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Abstract

Theoretical models have shown that full disclosure of private information will be induced when disclosures are credible and costless. Managers/sellers are predicted to disclose so as not to thought as holding the worst possible information. The objective of this paper is to test the basic model of full disclosure by using experimental methods. In this paper, I conducted 16 laboratory markets, manipulated two treatments and produced a 2×2 factorial cell design: (1) the number of possible states and (2) the existence of an antifraud rule. The former is due to question marks derived from the review of prior experimental researches. The latter is due to the concern for an antifraud rule posited as a critical condition in the model. The results support the theoretical and behavioral predictions generally, and provide some interesting findings.

JEL Classification: M41, C92

Key Words: Voluntary disclosure; Accounting regulation; Experimental Economics

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1. Introduction

In this paper I report some results of experimental markets designed to test the basic model of full disclosure¹ based on the theoretical model that was introduced from the ‘persuasion game’ of Milgrom (1981) and extended by Milgrom and Roberts (1986). Their researches shows that the senders of information will fully disclose their information so as not to be assumed to interpret non-disclosure as implying the worst possible news by the receivers of information when disclosures are both credible and costless.

The research of voluntary disclosures is of big importance because much issue has to do with the fundamental question of whether accounting regulation is necessary to enforce managerial disclosure or not (for example, King 1991a, 1991b, Choi and Muller 1992, Suda 1992, Okabe 1994, Fujii 1998, and Oishi 2000). According to the results of theoretical analyses above, there is no need to force firms to disclose any information, because market mechanism alone would induce managers to disclose their private informations voluntarily. Obviously, disclosure or accounting regulations will be led from a lot of political, social, and of course economic factors and conditions, most of which are not included in the basic model of full disclosure. Therefore, for setting up some regulation it is not sufficient only to understand how market forces exercise some influence on voluntary disclosures, but that is

¹ The term ‘the basic model of full disclosure’, of course, is my representation in this paper, and was not used in their papers.

essential to the setting process of accounting regulation² (Chow 1996, footnote 3, p.134).

As one of the realms that experimental approach can be exercise its intrinsic ability, the basic model of full disclosure has been already tested experimentally in Forsythe et al. (1989), King and Wallin (1990, 1991a, 1991b) and Chow et al. (1996). In additional to these papers, King (1995) has conducted experimental tests for the modified versions of the basic model of full disclosure too, which were motivated by many empirical results of discrepancy between the theoretical prediction and the real world (that is, full disclosure did not have always occurred). Except for Chow et al. (1996), it has been reported that the experimental results supported the theoretical predictions generally.

Accepting these findings of prior researches solely, I might be called for conducting experiments to investigate one revised model that has not been conducted yet. However, reviewing the prior disclosure experiments in greater detail, it seems to me that they have some question marks here and there about their operations, designs, and interpretations of the results. One of major puzzles is that, for example, not to speak of Chow et al. (1996) concluded that full disclosure of private informations had not been arisen, there are some which are difficult to admit myself the occurrences of full disclosures among papers obtaining positive conclusions. Added to those question marks, it must be pointed out, the prior researches that had been intended to conduct the straight experimental tests of the

² For copious discussions about accounting regulations, see Fujii (1998) and Oishi (2000).

basic model of full disclosure are few for the number of both designs and markets, which is the main focus of the tests of the modified versions.

On those accounts, I find it remained meaningful to test the basic model experimentally at this moment.

In this paper, 16 multiperiod experimental markets are conducted. In each market there were a single seller and three buyers. In each period, each seller was endowed with one commodity to offer for sale to the buyers. The distribution of commodity's value is assumed to be common knowledge. At the beginning of each trading period, the seller was informed of the realization of commodity's value, and decided its message whether to reveal it truthfully to the buyers or not. Receiving the seller's message, the buyers bade to purchase the commodity. The trading mechanism used was a first-price, sealed-bid auction institution. A 2×2 factorial design was created by manipulating (1) the number of possible commodity's values nature selects and (2) the existence of an antifraud rule³. The manipulation (1) is relied mainly on the review of prior researches. There is no solid theoretical prediction in the cell without an antifraud rule (by the manipulation (2)), but

³ According to King (1990), "an antifraud rule is a mechanism that requires that the disclosure set must include as one of its elements the true (known) quality level. The rule permits vagueness but not lying (*Ibid.*, p.860)." Non-disclosure is permitted because of not lying under this rule. While it might to be thought as a very strict assumption when applying to the real world, this setting may take on some realistic tinct if I assume both the existence of huge penalty and the positive probability that the fact of

the rule is an essential condition for the basic model of full disclosure. So, the cell without an antifraud rule was set up in order to examine the influence of excluding it on the results.

The results from this experiment, in general, supported the theoretical prediction of full disclosure, while sellers (i.e., managers in accounting context) were not indifferent between disclosures of the worst informations and non-disclosures of those, they usually disclosed their informations completely. The number of possible states (i.e., liquidating dividends) had little influence on the results. This is inconsistent with the results of prior papers. In the cells without an antifraud rule, overdisclosures occurred in general, but buyers (i.e., investors) saw through them and discounted fairly the commodity's (liquidating dividend's) values disclosed by sellers (managers).

The paper proceeds as follows. The next section 2 explains the basic model of full disclosure briefly, and describes how the model has been applied and modified in accounting context. In section 3, I indicate the reason why direct tests of the model has been conducted using experimental approach, review some prior researches, points out problems and question marks for the prior researches, and demonstrates the features of this paper. The experimental procedures and cell design are presented in the 4th section. Section 5 develops the hypotheses and some behavioral prediction and reports the experimental results. Summary and concluding remarks are given in section 6.

lying comes to light.

2. Theory – The basic model of full disclosure and its application and extension

2-1. The basic model of full disclosure

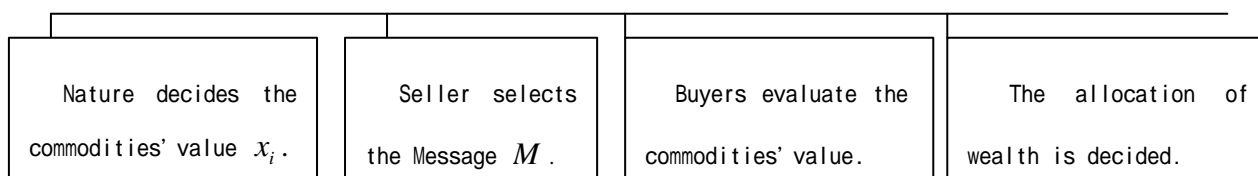
The basic model of full disclosure (hereafter, ‘the basic model’) is based on a theoretical model that was introduced from the ‘persuasion game’ of Milgrom (1981) and extended by Milgrom and Roberts (1986). In this section, I borrow heavily from their papers and explain ‘the basic model’ briefly⁴.

The persuasion game can be represented as a game of an extension form as follows. Players consist of one seller and buyers and the transaction of a commodity is put into practice. First, Nature determines a certain point x_i from a finite set X . This represents the seller’s private information at once⁵. Here, $i = 1, 2, \dots, n$ and $0 < x_1 < x_2 < \dots < x_n$. x_i is a number which is directly connected with the value of the traded commodity. Buyers know the probability that any x_i is selected, $P(x_i) > 0$. The seller observes x_i and sends some message M to the buyers. This message M is required to be truthful ($M = x_i$). That is, as far as the seller sends a message, he/she can’t lie to the buyers. He/ She only can

⁴ Here, the chief object in view is the ease of understanding. For the strict mathematical formation, see Milgrom (1981) particularly.

⁵ The fact that nature determines x_i has an important implication. While x_i is the numerical value that determines the final allocation of resource, it is given and the seller can’t influence its value. In short, it is assumed that what is called ‘moral hazard problem’ is out of question.

either send the true value of x_i ($M = x_i$) or send no message ($M = \emptyset$). In King (1990), the mechanism that gives reliability to the message is referred to an antifraud rule. All the buyers receive same message. So the seller can't take a selective action that he/she sends the message to only some of the buyers. Observing the message M from the seller, buyers evaluate its commodities. At the last, the final allocation is decided according to some transaction mechanism. The time line⁶ above is as follows.



The payoff of a seller is equal to the amount received from a purchased buyer, and that of a purchased buyer is equal to the commodities' value minus the amount he/she paid and 0 for buyers who lost in bid. So utilities of both a seller and buyers are supposed to be increasing functions of their payoffs, they have tried to maximize their payoffs.

In this dynamic game of incomplete information, there are many Bayesian-Nash equilibria. Each of them are composed two stages, i) being selected one message by a seller, buyers forms their belief about why that message are sended, and they decide bidding strategies aimed to maximize their expected payoffs, ii) given such buyers' strategies, a seller decides his/her message-sending strategy to maximize its expected utility (For more details, see the 4th chapter of Gibbons (1992)).

⁶ The term 'time line' is used in Berg et al. (1990).

Bayesian-Nash equilibrium of this game has two extreme cases, classified into the proportion that a seller sends a message about its truthful value of the commodity. One extreme is a case where a seller sends no message when any x_i 's determined by nature, buyers take it at face value and their prior beliefs are never changed, and they value its commodity at the average of the distribution (m). This means that, $p(x_i) = 1/n$ and $x_{s+1} - x_s = x_1$, assumed a discrete uniform distribution⁷, given no message, buyers continue to think that $p(x_i | M = \emptyset) = 1/n$ and evaluate its commodity's value at $m = \frac{(n+1)}{2} x_1$. Milgrom and Roberts (1986) express these buyers as 'unsophisticated' or 'naively credulous'. Other extreme is the equilibrium that Milgrom and Roberts (1986) express sophisticated or 'assume-the-worst', and in that equilibrium, perhaps except when $i=1$, a seller always announces its commodity's value x_i . When $i=1$, for a seller, it is indifferent between sending a truthful message and no message. Being sent a message, the buyer value the commodity at x_i , and he/she acts upon the belief that commodity's value is the lowest possibility x_1 in the case of no message.

There are many Bayesian-Nash equilibria between these two extreme proportions messages are sent, of 0 % or 100%. All of these equilibria are that the seller only reveals

⁷ Theoretical literatures don't specify one established distribution form. So in the analysis on and after and the following experiment, for the ease of understanding and handling, I use the discrete uniform distribution.

a specific level of the commodity's value. Corresponding to such seller's behavior, buyers build up their beliefs and bid zero for the seller's behavior deviated those equilibria. However, all these equilibria have undesirable properties, because buyers' beliefs are not rational and these information sets are off the equilibrium path. In particular, for example, when a seller reveals the truthful quality, it is not rational intuitively that buyers bid zero on the ground the behavior is out of their beliefs.

