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Essays on Seasoned Equity Offerings: An Examination of SEC's Rule 105

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ABSTRACT

ESSAY I: DOES SEC RULE 105 REDUCE THE SEO ISSUANCE COST?

The US Securities and Exchange Commission (SEC) replaced Rule 10b-21 with Rule 105 in April 1997 and shortened the short-sell-restricted period before seasoned equity offering (SEO). Rule 105 was adopted to reduce the unintended effects of short-sale constraints on informed trading and stock issuers' costs. In the present study, I examine the effectiveness of Rule 105 and find that instead of decreasing SEO discounts, which SEC expected, SEO discounts increased substantially after the adoption of Rule 105. In addition, after the implementation of Rule 105, price uncertainty increases significantly during the restricted period, but it decreases shortly before the restricted period. This finding supports my hypothesis that a shortened restricted period enables informed traders to sell short before the restrictions take effect. I also find a significantly positive correlation between the pre- and post-offer price movements during the Rule 105 period, which implies that negative information is not fully incorporated into the pre-offer prices after the restricted period has been shortened. The results of the present study show that, after controlling for other factors that may affect SEO pricing, such as price pressure, rounding of stock prices, transaction cost saving, and rent expropriation, SEO discounts are determined by the pre-offer increase in price uncertainty caused by a shortened restricted period. In short, my findings suggest that Rule 105

does not reduce the SEO discount; instead, the issuing cost increases after the implementation of Rule 105.

ESSAY II: MANIPULATION ON AN OPTIONS MARKET AROUND SEASONED EQUITY OFFERINGS

Since the adoption of the US Securities and Exchange Commission (SEC)'s Rule 10b-21 and Rule 105, many researchers have manifested their concern over the effectiveness of short sales constraints in inhibiting manipulative trading on the derivative securities market. Extending the work by Easley, O'Hara, and Srinivas (1998), I analyze whether options can be used as synthetic short sales to manipulate stock prices before their seasoned equity offerings (SEO). I predict that potential manipulators on an options market tend to choose put options as a trading vehicle during a pre-offer period. However, due to strict short-sales constraints on the equity market and market makers' anticipation of manipulative trading, it would be very costly for a manipulator to drive down stock prices artificially through direct short selling on an equity market or using synthetic short sales on an options market. The results of various empirical tests support these predictions.

ESSAY III: SEC RULE 105 AND PRICE DISCOVERY ON A SECONDARY MARKET

Using a bootstrap technique, I compare the speed of price discovery for an SEO issued during the US Securities and Exchange Commission (SEC)'s Rule 10b-21 period and an SEO issued during the Rule 105 period on the offer day. I find that, after the adoption of Rule 105, the speed of price discovery slows down on the offer day. It takes a longer time to complete 75% of the offer-day price discovery during the Rule 105 period. I also find that during Rule 105 period, the price changes occurred in the first trading hour are more likely to be temporary and efficient price discovery occurs much later on the offer day. I observe a higher fraction of price discovery attributable to private information under Rule 105, which is consistent with my hypothesis that a shortened restricted period makes it difficult to interpret the information contained in offer price discounts and results in high information asymmetry on the offer day.

ESSAY I

DOES SEC RULE 105 REDUCE THE SEO ISSUANCE COST?

DOES SEC RULE 105 REDUCE THE SEO ISSUANCE COST?

1. INTRODUCTION

Many studies (e.g., Altinkilic and Hansen 2003; Corwin 2003; Kim and Shin 2004) examine the substantial increase in SEO discounts in the 1990s[1]. They suggest that the adoption of SEC Rule 10b-21 was one of the main reasons for large SEO discounts. Rule 10b-21, adopted by the National Association of Securities Dealers (NASD) on August 25, 1988, prohibited short sellers from covering their short positions established after the filing of registration statements (or Form 1-A) with securities purchased from an underwriter, broker, or dealer participating in the offering. The rule was designed to prevent manipulative short sales that could prevent the market from functioning as an independent pricing mechanism and erode the integrity of an offer price. As Gerard and Nanda (1993) point out, however, if Rule 10b-21 restricted informative short selling activities, the adverse information could not be incorporated into existing stock prices. Therefore, issue discounts could increase as a result of the increased uncertainty of equilibrium price.

In order to reduce any unintended effects on informed short sales, in April 1997, SEC adopted Rule 105 to replace Rule 10b-21. Unlike Rule 10b-21, which restricted short sales made between the filing date and the offer date, Rule 105 only restricts short sales made 5 trading days before an offering's pricing. The SEC expected Rule 105's shorter restricted period to reduce Rule 10b-21's adverse effects on information-based short sales, improve the

[1] Other studies of U.S. seasoned offerings include Krigman, Shaw, and Womack (2001), Eckbo, Masulis and Norli (2007), and Heron and Lie (2004).

information efficiency of market prices, decrease uncertainty of stock prices, and reduce the cost to issuers.

A shorter restricted period, however, may not eliminate the negative effects on informed short sales because Rule 10b-21's effective restricted period was much shorter than it appeared. According to Reed (2003), equity borrowing is usually expensive, and the borrowing period is usually very short. Reed finds that 50% of these loans last for less than 3 calendar days, and three quarters of these loans are outstanding for less than 9 calendar days (approximately 7 trading days). Safieddine and Wilhelm (1996) find that the short interest level jumps up on the fifth day before an offer and continues to be high until the offer day. Therefore, it is more likely that informed traders who plan to cover their short positions with new shares will short sell close to an offer date. That is, although Rule 10b-21's nominal restricted period is usually very long, the effective restricted period should be short. Therefore, Rule 105 may not shorten the effective restricted period or reduce unintended adverse effects.

On the contrary, the problem may be exacerbated after the adoption of Rule 105 because the Rule 105's shortened restricted period may enable informed short sellers to cover their positions using shares in the offering. Short sellers who are able to cover their short positions using shares in the offering assume much less market risk than short sellers who intend to cover their positions using open market shares. When the restricted period is shortened to 5 trading days, informed short sellers are likely to time their trading to sell short in a relatively short period of time immediately before the start of the restricted period in order to cover their short positions using offering shares. (This timing strategy does not work under Rule 10b-21 because long-term equity borrowing is too costly. More importantly, investors did not know the SEO until it was registered, at which point it was too late to establish a short position that would be covered with the offer.) As a result, informed short sales during the restricted period may be reduced and price uncertainty may increase. If informed trading is timed to cover short positions using an offering's shares, there should be a substantial increase in the SEO discount after the adoption of Rule 105.

Using a sample of 850 SEOs issued on the NYSE from 1989 to 2005, I compare issue discounts during the Rule 10b-21 period and the Rule105 period. Although the SEC expected a reduction in SEO discounts as a result of Rule 105, I observe a pattern of increasing SEO discounts after Rule 105's implementation. I find that approximately 82% of firms' offer prices are lower than the pre-offer day closing transaction prices after the adoption of Rule 105 compared to 61% during the Rule 10b-21 period. I also find that SEO discounts increased substantially after the adoption of Rule 105. The mean and median discounting are 1.05% and 0.46%, respectively, during the Rule 10b-21 period, but they increase to 1.79% and 1.03%, respectively, after the adoption of Rule 105. This evidence shows that a shorter restricted period does not reduce the cost to issuers.

I test the hypothesis that Rule 105 leads to an increase in SEO discounts. My findings show that price uncertainty increases significantly during the pre-offer period for firms issuing new shares after April 1, 1997, whereas the increase in price uncertainty is much less obvious for firms issuing new shares before the implementation of Rule 105. In addition, during the Rule 105 period, I observe a decrease in price uncertainty shortly before the start of a restricted period. These findings support my hypothesis that a shortened restricted period enables informed short sellers to time their trades to establish short positions immediately before a restricted period.

I find a positive relationship between pre-offer returns and post-offer returns during Rule 105 period, which supports my hypothesis that negative information will not be fully incorporated into stock prices during Rule 105's pre-offer period.

I also examine the relationship between the effects of short sales rules on the information efficiency of pre-offer stock prices and the extent of SEO discounts. I find that after controlling for other factors that may affect SEO pricing, such as price pressure, rounding of stock prices, transaction cost saving, and rent expropriation, SEO discounts are determined by a reduction in the information efficiency of pre-offer stock prices. This evidence suggests that increases in the cost to issuers are at least partly due to the implementation of Rule 105.

The present study makes two main contributions to the literature. First, to my knowledge, this is the first study to examine the effects of replacing Rule 10b-21 with Rule 105. It is intuitive to think that a shorter restricted period will decrease the adverse effects on informed short selling and reduce SEO discounts. My findings, however, suggest that Rule 105 has increased the adverse effects on informed short selling and SEO discounts. Second, I observe a change in the uncertainty of stock prices before an offer and examine its effects on SEO pricing. Although previous studies suggest that Rule 10b-21 leads to an increase in price uncertainty before an offer, none of them directly examine the daily change in price uncertainty during the pre-offer period. Using the intraday transaction data of SEO firms, I am able to examine daily change in information efficiency and find direct evidence that short sales rules have adverse effects.

The remainder of this essay is organized as follows: In section 2, theories concerning the short sales rules and their negative effects are summarized, and testable hypotheses are developed; section 3 describes the sample data and summary statistics; section 4 discusses the influence of short sales constraints on the information efficiency of stock prices; section 5 describes the tests of hypotheses related to SEO discounting; and section 6 offers some conclusions.

2. THEORY AND HYPOTHESES

Short sales rules (i.e., Rule 10b-21 and Rule 105) were created because the pre-offer market is vulnerable to manipulation. It is commonly believed that covering short positions using fixed-priced offering shares is much less risky than covering short positions using open market shares, and manipulators tend to use less-risky short sales to gain profits. Therefore, SEC's regulations do not prohibit all short sales before SEO pricing; instead, they prohibit less-risky short sales in order to ensure that the motivation for a short sale is not manipulation.

