ANNALS OF ECONOMICS AND FINANCE **1**, 129–143 (2006)

The Impact of Insider Trading on the Secondary Market with Order-Driven System*

Jiang Xianfeng

School of Finance, Dongbei University of Finance and Economics, Dalian, China
E-mail: spirits77@263.net

and

Shi Yongdong

Research Center for Applied Finance, Dongbei University, Dalian, China
E-mail: ydshi@263.net

Combining Leland (1992), Madhavan (1992) and Repullo (1999) and under the framework of Rational Expectation Equilibrium (REE), the paper analyzes the impact of insider trading on the secondary market with order-driven system. We show that when insider trading is allowed, the average price will not change and there is a positive correlation between the future price and the current price. The volatility and liquidity change on uncertain directions with insider trading. With or without insider trading, the price will be efficient in some special cases. The insider is benefited by insider trading, while, the outsider and liquidity trader may be benefited or hurt by insider trading.

Key Words: Insider Trading; Secondary Market; Order-Driven System.
JEL Classification Numbers: C68, C73, D60, D81, G14.

1. INTRODUCTION

The United State said no to insider trading in the Securities Exchange Act of 1934 for the first time. From then on, United Kingdom, France, Germany, China and other countries established security laws against in-

*The first author thanks the grateful help from professor Feng Jinghai, Dalian University of Technology. We thank the financial support from the Fok Ying Tung Education Foundation (No. 81078) and the 8^{th} Shanghai Stock Exchange joint research program. The authors retain all responsibility.

1529-7373/2006

sider trading[1]. People seem to be prone to ban insider trading. But until the end of 1998, some countries, especially the emerging markets, such as Jordan, Iran, Zimbabwe, etc., haven't such laws. Do these countries welcome insider trading? Clearly, different people hold different attitudes to insider trading.

Insider trading is a heated issue not only in practices, but also in research of laws, economics, finance, etc.. The issue can be divided into two folds: pros and cons. The pros are proponents of unregulated insider trading. The pros justify that insider trading enables prices to reflect information more accurately, which can enhance the overall efficiency of security market. The pros also think insider trading has no side effect on market liquidity because the investors in public market trade independent of the existence (or non-existence) of insider trading (Carney, 1987).

The cons are the opponents of unregulated insider trading. The first reason is that the market with insider trading is "unfair". The insiders own more information than the outsiders. So, the other investors are reluctant to trade. This leads to the second reason that the market liquidity will be lower with insider trading. The insiders may trade aggressively with their privileged information, which makes the security market more volatile. This is the third reason.

In order to assess the validity of the arguments on insider trading, Leland (1992) establishes a REE model. When insider trading is allowed, (i) stock price will be higher on average; (ii) markets are less liquid and (iii) insiders will be benefited but outsiders and liquidity traders will be hurt. In reality, the factors favoring prohibiting insider trading is identified.

In Leland's model, the insider can accurately observe the future price of the stock and so that he is risk neutral. The supplier of the stock has no market power in the price. Leland also mainly cared about the primary market. These may not be robust. So, Repullo (1999) extends Leland's model from these aspects. Following Grossman and Stiglitz (1980), Repullo assumes that the insider observes the realization of a random variable and a noise signal of the future price. When the noise is zero, it's the same as Leland's. When the insider is risk neutral, the average price doesn't change even when insider trading is not restricted. This is also the fact in the case that the supplier has market power. In the secondary market, the price neither change.

While, in both Leland's and Repullo's models, the supply are the aggregate stocks in the market. This may not be the case in the secondary market, because not all stocks are traded. The situation in the secondary market can be described more appropriate by the market clearing rule with actual trading stocks, which is the main character of the order-driven sys-

[1]Data in this paragraph comes from Bhattacharya and Daouk (2002).

tem (Madhavan, 1992). And this paper is devoted to the effect of insider trading on the secondary market with order-driven system in this way.