Excluded all implausible equilibria by using the solution concept of perfect Bayesian-Nash equilibrium⁸, all of the equilibrium are removed except for that of buyers assuming worst⁹.

⁸ In Milgrom (1981) and Milgrom and Roberts (1986), the solution concept of sequential equilibrium is used. However, in Gibbons (1992, p.179), as stated (1) there's no difference between the perfect Bayesian equilibrium and the sequential equilibrium in many economic applications, and (2) for the complexity of a definition and the way of application, almost another use the former, so I denote 'perfect Bayesian equilibrium' here.

⁹ By reference to Verrecchia (1983, p.185), being transformed and abbreviated, this is demonstrated following numerical expression. The payoff of a seller is equal to (1) x_i when he/she send a message, and (2) the buyers' expectation given no message from him/her, i.e. $E(x_i | M = \emptyset)$ in the case of no message. Under the condition of no message, rational buyers assume that x_i is equal to some cutoff of disclosure (for example, \hat{x}) or fall below it. That is to say, they value the commodity at $E(x_i | x_i \leq \hat{x})$. A rational seller who aims to maximize its payoff recognized this, (1) if $x_i \geq E(x_i | x_i \leq \hat{x})$, he/she sends a message, and (2) given $x_i < E(x_i | x_i \leq \hat{x})$, he/she send no message. Therefore, for a seller the cutoff of disclosure is $x_i = E(x_i | x_i \leq \hat{x})$. At equilibrium, the cutoffs of both a seller and buyers are got to be equal. So it is $x_i = E(x_i | x_i \leq \hat{x})$. Based on the assumption here that the commodity follows a discrete uniform distribution, the last equation is $x_i = \frac{1}{2}x_i$ and this means all of the messages except for the case of lowest commodity's value are sended.

The explanation is as follows.

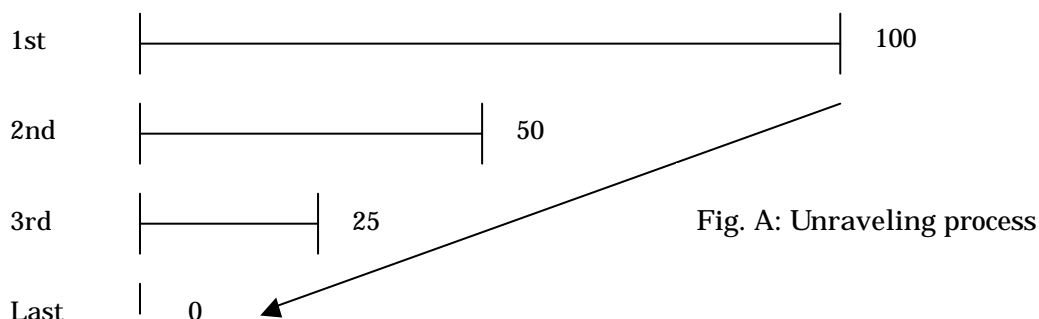
If a seller selects to send no message, therefore $M = \emptyset$, at the first step, a rational buyer might recognize that the seller prefer selecting $M = \emptyset$ and being valued at the average of distribution m such as the former extreme case to selecting $M = x_i$ and being valued at x_i . If nature selects the commodity's value beyond the mean (i.e., prior expectation of the distribution), a seller could get more payoff when he/she reveals it to buyers. So, under the condition of no message, the buyer gives zero to the percentage that the commodity's value is above the mean.

After this period, given these buyers' beliefs and strategies, a seller decides its message-sending strategy. At the second step, if a seller doesn't send any messages and reveal the commodity's value, it is recognized to below the mean by buyers and the commodity is valued at the average of zero and the mean of distribution m ($(0+m)/2 = m/2$) from the assumption of the discrete uniform distribution. Therefore, if the commodity's value is beyond $m/2$, a seller prefers to send a message.

These unraveling processes are continued same as above, and at last, the range of a commodity's value a seller can select when he/she doesn't send an informative message¹⁰ is vanished, and he/ she reveals all of the commodity's value perhaps except for only the

¹⁰ King et al. (1990) demonstrates that an informative message is that $E(\tilde{x}|M) \neq E(\tilde{x})$. Being send one message are not synonymous with being send no message, it demands to revise one's prior expectation.

lowest value. Fig. A depicts this process, using numerical lines and numerical values. It is assumed here that the commodity's value is distributed $[0,1,2,\dots,100]$.



The average of distribution is 50. Then, at the 1st step, if nature selects the commodity's value more than 50, a seller will be able to get more payoff to reveal it and evaluate its face value (for example, 70). For the buyers, so, both not to being revealed the commodity's value and that the commodity's value is from zero up to 50 are the same thing. At the 2nd step, if the commodity's value is more than 25, a seller gets more payoff to reveal it. Accordingly, when the commodity's value is not revealed, a rational buyer values it under 25. Hereafter, these downward unraveling process are repeated, finally at the perfect Bayesian equilibrium, a seller prefer to sending all of the message of commodity's value except of zero, and buyers take this into consideration and recognize that the commodity's value is the lowest possibility given no message¹¹.

¹¹ Showing here is the process of thinking to reach equilibrium, and it never means how many times needs to reach there or the space when a seller send no message have become $\frac{1}{2}$ trial by trials. The important thing is a process that, given no message, a rational buyer renews his/her belief.

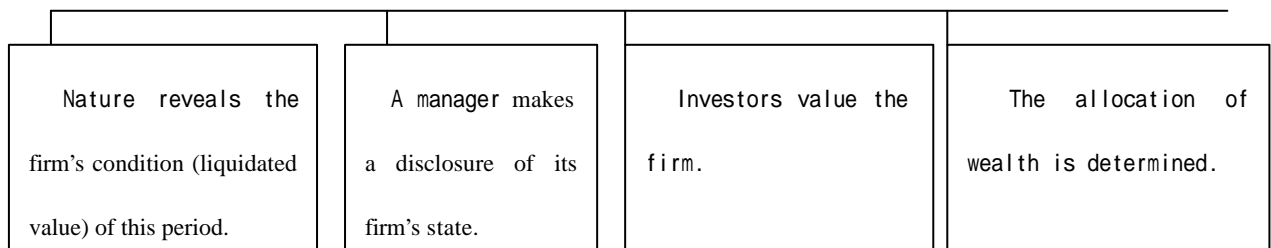
In short, though there are a lot of perfect Bayesian-Nash equilibria in this dynamic game of incomplete information, it reaches out perfect Bayesian-Nash equilibrium by excluding implausible equilibria that are off the equilibrium path. Consequently, except for the lowest value of the commodity, a seller discloses all of its values to buyers.

2-2. Applications and extensions of the basic model to accounting

For the basic model of perfect (or full) disclosure discussed in the section 2-1, though Milgrom (1981) and Milgrom and Roberts (1986) suggest the applicabilities to various economic instance, they don't deal with the accounting issues directly. However, it is clear that, this basic model has very important implications to accounting reports and regulations and is easily applicable. In that place, a 'seller' and 'buyers' are changed into a 'manager' and 'investors' respectively, the setting has changed that a manager transacts the asset (equity) that are paid the liquidation dividend at the end of a term with investors. In the first place, nature reveals to a manager some signal, concerned with the real liquidation value of its risky asset¹². It is not necessary to change the basic model's

¹² More easily, it is possible to think it as just the information about liquidation value of the asset (equity). Personally speaking, however, I think this signal as 'a critical information on one's decision making'. It's a main issue that the critical information is either disclosed or not by a manager and is recognized exactly or not by investors, but adding these, I think there is another stage that the investors make decision using the information.

assumption that only a manager is endowed with the signal and the distribution of the signal is common knowledge between the interested parties. Upon received the signal, the alternatives for a manager are disclosing its exact value or making no disclosure (under an antifraud rule). Receiving the disclosure or nondisclosure from a manager, investors value the firm in order to purchased the asset. It is the same as the former model that some transaction mechanism is used to decide the allocation¹³. The time line of the application of basic model to the accounting disclosure is as follows.



The result of analysis is just the same. If communication between the parties (and , and) has no cost and there is an antifraud rule in , at the equilibrium a manager makes full disclosure about its firm's state (perhaps, except for the worst). This consequence that occurs voluntary disclosures of information is called, 'disclosure principle'

¹³ It is assumed that a manager has to transfer its asset to the winning investor. The asset is of no value to the manager. This setting is referred in King (1990), and it is assumed a non-owner/manager. Jensen and Murphy (1990) carries on investigate the relation between accounting profits and rewards of CEOs. They obtain an interesting result, which shows the management reward increased by $\phi 17.7$ as the accounting profit increased by \$1,000. This finding may give some validity to the setting here that the payoff of a manager is influenced its firm's situation decided by nature. Still more, though the model assumes a firm liquidates period by period, the result of analysis holds true for going concerns too.

in Dye (1985) or 'market-induced information disclosure' in King (1991).

These results of analysis have a great interest in arguing accounting regulation¹⁴. By working some market mechanism, any information could be disclosed voluntarily by a manager. Therefore, it implies that there's no need to force firms to disclose publicly any information. Thinking out both the costs of accounting regulation¹⁵ and the propriety of forcing all of the firms to obey a same regulation¹⁶, this result casts a pall of gloom over the argument about accounting regulation on the assumption that more and more regulations must be needed.

The results in the basic model, however, have been revised and expanding by taking costly disclosure (Verrecchia 1983), costly obtainment of disclosure (Matthews and Postlewaite 1985), uncertainty of seller's disclosure endowment (Dye 1985, Jung and Kwon 1988), and

¹⁴ Definition of accounting regulation lies in Nakamura (1992) or Oishi (2000) for example. Here, I grasp it is 'what forces to disclose the critical information for making decisions' in a quite broad sense. It might be thought that the presence of an antifraud rule itself is an accounting regulation, but the problem is solved to some extent, adding that an antifraud rule provides to punishes a manager who makes a fictitious disclosure with a very severe penalty, assuming that there is a positive probability of being detected his/her fraud disclosure, and a manager imposes himself/herself an antifraud rule.