As rational traders, informed short sellers should also prefer less-risky short selling, and the restriction on short-selling activities may not only restrict manipulative sales, but also information-based sales. Gerard and Nanda (1993) argue that the restriction on information-motivated short-selling activities makes pre-offer prices less informative, and as a result, a firm is forced to discount their new shares in order to market them[2]. Recent empirical studies (e.g., Altinklic and Hansen 2003; Corwin 2003; Kim and Shin 2004) show that there is a substantial increase in SEO discounts during the Rule 10b-21 period, but Mola and Loughran (2004) find little support for the idea that short selling increases SEO discounts. They argue that it is the changing composition of issuers and stronger banker power that increases SEO discounts.

In this essay, I focus on answering two questions: (1) Does Rule 10b-21 have significant negative effects on informed short-selling activities? (2) Does Rule 105 reduce or increase the adverse effects on informed short sales? To answer these two questions, let us first look at a simple example.

Suppose firm A issues seasoned equity offerings under Rule 10b-21. The restricted period is from the filing date to the issue date. Let us assume the waiting period (i.e., the number of trading days between filing date to issue date) is 30 trading days. As Reed (2003) points out, equity loans are expensive, and the length of this type of loan is usually very short, with a median of 3 calendar days and a third quintile of 9 calendar days. Therefore, I assume that firm A's equity loan period will not be longer than 10 trading days.

<Insert Figure 1 here.>

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[2] Edwards and Hanley (2007) recently examine the effects of short sales constraints on IPO pricing. While their study is not directly comparable with my study, they interestingly find that the constraints on short selling immediately following an IPO may contribute to pricing inefficiencies in the short term.

Informed investors of firm A have two options for covering their short positions:

Option 1: Informed traders can cover short positions using open market shares. This strategy is risky because the future market price is uncertain.

Option 2: Informed traders can cover short positions using offering shares. This is less risky because the offer price has been fixed. This strategy, however, is only feasible when

(1) the short position is established less than 10 trading days before an offer and

(2) the short position is not established during the restricted period.

In this scenario, whether it is before the filing date or during the restricted period, informed investors only have one option: That is, they can only cover their positions using open market shares. Therefore, Rule 10b-21 should not affect their trading strategies.

Under Rule 105, the restricted period is shortened to 5 trading days. In this case, from day -10 to day -6 (relative to the issue day), the two conditions of the less-risky option are satisfied, and on other days, only the risky option is feasible. It is expected that informed traders may choose to trade from day -10 to day -6 because they can choose the less-risky short-sales option during this period. As a result, informed short sales are reduced during the restricted period. From this simple example, it appears that Rule 105 may increase the adverse effects on informed short sales.

Hypothesis 1: SEO discounts are larger under Rule 105 than under Rule 10b-21.

Rock (1986) presents a model in which a group of investors have better information than the firm and other investors. He shows that if new shares are priced at their expected value these informed investors will drive out other investors when new shares are good and withdraw from the market when new shares are bad. Therefore, issuers have to offer their new shares at a discount in order for the shares to be purchased by uninformed investors. This argument has been dubbed the "winner's curse." If, as shown by the simple example above, informed short sellers working under Rule 105 choose to trade before the restricted period, then the winner's curse can be aggravated as a result of the lower information efficiency of stock prices during the pre-offer period and issue discounts would increase.

Hypothesis 2: The increase in price uncertainty during the restricted period should be larger under Rule 105 than under Rule 10b-21.

The concentration of informed short sales before a restricted period reduces informed short-selling activities during the restricted period, which can slow down the incorporation of negative information into stock prices and increase the uncertainty of pre-offer stock prices. Therefore, under Rule 105, price uncertainty increases during the restricted period.

Hypothesis 3: Under Rule 105, an increase in price uncertainty during a restricted period for issuing firms with exchange-traded options is lower than an increase in price uncertainty for issuing firms without exchange-traded options.

Safieddine and Wilhelm (1996) suggest that option strategies can replace the short selling of issuing firms' stocks. If an issuing firm has options listed on exchanges, the effects of short-sales rules on informed trading could be reduced because informed traders can circumvent the restriction on less-risky short sales by purchasing a put or writing a call on the options market during the restricted period. As pointed out by prior studies (e.g., Chan, Chung, and Fong 2002; Easley, O'Hara, and Srinivas 1998; Mayhew, Sarin, and Shastri 1995), the information flow between equity markets and options markets is bidirectional. Therefore, the information released on options markets can, at least partly, be incorporated into stock prices. As a result, the pre-offer increase in price uncertainty could be lower when exchange-traded options are available.

Hypothesis 4: Under Rule 105, abnormal pre-offer price movements should be positively related to abnormal post-offer price movements.

Kim and Shin (2004) suggest that if informed trading is depressed by short sales rules in the days before SEO pricing and negative information is not fully reflected in pre-offer stock prices abnormal post-offer returns are positively related to abnormal pre-offer returns.

3. DATA

3.1 Sample Selection

The sample of SEO firms used in the present study was obtained from the Securities Data Company (SDC) database, which provides the offer date, gross proceeds, offer price, shares issued, and number of shares outstanding. The sample consists of 850 new equity issues on NYSE from 1989 to 2005, excluding IPOs. The following criteria were used to screen the data. First, to be included in the sample, the issues had to be ordinary common shares. They could not be a unit offering, shelf offering[3], closed-end fund, real estate investment trust (REIT), or American Depository Receipt (ADR). Second, firms with offer prices smaller than US$5.00 were not included in this study. Third, firms that are not listed in NYSE's Trade and Quote (TAQ) database or the CRSP database were not included in the present study.

As noted by Corwin (2003) and Lease, Masulis, and Page (1991), some firms announce new offer prices after the market closes, and the effective offer date should be the trading day after the SDC offer date. Safieddine and Wilhelm (1996) point out that the trading volume increases sharply on an offer day; therefore, the effective offer date is identified using a volume-based adjustment method. That is, if the trading volume on the day following a SDC offer date is more than twice the volume of the SDC offer date and more than twice the

[3] Rule 105's restriction on short selling did not apply to shelf offerings. Therefore, I exclude shelf offerings from my study, though over the past decade the fraction of US seasoned equity offerings executed using shelf offering has climbed dramatically (Autore, Kumar, and Shome 2005; Bortolotti, Megginson and Smart 2007).

average daily trading volume over the 250 days before the offer date, then the day following the SDC offer date is considered the effective offer date.

Intraday data were collected from the NYSE TAQ database. Raw transactions data, however, may contain some problems, such as misordered time series and the existence of data outside regular trading hours. Therefore, time series data are reordered, and observations that lie outside the trading interval (i.e., between 9:30 a.m. and 4:00 p.m. Eastern Standard Time) are not included in the present study. Market information, such as stock prices, returns, market index, and shares outstanding, was obtained from the CRSP database.

In order to identify whether a stock is listed on an options market, the database of monthly options trading volume was downloaded from the Chicago Board Options Exchange (CBOE) website.[4] If there was no record of options trading during the issuing month, this stock was identified as stock with no listing on the options market.

<Insert Table 1 here.>

Table 1 contains summary statistics that describe the offer and firm characteristics of the SEO firms examined in the present study. For each variable, Table 1 displays mean and median for the whole period and the two subperiods (i.e., Rule 10b-21 period and Rule 105 period). The *p*-value from a test that means (medians) are the same across different subperiods is listed in the last column. I find that offer characteristics do not change significantly over time. The median results show that median offer price is US$27.13 during the

[4]http://www.cboe.com/data/AvgDailyVolArchive.aspx

Rule 105 period compared to US$26.63 during the Rule 10b-21 period[5]. Although offer proceeds increase substantially from US$82.2 million during the Rule 10b-21 period to US$143.9 million during the Rule 105 period, there is little change in the relative offer size because the size of firms also increases during the second subperiod. In addition, there is no obvious change in *waiting period*, which is defined as the number of days from the filing date to the offer date. The median for the waiting period is 20 days during the Rule 10b-21 period and the Rule 105 period.

Partly as a result of a change in the underlying market microstructure, I observe large changes in firm characteristics. The mean and median trading volume during the Rule 105 period are approximately twice the size of the mean and median trading volume during the Rule 10b-21 period. At the same time, the bid-ask spread drops during the Rule 105 period because U.S. stock markets switched to decimal pricing. I do not, however, see a marked change in historical volatility. Mola and Loughran (2004) argue that the growing number of riskier issuers is one of the reasons for the increased average discount. I find no evidence to support this hypothesis in my sample.

3.2 Variable Definitions and Summary Statistics

3.2.1 Measure of SEO Discount

Following Altinkilic and Hansen (2003) and Corwin (2003), the discounting of seasoned equity offering is defined as follows:

[5] The mean and median SEO offer sizes during Rule 10b-21 period are comparable to those presented in other recent U.S. empirical studies (Burch, Nanda, and Warther 2005; Butler, Grullon, and Weston 2005; Fama and French 2005).

$$Discounting = \frac{P_{close} - P_{offer}}{P_{close}} \quad (1)$$

where P_{close} is the closing transaction on the day immediately before the offer day (i.e., day –1), and P_{offer} is the offer price.

I split my sample into two subperiod and use April 1, 1997 as the dividing point. Table 2 presents a comparison of discounting for the whole period and for the two subperiods.

<Insert Table 2 here.>

During the Rule 10b-21 period, the mean (median) discounting is 0.94% (0.37%), while during the Rule 105 period, the mean (median) of discounting increases by more than 86% (168%) to 1.75% (0.99%). The results of the Wilcoxon test and *t* test show that SEO discounting increases significantly after the adoption of Rule 105. Under Rule 105, 81% of SEOs are priced below the pre-offer closing transaction price, while under Rule 10b-21, only 56% are discounted, which further supports the idea that discounting is more pervasive during the Rule 105 period.

Figure 2 contains the mean and median of SEO discounts by year and illustrates a trend in increasing SEO discounts after the adoption of Rule 105. Before 1997, seasoned equity offerings had a mean discount of 0.20% to 1.37%, while after 1997, the discounts ranged from 1.41% to 2.24%.

