition, it is assumed that each analyst reveals his expectation truthfully and without garbling.

Based on prior studies (Laster et al. 1999; Lim 2001; Morgan and Stocken 2003; Fischer and Stocken 2010; Kameda et al. 2011), the analyst's payoff function is represented.[4] When an analyst i collects signal x, his payoff is denoted as follows:

$$U_i = \Pi - (a_i - \theta)^2 - c_i \quad (3)$$

where $\Pi\,(\geq 0)$ represents a fixed reward for analysts, a_i represents estimates submitted by the analyst, and c_i is the cost of acquiring $\tilde{x}$.[5] In contrast, when an analyst i does not collect x, the payoff is denoted as follows:

$$U_i = \Pi - (a_i - \theta)^2 \quad (4)$$

As stated above, when an analyst observes $\{y,x\}$, then $a_i = \mathrm{E}(\tilde{\theta}|y,x)$. Further, when he observes $\{y\}$, then $a_i = \mathrm{E}(\tilde{\theta}|y)$. Therefore, in each case, the expected payoff is represented as follows:

$$\begin{aligned} \mathrm{E}U_i &= \mathrm{E}\left[\Pi - \left\{\mathrm{E}(\tilde{\theta}|y,x) - \theta\right\}^2 - c_i\right] \\ &= \Pi - \frac{1}{\omega+\alpha+\beta} - c_i \end{aligned} \quad (5)$$

$$\begin{aligned} \mathrm{E}U_i &= \mathrm{E}\left[\Pi - \left\{\mathrm{E}(\tilde{\theta}|y) - \theta\right\}^2\right] \\ &= \Pi - \frac{1}{\omega+\alpha} \end{aligned} \quad (6)$$

$\Pi - 1/(\omega+\alpha+\beta)$ of equation (5) can be interpreted as the reputation that an analyst gains in the capital market. The remaining amount after deducting c_i is analyst i's expected payoff. Meanwhile, $\Pi - 1/(\omega+\alpha)$ of equation (6) shows that, if the analyst does not collect signal x, his reputation declines, but the cost of information gathering is saved.

Now consider the behavior of a

[3] The assumption that sales of signal x to other analysts is prohibited is based on the following. There are various rules that require financial institutions to build information barriers.
For example, to prevent premature leakage of market-moving information, several SEC and stock exchange rules mandate that the Chinese Wall be set up as an imaginary barrier between the investment banking, corporate finance, and research departments of a brokerage house, and the sales and trading departments (Downes and Goodman 2014). As long as these information barriers exist, transactions of signal x among analysts seem impossible to carry out.

[4] These prior researches consider forecasters' incentive to minimize forecast error by incorporating the quadratic loss term into their utility function.

[5] Unlike the investor, analysts may have an interview with managers. In that case, it is assumed that information acquisition cost is incurred to constant Π. However, none of the conclusions are changed on the assumption that $\Pi = 0$.

representative investor. The investor's objective is to maximize the precision of the forecast, and the analyst's forecast can be utilized at the prediction of forthcoming earnings. Therefore, the investor's action is described as follows. When all analysts submit $\alpha y/(\omega+\alpha)$ as their forecast, the investor adopts $\alpha y/(\omega+\alpha)$ as forecast. In contrast, when an estimate that is different from $\alpha y/(\omega+\alpha)$ is submitted by at least one analyst, the investor adopts the value, for the reason outlined below. Knowledge about signal y raises the investor's expectation that $\mathrm{E}(\tilde{\theta}|y) = \alpha y/(\omega+\alpha)$. Therefore, when the investor observes that the analyst's forecast is equal to $\alpha y/(\omega+\alpha)$, the investor conjectures that the analyst does not know signal x. On the other hand, when the analyst's forecast is not equal to $\alpha y/(\omega+\alpha)$, the investor guesses that the analyst does know signal x, unlike himself. As a result, the precision of the investor's forecast is $\omega+\alpha$ when all of the analysts submit $\alpha y/(\omega+\alpha)$, and is $\omega+\alpha+\beta$ when at least one analyst submits the forecast different from $\alpha y/(\omega+\alpha)$.