In the order-driven system, the traders submit orders to an exchange for execution by floor traders or dealers. It's different from a quote-driven system in some aspects, most of which is that the transaction price is not known at the order submission on the order-driven system. Madhavan shows that the rule of market clearing can well demonstrate the pricing process with true demand and supply. Another aspect of order-driven system is that there may be no market maker as in quote-driven system. While, most of the previous literatures focused on the quote-driven system (Kyle, 1985; Glosten, 1989; etc.).

Jain and Mirman (2002) show that the market structure matters in consideration of the effect of insider trading on economy. When the insider chooses price rather than output, it increases the price rather than output. When he chooses the output, the output will increase, but by less than that in the case of insider choosing price. Because of the difference of these two trading systems, we consider different market structure from the previous literatures. Our results should not be completely the same as the previous, which also should further the research of insider trading. From this aspect, this paper focuses in the market theory of insider trading (Beney, 1999).

When we analyze the impact of insider trading on the secondary market with order-driven system, we get the result: (i) When insider trading is allowed, the current price incorporates in some insider information. This creates a positive correlation between the current price and the future price. But the average price doesn't change. (ii) Insider trading has some impact on the volatility and liquidity of the current price. But the impact is not clear. (iii) The price efficiency turns up in some special cases. (iv) Naturally, the insider will be benefited by insider trading. As for outsiders and liquidity traders, their welfare may be higher or lower with insider trading.

The rest of the paper proceeds as follows. In section 2, we combine framework of Leland, Repullo and Madhavan and give a model and get the equilibrium with and without insider trading. In section 3, we compare the characteristics of the different equilibrium price and examine the price efficiency with and without insider trading. We also compare the welfare of participants by mean-variance utility function. Section 4 discusses some related cases. Section 5 gives the conclusion.

2. THE MODEL

We consider a two-time economy ($t = 0, 1$). There are two assets: risk asset of stock and risk free asset. The risk free asset's net return is normalized to zero and the risk asset's gross return, the future price, is $\nu \sim N(\overline{\nu}, \sigma_\nu^2)$.

There are three categories of participants: a single insider (or cartel of investors), outsiders and liquidity traders. They are all risk aversion with the coefficient of R $(R > 0)$[2]. The demand or supply of trading volume of insider, outsider and liquidity trader are d_I, d_O, d_L[3] respectively. The insider learns about the future price of the risk asset. But, there may be some noise in the market in the insider's knowledge. So, following Grossman and Stiglitz (1980), Repullo (1999), we assume the insider observes the realization of a random variable, θ, so that $\nu = \theta + \varepsilon$, where, ε is the noise. We assume that $\theta \sim N(\overline{\nu}, \sigma_\theta^2), \varepsilon \sim N(0, \sigma_\varepsilon^2)$, $\sigma_\theta^2 = \sigma_\nu^2 - \sigma_\varepsilon^2$, and θ and ε are independent. We also assume $\nu|\theta \sim N(\theta, \sigma_\varepsilon^2)$. The insider can deduce the liquidity trading from the current price. The current price is a REE price as in Leland (1992) with the form of

$$p = a + \beta(d_I + d_L). \tag{1}$$

Where, a and β are constant and β is nonnegative. The outsiders have no information about the future price. He knows the REE price formulation and tries to postulate the future price by the REE price function. But he cannot distinguish the insider's trading from liquidity traders' trading. The liquidity traders trade for exogenous reasons and trade randomly and $d_L \sim N(0, \sigma_L^2)$. The final wealth of each participant is $w_J = (\nu - p)d_J$[4]. Each participant's utility is $U_J = \exp(-Rw_J)$. The REE fits the Bayes-Nash equilibrium.