<Insert Figure 2 here.>

3.2.2 Measures of Change in Price Uncertainty

The change in intraday volatility during the restricted period, ΔVOL_t, is the first variable used to measure a change in price uncertainty as a result of a reduction in the information efficiency of a stock price, and it is calculated as follows:

$$\Delta VOL_t = \frac{VOL_t}{VOL_B} - 1 \tag{2}$$

where VOL_B is the intraday volatility during the benchmark period measured by average VOL during the 30 trading days ending 2 trading days before the filing date. Following Andersen et al. (2001), intraday volatility, VOL_t, is calculated as the square root of the total of sum of the squared 5-minute returns. That is,

$$VOL_t = 100 * \sqrt{\sum_{j=1}^{N_t} r_{t,j}^2} \tag{3}$$

where N_t is the number of 5-minute intervals during day t, and $r_{t,j}$ is the return in the j[th] interval, which is calculated as the difference of the logarithm of the last transaction price of the j[th] interval and the logarithm of the last transaction price of the (j-1)-th interval.

Standardized unexpected trading volume (SUV), which is calculated using a method similar to the market model approach, is another variable used to measure change in price uncertainty:

$$Volume_{it} = \hat{\alpha} + \hat{\beta}_1 \mid R_{it} \mid^{+} + \hat{\beta}_2 \mid R_{it} \mid^{-} + \varepsilon_{it}, \quad \text{t} \in \text{(Estimation Period)} \tag{4}$$

$$UVolume_{it} = Volume_{it} - \hat{\alpha} - \hat{\beta}_1 \mid R_{it} \mid^{+} - \hat{\beta}_2 \mid R_{it} \mid^{-} \tag{5}$$

$$SUV_{it} = UVolume_{it} / S_{it} \tag{6}$$

where $Volume_{it}$ is measured as the turnover ratio for stock i on date t. $|R_{it}|^{+}$ and $|R_{it}|^{-}$ denote the absolute value of positive daily return and absolute value of negative daily return for stock i on day t, respectively. S_{it} is the standard deviation of ε_{it} in Equation 4. The estimation period is defined as the 120 trading days ending 2 trading days before the filing date.

Garfinkel and Sokobin (2006) suggest that trading volume arises from three effects: (1) liquidity effects, (2) informedness effects (i.e., the extent to which some investors are more informed), and (3) consensus effects (i.e., the extent of agreement among investors). They assume that trading volume arising from informedness effects are related to price moves, and trading volume produced by liquidity and consensus effects is not related to price moves. Therefore, the intercept estimated in Equation 5 represents the trading volume produced by liquidity effects, and $\hat{\beta}_1$ and $\hat{\beta}_2$ capture the informedness effects. Unanticipated trading volume can be attributed to opinion divergence.

4. EVIDENCE OF SHORT-SALES CONSTRAINTS ON INFORMED TRADING

4.1 Short-Sale Rules and Change in Intraday Volatility

As suggested in the previous sections, the shortened restricted period under Rule 105 enables informed traders to establish less-risky short positions just before the start of a restricted period. If this hypothesis holds, I expect to observe a marked increase in price uncertainty during the restricted period and a decline in it during a short period of time immediately before the restricted period. In contrast, under Rule 10b-21, when restricted periods are usually much longer, such a timing strategy does not work. Therefore, I expect to observe no significant change in intraday volatility under Rule 10b-21.

<Insert Table 3 here.>

Table 3 shows daily volatility and daily change in volatility in a given period before an offer date. Table 3, panel A lists the median volatility during the benchmark period and the restricted period. I define *benchmark period* as the 30 trading days ending 2 trading days before a firm's filing date.

Table 3, panel A shows that volatility during the benchmark period is similar for the two subperiods. The results of the Wilcoxon test show that the difference in volatility between the two subperiods is not statistically significant (p = 0.14). This evidence excludes the possibility that discounting increases because more-risky firms issue seasoned equity offerings during the Rule 105 period.

Consistent with my hypothesis, under Rule 105, the restriction on less-risky short sales results in a substantial increase in volatility, jumping from 1.77% to 1.94%. In contrast, under Rule 10b-21, I observe a slight decline in volatility, declining from 1.87% to 1.83%. The results of the Wilcoxon test show that the median volatility during the restricted period under Rule 105 is much higher than the median volatility during the restricted period under Rule 10b-21 at the 5% level.

Table 3, panel B lists the change in intraday volatility during the restricted period relative to the benchmark period. My discussion here focuses on the median results because I observe a large positive skewness for this variable.[6] Before the adoption of Rule 105, I can see a decrease of 3% in volatility during the restricted period; however, after the adoption of Rule 105, the restriction on less-risky short sales leads to a substantial increase of 7% in price uncertainty, which is significantly at the 1% level. In addition, the results of the Wilcoxon test show that the change in price uncertainty under Rule 105 is significantly larger than the change in price uncertainty under Rule 10b-21. Overall, contrary to the expectation of SEC, Rule 105 contributes to a more-severe information asymmetry problem during the pre-offer period. In addition, there is a noticeable fall of 3% during the 2 trading days before the restricted period, which is consistent with my hypothesis that some informed traders choose to trade before a restricted period in order to benefit from relatively riskless short sales.

According to Cox and Rubinstein (1985) and Safieddine and Wilhelm (1996), options market could provide informed traders with a way to circumvent the constraints on less-risky short sales imposed by Rule 105. Therefore, it is not necessary for informed traders to trade before the restricted period if options are available; instead, they could trade in the days before an offer on an options market. As a result, I expect that the information efficiency of pre-offer stock prices of issuers with exchange-traded options should be higher than the information efficiency of pre-offer stock prices of issuers without exchange-traded options.

[6]The Student's t test, the most common test used in hypothesis testing, relies on normal distribution. The variables I am testing are not normally distributed, and I cannot use the t test. Instead, I use nonparametric tests such as the Wilcoxon test for an unpaired situation and the Sign test for a paired situation or a univariate test.

Table 3, panel C reports the change in price uncertainty for two subsamples of SEOs conditioned on the availability of exchange-traded options. As a result of the unavailability of data, the sample only includes stocks issued after 1998. For issuing firms without listed options, I observe a significant increase of 16% during the restricted period and a decline of 4% in the 2 days before the restricted period. In contrast, there is no change in volatility during the restricted period or in the 2 days before the restricted period for firms with options listed on an exchange. As the Wilcoxon test results show, the pre-offer increases in volatility for firms without exchange-traded options are much higher than the pre-offer increases in volatility for firms with exchange-traded options, and this finding supports the idea that an increase in price uncertainty is produced by Rule 105's adverse effects on informed short sales during the restricted period.

4.2 Short-Sales Rules and Divergence in Investors' Opinions

Under Rule 105, informed short sellers who hope to benefit from less-risky short sales would choose to trade before a restricted period. Therefore, during a restricted period, the incorporation of negative information could slow down, and the information efficiency of pre-offer stock prices would decrease. The cumulative effect of the short-sales rule could contribute to the difficulty of interpreting trading activities in the pre-offer stock market, and it could become more difficult to determine true stock values. Therefore, if Rule 105 leads to the timing of sells by informed short sellers, then I expect that under Rule 105 the divergence in investors' opinions increases during a restricted period.

<Insert Table 4 here.>

The divergence in opinions among investors is measured using standardized unanticipated trading volume, *SUV*, calculated by using Equations 4 through 6. A positive *SUV* indicates that investors' opinions become more divergent, while a negative *SUV* implies that investors' opinions are more unanimous.

Table 4 presents the median of standardized unexpected trading volume during the restricted period. Similar to the last section, I only focus on the median results because of the high skewness. Consistent with my expectation, I observe a significantly positive *SUV* of 0.54 under Rule 105, which indicates that investors' opinions become more divergent and stock prices are less informative during the restricted period. In contrast, under Rule 10b-21, median *SUV* experiences a decline of 7% during the restricted period, which is significant at the 1% level. This decline may occur because that part of speculative informed trading is curbed by the rule. In addition, the results of the Wilcoxon test show that the implementation of Rule 105 does not reduce price uncertainty, as expected by SEC; instead, it produces less informative pre-offer prices.

I observe a decline of 0.13 in *SUV* (p = 0.01) in the 2 trading days before the restricted period after the adoption of Rule 105. This finding is consistent with my hypothesis that informed traders are likely to trade before a restricted period in order to cover their position using offering shares.

I examine the difference in opinions divergence among investors between firms with listed options and firms without listed options. Similar to the results for change in intraday volatility, the opinion divergence during the restricted period for firms with listed options is lower than the opinion divergence for firms without listed options. In addition, I observe a decrease in opinion divergence in the 2 days before SEO pricing for firms without listed options, but there is only a minor change for firms with listed options, which further supports my hypothesis that Rule 105 reduces the information efficiency of pre-offer stock prices, especially for firms without options listed on an exchange.

4.3 Short-Sales Rules and Pre-offer Price Movements

Previous studies (e.g., Gerard and Nanda 1993; Kim and Shin 2004; Bayless, and Chaplinsky 1996; Heron, and Lie 2004; Meidan 2005; Loderer, Sheehan and Kadlec 1991) report significant temporary price declines in the days before SEO pricing. Gerard and Nanda (1993) argue that if pre-offer price movement is the result of manipulative short sales the ratio of temporary to permanent components in price movements may be higher. Kim and Shin (2004) suggest using the correlation between abnormal pre-offer returns and abnormal post-offer returns to test whether short selling before an offer is manipulative or motivated by information[7]. They argue that a negative correlation implies a pre-offer price movement is temporary and should be driven by manipulative short sales, no correlation indicates that pre-offer price movement is permanent

[7] It is not possible for the Rule 10b-21 and Rule105 comparison of short interest ratios (short interest relative to their shares outstanding). First, short interest does not always reflect short positions established immediately prior to offer date, because short interest data is only available on a monthly basis. Second, short-selling increases over time (see Asquith, Pathak, and Ritter 2005). The uptrend in short-selling will affect the Rule 10b-21 and Rule 105 comparisons.

and driven by informative short sales, and a positive correlation reveals that private information is not fully reflected in the pre-offer stock price. If Rule 105 depresses informative short sales during a restricted period, I expect to see a positive relation between pre-offer price movement and post-offer price movement.