There are four stages in this game. In the first stage, each analyst i observes c_i and decides whether to collect signal x or not. In the second stage, analysts simultaneously release forecasts by relying on public information y (and signal x if it had been collected). In the third stage, the investor expects forthcoming earnings based on analysts' forecasts. In the final stage, the realization of $\tilde{\theta}$ (and x if manager offered) are disclosed. In this game, once analysts decide whether or not to collect x during the first stage, analysts and the investor do not face the situation afterwards where they make decisions strategically. Therefore, this study focuses on analysts' decision-making during the first stage.

Hereafter, the case is considered where Reg FD is in force.[6] Under Reg FD, selective disclosure by the firm is prohibited. Hence, if a firm provides information to particular market participants, the firm must simultaneously release the information to the public. In other words, if at least one analyst extracts signal x with a cost, other analysts can simultaneously acquire x without a cost. Therefore, the information set is $\{y,x\}$ for each analyst, and his estimated results are $(\alpha y+\beta x)/(\omega+\alpha+\beta)$. On the other hand, when no one acquires x, every analyst's information set is $\{y\}$ and the estimate is $\alpha y/(\omega+\alpha)$. Now, under Reg FD, the investor comes to know the same information as analysts, and an information disadvantage over analysts disappears. Therefore, note that the analyst's forecast can no longer have information content, and it becomes redundant for the investor under Reg FD.

An expected payoff of analyst i is studied in three different cases. First, when analyst i collects signal x by

[6] The case where Reg FD is not enforced is investigated in Section 3.

himself, the expected payoff is denoted as equation (5). Second, if not only analyst i but also any other analysts do not collect signal x, the expected payoff is represented by equation (6). Lastly, suppose that analyst i does not collect signal x but that someone else collects it. In other words, suppose that analyst i free-rides on others. Then, the expected payoff is represented by:

$$\mathrm{E}U_i = \Pi - \frac{1}{\omega + \alpha + \beta} \tag{7}$$

Free-riding on others makes it possible for an analyst to improve his reputation without the cost of information gathering. Consequently, the expected payoff of equation (7) is higher than that of equation (5).

During the first stage, each analyst i conjectures other analysts' actions and decides whether or not to collect signal x. In this game, if even just one analyst acquires signal x, each analyst's payoff will increase. However, the cost of information acquisition generates the incentive to be a free-rider among analysts. Hereafter, the Bayesian Nash equilibria, consisting of symmetric pure strategies in which each type c_i, with $c_i \leq c^*$, acquires x, whereas every other type does not acquire x, is solved. Consequently, the following Lemma is obtained.

Lemma *The Bayesian Nash equilibrium in this game is the pair of strategies in which each type c_i, with $c_i \leq c^*$, acquires x, whereas other types c_i, with $c_i > c^*$, do not acquire x.*[7] *In addition, there exists a unique $c^* \in (0,1)$ that satisfies the following equation:*

$$\frac{(1-c^*)^{n-1}}{c^*} - (\omega + \alpha + \beta)(\omega + \alpha)\beta^{-1} = 0 \tag{8}$$

[Proof] All proofs are described in the Appendix.

As shown in equation (8), it is difficult to solve for c^* explicitly with $n \geq 3$. However, the implicit function theorem shows the behavior of c^*. In the next section, the result of comparative statics that focus on the threshold c^* is shown.

(3) Analysis

1. The Impact on Information Acquisition

The following Proposition states how parameters (such as n, ω, α and β) affect analysts' information acquisition.

Proposition 1 *The sign of the partial derivative of c^* with respect to each of the parameters is represented by:*

$$\frac{\partial c^*}{\partial n} < 0, \quad \frac{\partial c^*}{\partial \omega} < 0, \quad \frac{\partial c^*}{\partial \alpha} < 0, \quad \frac{\partial c^*}{\partial \beta} > 0.$$

We can interpret the result of Proposition 1 as follows. First, the

[7] In the case of $c_i = c^*$, it is indifferent in terms of expected payoff whether or not to acquire signal x. In that case, the model assumes that analysts acquire signal x.

reason why $\partial c^*/\partial n < 0$ is that the larger n becomes, the more analysts rely on other analysts' information collection. [8] In other words, the motivation to be a free-rider arises among analysts, and the tolerable level of the cost of information gathering declines. Therefore, an increase of n leads analysts to neglect to extract information from the manager, so that analysts become dependent on public information only.[9]

Second, the reason why $\partial c^*/\partial \omega < 0$ is shown below. The payoff difference between collecting and not collecting information reduces as ω becomes large. Consequently, the incentive to acquire x in exchange for c_i weakens. In other words, analysts cease to gather additional information as the volatility of earnings decreases.