¹⁵ In Nakamura (1992, *Ibid.*, p.30), they are 'the costs related consumption of the resources resulting from the establishment of the accounting laws or principles, observance and lookout, and lawsuit. In the opposite direction, the government will impose taxes on the people.

¹⁶ Fujii (1998) points out, standing a point of view that any regulations are unnecessary, because of the diversity of firms' managerial environment, optimal disclosure levels can be different between firms.

the presence of proprietary information (Dye 1985, Wagenhofer 1990) and so on. All of them attempt to address some situation where a manager has an incentive to withhold disclosure in some range among the state nature selected on the assumption of an antifraud rule. For example, Jung and Kwon (1988) analyze the settings there is positive probability that a manager doesn't know its firm's state of one period. Then, investors can't distinguish non-disclosure from either the seller's lack of information or the unfavorableness of his/her information same as the basic model. Under such situation, it might be the case that the information is threshold and is not disclosed voluntarily.

These expansions of the basic model focus on some discrepancy between the theoretical prediction for voluntary disclosures and the real world. First, there are lots of empirical evidences which prove voluntary disclosures don't always occur. Some of them are including papers such as, the earnings prediction of a manager and its reaction of the capital market (Patel 1976, Waymire 1984, 1985, and Lev and Penman 1990), the practice of blind bidding behavior in the motion picture industry in the U.S.A., and gas-octane reporting (Jovanovic 1982). For example, Lev and Penman (1990) argued that, managers tend to disclose good news rather than bad news and the firm not to disclose doesn't experience the drastic fall in its stock price. And second, the evolutions of the basic model are originated from the accounting regulations in the real world. As pointed out, accounting regulation in many countries are heading the way of tightening, and there is some empirical researches,

stating that the public and the quasi-public accounting principle setting institutions pass a judgment that market force is not enough to enforce managers to make sufficient disclosures (A series of movement in the U.S.A. is detailed in Chow et al. (1996)).

However, is it possible to do direct tests of the model by the empirical researches using data from naturally occurring markets¹⁷? In the next section, I'll give a negative view on this question and explain why experimental approach has used.

3. Experimental approach

3-1. The limitation of empirical research¹⁸ why the experiment is fit?

As noted in the former section, the tests of the model using data from naturally occurring markets are problematic. Chow et al. (1998, *Ibid.* p.135) remarks that, touching this point at issue, "in addition to problems of potential model misspecifications and omitted variables, a key difficulty is measurement error in variables, which is an especially significant obstacle because of the researcher's lack of access to the complete information set of managers." Showing along time line of the model, that is, it is impossible for empirical researches using data from naturally occurring markets to recognize the critical

¹⁷ They are also called 'archival data'. To compare the data generating in the laboratory, this term is used.

¹⁸ It's true that the experimental approach is one of the methods of empirical research. So, the title of this section may be needed to add an objective verb 'previous'.

matters for analysis, for example what states that nature selects can be arisen (prior distribution) or what means (actions) a manager can select. Since it is necessary to provide some assumptions and comparisons, it demands some interpretations for the findings of these empirical researches and it makes unclear the result itself (For similar views, see the section 6 of Waymire (1985)).

Contrary to above problems, in the experiment, both the states of its firm which are selected by nature at and the means which a manager can select at can be determined as a rules in a laboratory, and we can have control over them perfectly. Therefore, we can do the direct test of models.

Both methods of empirical researches using datas from naturally occurring markets and experimental datas are not alternative or exclusive each other. It is true that, taking the former researches opportunities, theoretical models have been revised, and the new experiments have been stimulated to conduct (For more details, see the chapter 1 of Kagel and Roth (1995)). However, for the tests of the basic model and the models revised/expanded it, it is not appropriate using the data from naturally occurring markets, experimental approaches become powerful means.

3-2. Prior experimental researches

There are some prior experimental researches. Some of them had already incorporated the

extension of the basic model as above, and the issues to confirm by experiments have developed from “Can the private disclosure suggested by the basic model occur in laboratory actually?” into “Under what conditions does a manager have an incentive to threshold his/her information disclosure?”

Forsythe et al. (1989) is one early experimental literature addressing this issue. Taking into account the institution of blind bidding in the motion picture industry of the U.S.A., and the actual cases such that entering protects from exhibitors (i.e., owners and operators of movie theaters) and laws prohibiting its practice by some states, they conducted tests of the basic model. Numbers of the possible states which nature selects were 125 in one cell ($[1,2,\dots,125]$) and 8 in another cell ($[Type, \dots,] + ([1,2,\dots,15])$)¹⁹. In Forsythe et al. (1989), their experimental markets consisted of four sellers and four buyers, differing widely in that there were a single seller and three (or four) buyers in other prior experiments. They explain “the purpose of having multiple sellers was simply so that buyers could have more rapidly gain experience with the trading rules (*Ibid.*, p.221).” This factor does not affect the predictions of the theory in a significant way as they describe, but it was not the direct tests of the model. Each four buyer made decisions to purchase four items from four

¹⁹ In this latter cell, the value of an asset was determined by both its common value $[Type, \dots,]$ (type number were multiplied by fifteen) and the private value $([1,2,\dots,15])$. The common value was same among all subjects acting as buyers in the markets, but the private value was different for each subject. And its total represented the asset value for one buyer.

distinct sellers each period, and taking both this setting and competitions with other rivals into consideration, each four seller decided its disclosure. Forsythe et al. (1989) conclude that “it is clear that the sequential equilibrium model is a good predictor of behavior in these simple markets (*Ibid.*, p.230)”, revealing a support of full disclosure model.

R. R. King and D. E. Wallin are researchers who have conducted the most extensive experimental researches in this realm. In King and Wallin (1990), the thesis was effect of antifraud rules and ex post verifiability on theoretical predictions of the model, and some experiments were conducted in a 2×2 cell setting. An asset of an object for transaction was, differing critically from other experiments, a \$1 lottery ticket. The ticket could have one of three realization levels that nature selected (10, 50, and 90 percent), specifying the probability that it would pay \$1 or zero. For example, in the cell with an antifraud rule, when a seller revealed that the realization level was 90 percent, each buyer valued the lottery ticket which was pay out \$1 by the probability of 90 percent²⁰. Same transactions were repeated fifty times, and for each period one unit was traded. The exchange institution used was a first-price sealed bid auction. Their results supported the prediction of the basic model strongly, in the cells with an antifraud rule, and the equilibrium of full disclosure occurred generally regardless of export verifiability.

King and Wallin (1991b) investigated the prediction of the basic model and the effect of

the number of disclosure options available to a seller. It was assumed that there was an asset which was paid a liquidating dividend chosen from one uniform discrete distribution $[15,25,\dots,85]$, while a seller was restrained by an antifraud rule, he/she had some disclosure options. The last setting was that, for example, when nature had selected 55 from above distribution, a seller was able to make four forms of disclosure options such as; (1) a point disclosure of $\{55\}$, (2) a consecutive pair of $\{45,55\}$ or $\{55,65\}$, (3) the latter half of possible dividend values of $\{55,65,75,85\}$, and (4) non-disclosure which would be $\{15,25,35,45,55,65,75,85\}$. Their intention was to investigate the effect of the disclosure options on the arrival at equilibrium, because given the theoretical prediction that the rational buyer put a lower and lower estimation on the value of an asset when no disclosure is made, the number of disclosure options may weaken the buyer's ability to reach some equilibrium. Also, a double auction (DA) was adopted as the trading institution because of its favorableness to converge to competitive equilibrium, and eight assets were endowed with a seller and were traded each period. These settings are characteristic of this paper. The result is that, the seller moved toward full disclosure (in their paper, referred to 'market-induced information disclosure: MID), though the theoretical predictions were weakened as the number of disclosure options increased, *ceteris paribus*.

In King and Wallin (1991a), the asset value of one particular period was drawn out of the

²⁰ They also have introduced two different distributions of realization levels, but it is not interest here.

uniform discrete distribution identical with King and Wallin (1991b). It was characteristic of this paper to report experimental results in the case that there was positive prior probability both a seller and buyers were given no information about the asset value of that period, based on the model in Dye (1985) and Jung and Kwon (1988). The prior probability a manager was endowed with no information was 0, 0.1, or 0.3. Then, it was not different from the basic model in the case of 0, but, for example if it was set at 0.3 in one setting, a manager was not informed of its period's asset value at the probability of thirty percent of all trading periods (= 50 in their setting), so a manager didn't know the asset value either. Though coincidence with a point prediction from the theoretical calculations were not found out, they concluded that their results were consistent with the general proposition of the model stating that the range of no disclosure had come to large as the prior probability increased.

King and Wallin (1995) presented the results of experimental test based on Wagenhofer's (1990) model. In Wagenhofer (1990), it was assumed that there was an opponent who entered the market and reduced the terminal value of the asset by certain fixed amount only if the opponent believed the firm's expected value was more than one exogenously specified threshold. In this case, a buyer can't know the reason why a seller makes no disclosure either due to unfavorableness of his information about the firm's value (similar to the basic model) or due to the avoidance of loss from entering an opponent. Wagenhofer

(1990) proved the existence of three sequential equilibria, then King and Wallin (1995) investigate which equilibrium would have reached in the laboratory. The uniform distribution of the asset's value here was $[0,1,...400]$. Mixed with above complex settings, although they concluded that the experimental results supported the theoretical prediction of Wagenhofer's (1990) disclosure model, but the results were somewhat unclear to interpret ²¹.

Chow et al. (1996) is the only article argued "this findings fails to support the (equilibrium) prediction of analytical research that when disclosure is costless, managers voluntarily disclose all news (*ibid.*, p.149)." In this experiment, the number of possible values of asset was 201 which was drawn from the uniform discrete distribution such as $[0,1,...,200]$, and added to the basic model, they investigated the Verrecchia's (1983) disclosure model which proved that, full disclosures might not have occurred in the certain situation when disclosure was costly. Even in the cells with no cost of disclosure, however, among four test periods out of all 13 periods (from period 9 to 12) of 39 markets conducted, no disclosures were occurred by the proportion of 41.7 percent, failing to support the theoretical predictions. Chow et al. (1996) point out as the main reasons, sparing the

²¹ To add to this, King (1996) researches the effect of allowing a seller discretionary disclosures on the parties' actions. However, I don't refer to it here because buyers' payoffs were influenced directly by a seller's action in his setting.

number of pages about why such results were achieved, there existed some buyers who didn't price-protected themselves (that is, didn't assume the worst), continued to bid the higher prices, hold the seller's payoff at higher levels, and didn't give sellers incentives to disclose²².