<Insert Table 5 here.>

Table 5, panel A lists the medians of cumulative market-adjusted returns (CAR) for a given period around an offer. *Daily market-adjusted returns* are defined as the daily returns in excess of CRSP value-weighted index return. I observe that pre-offer CARs are more negative and post-offer CARs are more positive under Rule 105 than under Rule 10b-21. The *pre-offer period* is defined as the last 5 trading days of the restricted period if the waiting period is longer than 5 trading days and the whole restricted period if the waiting period is shorter than 5 trading days. However, the results of the Wilcoxon test shows that the difference between these two subperiods is not significant.

Table 5, panel B shows the correlation coefficients between pre-offer CAR and post-offer CAR. I find almost no correlation coefficients between pre-offer CAR and post-offer CAR during the Rule 10b-21 period, but there is a significant positive correlation between pre-offer CAR and post-offer CAR during the Rule 105 period, which supports my hypothesis that under Rule 105 information is not fully incorporated into stock prices, and the information efficiency of stock prices is low during a restricted period.

I also examine the correlation between pre-offer CAR and post-offer CAR for SEOs with a negative pre-offer CAR, which are more likely to have negative private information. I find a more positive relationship between pre-offer CAR and post-offer CAR under Rule 105, but the correlation under Rule 10b-21 is close to zero. These findings indicate that Rule 105 depresses informed short sales during a restricted period, and negative information is not fully reflected in pre-offer stock prices.

5. SEO DISCOUNTS AND RULE 105

5.1 Factors Related to SEO Discounting

5.1.1 Price Uncertainty and Rule 105

My argument that Rule 105 increases SEO discounts is based on the assumption that Rule 105 results in less-informative short sales and higher price uncertainty in the days before a stock offer. I expect SEO discounts to be positively related to price uncertainty, especially pre-offer price uncertainty.

5.1.2 Permanent versus Transitory Price Pressure

The theories about price pressure vary. Some researchers (e.g., Mikkelson and Partch 1985; Scholes 1972) maintain that price pressure is temporary, and investors should be compensated for absorbing this temporary pressure. Other researchers (e.g., Asquith and Mullins 1986) argue that price pressure leads to a permanent increase in supply and a corresponding permanent reduction in stock price. If the market is efficient, the downside price adjustment should be completed immediately after the announcement of the new offer. In other words, the closing stock price before an offer should have already incorporated the price pressure of a new offer, and therefore, it is not necessary for underwriters to artificially discount the offer price. In this present study, underwriters' response to an increased supply of shares is estimated to determine whether price pressure is permanent or transitory.

5.1.3 Transaction Cost Savings

Loderer, Sheehan, and Kadlec (1991) argue that investors do not need to pay transaction costs when they buy new shares directly from underwriters. This saving on transaction cost can be viewed as another form of compensation to investors. Therefore, underwriters should offer a smaller discount for stocks with high transactions costs. If this argument holds, I expect to find a negative relation between transaction costs and the extent of SEO discounting.

5.1.4 Pricing at Closing Bid and Rounding of Closing Price

Research (Bradley et al. 2004; Corwin 2003; Mola and Loughran 2004) shows that sometimes SEOs are priced at the closing bid quote or at integers. For example, Corwin (2003) reports that 24.36% of the new offers on NYSE are priced at the closing bid quote. Bradley et al. (2004) and Mola and Loughran (2004) note that the offer prices of SEOs and IPOs cluster at integers. I examine whether the value discounts of SEOs are the result of these two pricing practices.

5.1.5 Rent Expropriation

Loughran and Ritter (2002) point out that lead underwriters tend to exploit the gains of issuers by underpricing for investors who are more likely to repay the bank through future reciprocal deals. Affleck-Graves, Hedge, and Miller (1994) suggest that if this hypothesis is true, then discounts will be higher when more good news is released about a firm, regardless of whether the news is private or public. Therefore, it is assumed that there is a positive relation between the positive cumulative abnormal returns over the 5 trading days immediately before the SEO and the extent of discounting.

The empirical predictions of the main theories that explain the determinants of SEO discounting are summarized in Table 6.

<Insert Table 6 here.>

5.2 Univariate Results

Table 7 presents the univariate quintile results. I rank the sample into quintiles according to the magnitude of each explanatory variable and then test the null hypothesis that the mean values of SEO discounts are not significantly different across the five groups.

<Insert Table 7 here.>

Consistent with the price uncertainty hypothesis, SEO discounts decrease with firm size, with the exception of quintile 1, increase with volatility during the benchmark period and the pre-offer period, and increase with a divergence in pre-offer investors' opinions. I do not observe a relation between SEO discounts and bid-ask spreads, which is not consistent with the transaction cost savings hypothesis. The results for pre-offer CAR suggest that larger price movements lead to larger SEO discounts, regardless of direction. SEO discounts also decrease with price, which is consistent with the offer price rounding hypothesis.

5.3 Multivariate Results

The results of a multivariate regression are presented in Table 8.

<Insert Table 8 here.>

From model 1, I see that consistent with the uncertainty hypothesis SEO discounts are generally higher for small firms and firms in the utility industry. The coefficient for firm size (*CAP*) is negative and significant at the 1% level, and the coefficient for the utility industry dummy variable (*UTILITY*) is negative and significant at the 5% level. I also find that the coefficient for volatility during the benchmark period (VOL_B) is positive and significant at the 1% level, which further supports for the hypothesis of uncertainty. It is notable that the coefficient for dummy variable *Rule105* is 0.90, which is significant at the 1% level. This indicates that after accounting for the change in issuer composition SEO discounting increases after the adoption of Rule 105.

Consistent with the short-sale rule hypothesis, the coefficient for change in volatility (ΔVOL) is positive and significant at the 1% level in model 1, and the coefficient for investors' opinion diversity (*SUV*) is positive and significant at the 1% level for all specifications. This evidence reveals that a pre-offer change in volatility plays an important role in the magnitude of SEO discounts. When I incorporate ΔVOL and *SUV* into the model, there is a large decrease in the significance level of ΔVOL. This occurs because of the high correlation between these two measures. In addition, the incorporation of these two measures leads to a substantial decline in the coefficient for the dummy variable

Rule105, which indicates that the pre-offer change in price uncertainty can, at least partly, explain the increase in SEO discounts after the adoption of Rule 105.

I find a negative coefficient for time-weighted relative bid-ask spreads (*SPREAD*), but the coefficient is not significant, even at the 10% level. This is not consistent with the transaction cost saving hypothesis that predicts underwriters discount less for offers with high transaction costs.

The results of the multivariate regression support Corwin's (2003) discount theory, which suggests some offers are priced at the closing bid. These results (in models 5 to 7) show that the coefficient for *BID_PRC* is positively significant at the 1% level.

Models 5 to 8 show that the coefficient for *ROUND* is positively significant at the 1% level. This finding supports Mola and Loughran's (2004) offer price rounding hypothesis.

Loughran and Ritter's (2002) rent expropriation theory predicts that underwriters obtain profits from firms with good news. In other words, the magnitude of discounts is positively related to positive cumulative abnormal returns (*CAR_pos*). The results of Table 8, model 6 support this prediction, with a positive, significant correlation between SEO discounting and *CAR_pos*. This evidence supports the rent expropriation hypothesis.

The results of the present study do not show any relationship between discounting and the measure of price pressure (*OFFSIZE)*. Further analysis of the correlation between pre-offer volatility and relative offer size shows that pre-offer volatity and the measure of price pressure are positively, significantly correlated at approximately the 10% level. This indicates that the effects of relative offer size may be captured by pre-offer volatility. According to Myers and Majluf (1984), if there is information asymmetry between managers and investors, then firms only issue equity when their stock is overpriced. Following this line of reasoning, a relatively larger offer size tends to increase the uncertainty of stock prices. Therefore, underwriters should compensate investors for the additional risk they face in buying the offered shares. This evidence partly supports the temporary price pressure hypothesis.

To control for the effects of market sentiment on SEO discounts, I include a variable SENTI, which is defined as the cumulative value-weighted return of NYSE during the 120 trading days before a SEO offer, in model 7. This model shows no positive correlation between SEO discounts and the whole market performance, which excludes the effects of market sentiment on SEO pricing.

6. CONCLUSION

In April 1997, SEC replaced Rule 10b-21 with Rule 105 in order to reduce the unintended effects on informed trading and costs to issuers. Rule 105, however, does not reduce these negative effects on informed short sales; instead, the problem becomes more severe after the implementation of Rule 105 because the shortened restricted period enables informed traders to trade before the restricted period and cover their positions using shares in the offering. This leads to lower information efficiency of pre-offer stock prices.

Contrary to the SEC's expectation, there is a substantial increase in SEO discounts after the implementation of Rule 105. I also find that price uncertainty increases significantly during the pre-offer period for firms issuing new shares during the Rule 105 period, while price uncertainty decreases slightly for firms issuing new shares during the Rule 10b-21 period. In addition, there is lower price uncertainty shortly before the start of a restricted period under Rule 105. These results show that shortening the restricted period enables informed short sellers to choose the timing of their trading and establish short positions in a short period immediately before the restricted period.

The results of the present study show that pre-offer price movements are permanent, and there is no negative correlation to post-offer price movements, which indicate that not all the trading activities before an offer are the result of manipulative trading. In addition, during the Rule 105 period, there is a significantly positive relation between pre-offer price movements and post-offer price movements. This finding supports the idea that negative information cannot be fully reflected in a stock price during the pre-offer period after shortening the restricted period.