Definition 2.1. A Bayes-Nash equilibrium consists of a vector of strategy function $\overline{d}$ and a price p^*, such that:

(a) $d_I(p^*) + d_L(p^*) + d_O(p^*) = 0.$ (2)

(b) $d_J(p^*) \in \arg\max_{d_J} E(u_J(p^*, d_J)|\Phi_J, \overline{d_{-J}}).$ (3)

Condition (a) requires that market clears in equilibrium. Condition (b) requires that the strategy of trader J maximizes his expected utility given the $\overline{d_{-J}}$ equilibrium price and strategies of other agents, the . In the following analysis, we follow Leland (1992), Repullo (1999), Grossman and Stiglitz (1980) and assume both $w_J|\Phi_J$ and $\overline{d_{-J}}$ are normal distribution. Then condition (b) is also equivalent to that

(b') $d_J(p^*) \in \arg\max_{d_J} E(w_J|\Phi_J, \overline{d_{-J}}) - \frac{R}{2}\mathrm{var}(w_J|\Phi_J, \overline{d_{-J}}).$ (3')

[2]When $R = 0$, the participants is risk neutral. This doesn't change the nature of the model and is discussed in the section 4.

[3]Let $J = I, O, L$. I denotes the insider trader. O denotes the outsider and L denotes the liquidity trader. When $d_J > 0$, the trader J purchases shares and the trading is demand. When $d_J < 0$, the trader J sells or sells short shares and the trading is supply. When it is zero, the trader doesn't trade.

[4]As we show in the behind, we can consider the cost of the liquidity trader instead of wealth because he randomly trades with externally reasons.

We use the formulation in (3') to measure the participants' preference, which means the participants have mean-variance preference.

PROPOSITION 1. *Under the above assumptions, there exists an equilibrium price when insider trading is permitted:*

$$p = \alpha + \beta(d_I + d_L) = A + B\theta + Cd_L. \tag{4}$$

Where, $A = \frac{\alpha(R\sigma_\varepsilon^2+\beta)}{R\sigma^2\varepsilon+2\beta}$, $B = \frac{\beta}{R\sigma_\varepsilon^2+\beta}$, $C = \frac{\beta(R\sigma_\nu^2+\beta)}{R\sigma_\varepsilon^2+2\beta}$. β *is the real solution to the nonlinear equation:* $\beta = \frac{RB(\sigma_\nu^2 - k\sigma_\theta^2)}{B-K}$, *where* $K = \frac{B^2\sigma_\theta^2}{B^2\sigma_\theta^2+C^2\sigma_L^2}$. *When insider trading is not permitted, there also exists an equilibrium price:*

$$p' = \overline{\nu} + R\sigma_L^2 d_L. \tag{5}$$

Proof. When insider trading is allowed, insider's final wealth is

$$w_I = (\nu - p)d_I. \tag{6}$$

Insider chooses d_I to maximize his utility based on his information set. Following Repullo (1999), this means

$$d_I \in \arg\max E(w_I|\theta) - \frac{R}{2}\mathrm{var}(w_I|\theta). \tag{7}$$

So, we get

$$d_I = \frac{\theta - p}{R\sigma_\varepsilon^2 + \beta}. \tag{8}$$

Substituting (8) into the REE price function (1) gives the same form of p on θ, d_L in the second equality of (4).

The outsiders cannot observe the information about the future price θ, but they can observe the current price and recognize that (4) as well as (1) describes the REE price function. So,

$$d_O \in \arg\max E(w_O|p) - \frac{R}{2}\mathrm{var}(w_O|p). \tag{9}$$

From (4), we get the outsider's demand or supply

$$d_O = \frac{E(\nu|p) - p}{R\mathrm{var}(\nu|p)}. \tag{10}$$

We assume $\nu|p$ is normal distribution as Leland and Repullo. The conditional expectation and variance of ν on p is

$$E(\nu|p) = \overline{\nu} + \frac{k}{B}[p - (A + B\overline{\nu})]. \tag{11}$$

$$\mathrm{var}(\nu|p) = \sigma_\nu^2 - k\sigma_\theta^2. \tag{12}$$

Substituting (11), (12) into (10) and making the sum of d_I, d_O, d_L to zero leads to

$$p = \frac{[B\overline{\nu} - k(A + B\overline{\nu})] + RB(\sigma_\nu^2 - k\sigma_\theta^2)(d_I + d_L}{B - k}. \tag{13}$$

Equaling the constant and coefficient of $(d_I + d_L)$ to those in REE price function in (1) leads to the formulas of A, B, C in proposition 1.