In summary, except for Chow et al. (1996), the prior researches have obtained the affirmative conclusions about the theoretical predictions of both the basic model and its modified models.

3-3. Problems and question marks for the prior researches

Accepting these findings of prior researches solely, it might be necessary to conduct experiments to investigate one revised model that has not been conducted yet. However, reviewing the prior disclosure experiments minutely, it is true to find some question marks here and there about their operations, designs, and interpretations of results. In this section, I will point out some problems in the prior researches and explain this paper's standpoint positing an emphasis on the experiments of the basic model.

One major puzzle is that, not to speak of Chow et al. (1996) concluded full disclosures of

²² It has not been given a clear explanation about why right then such buyers existed. However, they suggested that the realized pay for subjects acting as buyers was admittedly low. I will touch this problem of reward in the experiment later.

private informations had not been arisen, there are some papers which are difficult to interpret as the occurrences of full disclosures among papers obtaining positive conclusions. For instance, in King and Wallin (1991b), no disclosure occurred in the proportion of 40 percent (in cell A: a manager was endowed with the firm's value and it was common knowledge among all subjects, that is similar to the basic model) even in the latter half of their fifty trading periods. Also, in King and Wallin (1991a), no disclosure occurred in the proportion of 8 to 34 (=23.5 percent) in the situation which was predicted theoretically the occurrence of full disclosures. In Forsythe et al. (1990), these problem is somewhat moderated, but no disclosure occurred in the ratio of about one to five.

Having reviewed the prior researches in detail above, one can notice that King and Wallin (1990) is the only paper that is able to accept the occurrences of full disclosures without reservation. In King and Wallin (1990), disclosures occurred in the proportion of both 95.5 percent (=128/134, in the setting of cell A, which had an antifraud rule and all the buyers were informed of what had happened in its period trial by trial) and 89.6 percent (120/134, in the cell B, which also had an antifraud rule but the buyers were not informed of the consequence of one period). As pointed out in the section 3-2, however, in this experiment, it was a lottery ticket, which took only one of three probabilities to come up. So, it turns out that the equilibrium was able to be reached without reservation when the number of possible states selected by nature was three, but the experimental results became

somewhat ambiguous as the number increased to 8, and it put obvious obstacles to reach the analytical equilibrium as the possibilities numbered in 125 or 201. This matter is of importance, I think. That is to say, it can be interpreted that, only in the case where it is a common knowledge that the firm's value (or the liquidating dividend of one period) could take one form from only three forms, for example, that is 'high', 'neutral' and 'low', a manager discloses its value except for 'low' and investors can find it to be 'low' when no disclosure is made. Consequently, the applicability of the results to real world that the distribution of firm's value must be continuous and not a common knowledge may be constrained severely. Also, though employing last one or a few from dozens of trials for its test period and arriving at some decision, it means that it needs to take considerable trials to reach an equilibrium.

Relatively low monetary rewards to subjects may be one of the problems. For example, in Chow et al. (1996), the average monetary reward for their three hours experimental session was \$13.84 ($s=\0.85) to subjects participated as sellers and \$7.76 ($s=\10.53) to ones participated as buyers, it might have not been enough to motivate subject students²³.

²³ There always exists criticisms for the experimental method itself that whether certain theory is supported or not depends on the level of monetary rewards. I don't deliberate this here, but generally speaking, it doesn't give a great influence upon experimental results insofar an experimenter pays its experimental rewards according to induced-value theory of Smith (1976). However, it seems that when student subjects are involved in the experiment, it is necessary for an experimenter to design his/her

In addition to the monetary motivation for subject's level of interest and involvement, there is an intrinsic problem in the method of determining subject's reward of disclosure experiment, which indicated in Berg et al. (1990) as "a trading institution that gives all gains to trade to one side of the market (*Ibid.*, p831)"²⁴. In other words, it is a zero profit condition whose expected trading profits are zero for subjects acting as buyers (investors). In some equilibrium predicted theoretically, a seller (manager) makes full disclosures of his/her private informations. Being no disclosures, investors (buyers) can detect that the manager (seller) has the worst possible information. Then investors (buyers) are confronted with making decisions on which how they valued the asset whose terminal value (liquidating dividend) is known, and competitions among investors (buyers) drive buyers' expected profit to zero. That is, a winning investor (buyer) expects to value at 100 and receive 100 when a manager (seller) disclosed the firm's state is 100, for example, As the amount received become equal to the amount paid, investors' (buyers') trading profits expect to equal to zero in the equilibrium²⁵. How do the subjects acting as buyers think that the consequences of their rational decisions are not quite connected with their monetary

experimental settings taking their due reward levels for the part-time jobs into consideration.

²⁴ King and Wallin (1991, p.176) point out the similar problem.

²⁵ As denoted above, my awareness of problem is whether one critical information for decision making is disclosed or not, and I assume to be a next stage in which investors (buyers) make decisions themselves taking the manager's (seller's) behavior into consideration. They are assumed to gain in this next stage, so

rewards?

The number of trials in one experimental session, too, may be problematic. In prior researches, there is major difference between King and Wallin (1990) which was used the computer system (AEMLS: the Arizona Experimental Markets Laboratory System) in experimentation and was able to report 50 times, and Forsythe et al. (1989) and Chow et al. (1996) which manually conducted their experiments and could duplicate only 20 and 13 times, respectively. Chow et al. (1996, p.149) reveals that, by referring this issue particularly, their primary obstacles to the number of trading periods was the tight time demand of manually conducting their experiment. In contrast, many trading periods such as 50 trials and more may arise another problem of slowness to reach the equilibrium.

Because of easier learning and favorableness to reach the equilibrium, in some prior researches, the experimental designs such as the double auction (DA) institution with multiple assets (King, 1991b) and the competitions among four sellers has been introduced to test the basic model. Though the theory itself does not stipulate one particular trading mechanism, the DA institution is not appropriate for the test of basic model because it would have admit some additional information flow from a manager (seller) to investors (buyers) by way of the offer made and the bids accepted²⁶. Introduction of competitions

it is not a wonder their inferences given no or full disclosure don't make profits.

²⁶ This is just what themselves point out in King and Wallin (1990, p.870).

among plural managers (sellers) imports a new factor into the basic model, although Forsythe et al. (1989, p.221) expresses the factor does not affect the predictions of theory in a significant way. The buyers have bid to purchase plural assets from the distinct sellers at the same time.

Finally, I want to point out too, it should also be stressed that the prior researches that had been intended to conduct the straight experimental tests of the basic model are few for the number of both designs and markets.

In summary, I find it remained meaningful to test again the basic model experimentally. On the other hand, it is the case that there is ample scope leaving its design to the experimenter's discretion even if one experiment is directed toward the test of the basic model. For that reason, in this paper, according to the findings of prior researches and my question marks above, it should be very significant to conduct experiments to test the prediction of the basic model using as refined design as possible.

4. Experimental methods

4-1. Market environment

The terms such as, 'a manager', 'investors', and 'the firm's state (liquidating dividend)', and 'disclosures', may give subjects some psychological biases. So, I use more general terms such as, 'a seller', 'buyers', 'the commodity's value', and 'sending messages' as a substitute

for such words as ‘a manager’, ‘investors’, and ‘the firm’s state (liquidating dividend)’, and ‘disclosures’, respectively ²⁷. Therefore, although I have more passionate concern for accounting settings, the general terms are in principle used in this and next sections while in part both are used compatibly.

In each market, there were a single seller and three buyers. This group consisted of four subjects has been maintained throughout the periods of one experimental session²⁸. The tasks of subjects in this experiment were transactions of fictitious commodities²⁹. In each

²⁷ In consequence, the experiments have been conducted in consonance with the models of Milgrom (1980) and others. This transformation into more general words may be interpreted to be an obstacle in case of the application of experimental results to the real world. However, the more realistic the objects that we want to test in the experiments are, the further the experiments part from the empirical inspections of theories without removing the factors which the subjects may act based on outside of their monetary incentives. For example, it is physically impossible to believe that, informing the subjects that the experiment researches about bribery, tax evasion, or swindle, gives no psychological bias.

²⁸ It can be thought the experimental design, which changes the matching of seller with buyers in each period of one session, or what more, which changes to assign even the subject’s role in one experiment randomly. But it was not employed because the adoption of such setting would have got the control of experiment very intricate. So, the influences of these designs to the results are remained unknown. If it is true for the theoretical prediction that the reasonable buyer revises his/her beliefs gradually and reach the equilibrium over time, the results might be deteriorated when such settings were adopted.

²⁹ Informally, I received an indication from a practioner that some prior image against the tangible/intangible goods/service is essential to a transaction of commodity (that is, the commodity of this ‘widget’ is like this). Though I intended to get over this by the setting of distribution of possible values of the commodity, the indication was thought to be convincing. The complement ‘fictious’, therefore, was interpolated in the instruction.

period, each seller had only one commodity to offer for sale to the buyers. At the beginning of each trading period, each seller was informed of the realization of the commodity's value for sale in that period, and buyers were conscious that the seller had that knowledge. In each period and for each commodity, this value was drawn with replacement from the discrete uniform distribution described after, where all integers in that interval were equally likely. Both the seller and the buyers knew the distribution of the commodity values. Also, the seller and the buyers were told that the commodity was sold in each period without reserve. If no transaction occurred, any unsold commodities were worthless to the seller, but all the market participants were not informed of this³⁰.

The trading mechanism was a first-price sealed-bid auction institution. As the theory itself does not stipulate a specific institution, other trading mechanism can be selected. But I selected this institution because the double auction (DA) institution was somewhat problematic as argued in the section 3-3 and other institution such as the second-price sealed-bid auction institution was thought to be difficult to understand for subjects, while the second-price sealed-bid auction institution had an advantage to reveal buyers' evaluation of the commodity completely³¹. And one reason why the first-price, sealed-bid

³⁰ As denoted in the next section 5, some subjects took advantage of the characteristic in this experimental design.

³¹ Under the second-price sealed-bid auction institution, the dominant strategy for each buyer is to bid his/her true reservation price.

auction was implemented is to relax a zero profit condition, which was mentioned above.