The results of the multivariate analysis in the present study suggest that after controlling for other factors that may affect SEO pricing, such as price pressure, rounding of stock prices, transaction cost saving, and rent expropriation, SEO discounts are determined by the pre-offer increase in price uncertainty caused by short-sales rules. As a result, the implementation of Rule 105 increases stock issuers' costs.

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Table 1
Summary Statistics for Seasoned Offers, 1989 through 2005

This table presents means [medians] for 850 seasoned offers issued on the NYSE from 1989 to 2005. Shelf offerings are not included. The sample is divided conditioned on whether the offer is issued before April 1, 1997 (Rule 105 implementation date) or not. The p-value is from a test of the restriction that means [medians] are equal across subperiod based on t-test [median test]. Offer proceeds equals the offer price times the number of offered shares. Relative offer size is the ratio of offered shares and shares outstanding of the day prior to the offer (*10000). Market value equals the closing price times the number of shares outstanding of the day prior to the offer. Waiting period is the number of days from the filing date to the offer date. Daily volume is the average daily shares volume over the thirty trading days ending 2 trading days before the filing date. Bid-ask spread is the average of time-weighted average of relative quoted spreads over thirty trading days ending 2 trading days before the filing date. Volatility is the average daily intraday volatility over thirty trading days ending 2 trading days before the filing date.

		By Category		
Variables	All	Rule 10b-21	Rule105	*p-value*
N	850	523	327	
Panel A: Offer Characteristics				
Offer price	30.20	28.59	32.78	0.00
	[26.88]	[26.63]	[27.13]	[0.62]
Offer proceeds (mil.)	174.19	131.90	241.84	0.00
	[104.75]	[82.20]	[143.90]	[0.00]
Relative offer size	14.80	14.99	14.44	0.61
	[11.74]	[11.75]	[11.63]	[0.87]
Waiting period	26.74	24.77	29.90	0.00
	[20.00]	[20.00]	[20.00]	[0.82]
Panel B: Firm Characteristics				
Market value (mil.)	1926.03	1374.10	2808.16	0.00
	[750.86]	[648.35	[1012.07]	[0.00]
Daily volume ('000)	122.51	52.70	234.16	0.00
	[48.32]	[33.11]	[125.82]	[0.00]
Bid-ask spread (%)	0.75	0.94	0.43	0.00
	[0.66]	[0.84]	[0.34]	[0.00]
Volatility	2.07	2.12	1.98	0.04
	[1.82]	[1.87]	[1.76]	[0.14]

Table 2
Discounting for Seasoned Offers, 1989 through 2005

This table lists discounting for 850 seasoned offers issued on NYSE from 1989 to 2005. Discounting is defined as -1 times the return from the previous day's closing transaction price to the offer price. The sample is divided conditioned on whether the offer is issued before April 1, 1997 (Rule 105 implementation date) or not.

		By Category		
Discounting	All	Rule 10b-21	Rule 105	*p-value*
N	850	523	327	
Mean	1.25	0.94	1.75	0.00
Median	0.54	0.37	0.99	0.00
Percentage Positive	26%	37%	9%	
Percentage Zero	66%	56%	81%	

Table 3
Intraday Volatility for Seasoned Offers, 1989 through 2005

This table presents the median of the intraday volatility and change in intraday volatility in a given period preceding the offer date of seasoned equity offerings (SEOs) from 1989 to 2005. Intraday volatility is the average daily intraday volatility in a given period. Change in intraday volatility is defined as the average daily intraday volatility in a given period standardized by the mean daily intraday volatility over the benchmark period, which is thirty trading days ending two trading days before the filing date. When comparing the two subperiods, p-values of difference-of-medians $\chi 2$-statistics (from the median test procedure are reported. Pre-offer period here is defined as the last five trading days of the restricted period if the waiting period is longer than five trading days, and the whole restricted period if the waiting period is shorter than five trading days.

Panel A: Intraday volatility (full sample)

	Benchmark period	Restricted period	Pre-offer period	Two days before restricted period
Rule 10b-21 period (N=523)	1.87	1.83	1.82	-
	(0.00)	(0.00)	(0.00)	-
Rule 105 period (N=327)	1.77	1.94	1.94	1.75
	(0.00)	(0.00)	(0.00)	(0.00)
Difference	0.10	-0.13	-0.12	-
	(0.14)	(0.04)	(0.04)	-

Panel B: Change in intraday volatility (full sample)

	Restricted period	Pre-offer period	Two days before restricted period
Rule 10b-21 period (N=523)	-0.03	-0.04	-
	(0.04)	(0.02)	-
Rule 105 period (N=327)	0.07	0.07	-0.03
	(0.00)	(0.00)	(0.07)
Difference	-0.10	-0.11	-
	(0.00)	(0.00)	-

Panel C: Change in intraday volatility (SEOs issued after year 1998)

	Restricted period	Two days before restricted period
Without listed options (N=191)	0.16	-0.04
	(0.00)	(0.12)
With listed options (N=90)	0.00	-0.03
	(0.91)	(0.38)
Difference	0.16	-0.01
	(0.00)	(0.66)

Table 4

Standardized Unexpected Trading Volume for Seasoned Offers, 1989 through 2005

This table presents the median of standardized unexpected trading volume in a given period preceding the offer date of seasoned equity offerings (SEOs) from 1989 to 2005. Standardized unexpected trading volume is calculated using a methodology that is similar to the market model approach.

$$Volume_{it} = \hat{\alpha} + \hat{\beta}_1 \mid R_{it} \mid^{+} + \hat{\beta}_2 \mid R_{it} \mid^{-} + \varepsilon_{it},\ \text{t} \in \text{(estimation period)}$$

$$UVolume_{it} = Volume_{it} - \hat{\alpha} - \hat{\beta}_1 \mid R_{it} \mid^{+} - \hat{\beta}_2 \mid R_{it} \mid^{-}$$

$$SUV_{it} = UVolume_{it} / S_{it}$$

where The estimation period here is defined as the 120 trading days ending two trading days before the filing date. $Volume_{it}$ is turnover ratio for stock i at date t. $\mid R_{it} \mid^{+}$ and $\mid R_{it} \mid^{-}$ denote absolute value of positive daily return and absolute value of negative daily return for stock i at date t, respectively. S_{it} is the standard deviation of ε_{it} in the first model. When comparing the two subperiods, p-values of difference-of-medians $\chi 2$-statistics (from the median test procedure) and p-value of difference-of-means *t*-statistics are reported. Pre-offer period here is defined as the last five trading days of the restricted period if the waiting period is longer than five trading days, and the whole restricted period if the waiting period is shorter than five trading days.

Panel A: Standardized Unexpected Trading Volume (full sample)

	Restricted period	Pre-offer period	Two days before restricted period
Rule 10b-21 period (N=290)	-0.07	-0.04	-
	(0.00)	(0.05)	-
Rule 105 period (N=333)	0.54	0.54	-0.13
	(0.00)	(0.00)	(0.01)
Difference	-0.61	-0.58	-
	(0.00)	(0.00)	-

Panel B: Standardized Unexpected Trading Volume (offers issued after year 1998)

	Restricted period	Two days before restricted period
Without listed options (N=191)	0.68	-0.15
	(0.00)	(0.01)
With listed options (N=90)	0.58	0.02
	(0.00)	(0.65)
Difference	0.10	-0.17
	(0.55)	(0.31)

Table 5
Market-adjusted Returns around Seasoned Equity Offers

Panel A presents cumulative-adjusted returns in a given period around the offer date of SEOs. Market-adjusted returns are calculated as the daily returns in excess of CRSP value-weighted index return. When comparing the two subperiods, p-values of difference-of-medians $\chi 2$-statistics (from the Wilcoxon test procedure) and p-value of difference-of-means *t*-statistics are reported. Panel B and Panel C report the Pearson correlation coefficients between pre-offer cumulative market-adjusted returns and post-offer cumulative market-adjusted returns for the whole sample and for a subsample which contains SEOs with negative pre-offer CAR, respectively. Pre-offer period here is defined as the last five trading days of the restricted period if the waiting period is longer than five trading days, and the whole restricted period if the waiting period is shorter than five trading days.

Panel A: Cumulative market-adjusted returns

	Pre-offer CAR	CAR(0, 5)	CAR(0, 10)	CAR(0, 20)
Rule 10b-21 period (N=290)	-1.58	1.26	1.91	2.64
	(0.00)	(0.00)	(0.00)	(0.00)
Rule 105 period (N=333)	-2.00	1.26	2.03	3.57
	(0.00)	(0.00)	(0.00)	(0.00)
Difference	0.42	0.00	-0.12	-0.97
	(0.53)	(0.94)	(0.72)	(0.23)

Panel B: Correlation Coefficients (full sample)

		CAR(0, 5)	CAR(0, 10)	CAR(0, 20)
Rule 10b-21 period (N=290)	Pre-offer CAR	-0.01	-0.04	-0.03
		(0.71)	(0.36)	(0.56)
Rule 105 period (N=333)	Pre-offer CAR	0.10	0.12	0.10
		(0.07)	(0.03)	(0.08)

Panel C: Correlation Coefficients (for SEOs with negative pre-offer CAR)

		CAR(0, 5)	CAR(0, 10)	CAR(0, 20)
Rule 10b-21 period (N=177)	Pre-offer CAR	-0.08	-0.06	-0.06
		(0.14)	(0.29)	(0.30)
Rule 105 period (N=207)	Pre-offer CAR	0.10	0.16	0.15
		(0.15)	(0.02)	(0.03)

Table 6
Summary of Empirical Predictions Related to SEO Discounting

This table summarizes the directions of expected empirical relationships between the hypothesized explanatory variables and SEO discounting. The hypotheses are discussed in section 5.1. DISCOUNT, is defined as -1 times the return from the previous day's closing transaction price to the offer price. CAP is the natural logarithm of the market value of outstanding equity the day before the offer-day. VOL_E is the median of intraday volatilities over two trading days immediately before an (i.e., from day -2 to day –1). SUV is defined as the median of standardized unexpected trading volumes over two trading days immediately before an offer (i.e. day -2 and day -1). SPREAD is the median of time-weighted average of percentage bid-ask spreads over the two trading days immediately before an offer (i.e. day -2 and day -1). CAR is cumulative market-adjusted return over the five trading days prior to the offer, where market return is CRSP value-weighted index return. CAR_pos (CAR_neg) is equal to CAR if positive (negative) and 0 if otherwise. OFFSIZE is defined as the natural logarithm of the ratio of offered shares to total shares outstanding prior to an offer. ROUND is a dummy variable that equals 1 if the offer is priced at $0.25 increments. BID_PRC equals to percentage difference between closing price and closing bid. PRICE is the natural logarithm of closing transaction price of the day before an offer. UTILITY is a dummy equal to one if the issuer operates in the two-digit SIC industry of 49.