Third, the reason why $\partial c^*/\partial \alpha < 0$ is that an increase in α reduces the payoff difference between collecting and not collecting information, so that analysts lose the motivation to collect information. Accordingly, if sufficiently precise public information becomes available, additional information acquisition by analysts will be crowded out. Thus, an increase in the value of parameters (such as n, ω, and α) weakens analysts' incentive for information gathering, and increases their dependence on public information.

Finally, the reason why $\partial c^*/\partial \beta > 0$ is that an increase in β enhances the attractiveness of signal x, and hence the tolerable level of the cost of information gathering increases. Consequently, the quality of information activates analysts' collection. In that sense, the effect of β is in contrast to that of α.

2. The Impact on the Investor's Predictive Ability

The discussions are now extended to investigate the impact of parameters on the investor's predictive ability. It is evident that his predictive ability is dependent on analysts' information acquisition behavior. If all analysts do not collect x, then the investor accepts the analyst forecast $\alpha y/(\omega+\alpha)$ as estimate, or predicts by himself, based on signal y. Consequently, the precision of the prediction results in $\omega+\alpha$. On the other hand, if at least one analyst collects x, then the investor accepts the analyst forecast $(\alpha y+\beta x)/(\omega+\alpha+\beta)$ as estimate, or predicts by himself, based on signals y and x. Hence, the precision of the prediction increases to $\omega+\alpha+\beta$. The probability that all analysts do not collect x is $(1-c^*)^n$, and the probability that at least one analyst collects x is $1-(1-c^*)^n$. Then the ex-ante expected precision of the forecast is represented by:

[8] Intrinsically, n is an integer. However, for convenience, it is assumed here to be a real number.

[9] In contrast, Frankel and Li (2004) show that, as the number of analysts covering a firm grows, confidential information leaks out and information asymmetry between insiders and investors diminishes.

$$(1-c^*)^n \times (\omega+\alpha) + \{1-(1-c^*)^n\} \times (\omega+\alpha+\beta)$$

The above function can be rearranged to $\omega+\alpha+\beta-\beta(1-c^*)^n$. Let it be function g. Hereafter, this study inquires how an increase in n affects the value of g.

Corollary 1 *The sign of $\partial g/\partial n$ depends on the value of threshold c^*. Specifically, when $c^* > 1/2$, then $\partial g/\partial n < 0$ is satisfied. When $c^* = 1/2$, then $\partial g/\partial n = 0$ holds. In addition, when $c^* < 1/2$, then $\partial g/\partial n > 0$ is satisfied.*

As stated above, the effect of n on g varies depending on the value of c^*. When c^* is high or, in other words, when analysts' motivation to collect additional information is weak, the value of g decreases in response to the growth of n. The growth of n has a two-sided effect. The one is negative: the growth of n lowers g, because analysts' incentive to collect information will be dampened. Another is positive: the growth of n increases g, because the possibility that at least one analyst collects x increases. When the threshold c^* is high, the negative effect outweighs the positive effect.[10]

Next, the partial derivative of g with respect to α is represented by;

$$\frac{\partial g}{\partial \alpha} = 1 + \beta n(1-c^*)^{n-1}\frac{\partial c^*}{\partial \alpha} \qquad (9)$$

The sign of $\partial g/\partial \alpha$ is not definite, because an increase in α directly increases g, while an increase in α reduces g due to the reduction of c^*. Here, it is shown that a set of parameters exists that satisfies $\partial g/\partial \alpha < 0$. For example, let $n=2$, $\omega = 0.5$, $\alpha = 1$, and $\beta = 4$. For these parameter values, $c^* = 0.327$ and $\partial g/\partial \alpha = -0.187$. If the firm controls α to increase g, then the firm must reduce rather than increase α in this case. This result disputes the conventional view that high quality public information leads to improved decision-making by investors. Thus, under Reg FD, as the quality of public information improves, analysts' incentive to collect additional information becomes weaker, and the investor's predictive ability may decline.