In a main issue of this experiment is to investigate whether the theoretical prediction of full disclosures of private informations takes place in the laboratory, and if not, where the causes on the equilibrium path are. Based on such a concern, it is problematic to set a new stage that reveals the buyers' evaluation of the commodity using this trading mechanism, the first-price, sealed-bid auction (the model doesn't consider this stage). The prediction of the theory may be influenced by this new stage. However, in the theoretical model it is assumed that there is an antifraud rule, so the value of commodity reveals itself when not only a message is sended, but also in equilibrium no message is sended. Competition among the buyers drives their evaluations to be nearly equal to the price. Therefore, using the first-price, sealed-bid auction institution in the experiment does not generate inconsistency with the theory (for detailed arguments of using the sealed-bid auction in more complex settings, see the section 2 of Forsythe et al. (1989, p.219)).

4-2 Experimental designs

Two manipulations³² were conducted. One of them was the distribution of commodity's value from which nature selected. The commodity's value was randomly drawn from the

³² It is also called 'treatment'.

discrete uniform distribution either of [25,50,75,100,125,150,175] or of [25,26,...,175]³³. These two were equal in ranges and means of one hundred, but differ widely in that the numbers of possible commodity's value were 7 in one cell and 151 in the other. These reflect the argument in the section 3-3, in which the number of possible states nature select may influence on the experimental results, and will discuss particularly in the next section of the Hypotheses.

Another manipulation was related to the existence and inexistence of an antifraud rule. The existence of an antifraud rule is a critical factor for the basic model and its modification. So, given no antifraud rule, the theory losses its predictable power. While some forecasts are possible and I will dispute over that issue, experiments of the cell without an antifraud rule were conducted not to test the solid theoretical prediction but to obtain some findings about influences of no antifraud rule.

According to these two manipulations, cells design of this experiment is represented as follows.

		Cells design of the experiment	
		The number of possible states	
		7	151
An antifraud rule	Exist	Cell	cell
	Not exist	Cell	cell

³³ These number settings were arbitrary.

4-3. Conduct of experiments

Experimental markets were run at the Toyonaka campus, Osaka University on the 26th and next 27th of November in 1998. Subjects were students of Osaka University recruited from graduate and undergraduate courses, and they were manifold in their academic background³⁴. All four cells had four independent markets, and each market had one seller of a commodity and three buyers, figuring up 64 subjects.

Each market consisted of a number of repetitions of same events. Upon arrival at a classroom, subjects drew lots³⁵ at the entrance and were ushered their numbers' seats guided by assistants. A written instruction and experimental materials³⁶ within an envelope were prepared for in advance on each seat, and the subjects were cautioned not to open and look at them before indicated. There placed kitchen guards³⁷ on their desks to prevent one subject from seeing others' informations and decisions. After all the subjects

³⁴ For example, they were majoring economics, law, literature, science, medicine, and so on. In the prior papers, Forsythe et al. (1989) denoted to use undergraduate students at three different location (Carnegie-Mellon University, the University of Arizona, and the University of Iowa), and in Chow et al. (1996) there were 156 students recruited from upper level and graduate finance course, and in King and Wallin (1991a, 1995) and King (1996), Washington University business students were involved as subjects. Upon recruiting subjects, I did not ask any academic backgrounds, grades, and knowledge.

³⁵ The lots were used to assign randomly the subjects to their tasks in a particular markets.

³⁶ The instruction and the main experimental materials are available upon request from the author.

³⁷ The kitchen guard is an oil-guarding steel board using generally in the kitchen. Three directions are intercepted from other subjects by about thirty centimeters in height.

took their seats, the experimental sessions were started. At first, I took considerable time for the instruction to inform the subjects about their tasks and the rules governing trade and how their cash reward would be determined. Written instruction was given each and playbacked by a cassette recorder with a radio. At the end of the instruction, two examples were given to confirm the actual transaction flow and payoffs. A transaction in each period was as follows (the parenthetic numbers (1)-(4) correspond to the time line of the basic model in the section 2-1).

- (1) The value of its period's commodity was determined by nature from the distribution described above³⁸, and was informed only to the subject acting as a seller. The preselected value sequences differed for each market in the same session, but they were same in the cell and the cell , and in the cell and the cell ³⁹.
- (2) The seller decided whether to reveal this information to buyers (i.e., message). In this case, it meant that all three subjects acting as buyers received the same message from a seller (so, some different treatment across the buyers was not allowed). In the cell

³⁸ The sequence of commodity's values over all twenty periods had been preselected using random number generating tool of the software. See DeJong et al. (1985) for a discussion of this presequencing.

³⁹ Given the same distribution is used, it has been found that the actual value flows drowned from its distribution had some influence on the experimental results (for example, King 1996). So I changed the sequences market by market although the subjects were not able to know anything about the other market in which they were not participated. The reason why the cells with and without an antifraud rule had the same sequence was to facilitate the comparison of the results.

and the cell , the disclosure options available to the seller was either ‘disclosing the informed value truthfully’ or ‘making no disclosure’, but in the cell and the cell without antifraud rules, the former option was changed to ‘selecting one possible value and disclosing it’ and the antifraud rule was excluded according to the cell designs in this way.

(3) Receiving the seller’s message, the buyers valued the commodity to purchase in that period and tendered written bids.

(4) The highest bid among the three wined in the auction, and the winning buyer paid the amount equal to his/her bid. If plural buyers tied for the highest bid, then a dice determined who purchased its commodity.

It is the payoff of that period for a winning buyer to be the trading profit (or loss) that equaled to the commodity’s value minus the amount paid was. The payoff of a seller was equal to the bid amount received from the buyer and those of the losing buyers were zero in that period.

All three bid prices, the winning bid, the commodity’s value, and the identification of the winning buyer in that period were told to all the participants in the market at the end of each period⁴⁰.

⁴⁰ There are some design choices such as, the only winning buyer and (of course) the seller can know the highest bid, or not all three bid prices but only the highest bid is revealed publicly. The design used in this

All necessary informations, for example that period's commodity value and bids submitted etc., were informed and transmitted using B8 cards by assistants.

The transaction of commodity was repeated 20 times, which was prescribed and informed to all subjects in the instruction⁴¹. The total payoff for twenty periods (= rewards) was fixed according to the following expressions (in: ¥).

The seller: $\boxed{\text{the sum of the amount received from buyers}}$
+ $\boxed{\text{the number of period conducted}} (=20) \times 40$

The buyers: $\boxed{\text{the sum of his/her trading profit}} \times 2 + 1,000$
+ $\boxed{\text{the number of period conducted}} (=20) \times 80$

In consonance to the theory, I asked the subjects for acting to maximize the first term, but the other terms were added in. 1,000 was the initial endowment (referred to the 'budget' in the experiment due to the facility of comprehension), and it was given to the buyer because he/she was not endowed with a commodity in each period and there was positive probability to suffer the loss in the transaction. The payoffs that were related to the number of periods conducted were added in because of a zero profit condition for the buyers

experiment might have functioned to fasten the subjects' learning.

⁴¹ Letting the subjects know the terminal trading period may have an effect on the outcome of the game. Chow et al. (1996, p.140), for example, consider the potential biases of end-of-game strategic behavior. However, actually such an effect has been found. I, therefore, do not touch this problem hereafter.

as mentioned above⁴². The same reasoning applies to the treatment that the sum of the buyer's trading profit was doubled⁴³.

After the actual trading session ended, the subjects completed an evaluation forms and then questionnaires, were paid and left. Throughout the instruction and actual experiment, all participants were monitored to prevent communication with each other. Each experimental market lasted about two hours and twenty minutes. Average cash pay was ¥2,721.86, the maximum was ¥3,384 and the minimum was ¥2,249⁴⁴.

5. Hypotheses and experimental results

5-1. Hypotheses and behavioral forecasts

Hypotheses of the cells with an antifraud rule (i.e., the cell and)

The first hypothesis is directly linked with the main theme of this paper. As being posited an antifraud rule, a seller must inform the realization of its commodity's value as far as

⁴² Although the intention was quite different, Forsythe et al. (1989) gave the similar payoffs to only the buyers as commission values.

⁴³ According to these expressions, the prior expected payoffs for the subjects were, ¥2,800 for the seller and ¥2,600 for the buyer, respectively. A slight higher expected payoff for the seller was due to the result of a non-cash payment pretest, which had been conducted using undergraduate students majoring accounting on the 9th of November. Being priced very low by the subjects acting as buyers, the seller had been taken away much of its payoff. Also, for the seller, the expected pay is equal to the maximum too.

⁴⁴ Because of its design, there were not large differences among the subjects. To give incentives to involve hardly for them, it might be desirable to come out perceptive differences due to their decision-makings. In this respect, I might have to say that this is one of the intrinsic problems of these disclosure experiments.

he/she send a message. Then, the theory in the section 2-1 predicts the disclosure pattern in equilibrium as follows.

Hypothesis 1: In the cells with an antifraud rule, a seller reveals all the commodity's value.

So, $M = x_i$. When the commodity's value is the lowest, namely 25 in the setting here, the seller is indifferent between disclosing it and withholding it.

As the somewhat plausible alternative hypotheses, this paper attempts to research the convergences to other representative Bayesian Nash equilibria such as, the naive expected value model in King and Wallin (1991b), the goods news hypothesis in King and Wallin (1991a), and the naive model in Miller and Plott (1985), and so on. Concretely speaking, there are: (1) no disclosure always occurs, (2) the values more than the mean of the distribution (i.e., here 100) are only revealed by sellers, (3) disclosures of some specific values (or value) and (4) random disclosures occur.

In order to examine whether the perfect Bayesian equilibrium could be reached or not, including the relevant actions on the side of subjects acting buyers, some conditions are necessary to set. Unlike Forsythe et al. (1989), these conditions are not set as formal hypotheses. However, I will investigate properly whether the subjects acted as suggested to

the theoretical prediction or not, as argued in Forsythe et al. (1989) and Chow et al. (1996).

The second hypothesis is built on the indication of the section 3-3, implying the question marks from the reviews of prior researches. There was one of the question marks as to 'the relationship between the number of possible states and the experimental result'. It mentioned that, the results had been weakened as the numbers were increased to 8, 125, and 201, respectively, although full disclosure occurred undoubtedly when the number of possible states is three. The unraveling process predicts that the buyer narrows the set of commodity's value gradually given no disclosure. Therefore, it could be understood that it does not imply that the number of possible states influences the experimental results, but this dysfunction in the case of 8 suggests that the experimental results are less applicable to the real world. In this paper, I examine this issue to judge the possibility for future developments of these experiments by changing the number of possible commodity's values into 7 (= cell) and 151 (cell).