When insider trading is prohibited, the insider doesn't trade and d_I is zero. The REE price function doesn't incorporate in the insider information. Thus, the outsider will choose d_O to maximize his utility with the unconditional expectation and variance. It means

$$d'_O \in \arg\max E(w'_O) - \mathrm{var}(w'_O). \tag{14}$$

It follows

$$d'_O = \frac{\overline{\nu} - p'}{R\sigma_\nu^2}. \tag{15}$$

Using the similar logic above, it leads to the second case in proposition 1. ▌

We can give some intuitions to the REE price function with and without insider trading in proposition 1. When insider trading is permitted, the insider observes the realization of the future price of the risk asset. His trading will be dependent on this information. So, d_I in REE price function (1) can be replaced with θ in (4). When he observes a high realization, $\theta > p$, he buys stocks at the current price and this trading forms demand. From (8), it is the fact that $d_I > 0$. When he observes a low realization, $\theta < p$, he sells or sells short shares at the current price and this trading forms supply. From (8), $d_I < 0$. When he observes no change between the future price and the current price, he doesn't make transaction. When insider trading is restricted, the insider information will not enter the REE price function. This is the case of (5). The current price is determined only by the unconditional expectation of the future price and the liquidity trading.

3. COMPARISONS OF CHARACTERISTICS OF PRICE, WELFARE WITH AND WITHOUT INSIDER TRADING

After obtaining the equilibrium price, we can compare the characteristics of REE price and welfare of different participants on the markets with and without insider trading. Although it is difficult to get a direct comparisons because there are too many parameters in the REE price function with insider trading, we can consider a special case that there is no noise on the future price for the insider, which means $\varepsilon = 0$ and $\sigma_\varepsilon^2 = 0$. In this case, we get $\alpha = \overline{\nu}$, $\beta = \frac{R\sigma_\theta^2\sigma_L + \sigma_\theta\sqrt{R^2\sigma_\theta^2\sigma_L^2+4}}{2\sigma_L} > R\sigma_\theta^2$ and $A = \frac{\alpha}{2}, B = \frac{1}{2}, C = \frac{\beta}{2}$. The price function with insider in (4) can be rewritten as

$$p = \frac{\overline{\nu} + \theta + \beta d_L}{2}. \tag{16}$$

Now, the REE price function is similar to Leland's in some aspects. The sensitivity of current price to the insider information is constant (1/2). Half of the insider information enters the price function. The constant ($\overline{\nu}$) in the REE price has no correlation to the variance of the liquidity trading and insider information.

3.1. Comparisons of characteristics of REE price

1. The average current price doesn't change with and without insider trading, $E(p) = E(p') = \overline{\nu}$. In the price function (16) and (5), $E(d_L) = 0$ and the insider information (θ) enters (16) by half. This leads to the result. This is consistent with Repullo's cases when the insider is risk neutral and that the supplier of the risk asset has market power and that the insider trading takes place in the secondary market. While, the average is higher with insider trading in Leland's model and Repullo's model when the insider is risk aversion.