Lastly, the partial derivative of g with respect to β is represented by:

$$\frac{\partial g}{\partial \beta} = 1-(1-c^*)^n + \beta n(1-c^*)^{n-1}\frac{\partial c^*}{\partial \beta} > 0 \qquad (10)$$

Therefore, the quality of signal x is positively correlated with the value of g. The improvement of β increases g not only directly, but also indirectly through an increase in the probability that signal x is acquired.

3. The Case where Reg FD is not Enforced

So far, the case where Reg FD is in force has been considered. Next, the case where Reg FD is not enforced is considered, and the difference between

[10] Now, $c^* = 1/2$ represents the mean of the probability function of c_i.

the cases is illustrated. In the absence of Reg FD, an analyst cannot free-ride on other's information, because signal x is not shared by analysts. Hence, analyst i collects x only if the value of equation (5) equals or exceeds that of (6). This condition can be simplified as follows:

$$c_i \leq \frac{\beta}{(\omega+\alpha)(\omega+\alpha+\beta)} \qquad (11)$$

The right-hand side of equation (11) denotes the threshold of cost that determines an analyst's action.[11] Let the threshold be k^*. It is clear that k^* is independent of n. That is, when Reg FD is not enforced, the number of rivals is irrelevant to the analyst's decision-making.

Now, define an expected precision of the investor's forecast as function h. Then, the following Corollary is derived.

Corollary 2 *Suppose that Reg FD is not enforced. If* $k^* \geq 1$, $h = \omega + \alpha + \beta$ *holds regardless of* n. *Meanwhile, if* $k^* < 1$, $\partial h/\partial n > 0$ *is satisfied, where* $k^* = \beta/[(\omega+\alpha)(\omega+\alpha+\beta)]$.

Thus, h is a constant function independent of n, or an increasing function of n. That is, in the absence of Reg FD, an increase of n might increase h, but it will never reduce h. In contrast, Corollary 1 states that, under Reg FD, an increase in n may reduce g. Hence, the presence or absence of Reg FD brings about a significant difference in the investor's predictive ability. As described in 3. 2, an increase in n has both positive and negative effects under Reg FD. On the other hand, when Reg FD is not enforced, an increase in n does not bring about a negative effect. Accordingly, without Reg FD, an increase in the number of analysts has a nonnegative effect on the investor's predictive ability.

Lastly, the following Proposition evaluates Reg FD based on the investor's perspective.

Proposition 2 *With respect to the ex-ante expected precision of the investor's forecast,* $g < h$ *is satisfied.*

Thus, in terms of expectation, Reg FD reduces the precision of the investor's forecast. The reason for this is that $c^* < k^*$ or, in other words, Reg FD undermines analysts' incentive to collect information. It is noteworthy that Reg FD, which intends to improve the information environment surrounding security market participants, has these unintended consequences.

(4) Conclusion

This paper develops a model in which analysts, who observed public information, decide whether or not to collect costly information. Under Reg FD, which prohibits selective disclosure, when a firm provides information to a particular analyst, the firm must release the information to other

[11] In the case of $c_i = \beta/[(\omega+\alpha)(\omega+\alpha+\beta)]$, it is assumed that analysts acquire signal x.

analysts at the same time. Hence, individual analysts have the incentive to free-ride on information acquired by other analysts, rather than to collect by themselves.

The findings of this paper include, under Regulation FD, that as the number of analysts grows, their motivation to collect information becomes weaker, and they depend only on public information. Further, without Regulation FD, an increase in the number of analysts has a nonnegative effect on the investor's predictive ability. Finally, under Regulation FD, the investor's predictive ability is at a low level compared to a case without the regulation. Thus, under Reg FD, the motivation to be a free-rider arises among analysts, and impairs the investor's predictive ability. The results of this paper clarifies an aspect of Reg FD which has not been pointed out yet.

However, two considerations remain unexplored. The first relates to the endogeneity of parameters. It has been assumed that the number of analysts is an exogenous variable. However, analysts decide whether to enter the market while taking the competitive environment into consideration. Hence, endogenization of the number of analysts must be addressed in the future. The second consideration relates to additionally collected information. This study assumed that signal x is common to all analysts. How will conclusion be altered under the premise that a signal is different for each analyst? Further studies are required to clarify these considerations.