According to the theory, the number of possible states does not have any influences.

Hypothesis 2: About sellers' disclosure patterns, there is no difference between the cell

and the cell .

Behavioral forecasts of the cells without an antifraud rule (i.e., the cell and)

As stated in the section 4-2 of experimental design, the creation of cells without an antifraud rule is not based on any theoretical prediction. And, the argument of the basic model explained in the section 2 and its modified versions were all premised on this rule. In contrast, there seems no solid theoretical prediction about what the equilibrium of the cells without an antifraud rule is, while it is one of the hot topics in the researches of truth-telling and reputation formation. Because at present it has not been analyzed and resolved completely, given positive probability of seller's fraud reporting, how the buyer actually values the commodity after receiving the seller's report, and given the buyers' beliefs and strategies grounded on their beliefs, how a seller in fact decides a message-sending strategy. That is the reason why I made this section's title not 'hypotheses' but 'behavioral forecasts'.

However, "in practice, antifraud rules are imperfect due to the cost and complexities of enforcement (King, 1996, *Ibid.*, p.375)." So, although I realize the integrity of theoretical models whose critical bases of functioning are the existences of antifraud rules, the cells without an antifraud rule have been set up for this experiment. Thus, these cells are just exploratory cells and only designed to obtain some preliminary evidence.

The experimental researches, which was supposed that there was no antifraud rule and examined its influences are, for example, the cell B of King and Wallin (1990) which was the test of the basic model with no antifraud rule and the NC session in King (1996) which

investigated in the setting with no antifraud rule and no cost telling lies. The former was the setting that the number of possible values was three and the traded asset was a lottery ticket as denoted earlier and the latter was that experimenter paid for precisions in the prediction itself of subjects., so both settings are different from that of this experiment.

Regarding a taste of the behavioral predictions, they explained as follows. The buyer anticipates, in the single period game, a seller sends a false message about commodity's value because the buyer is not able to impose a penalty on lying itself. Since the message is not informative, the buyers will ignore the seller's message and value the commodity at the mean of the distribution m , i.e., 100 here, because of competition among buyers. Given that the buyers are expected to ignore the message, the seller's best response is uncertain. But if there is positive probability which the buyer might believe a seller's message, the seller might overstate the value nature selected⁴⁵. In the finitely repeated game, this result is regarded as one of plausible ones using backward induction. For more detailed discussions about the seller's incentive to deviate from truthful reporting and the mechanism that caused to occur the equilibrium of seller's truthful disclosure by positing some additional assumptions when there is no antifraud rule, see King and Wallin (1990)

⁴⁵ On the contrary, in this situation, it may not be advantageous to a seller to under-state, that is, to send a message that the commodity value is below the value nature selected. Because it is not reasonable for the buyer to bid above 100 when the commodity value is revealed just 100, even if the buyer ignores the seller's message.

and King (1996).

5-2. Results and data analyses

In this section, I analyze the experimental data and report the results. In carrying out statistical tests, plural (more than one) observations from each experiment will be used. Therefore, there may be serial correlation, and conclusions should be deliberated with this in mind. Also, I must point out there are only a little data of 80 (= each cell had four market and each market had 20 periods)⁴⁶.

In the analyses of cells with an antifraud rule, the data from the latter half mentioned frequently, as well as the data of all 20 periods. The reason why I will deal with such an additional data is that the subjects are assumed to establish their consistent message-sending/bidding behavioral rules in the course of repeated trials. In this experiment, the question 3 and 7 of the post-experiment questionnaire asked all subjects acting as either sellers or buyers: 'How many periods did you take to establish the way of reacting to opponents' behaviors approximately?' Their answers to the post-experiment questionnaire suggested that the almost all subjects had established their consistent approaches by the end of period 10. Thus, I write the data from the latter half in a separate with the intention of the analysis based on results that were arisen after all market participants fixed their

behavioral rules. Whereas the subjects acting as buyer decided how to react by five period at latest (some already had decided it at the 2nd period!), the subjects acting as sellers were clearly slow at deciding, although these results might not be surprising.

Results from the cells with an antifraud rule (i.e., the cell and)

Table 1: Proportions of disclosures

	All 20 periods	The latter half (Period 11 ~
Cell (7)*	68.8% (= 55/80)	77.5% (= 31/40)
Cell (151)*	67.5% (= 54/80)	75.0% (= 30/40)

* Parentheses represent the number of possible value.

Table 1 represents the proportions of disclosures in each cell (calculations are given in parentheses). On average, in the cell and sellers sended messages on 68.8 percent and 67.5 percent for all 20 periods, and the proportions of the cell and has increased to 77.5 percent and 75.0 percent for the latter half, respectively. However, these differences between all the periods and the latter half are not statistically significant ($z = 1.216$, $p > 0.1$ for the cell , and $z = 1.026$, $p > 0.15$ for the cell). Using a test of proportions, even if the data from the latter half are employed, these proportion are significantly below 1.0 ($z = 3.41$ for the cell and $z = 3.65$ for the cell , both $p < 0.01$). Therefore, it would be impossible to conclude that full disclosures were occurred. However, it is here necessary to demonstrate the limitation on statistical test, which is derived from both the small samples of 40 and the fact that a single non-disclosure when

⁴⁶ Experimental datas are available upon request from the author.

disclosure is theoretically predicted causes rejection of a 0 or 100 percent base-rate hypothesis⁴⁷.

The basic model of disclosure does not always predict the occurrence of full disclosure. For sellers, the worst information (the lowest commodity's value) is indifferent between to disclose and not to disclose. To argue the Hypothesis 1, I examined the proportions of disclosures both in each possible value of commodity (the cell) and in each range of the commodity's values (the cell). The results are presented in Figure 1-1 (the cell) and Figure 1-2 (the cell). Also, in Figure 1-2 of the cell , as the number of possible values were 151, I divided them into 5 equal ranges arbitrarily. That is, the five range are, 'the neutral news' which is from 85 to 115 and includes the mean of distribution 100, 'the good news' and 'the very good news' which are beyond 'the neutral news' and from 115 to 145 and from 145 to 175, respectively and 'the bad news' and 'the very bad news' which are below 'the neutral news' and is from 55 to 85 and from 25 to 55, respectively. Three values that just dropped on the border are not depicted in the Figure 1-2. These two figures seem to provide the obvious support for Hypothesis. Except for both the realizations of 25 when the number of possible value was 7 and the range [25,...,55] (i.e., 'the very bad news') when it

⁴⁷ For example, in order not to reject the null hypothesis that the proportion of disclosures is 100 percent at significant level of 0.05, that is, to show that it is impossible to conclude that full disclosures are not occurred, more than 95 percent (i.e., 38/40) disclosure must be made (then $z = 1.45$, $p > 0.07$).

was 151, in the latter half of the experimental sessions, disclosures were occurred in the proportions of 31/32 (the cell) and 30/34 (the cell ⁴⁸). In summary, although a seller was indifferent as to disclose of the realization of the lowest possible value, it can be concluded that he/she generally moved toward full disclosure. Other Bayesian Nash equilibriums as alternative hypotheses cannot explain the results here.

Now I will conduct some further analyses which focus on whether the subjects behaved in ways consistent with the basic model or not.

The theory assumes that, given no disclosure, buyers bid the mean of distribution at first and gradually revise them downward over time. When the subjects acting as sellers had sended no messages at the first time⁴⁹, the averages of the buyers' bids were 35.83 for the cell and 37.25 for the cell . These values are significantly different from the mean of

⁴⁸ All four non-disclosures here were happened in the range of commodity's value [85, ..., 115], which is named 'the neutral news'. And 3 in 4 were due to a single subject acting as a seller in one market. She replied to the question 7 of the post-experiment questionnaire that she randomly made her disclosure decisions to intend the disturbance of market because she had been suffering the low payoffs from too much 'solid' bidding behaviors by the buyers. However such her strategy drove her to lower her payoffs less and less, and she replied to the next question 8, which was asked what the payoff-maximizing strategy had been she thought, that 'to disclose all the commodity's values or not to disclose anything'. There is an opinion that only experimental datas can tell its results. So I do not enter this issue further, but at last I denote as an interesting fact that these non-disclosure behaviors were strategic outcomes and she had reached both two extreme Bayesian Nash equilibrium introduced in the section 2.

⁴⁹ In all of eight markets with an antifraud rule, the case which sellers had sended no message occurred

distribution 100 ($t = 8.488$ for the cell and $t = 16.62$ for cell , both $p < 0.0001$).

However, in the cell , the average bid is significantly different from 25 ($t = 3.25$, $p < 0.005$), which is the lowest possible value. This result shows that the buyers could have appreciated that making on disclosure was synonymous with possession of bad news.

From the unraveling process referred in the section 2, it would be interesting to examine further as follows. For subjects acting as sellers,

(a) Non-disclosures involving commodity's value greater than the values he once had disclosed,

(b) Disclosures involving commodity's values less than the previous highest bid price given no disclosure,

(c) Non-disclosures involving the commodity's value greater than the previous highest bid price given no disclosure,

and for those acting as buyers,

(d) To bid above the previous lowest commodity's value in the case of no disclosure, and more severely,

(e) To bid above the average of 25 and the previous lowest commodity's value given no message⁵⁰.

by the 4th period at latest.

⁵⁰ Explaining (c), if a seller obtained the bid price of 60 when he/she had sended no message lately, he/she

These behavioral patterns deviating from the unraveling process are exhibited in Table 2.

The number of ‘total periods’ corresponds to the seller’s behavior in each market, and depends on the first non-disclosure, i.e., the number is 18 (= 20 - 2) if a seller didn’t disclose in the 2nd period.

Table 2: Behaviors deviating from the unravelling process

	Cell				Cell			
	Market 1	Market 2	Market 3	Market 4	Market 1	Market 2	Market 3	Market 4
(a)	1	0	0	4	0	4	3	2
(b)	1	0	0	0	0	2	0	2
(c)	3	2	0	3	4	4	4	4
(d)	4	0	0	7	0	5	0	0
(e)	11	0	0	22	3	15	7	8
Total periods	18	19	17	16	18	17	16	18

On equal terms with Chow et al. (1996), calculating the proportions of the number of deviating times to the possible largest unraveling processes, those are 20.86 percent (= 29/139) for the sellers and 15.83 percent (= 66/(139×3)) for the buyers. In view of the fact the subjects acting as buyers deviated these in the proportions of about 55 percent in Chow et al. (1996), it might to be said that somewhat contractive results are due to the existence of the buyers who were able to take their actions consistent with the theory. The subjects acting as buyers were able to make game-theoretic reasoning sufficiently, and the subjects acting as sellers unwillingly made voluntary disclosures of the commodities’ values in response to the buyers’ behaviors.