2. The volatility of current price will be lower or higher, with uncertainty, when insider trading is permitted. The volatility of current price with insider trading is

$$\operatorname{var}(p) = \frac{R^2\sigma_\theta^2\sigma_L^2 + 4\sigma_\theta^2 + R\sigma_\theta^3\sigma_L\sqrt{R^2\sigma_\theta^2\sigma_L^2+4}}{8}. \tag{17}$$

When insider trading is not allowed, the volatility of current price is

$$\operatorname{var}(p') = R^2\sigma_\theta^2\sigma_L^2. \tag{18}$$

Insider trading will make price more volatile when

$$4 + R\sigma_\theta\sigma_L\sqrt{R^2\sigma_\theta^2\sigma_L^2+4} - 7R^2\sigma_L^2 > 0. \tag{19}$$

Otherwise, insider trading will lower or unchange the price volatility. Leland thinks insider trading makes price more volatile for Reasonable Parameters Values. We can also use Reasonable Parameters Values to get a more definite result for volatility as Leland. But this is no sense in global security markets. For example, the volatility in Italy is almost twice as high as that in the United States from December 1984 to December 1998. For the same time, the Chinese and the Russian markets, respectively, are 350% and 650% as volatile as that in the U.S market (Du and Wei, 2003).

Although the condition in (19) is unclear in R and σ_L^2, it's clearly increasing in σ_θ^2. When the insider learns little about the future price, σ_θ^2 will be high and the price will be more volatile when insider trading is permitted (with other parameters given). When the insider learns more about the future price, σ_θ^2 will be low and insider trading will make price less volatile (with other parameters given).

More accurately, insider trading will always increase the price volatility in any case when

$$20 + 49R^4\sigma_L^4 - 56R^2\sigma_L^2 \leq 0. \tag{20}$$

When the condition in (20) is not met, insider trading will increase price volatility when

$$\sigma_\theta^2 > \frac{-2 + \sqrt{20 + 49R^4\sigma_L^4 - 56R^2\sigma_L^2}}{R^2\sigma_L^2}. \tag{21}$$

Otherwise, price will be less volatile when insider trading is permitted.

3. The effect of insider trading on the correlation between the future price and the current price is consistent with Leland's model. When insider trading is permitted, the future price will be positively correlated to the current price. When insider trading is allowed, the correlation is

$$\rho = \frac{\sigma_\theta^2}{\sqrt{\sigma_\theta^2 + \beta^2\sigma_\theta^2}} > 0. \tag{22}$$

The correlation without insider trading is $\rho' = 0 < \rho$. The result is natural. In the price function (16) with insider trading, the information is included. But the price function (5) without insider trading has nothing about the future price.

4. Both Leland and Repullo think that insider trading will make the price less liquid for Reasonable Parameters Values, but the result is more obscure here. The liquidity is measured by the inverse of the coefficient of the liquidity traders' trading (d_L). Because of possible negative value, we measure it by the absolute value. When insider trading is allowed, it is $\frac{4\sigma_L}{R^2\sigma_\theta^2\sigma_L^2+\sigma_\theta\sqrt{R^2\sigma_\theta^2\sigma_L^2+4}}$. Without insider trading, it is $\frac{1}{R\sigma_\theta^2}$. When $R^2\sigma_\theta^2\sigma_L^2 \geq$

$\frac{1}{2}$, insider trading will increase the market liquidity. Otherwise, it is the reverse.

3.2. Comparisons of price efficiency

Madhavan examines the price efficiency in quote-driven system and order-driven system. The efficiency is similar to what EMH (Efficient Market Hypothesis) says. The mechanism is semi-strong form efficiency if the price follows a martingale, which means the price reflects all public information to the time. If price reflects all available information, including not only public but also private information, it is strong form efficiency. In the order-driven system, Madhavna proves that price in continuous auction does not follow a martingale and it is not semi-strong form efficiency. For the same mechanism, Madhavan also proves that the price converges to strong form efficiency in a particular periodic auction. Following Madhavan, we examine the price efficiency with and without insider trading, without distinguish of continuous and periodic auctions.