Hypothesis	CAP	VOL_E	SUV	SPREAD	OFFSIZE	CAR	ROUND	PRICE	BID_PRC
Uncertainty	(-)								
Short Sales Rule		(+)	(+)						
Temporary Price Pressure					(+)				
Transaction Cost Savings				(-)					
Offer Price Rounding							(+)	(-)	
Pricing at the Bid									(+)
Rent Expropriation						(+)			

Table 7
SEO Discounts by Category

The table presents mean SEO discounts for quintiles of seasoned offers ranked according to explanatory variables. DISCOUNTING is defined as -1 times the return from the previous day's closing transaction price to the offer price. CAP is the natural logarithm of the market value of outstanding equity the day before the offer-day. VOL_B is the median of intraday volatilities in the benchmark period (i.e. from day -30 to day -21). VOL_E is the median of intraday volatilities over two trading days immediately before an offer (i.e., from day -2 to day –1). SUV is defined as the median of standardized unexpected trading volumes over two trading days immediately before an offer (i.e. day -2 and day -1). SPREAD is the median of time-weighted average of percentage bid-ask spreads over the two trading days immediately before an offer (i.e. day -2 and day -1). CAR is cumulative market-adjusted return over the five trading days prior to the offer, where market return is CRSP value-weighted index return. PRICE is the natural logarithm of closing transaction price of the day before an offer.

	Quintile 1 (Low)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (High)	*p-value*
CAP quintiles	1.12	1.34	1.14	1.06	0.73	0.0181
VOL_B quintiles	0.79	0.92	0.98	0.98	1.71	0.0000
VOL_E quintiles	0.55	0.92	0.91	1.25	1.76	0.0000
SUV quintiles	0.69	0.93	1.03	1.04	1.73	0.0000
CAR quintiles	1.63	0.94	0.78	0.72	1.33	0.0000
SPREAD quintiles	1.42	0.97	0.99	0.83	1.17	0.0118
PRICE quintiles	1.66	1.08	0.93	0.98	0.73	0.0000

Table 8
Determinants of SEO Discounts

This table lists coefficients (*p-value*) from regressions of discounting on firm and offer characteristics. The dependent variable, DISCOUNTING, is defined as -1 times the return from the previous day's closing transaction price to the offer price. CAP is the natural logarithm of the market value of outstanding equity the day before the offer-day. VOL_B is the average intraday volatility during the benchmark period (i.e., 30 trading days ending two trading days preceding an issue's filing date). ΔVOL is median change in intraday volatility over pre-offer period relative to the benchmark period. Pre-offer period is defined as the last five trading days of the restricted period if the restricted period is longer than five trading days and the whole restricted period if the restricted period is shorter than five trading days. SUV is defined as the average standardized unexpected trading volumes during the pre-offer period. SPREAD is the mean of time-weighted average of percentage bid-ask spreads during the pre-offer period. CAR is cumulative market-adjusted return during the pre-offer period, where market return is CRSP value-weighted index return. CAR_pos (CAR_neg) is equal to CAR if positive (negative) and 0 if otherwise. Rule105 is a dummy equal to 1 if the issue takes place after Apr 1, 1997. OFFSIZE is defined as the natural logarithm of the ratio of offered shares to total shares outstanding prior to an offer. ROUND is a dummy variable that equals 1 if the offer is priced at $0.25 increments. BID_PRC equals to percentage difference between closing price and closing bid. PRICE is the natural logarithm of closing transaction price of the day before an offer. SENTI is the cumulative value-weighted return of NYSE during the 120 trading days before a SEO offer. UTILITY is a dummy equal to one if the issuer operates in the two-digit SIC industry of 49.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	-0.73	-0.77	-0.65	-0.69	-1.33	-1.42	-1.74	-1.29
	(0.00)	(0.00)	(0.00)	(0.00)	(0.12)	(0.10)	(0.05)	(0.25)
CAP	-0.35	-0.34	-0.30	-0.30	-0.17	-0.13	-0.13	-0.18
	(0.01)	(0.02)	(0.04)	(0.04)	(0.28)	(0.41)	(0.39)	(0.50)
VOL_B	0.42	0.47	0.43	0.46	0.34	0.29	0.29	0.36
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ΔVOL	-	0.58	-	0.39	0.19	-0.05	-0.02	0.23
	-	(0.00)	-	(0.06)	(0.35)	(0.81)	(0.92)	(0.35)
SUV	-	-	0.19	0.16	0.18	0.15	0.17	0.12
	-	-	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.07)
SPREAD	-	-	-	-	-2.20	-1.61	-0.90	-9.62
	-	-	-	-	(0.92)	(0.94)	(0.97)	(0.72)
OFFSIZE	-	-	-	-	-	-	-	-0.03
	-	-	-	-	-	-	-	(0.95)
CAR_pos	-	-	-	-	-	0.07	0.04	-
	-	-	-	-	-	(0.00)	(0.59)	-
CAR_neg	-	-	-	-	-	-0.06	-0.18	-
	-	-	-	-	-	(0.00)	(0.00)	-
CAR_pos*Rule105	-	-	-	-	-	-	0.02	-
	-	-	-	-	-	-	(0.63)	-
CAR_neg*Rule105	-	-	-	-	-	-	0.08	-
	-	-	-	-	-	-	(0.02)	-
Rule105	0.90	0.82	0.76	0.73	0.85	0.83	1.01	1.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
BID_PRC	-	-	-	-	0.70	0.69	0.72	0.68
	-	-	-	-	(0.00)	(0.00)	(0.00)	(0.00)
ROUND	-	-	-	-	0.94	0.91	0.91	0.92
	-	-	-	-	(0.00)	(0.00)	(0.00)	(0.00)
PRICE	-	-	-	-	-0.09	-0.09	-0.06	-0.14

	-	-	-	-	(0.65)	(0.64)	(0.74)	(0.57)
SENTI	-	-	-	-	-	-	-0.77	-
	-	-	-	-	-	-	(0.27)	-
UTILITY	-0.63	-0.57	-0.64	-0.61	-0.38	-0.32	-0.33	-0.39
	(0.00)	(0.00)	(0.00)	(0.00)	(0.08)	(0.14)	(0.13)	(0.10)
Adj. R-square	0.10	0.11	0.12	0.12	0.18	0.20	0.20	0.18

Figure 1
A Simple Case: Trading Strategies of Informed Short Sellers prior to SEO Pricing

Figure 1 illustrates the different trading strategies of informed short sellers under different rules by using a simple example. Suppose firm A issues seasoned equity offerings during both Rule 10b-21 period and Rule 105 period and the waiting period (the number of trading days between filing date to issue date) is 30 trading days. We also assume that loan period for firm A's equity should not be longer than ten trading days. Informed investors of firm A have two options of covering their short positions. Option 1: Cover short positions using open market shares. This strategy is risky because future market price is uncertain. Option 2: Cover short positions using offering shares. This is less risky because offer price is fixed. However, this strategy is only feasible when (1) the short position is established less than ten trading days before an offer and (2) the short position is not established during the restricted period.

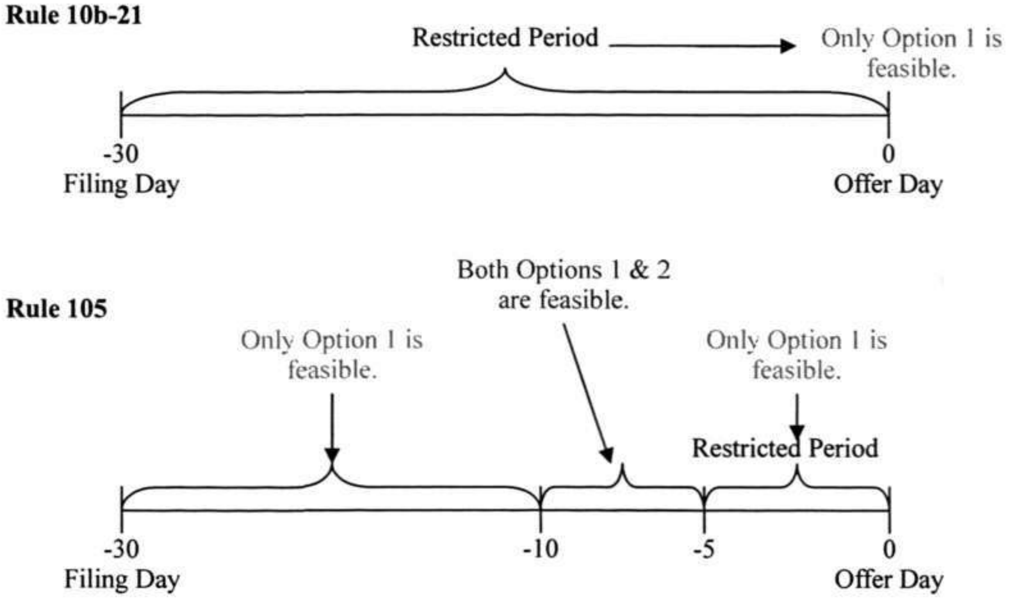
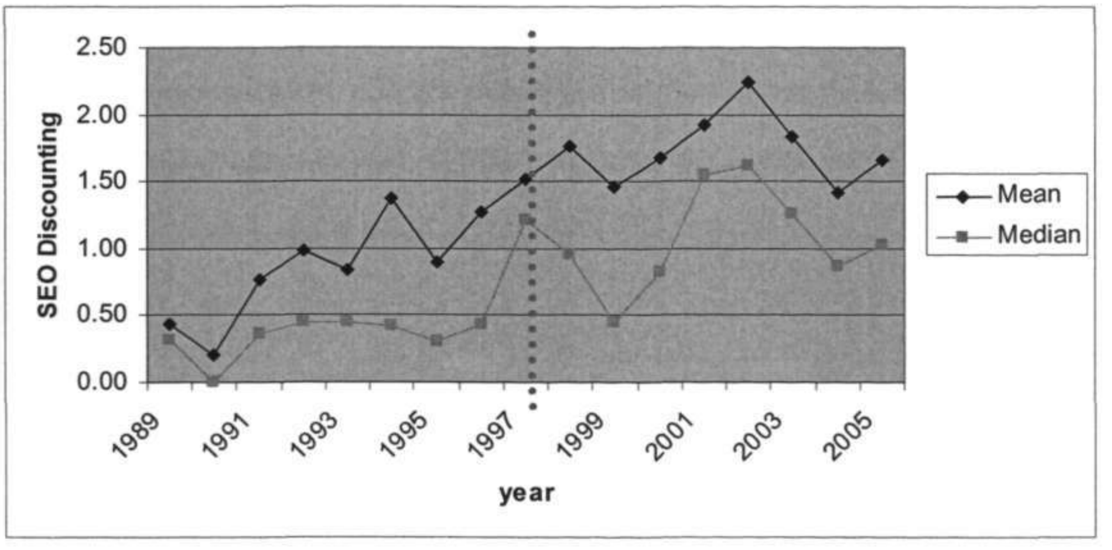