The results support Hypothesis 1. In the cells with an antifraud rule, the equilibrium

is thought to be unreasonable not to disclose the commodity’s value above 60, for example 100. He/she will

seemed to be one of full disclosure, although there are some methodological limitations as mentioned. In general, sellers disclosed all the realization of commodity's value but those of the lowest one, and buyers were able to adjust such sellers' behaviors.

Hypothesis 2 was motivated from the reviews of prior experimental researches to examine the relation between the number of possible commodity's values and the experimental results. Table 1 shows that both for all 20 periods (from 68.8 percent to 67.5 percent) and for the latter half (from 77.5 percent to 75.0 percent), proportions of disclosures were not significantly different between the cell and the cell ($\chi^2 = 0.029$ and 0.069).

Therefore, Hypothesis 2 cannot be rejected. The number of possible states had, in the settings of this experiment, little influence on the results. It is unclear why such an inconsistent result between the prior researches and this paper happened.

Results from the cells without an antifraud rule (the cell and the cell)

As stated in the section 5-1, there is no solid theoretical prediction in the cells without an antifraud rule. Therefore, what happened in these cells is reported first, and next, I will attempt to compare them with the cells with an antifraud rule.

Figures 2 (Figure 2-1 and 2-2) represent 'the commodity's value vs. message' in the cells without an antifraud rule. Figure 2-1 displays the result of the cell and Figure 2-2

get nearly 100 (>60) if the commodity's value is revealed.

displays that of the cell , graphically depicting what message the seller sended in response to the commodity's value nature had selected. For the cell , the third dimension 'frequency' is set up additionally because each coordinate potentially has plural observations. For example, if a seller sended a message of 100 in one market period when the commodity's value was 100 (i.e., he/she disclosed truthfully), this corresponds to coordinate (100, 100) and Figure 21 tells us there was one case like this. Given no antifraud rule, the seller was able to send a message of the value other than its real realization, he/she had sometimes informed the buyers of 75, 125, and so on when the realization was 100. For the cell , Figure 2-2 is easier to understand, and the diagonal line presents the cases which the commodities' value were equal to the messages, that is, truthfully disclosures occurred, and the points upper left-hand of the diagonal line represent the cases where the commodities' value were less the messages, i.e., overdisclosures occurred, and the points lower light-hand represent those where the commodities' values were more than the messages, i.e., underdisclosures occurred.

Figures 2, in general, show the disclosure of value is either equal to or more than the realization, namely truthful disclosures or overdisclosures. Though underdisclosures might be disadvantageous to the sellers, King (1996) reports that sellers under-reported 11

percent of the time in his NC sessions, whereas there was few under-report⁵¹. Clearly, the experimental results are fairly consistent with the informal behavioral prediction that maintains overdisclosures occur generally given no antifraud rule. Also, this tendency towards overdisclosures seems to strengthen as the number of possible states increased. To compare with the cell in which only one underdisclosure in 66 message sending opportunities occurred, 6 underdisclosures and 29 truthful disclosures in 62 opportunities occurred in the cell . In the cells without an antifraud rule, two possible seller's behaviors were non-disclosure and 'choosing one of possible commodity's values'. Thus , in the cell , sellers were forced to announce one of possible values and were not allowed to send messages of the values other than possible commodity's value (i.e., announcing 105 when it is 100). There were therefore only 8 message-sending patterns including no disclosure in the cell . If underdisclosure is intuitively unreasonable, a seller's option of sending message becomes smaller and smaller as the higher realization of commodity's values is selected by nature. Because of this small set from which the seller was able to send messages, these results may be caused.

Given no antifraud rule, truthful disclosures of the commodities' values are difficult to take place in general, and have a tendency toward less unfavorable as the prior uncertainty of commodity's value increase. As regards this issue, I am interested in examined how the

⁵¹ In King (1996), the number of possible states was 101.

buyers responded to such sellers' behavior.

Table 3: Trading profit (= the commodity's value minus the purchasing price) in all 4 cells

		Av.	s	Profit	Loss			Av.	s	Profit	Loss
Cell	Disclosure	6.45	8.19	66	12	Cell	Disclosure	18.95	48.58	51	28
	No Disclosure	6.84	37.87				No Disclosure	2.22	55.96		
Cell	Disclosure	8.78	9.13	71	4	Cell	Disclosure	12.92	33.23	56	23
	No Disclosure	24.58	27.77				No Disclosure	1.57	36.05		

(Note) Column 'Profit' and 'Loss' represent its frequency.

Table 3 displays averages (column 'Av.') and standard deviation (column 's') for the buyers' trading profits and losses (using data from all periods), and shows how many times the buyers made trading profits (column 'Profit') or suffered the losses (column 'Loss') among all 80 trading periods in all 4 cells⁵². Regardless both of the cells and of the existence or inexistence of disclosures, the buyers made profits from trades in average (all Av.>0). However, the amounts and standard deviations have considerable differences among every cell. In the cells with an antifraud rule (the cells and), the buyers gained more profit in the case of non-disclosure. In contrast, the buyers gained much more profits when making disclosures in the cells without an antifraud rule (the cells and). Comparing the cells with an antifraud rule to the cells without it, both the proportion suffering losses (31.9 percent = 51/160) and the standard deviations of trading profits in the cells without an antifraud rule are larger than those (10 percent = 16/160) in another cells. This may means that, an antifraud rule plays the critical role in both the avoidance of losses from the trade and the belittlement of variances in trading profits. Also, the larger the number of

⁵² The existence of some cases that the commodity's value equaled bid price (i.e., trading profit/loss was

possible commodity's value, the smaller the number and amount of trading losses. Taking these all into considerations, it may be concluded that the buyers might have conducted deliberately in order to avoid losses as the complexity of their conjectures at the moves had increased.

In order to investigate the influence of an antifraud rule further, it is significant to discuss the buyers' responses to sellers' message. Figure 3 (Figure 3-1 and 3-2) shows the price (i.e., the highest bid)⁵³ versus messages and displays graphically the results of regressions of the price on message as the independent variable. Figure 3-1 and Figure 3-2 represent the outcomes with and without an antifraud rule, respectively.

When with an antifraud rule, a slope of the regression was 0.9672, an intercept was -3.6192, and this fitted model explained virtually all variances ($R^2 = 0.955$).

On the contrary, the result of the regression was widely different in the cells without an antifraud rule. The explanatory power of the model without an antifraud rule was considerably less ($R^2 = 0.4918$). However one of the behavioral prediction here was that seller's message would be completely ignored. This was not the case. The slope was 0.4734 and the intercept was 30.207. That is, the buyers took the sellers' message into

zero) prevents the total times from being 80.

⁵³ It can be thought as the measure which is able to infer the buyers' responses other indexes such as all bids, average bid or median bid, and so on. However, I used the price as a substitute for those because of the practice of the first-price sealed-bid auction in this experiment.

consideration to some extent, and the tendency that a higher message generated a higher price is at least admitted.

6. Summary and concluding remarks

While it is necessary to assume an antifraud rule as one of critical factors, the prediction of full disclosure seems to be correct as the basic model suggests. Sellers (i.e., managers in accounting context) were not indifferent between disclosures of the worst news and non-disclosures of those, but they generally moved to disclose their private informations completely. Unlike prior researches, in the setting of this experiment, the number of possible states (i.e., commodity's values or liquidating dividends) had little influence on the results. The causes for this divergence between the results from prior researches and the experimental result in this paper remain unresolved. The reason why the theoretical prediction was generally supported is mainly due to the existence of the buyers (i.e., investors), who were able to appreciate at earlier period that the commodity's value (liquidating dividend) was lowest when a seller (a manager) made no disclosure. I can say, such buyers urged sellers to make full disclosures.

In the cells without an antifraud rule, overdisclosures, that are the case where a seller (a manager) informs the commodity's value (liquidating dividend) beyond its realization, occurred in general. Furthermore, such tendency become outstanding as the number of

possible states increased. On the contrary, underdisclosures were of rare occurrence (particularly in the cell), and this is fairly different from King (1996), which reports that sellers under-reported 11 percent of the time in his NC sessions.

While buyers (investors) valued the commodity (liquidating dividend) and bid based on only seller's (manager's) disclosure in the cells with an antifraud rule, the buyers (investors) discounted fairly the value disclosed by the sellers (managers) in the cells without it, though it was not as perfect as predicted. Though the buyers (investors), in average, did not suffer trading losses, but there were obviously more periods of losses in the cells without an antifraud rule than in the cells with it.

These are main results in this paper. The attempt to find some linkage between these experimental results and the naturally occurring markets can be severely limited at present. The reason is that the model tested in this experiment was too simple and a lot of factors in which will be necessary to apply to the real world were omitted and not virtually considered⁵⁴. Also, as pointed out repeatedly in the chapter 1 of Kagel and Roth (1995), not one single experiment but a series of experiments can only explain something more about the real world. But, it is true that the results of this experiment suggest some possibility of further sophisticated experiments on this realm that are motivated from the brand-new modified models grounded on the real world. From now on, it is necessary to grasp the

situation of real world (particularly, Japan), to comprehend the theoretical models entirely and to increase their tractability as much as possible, in order to understand managers' incentives to voluntary disclosure more precisely.

Like all of the other experimental researches, this experiment also continually have to be questioned about, (1) whether I had given some bias to the subjects and led to some arbitrary result or not throughout all the phases of experiment, and (2) whether the design was suitable for the experimental test of the basic model or not. Also, conducts of experiment taught me how difficult to bring out the subjects' incentives to involve hardly (by responses to the post-experiment questionnaires and postures in the laboratory). The design that the cash payment depends more directly on the quality of subject's decision making⁵⁵, and producing the experimental task with more challenge seem to be strongly requested. These all may suggest some modifications on the design of this experiment.

⁵⁴ For further discussions of this issue, see King (1991, p.194).