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Appendix

Proof of Lemma

It is assumed that any analyst i adopts a strategy in which he collects x only if $c_i \leq c^*$. Suppose that analyst i does not acquire signal x. In addition, suppose that other analysts do not acquire signal x. Then, a value of multiplying occurrence probabilities of the event by analyst i's expected payoff is represented by:

$$(1-c^*)^{n-1} \times \left(\Pi - \frac{1}{\omega+\alpha}\right)$$

Next, suppose that analyst i does not acquire x, but at least one analyst acquires x. Then, a value of multiplying occurrence probabilities of the event by analyst i's expected payoff is represented by:

$$\{1-(1-c^*)^{n-1}\} \times \left(\Pi - \frac{1}{\omega+\alpha+\beta}\right)$$

Lastly, suppose that analyst i acquires x by himself. Then his expected payoff is represented by:

$$\Pi - \frac{1}{\omega+\alpha+\beta} - c_i$$

Hereafter, I c^* is solved for using the same procedures as Osborne (2009, p.290). For any i, if $c_i \geq c^*$, the following inequality is satisfied:

$$
\begin{aligned}
&(1-c^*)^{n-1}\times\left(\Pi-\frac{1}{\omega+\alpha}\right)\\
&\quad+\{1-(1-c^*)^{n-1}\}\\
&\quad\times\left(\Pi-\frac{1}{\omega+\alpha+\beta}\right)\\
&\quad\geq\Pi-\frac{1}{\omega+\alpha+\beta}-c_i
\end{aligned}
\tag{12}
$$

In contrast, if $c_i \leq c^*$, the following inequality is satisfied:

$$
\begin{aligned}
&(1-c^*)^{n-1}\times\left(\Pi-\frac{1}{\omega+\alpha}\right)\\
&\quad+\{1-(1-c^*)^{n-1}\}\\
&\quad\times\left(\Pi-\frac{1}{\omega+\alpha+\beta}\right)\\
&\quad\leq\Pi-\frac{1}{\omega+\alpha+\beta}-c_i
\end{aligned}
\tag{13}
$$

Hence it follows that, if $c_i = c^*$, the following equation holds:

$$
\begin{aligned}
&(1-c^*)^{n-1}\times\left(\Pi-\frac{1}{\omega+\alpha}\right)\\
&\quad+\{1-(1-c^*)^{n-1}\}\\
&\quad\times\left(\Pi-\frac{1}{\omega+\alpha+\beta}\right)\\
&\quad=\Pi-\frac{1}{\omega+\alpha+\beta}-c_i
\end{aligned}
\tag{14}
$$

Equation (14) can be simplified as follows:

$$(1-c^*)^{n-1}-(\omega+\alpha+\beta)(\omega+\alpha)\beta^{-1}c^*=0$$

Let the left-hand side of the above equation be $G(c^*)$. Then $G(c^*)$ is a function that is continuous on c^* and $\partial G/\partial c^* < 0$ for any $c^* \in \mathbb{R}$. In addition, $\lim_{c^*\to 0} G(c^*) = 1$ and $\lim_{c^*\to 1} G(c^*) < 0$ hold. Hence, there is a unique $c^* \in (0,1)$ that satisfies $G(c^*) = 0$.

■

Proof of Proposition 1

Let the left-hand side of equation (8) be function f. Then c^* of f is a function implicitly represented by n, ω, α, and β. Therefore, from the implicit function theorem, the following inequalities are derived:

$$
\begin{aligned}
\frac{\partial c^*}{\partial n} &= -\frac{\partial f/\partial n}{\partial f/\partial c^*}\\
&= \frac{(1-c^*)^{n-1}(c^*)^{-1}\log(1-c^*)}{(n-1)(1-c^*)^{n-2}(c^*)^{-1}+(1-c^*)^{n-1}(c^*)^{-2}}\\
&< 0
\end{aligned}
\tag{15}
$$

$$
\begin{aligned}
\frac{\partial c^*}{\partial \omega} &= -\frac{\partial f/\partial \omega}{\partial f/\partial c^*}\\
&= -\frac{\beta^{-1}(2\omega+2\alpha+\beta)}{(n-1)(1-c^*)^{n-2}(c^*)^{-1}+(1-c^*)^{n-1}(c^*)^{-2}}\\
&< 0
\end{aligned}
\tag{16}
$$