Figure 2
SEO Discounting by Year

The figure plots mean and median SEO discounting by year. Discounting is defined as -1 times the return from the previous day's closing transaction price to the offer price. The sample includes 850 offers on NYSE from 1989 through 2005.



ESSAY II

MANIPULATION ON AN OPTIONS MARKET AROUND SEASONED EQUITY OFFERINGS

MANIPULATION ON AN OPTIONS MARKET AROUND SEASONED EQUITY OFFERINGS

1. INTRODUCTION

Before the U.S. SEC's adoption of Rule 10b-21, it was popularly believed that some investors manipulated stock prices using short selling during a pre-offer period. Market participants assumed that informed investors with favorable private information about issuers would trade contrary to their private information to drive down the open market price. The prices of new offers are typically based on the closing price before pricing; therefore, stock manipulation distorts a security's market price, inhibits the stock market from functioning as an independent pricing mechanism, and erodes the fairness of offer prices.

In 1998, SEC adopted Rule 10b-21, which prohibited a short seller from covering short positions established during the restricted periods with shares purchased in the offering. The Rule's restricted period is typically from the announcement date to the offer date of the SEO. Rule 10b-21 was designed to protect issuers from manipulative short sales immediately before the pricing of an offer. Researchers suspect, however, that the development of the derivative securities market provides potential manipulators with more ways to circumvent Rule 10b-21's restrictions on short sales. Many scholars have studied investors' strategies when faced with short-sales constraints and suggest that options can be substitutes for short sales. They point out that although Rule 10b-21 can curb direct short sales on the stock market it cannot stop synthetic short sales on an options market (see Safieddine and Wilhelm 1996). Diamond and Verrecchia (1987) suggest that the introduction of options can "reduce the cost of establishing what is effectively a short position". Danielsen and Sorescu (2001) find that options can effectively mitigate short-sale constraints and eliminate the overvaluation of stocks. Safieddine and Wilhelm (1996) report a shift from direct short sales on equity markets to synthetic short sales on options markets after the adoption of Rule 10b-21.

In this paper, I modify Easley, O'Hara, and Srinivas' (1998) trading venue model in order to analyze manipulators' trading strategies on equity markets and options markets. The objective of this study is to discover whether manipulators use options as synthetic short sales to manipulate stock prices on a secondary market and whether informed traders with favorable private information can use the options market to disseminate fake unfavorable information to the public.

In the spirit of Easley, O'Hara, and Srinivas (1998), I create a simple model to simulate the trading strategies of potential manipulators, other informed traders, and uninformed traders. The model also includes market makers' rational responses to observed transactions on an equity market and options market. My model predicts that due to short-sales constraints on the spot market and market makers' rational anticipation of manipulation it will be very costly for potential manipulators to distort stock prices using direct short sales or synthetic short sales.

I conduct empirical tests to examine the trading strategies of manipulators who hold favorable information and informed traders with unfavorable information. I find that trading volume and open interest increase substantially on a pre-offer options market, which is consistent with the finding of Safieddine and Wilhelm (1996). I also find that compared to the calls market it appears that the puts market draws trading activities away from the equity market. After dividing the whole sample into two subsamples (i.e., firms with unfavorable information and firms with favorable information), conditioned on the sign of 21-day, post-offer CAR (i.e., CAR[0, 20]), I observe that the abnormally large increases in open interest of puts are likely the result of manipulators' trading activities. I also find that a pre-offer CAR and post-offer CAR are significantly and negatively correlated only in the category with the highest increase in puts' open interest, which reveals that manipulators have to trade contrary to their private information in order to accomplish their goals.

The remainder of the paper is organized as follows. In section 2, I review studies that examine the information flow between equity and options markets and studies that examine manipulative activities on equity or derivative markets. In section 3, I develop my model of multimarket transactions and analyze the trading strategies of different types of traders on equity and options markets. I also discuss the conditions that encourage informed traders to engage in manipulative activities. I describe the data in section 4 and empirically investigate the predictions of my model in section 5. I conclude my study in section 6.

2. LITERATURE REVIEW

The direction of the information flow between an equity market and options market is very important to a manipulator who would like to manipulate stock prices on a secondary market. If stock prices do not respond to the trading volume or trading direction on an options market or if this response is immaterial, it makes no sense for a trader to trade contrary to his or her private information on an options market.

Previous studies show that information flow between an equity market and options market is bidirectional, and under certain conditions, the options market leads the equity market. Mayhew et al. (1995) analyze the impact of the change of equity-option margin and find that margin plays a very important role in the allocation of informed trading across related markets. Easley et al. (1998) model informed traders' choice of trading venue and suggest that when the leverage on an option trade is higher or when the options market is more liquid options trades convey more information than stock trades. Chan et al. (2002) demonstrate that it is quote revisions, not trades on an options market, that provide the market with information. Amin and Lee (1997) observe the trading activities on both markets before quarterly earnings announcements and find that options traders trade on their private information before earnings announcements. Cao et al. (2005) examine the information content on both markets before takeovers.[1] They find that call volume imbalance has more predictive power for the next day's stock return, and conclude that the options market contributes more to price discovery in the presence of a pending extreme information event.

The two-way information flow creates the necessary condition for manipulative activities on an options market. However, manipulators only have the incentives to engage in manipulative trading when the loss incurred on the options market can be totally compensated by profits gained from the issuing market. Safieddine and Wilhelm (1996) argue that if arbitrage links options and equity markets together, based on put-call parity, buying the put or selling the call will drive down stock prices, and investors can easily depress stock prices by trading on the options market. However, the true story is not so simple. Ofek, Richardson, and Whitelaw (2004) indicate that as a result of short-sales constraints the arbitrage between equity and options markets is asymmetrically violated, and stock prices are more likely to exceed the upper bound implied by put or call prices. In addition, as a result of market makers' rational anticipation of manipulation, it is less likely for market makers to adjust quotes down when they observe bear signals, such as selling stocks, writing calls, or buying puts. In other words, if manipulators attempt to mimic the trading behavior of informed traders with unfavorable information, then they have to increasingly trade contrary to their information, which produces more loss in options

[1] Compared to a prescheduled information event (e.g., earnings announcement), takeover announcements may contain more superior private information as a result of the lack of analyst forecasts about takeovers.

transactions. Therefore, the rational expectation of market makers and the asymmetric violation of put-call parity make it difficult to manipulate stock prices through an options market.

A large number of studies have theoretically or empirically examined the feasibility of manipulation in different types of settings. Some studies examine manipulative behaviors on equity markets. Aggarwal and Wu (2004) find that manipulators can achieve their goals in the presence of information seekers, who play a vital role in sustaining manipulation. Mei, Wu, and Zhou (2004) study manipulation from a behavioral finance perspective. They find that when investors are irrational and arbitrages are limited, manipulators can profit from pump-to-dump strategies (i.e., buying a large number of shares to drive the price up and then selling them at a high price).

Some studies examine manipulation by linking equity markets and derivative markets. Kumar and Seppi (1992) model the possibility of manipulations with cash settlements on the futures market. They suggest that uninformed traders can earn profits by establishing a futures position and then manipulating the spot price by trading on the spot market. In their analysis, they find that informed traders only trade on the spot market, and a futures market is only a venue for hedging. They point out, however, that the profit earned from this type of a trading strategy cannot be guaranteed because when more investors trade in this way the profits from manipulation fall to zero. Jarrow (1994) examines how to manipulate the stock market through trading derivative securities to corner the market and suggests that when the stock market and derivative market are closely linked it is difficult for a large trader to manipulate stock prices.