⁵⁵ On a parallel with the trade of lottery ticket in King (1991), if the setting is changed that the experiment task of an investor is making some investment decision to one project, nature selects its probability of success, and a manager is informed and decides to disclose this probability or not, this problem may be mitigated in some degree. However such a setting needs to be set up a new experimental session, in which asks subjects their attitudes towards risk directly (that is, for example, 'How much do you invest a project which brings you in one return of ¥1,000 with probability 50 percent?'). Allowing subjects transact plural commodities in each period may submit one of the solutions for this problem, such as in Forsythe et al. (1989).

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Figures

Figure 1-1. The proportion of disclosures for Cell

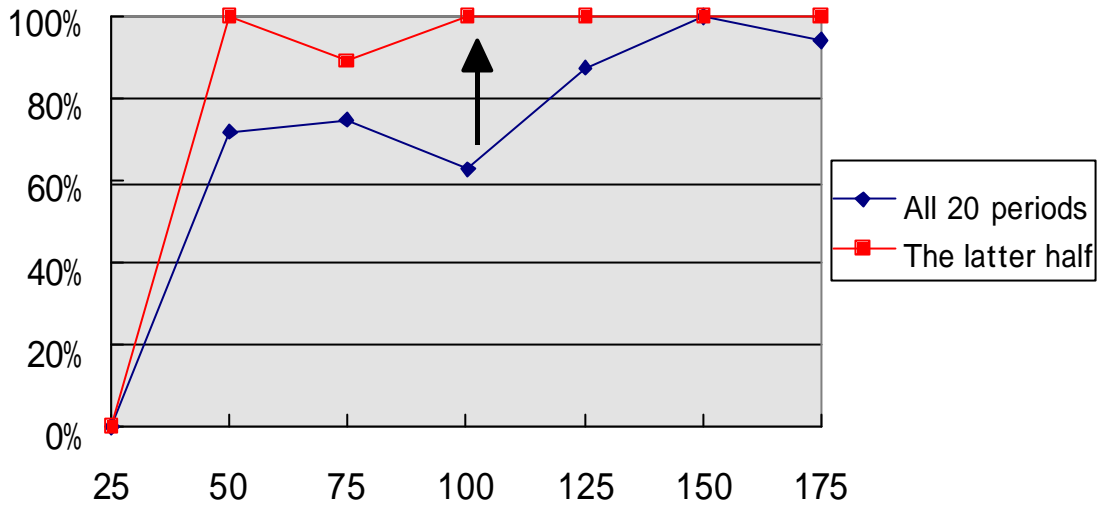


Figure 1-2. The proportion of disclosures for Cell

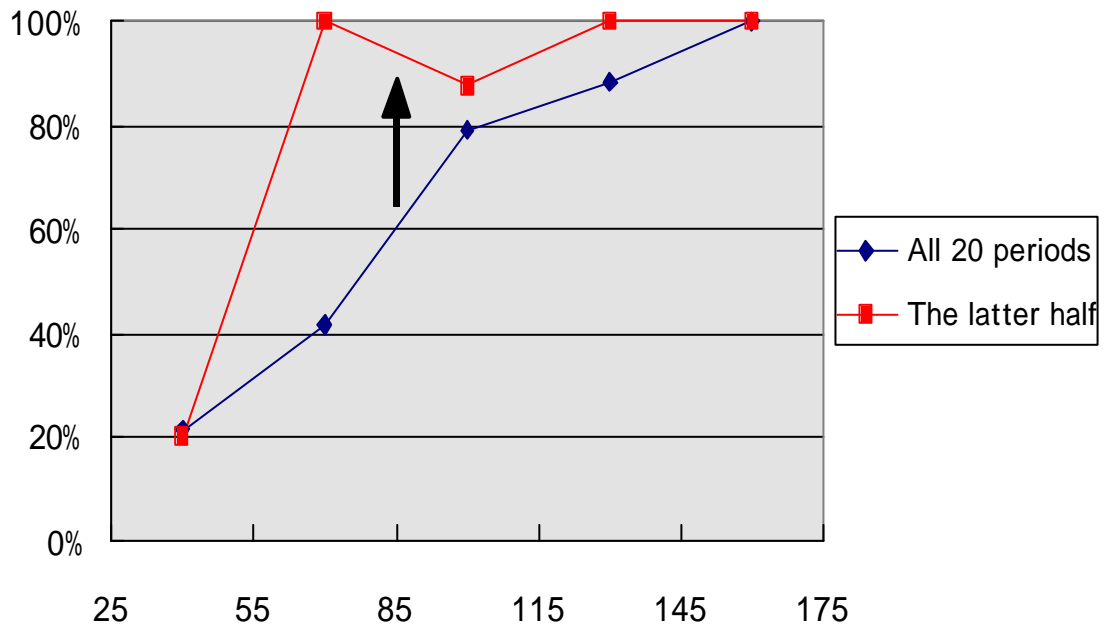


Figure 2-1. Commodity's value vs. message (Cell)

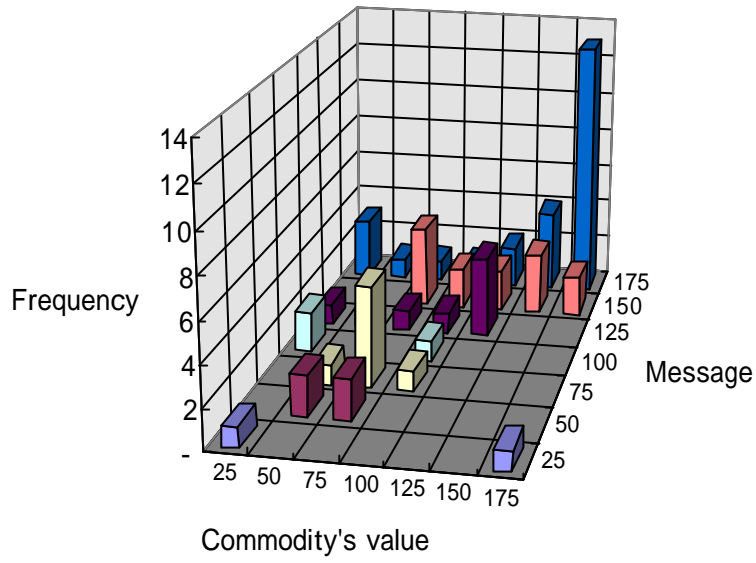


Figure 2-2. Commodity's value vs. Message (Cell)

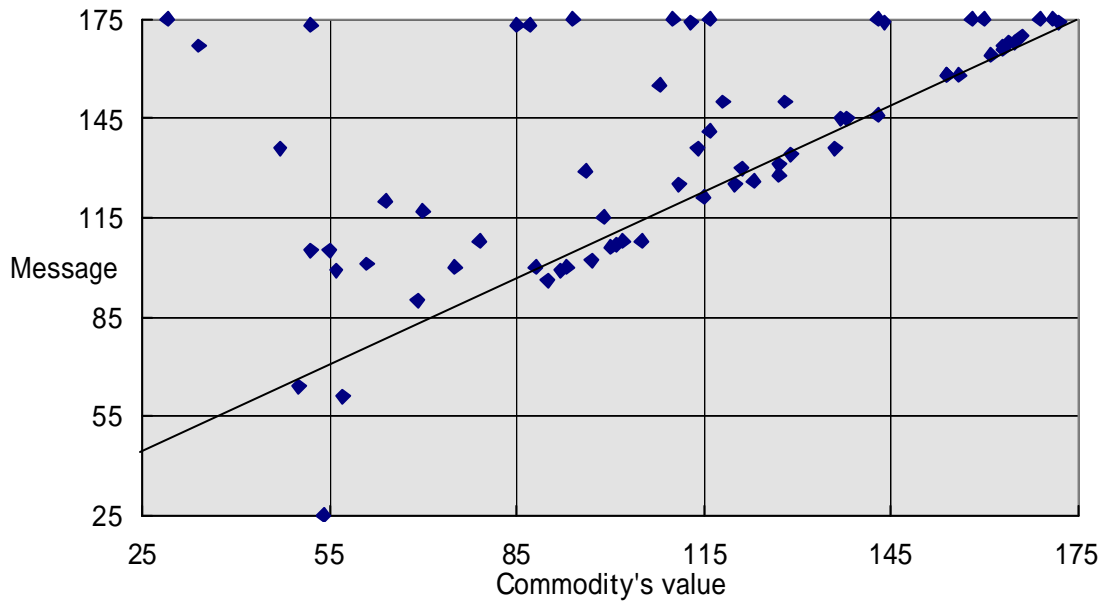


Figure 3-1. Cells with an antifraud rule (Cell and)

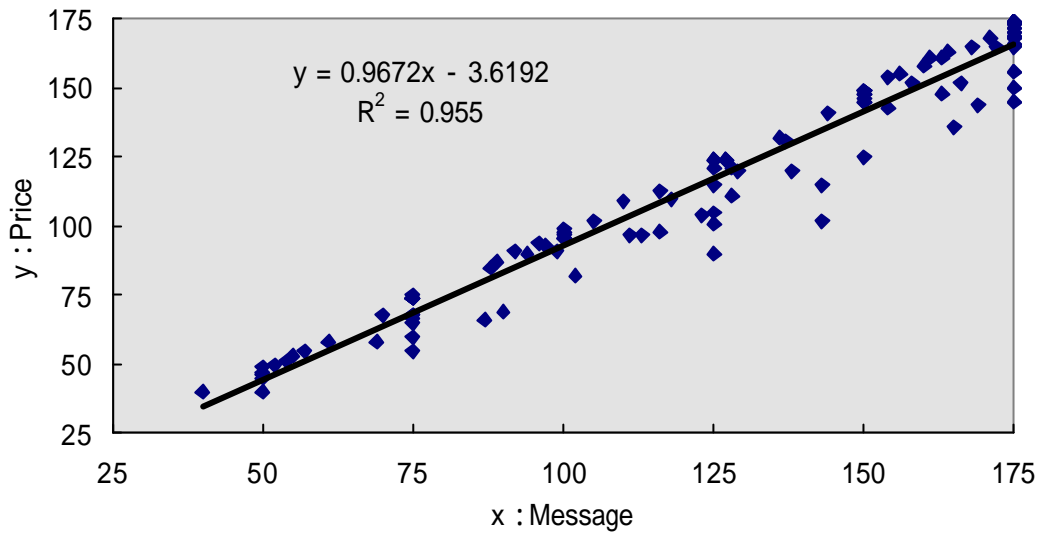


Figure 3-2. Cells without an antifraud rule (Cell and)