PROPOSITION 2. *If the liquidity trader is risk neutral, the price without insider trading is semi-strong form efficiency, $E(\nu|p') = p'$. If (a): $\theta + \beta d_L = 2(M+1)\overline{\nu}$, the price with insider trading is semi-strong form efficiency, $E(\nu|p) = p$, where $M = \frac{\sigma_\theta^2 + \beta^2\sigma_L^2}{\sigma_\theta^4}$. If (a) and (b): $\theta - \beta d_L = \overline{\nu}$, the price with insider trading is strong form efficiency, $E(\nu|p) = p$ and $E(\nu|\theta) = p$.*

Proof. When insider trading is prohibited, the expectation of future price conditional on the current price (the public information) is

$$E(\nu|p') = \overline{\nu}. \tag{23}$$

As we assume that all participants are risk aversion with $R > 0$, $E(\nu|p') < p'$ and the price is not semi-strong form efficiency. While, the REE price function will not change if the participants are risk neutral, except that R is zero in (5). In (5), R is the coefficient of the risk aversion of the liquidity trader. Thus, if the liquidity trader is risk neutral, the price will be semi-strong form efficiency and

$$E(\nu|p') = p' = \overline{\nu}. \tag{24}$$

The current price reflects the information as same as the public information. Because insider trading is precluded, there was no private information. So, there is no strong form efficiency.

When insider trading is permitted, the expectation of future price conditional on the current price is

$$E(\nu|p) = \overline{\nu} + M(p - \frac{3\nu}{2}). \tag{25}$$

The price will be semi-strong form efficiency if the condition (a) in proposition 2 is met. The private information is the insider's information θ. The strong form efficiency means that the price incorporates in all the public information and the private information. We can describe it by $E(\nu|p) = p$ and $E(\nu|\theta) = p$. The conditional expectation of the current price on the private information is

$$E(\nu|\theta) = \theta. \tag{26}$$

Making the conditional expectation be equal to the current price gives the condition (b) in proposition 2. ∎

Fama (1970) tries to formalize the EMH theory and divides it into three forms by weak form, semi-strong form and strong form and give them revised definitions in 1991 (Fama, 1991). But, the EMH has been challenged for ever. We show that the price efficiency turns up in some special cases. But, the price is not efficient if the conditions in proposition 2 are not met. Although the public information embodies more information than just the current price, the results here indicate that there are more things to de done for EMH.

3.3. Comparisons of participants' welfare

Leland compares the welfare of each class of participants with and without insider trading. He measures the welfare by the prior or unconditional expectation and variance. But, the participant makes decision on what he observes. It is more appropriate to use the conditional expectation and variance on their information set. And we assume the participant is benefited by insider trading when his welfare is equal with or without insider trading.

When insider trading is permitted, the insider's welfare is

$$U(w_I|\theta) = E(w_I|\theta) - \frac{R}{2}\mathrm{var}(w_I|\theta) = d_I(\theta - p) - \frac{Rd_I^2\sigma_\theta^2}{2}. \tag{27}$$

Substituting the insider trading of (8) into (27) gives

$$U(w_I|\theta) = \frac{(\theta - p)^2}{\beta}(1 - \frac{R\sigma_\theta^2}{2\beta}). \tag{28}$$

When insider trading is not permitted, the insider trades nothing and his welfare is zero.

With insider trading, the outsider's welfare is

$$\begin{aligned} U(w_O|p) &= E(w_O|p) - \frac{R}{2}\mathrm{var}(w_O|p) \\ &= d_O(E(\nu|p) - p) - \frac{R}{2}d_O^2\mathrm{var}(\nu|p). \end{aligned} \tag{29}$$

Substituting the outsider's trading of (10) into (29) gives

$$U(w_O|p) = \frac{(E(\nu|p) - p)^2}{R\mathrm{var}(\nu|p)}(1 - \frac{R}{2}). \tag{30}$$

If there is no insider trading, the outsider's welfare is

$$\begin{aligned} U(w'_O) &= E(w'_O) - \frac{R}{2}\mathrm{var}(w'_O) \\ &= -\frac{R\sigma_L^2}{2}(\overline{\nu}^2 + 2R^2\sigma_\theta^4\sigma_L^2 - \sigma_\theta^2). \end{aligned} \tag{31}$$