$$
\begin{aligned}
\frac{\partial c^*}{\partial \alpha} &= -\frac{\partial f/\partial \alpha}{\partial f/\partial c^*}\\
&= -\frac{\beta^{-1}(2\omega+2\alpha+\beta)}{(n-1)(1-c^*)^{n-2}(c^*)^{-1}+(1-c^*)^{n-1}(c^*)^{-2}}\\
&< 0
\end{aligned}
\tag{17}
$$

$$
\begin{aligned}
\frac{\partial c^*}{\partial \beta} &= -\frac{\partial f/\partial \beta}{\partial f/\partial c^*}\\
&= \frac{\beta^{-2}(\omega+\alpha)^2}{(n-1)(1-c^*)^{n-2}(c^*)^{-1}+(1-c^*)^{n-1}(c^*)^{-2}}\\
&> 0
\end{aligned}
\tag{18}
$$

■

Proof of Corollary 1

The partial derivative of g with respect to n is represented by:

$$
\begin{aligned}
\frac{\partial g}{\partial n} = -\beta(1-c^*)^n\Big\{&\log(1-c^*)\\
&-\frac{n}{1-c^*}\frac{\partial c^*}{\partial n}\Big\}
\end{aligned}
\tag{19}
$$

Equation (19) can be simplified as follows, by using (15):

$$\frac{\partial g}{\partial n} = \beta(1-c^*)^n \log(1 - c^*)\frac{2-(c^*)^{-1}}{n-2+(c^*)^{-1}} \quad (20)$$

It is shown that, in the above equation, $\log(1-c^*)$ is negative, and the denominator $n-2+(c^*)^{-1}$ is positive. Therefore, the sign of $\partial g/\partial n$ depends on the sign of the numerator $2-(c^*)^{-1}$.

■

Proof of Corollary 2

When parameters satisfy the condition that $1 \le \beta/[(\omega+\alpha)(\omega+\alpha+\beta)]$ or, in other words, $1 \le k^*$, all of the analysts are sure to acquire signal x. Hence, $h = \omega+\alpha+\beta$ holds in this case, regardless of the value n. In contrast, when parameters satisfy the condition that $\beta/[(\omega+\alpha)(\omega+\alpha+\beta)] < 1$ or, in other word, $k^* < 1$, only analysts whose cost of information gathering is lower than k^* acquire signal x. If all n of the analysts do not collect x, the precision of the investor's prediction results in $\omega+\alpha$. On the other hand, if at least one analyst collects x, the precision of the investor's prediction rises to $\omega+\alpha+\beta$. The probability that the former state occurs is $(1-k^*)^n$, and the latter state occurs is $1-(1-k^*)^n$. Consequently, h is represented as follows:

$$\omega+\alpha+\beta-\beta(1-k^*)^n$$

The partial derivative of h with respect to n is represented by:

$$\frac{\partial h}{\partial n} = -\beta(1-k^*)^n \log(1-k^*) > 0 \quad (21)$$

■

Proof of Proposition 2

Suppose that $n=2$. Compare c^*, which is obtained by equation (8), and k^*. Then it is shown that the following inequality is satisfied:

$$c^* = \frac{\beta}{(\omega+\alpha)(\omega+\alpha+\beta)+\beta} < k^* = \frac{\beta}{(\omega+\alpha)(\omega+\alpha+\beta)}$$

Suppose that $n>2$. Then $c^* < k^*$ is also satisfied.

The result follows from the fact that $\partial c^*/\partial n < 0$, as asserted in Proposition 1, and that threshold k^* is independent of the value n.

As we have seen, g is represented by $\omega+\alpha+\beta-\beta(1-c^*)^n$. On the other hand, Corollary 2 shows $h = \omega+\alpha+\beta-\beta(1-k^*)^n$ such that $0 < k^* < 1$, and $h = \omega+\alpha+\beta$ such that $1 \le k^*$. Consequently, from $c^* < k^*$, the following inequalities are satisfied.

$$\omega+\alpha+\beta-\beta(1-c^*)^n < \omega+\alpha+\beta-\beta(1-k^*)^n < \omega+\alpha+\beta$$

That is, $g < h$ holds for $n \ge 2$.

■

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