As for the liquidity trader, the measurement is as Leland's. We measure it by the welfare relative to cost. Because when they do buy, they will tend to do so at a price greater than average. When they sell, they tend to do so at a price lower than average. The cost of the liquidity trader is $-pd_L$. It follows that

$$\begin{aligned} U(\cos t) &= E(\cos t) - \frac{R}{2}\mathrm{var}(\cos t) \\ &= -\frac{\beta\sigma_L^2}{2} - \frac{R}{2}\left(\frac{\overline{\nu}^2\sigma_L^2}{4} + \frac{\beta^2\sigma_L^2}{2} + \frac{\sigma_\theta^4\sigma_L^2}{4}\right). \end{aligned} \tag{32}$$

If there is no insider trading, the liquidity trader's welfare is

$$\begin{aligned} U(\cos t') &= E(\cos t') - \frac{R}{2}\mathrm{var}(\cos t') \\ &= R\sigma_L^2(\sigma_\theta^2 - \frac{\overline{\nu}^2}{2} - \sigma_\theta^4). \end{aligned} \tag{33}$$

PROPOSITION 3. *When insider trading is allowed, the insider is always benefited in any case. But insider trading has indistinct impact on the outsider's and liquidity trader's welfare. How the participant is risk aversion is important.*

Proof. We have shown above that $\beta > R\sigma_\theta^2$. (28) is nonnegative and the result for the insider in proposition 3 is immediately arrived. This is quite natural. When insider trading is permitted, the insider will trade only when he observes a good information. Otherwise, he doesn't trade.

There are too many parameters in the outsider and liquidity trader's welfare, which makes it difficult to get a direct comparison. So, the effect of insider trading on outsider and liquidity trader is indistinct. However, we can still get a rough result related to the degree of risk aversion. When the coefficient of risk aversion is no more than 2, the outsider's welfare in (30) with insider trading is nonnegative. And his welfare without insider trading will be negative when the condition is also met that

$$\sigma_\theta^2 \leq \bar{\nu}^2 + 2R^2\sigma_\theta^4\sigma_L^2. \tag{34}$$

In this case, the outsider's welfare is more with insider trading than that without insider trading. The outsider is benefited by insider trading. Contrarily, when $R > 2$ and the condition in (34) is not met, the outsider will be hurt by insider trading.

When the participant is risk neutral with $R = 0$, the outsider's welfare is nonnegative and the liquidity trader's welfare is negative with insider trading. Both the outsider's and liquidity trader's welfare are zero without insider trading. In this case, the outsider is benefited by insider trading and the liquidity trader is hurt by insider trading. The comparisons of outsider's and liquidity trader's are not clear in other cases. ∎

Leland shows the insider is benefited and the outsider and liquidity trader is hurt when insider trading is permitted. We also get the same results for the insider. But our results for outsider and liquidity trader are different from them. This indicates the trading mechanism is important but the reasons need further research.

4. DISCUSSIONS

4.1. Risk aversion versus risk neutral

At the beginning of the model, we assume the participants are all risk aversion with the coefficient R¿0. Then, we analyze some cases with the participants with risk neutral. This is not paradise. When he is risk neutral, the coefficient of risk aversion is just equal to zero and other things in these formulations don't change. We have referred to the importance of the risk neutral in the comparisons of the characteristics of the price and the traders' welfare. When all the traders are risk neutral, the price without insider trading is semi-strong form efficiency. The outsider is benefited and the liquidity trader is hurt by insider trading.

As for the insider, there may be more about whether he is risk aversion or risk neutral. Repullo shows that it is important. However, after some scrutiny, we find the model is robust and the result doesn't change. When the insider is risk neutral, it is almost the same as the case of section 3 with $\sigma_\varepsilon^2 = 0$.

4.2. Additional limits to the insider

Repullo also thinks that there may be a number of insiders behaving as monopolistic cartel, but not a single as in the model of Leland. He shows that the price changes with the number of insiders. Here, it is not necessary. When there is more than one insider, n for example, each insider's final wealth is $w_I^i = (\nu - p)\frac{d_I}{n}$. We find the parameter of n doesn't take any roles.

We normalize all the participants' initial wealth to zero, while, the initial holding of stocks of the insider may be important. There may be some relationship between how many the insider's initial holding is and whether he will choose to trade. Considering the insider's initial holding of stock with x, his final wealth is $\nu(x + d_I) - d_I p$. The initial holding of x neither has much impact to the results.

4.3. Real investment

The effect of insider trading on real investment is important. It's also the main part of Leland's and Repullo's. But we don't consider it at all. Is it incompletely? The answer is no. Leland and Repullo give valuable results about this effect by assuming the supply is the total shares, proportional on the real investment. But this may not be the case in secondary market, as we described above. So, it is more appropriate to assuming that both supply and demand come from the trading in the secondary market. Under this framework, it is not necessary to analyze the effect on the real investment, while, we'll make another model to incorporate in this in the future research.

5. CONCLUSIONS

Insider trading is a heated ongoing debate. This paper tries to assess the impact of it on the secondary market without subjective values. We assume that all the demand and supply come from the stocks trading, not the total stocks denoting the supply. This is different from Leland and Repullo and it can be described by the order-driven system in Madhavan. Combining with these authors' work, we worked out this paper.

There exists equilibrium with and without insider trading. But the equilibrium with insider trading is so complex that it can not give a direct result. Still, we give rough comparisons when there is no noise for the insider to observe the future price. We show that the average price doesn't change because half of the insider information enters the price function and the constant is half of the unconditional expectation of the future price with insider trading. The future price is positively correlated with the current price with insider trading because the current price includes some insider information. The impacts of insider trading on the price volatility and liquidity are obscure. Whether the traders are risk aversion or neutral is important for these impacts.

We examine the price efficiency with and without insider trading. The price efficiency turns up in some cases and doesn't in other cases. When the liquidity trader is risk neutral, the price is semi-strong form efficiency without insider trading. The welfare of different participants is examined, too. Naturally, the insider will be benefited when insider trading is allowed. Whether the outsider or liquidity trader is benefited or hurt is not clear. The reasons for the results for welfare need further research.

In the section of discussions, we find the results are robust. And we will further the research by considering the effect on the real investment in the future.

REFERENCES

Beny Laura N., A comparative empirical investigation of agency and market theories of insider trading. *Discussion paper*, Havard University.

Bhattacharya Utpal and Hazem Daouk, 2002. The world price of insider trading. *Journal of Finance* **57**, 75-108.

Carney William J., 1987. Signaling and causation in insider trading. *Catholic University Law Review* **36**, 863-98.

Du Julan and Shang-Jin Wei, 2003. Does insider trading raise market volatility? *Working paper*, NBER.

Fama Eugene F., 1970. Efficient capital markets: A review of theory and empirical work. *Journal of Finance* **25 (May)**, 383-417.

Fama Eugene F., 1991. Efficient markets: II. *Journal of Finance* **46 (December)**, 1575-1617.

Grossman S. J. and Stiglitz J. E., 1980. On the impossibility of informationally efficient markets. *American Economic Review* **70**, 393-408.

Glosten Lawrence R., 1989. Insider trading, liquidity and the role of the monopolist specialist. *Journal of Business* **62**, 211-36.

Jain Neelam and Leonard J. Mirman, 1998. Effects of insider trading under different market structures. *Working paper*, NBER

Leland Hayne E., 1992. Insider trading: Should it be prohibited. *Journal of Political Economics* **100**, 859-87.

Madhavan, Ananth, 1992. Trading mechanisms in securities markets. *Journal of Finance* **47(2)**, 607-41.

Kyle, Albert S., 1985. Continuous auctions and insider trading. *Econometrica* **53(6)**, 1315-35.

Repullo Rafael, 1999. Some remarks on Leland's model of insider trading. *Economica* **66**, 359-74.