Similar to the setting of my model, Gerard and Nanda (1993) study the potential for manipulation before the SEO. Their model predicts that manipulators will manipulate stock prices if they will be allocated a large number of new shares or if their manipulative activities will not be identified by market makers. However, my study differs from Gerard and Nanda's (1993) model in several aspects. First, Gerard and Nanda's (1993) study is based on the assumption that there are no constraints on short sales, while in my model, short sales are strictly restricted before the pricing of offers. Second, Gerard and Nanda's (1993) model is designed for a unitary equity market. I include the options market in my model. Third, Gerard and Nanda (1993) analyze a manipulator's trading strategies independently. In their model, they assume that other traders' trading directions are given and analyze the behavior of individual manipulator's trading strategies based on his or her observation of other traders' actions. Compared to their static game, I design a sequential model that focuses on the interactions among manipulators, nonmanipulators, and market makers. In my model, each market participant can observe the other participants' actions and adjust his or her actions according to these observations. The design of my model ameliorates Gerard and Nanda's (1993) setting and makes the framework of analysis tally with the real situation on security markets around the SEO.

3. THE MODEL

3.1 Market Participants

In this section, I discuss my multimarket trading model, which is based on the model developed by Easley, O'Hara, and Srinivas (1998). I assume three types of investors in my model. First, there is a group of traders who have knowledge about stock value in the future and choose how to trade based on their private information. For simplicity sake, I also assume the future value follows a binomial distribution. With probability δ, the future stock value is low, $\underline{V}$, and with probability (1- δ), the future value is high, $\overline{V}$. It is necessary to note that in my model informed traders obtain information through their analyses of publicly available sources rather than directly from insiders. Therefore, their trading is permitted by regulation.

Second, among informed traders with favorable private information about the future performance of issuers, there are one or more potential manipulators who plan to buy a large number of new shares in the issuing market. These informed traders have the potential to trade contrary to their private information. That is, despite their favorable private information, they try to confuse market makers by mimicking the trading behavior of informed traders with unfavorable information, such as selling stocks on the equity market, writing calls, or buying puts on the options market. The actions of these manipulators may reduce the informativeness of stock prices and drive stock prices below their true values.

Third, there are a large number of uninformed traders on the market. These traders are assumed to be liquidity traders. The propensity of uninformed traders to buy or sell stocks or options is exogenous. It is assumed that their propensity to buy stock, sell stock, buy put, write put, buy call, or write call are a, b, c, d, e, and f, respectively. The existence of numerous uninformed traders sustains the trading of regular informed traders. Uninformed transactions improve the depths of financial markets, which increases market liquidity and make informed trading hard to detect. However, the dilution effects of these liquidity transactions make it difficult for manipulators to mislead market makers.

Besides these three types of investors, market makers also play an important role in the pricing mechanism. In my model, market makers are assumed to be risk neutral and competitive. They are also rational traders and have a rational anticipation of manipulation. Market makers quote bid and ask prices based on their observation of trading on both an equity market and options market. As a result of the competition among market makers across markets and the homogeneity of their information, there is no arbitrage between an equity market and options market. This means that the call-put parity should hold if there are no additional restrictions.

3.2 Market Transactions, Market Makers' Rational Expectations, and Manipulators' Trading Strategies

As discussed earlier, manipulators distort market prices by confusing market makers with trading activities that appear motivated by negative private information. Figure 1 illustrates the trading propensities of uninformed and informed traders on equity and options markets before SEO. I denote the percentage of informed and uninformed traders using μ and 1- μ, respectively, which will be viewed as an exogenous factor in the following sections. I also denote an investor's propensity to trade on an equity market given he or she is an informed trader with unfavorable information, a regular informed trader with favorable information, or a manipulator using $\alpha_{\underline{V}}, \alpha_{\overline{V}}, \alpha_m$, respectively. Similarly, $\beta_{\underline{V}}, \beta_{\overline{V}}, \beta_m$ are used to denote an option trader's propensity to trade calls on the options market if he or she is an informed trader with unfavorable information, a regular informed trader with favorable information, or a manipulator, respectively. ρ is used to denote the percentage of informed traders with favorable information who trade contrary to their private information.

<Insert Figure 1 here>

Do market makers price stocks based only on trading activities observed on financial markets? The answer is no. Market makers are rational traders, and they expect the presence of manipulators. They *ex ante* estimate the propensity of an informed trader with favorable information to trade contrary to their information and incorporate this assumption into the pricing of stocks. Figure 2 illustrates market makers' assumption that manipulators exist on financial markets. κ is used to denote underwriters' assumption about the conditional probability of manipulation if an investor is an informed trader with favorable information. As a result of the possibility of manipulation, market makers will lower their estimation of low firm value when they observe bear signals.

<Insert Figure 2 here>

3.3 EQUILIBRIUM PRICES ON THE OPTIONS AND EQUITY MARKETS IN THE PRESENCE OF MANIPULATORS

Easley, O'Hara, and Srinivas (1998) discuss equilibrium quotes on options and equity markets in the absence of manipulators. In this section, I analyze the impact of manipulators on equilibrium quotes.

Equilibrium requires prices set by market makers to be equal to their expectation of the stock value based on the received orders' trading directions. I use b_s, a_s, b_c, a_c, b_p, and a_p to denote bid and ask quotes for stocks, calls, and puts, respectively. Also, I assume that the relative number of shares controlled in an option transaction is θ and the relative number of shares controlled in a stock transaction is γ.

I first determine the quotes for stocks. According to the conditions of equilibrium, the bid quote set for a stock should be equal to its conditional expected value if a trader sells the stock. From Figure 2, I know that when a trader chooses to sell stock the probability that the future firm value is low or high is $\delta[\mu\alpha_{\underline{V}}+(1-\mu)b]$ and $(1-\delta)(\mu\kappa\alpha_m+(1-\mu)b)$, respectively. Therefore,

$$b_s = E[V \mid Sell\_Stock] = \frac{\underline{V}\delta(\mu\alpha_{\underline{v}}+(1-\mu)b)+\overline{V}(1-\delta)(\mu\kappa\alpha_m+(1-\mu)b)}{\delta\mu\alpha_{\underline{v}}+(1-\delta)\mu\kappa\alpha_m+(1-\mu)b} \quad (1)$$

For the similar reasons,

$$a_s = E[V \mid Buy\_Stock] = \frac{\underline{V}\delta(1-\mu)a + \overline{V}(1-\delta)[\mu(1-\kappa)\alpha_{\overline{V}} + (1-\mu)a]}{(1-\delta)\mu(1-\kappa)\alpha_{\overline{V}} + (1-\mu)a} \tag{2}$$

Calculating the first-order differentiation coefficient for bid and ask quotes with respect to κ, I find that

$$\frac{\partial b_s}{\partial \kappa} = \frac{(\overline{V}-\underline{V})(1-\delta)\mu\alpha_m\delta(\mu\alpha_{\underline{v}} + (1-\mu)b)}{[\delta\mu\alpha_{\underline{v}} + (1-\delta)\mu\kappa\alpha_m + (1-\mu)b]^2} > 0 \text{ and}$$

$$\frac{\partial a_s}{\partial \kappa} = \frac{(\underline{V}-\overline{V})\delta(1-\mu)a}{[(1-\delta)\mu(1-\kappa)\alpha_{\overline{V}} + (1-\mu)a]^2} < 0$$

A positive (negative) relationship between κ and b_s (a_s) means that an increase in κ leads to an increase in b_s (decrease in a_s). Therefore, when market makers believe there are manipulators on the market, they will narrow the bid-ask spread because the manipulators' reverse trading is beneficial for market makers.

The requirement for equilibrium is also applied to the calls market. A buyer of a call at strike price Y profits $\theta(\overline{V}-Y)$ if the future value of a firm is high and earns nothing if the future value is low. Similarly, for a seller of a call at strike price Y, this contract is worth $\theta(\overline{V}-Y)$ when future value is low, and it is worthless if future value is high. Therefore,

$$\begin{aligned} b_c &= E[Value\_of\_Call \mid Sell\_Call] \\ &= (\overline{V}-Y)\theta * \Pr(\overline{V} \mid Sell\_Call) + 0 * \Pr(\underline{V} \mid Sell\_Call) \\ &= (\overline{V}-Y)\theta \frac{(1-\delta)[\mu\kappa(1-\alpha_m)\beta_m + (1-\mu)f]}{\delta\mu(1-\alpha_{\underline{v}})\beta_{\underline{v}} + (1-\delta)\mu\kappa(1-\alpha_m)\beta_m + (1-\mu)f} \end{aligned} \tag{3}$$

$$a_c = E[Value\_of\_call \mid Buy\_Call]$$
$$= (\overline{V} - Y)\theta \frac{(1-\delta)\mu(1-\kappa)(1-\alpha_{\overline{V}})\beta_{\overline{V}} + (1-\delta)(1-\mu)e}{(1-\delta)\mu(1-\kappa)(1-\alpha_{\overline{V}})\beta_{\overline{V}} + (1-\mu)e} \qquad (4)$$

After examining the impact of κ on a_c and b_c, I get

$$\frac{\partial b_c}{\partial \kappa} = (\overline{V} - Y)\theta \frac{(1-\delta)\delta\mu(1-\alpha_m)\beta_m[\mu(1-\alpha_{\underline{v}})\beta_{\underline{v}} + (1-\mu)f]}{[\delta\mu(1-\alpha_{\underline{v}})\beta_{\underline{v}} + (1-\delta)\mu\kappa(1-\alpha_m)\beta_m + (1-\mu)f]^2} > 0 \text{ and}$$

$$\frac{\partial a_c}{\partial \kappa} = (\overline{V} - Y)\theta \frac{-(1-\delta)\delta\mu(1-\alpha_{\overline{V}})\beta_{\overline{V}}(1-\mu)e}{[(1-\delta)\mu(1-\kappa)(1-\alpha_{\overline{V}})\beta_{\overline{V}} + (1-\mu)e]^2} < 0$$

The differentiation coefficient for Equation 3 shows that the bid quote increases with market makers' estimation of the percentage of manipulators, κ. Similarly, the differentiation coefficient for Equation 4 shows that the ask quote moves inversely with the estimated proportion of manipulators. Therefore, market makers on options markets are also expected to narrow bid-ask spreads as a result of the contribution made by manipulators.

The situation in the puts market is similar. For the buyer of a put, the value of the contract is $\theta(X - \underline{V})$ if a firm's future value is low and zero if otherwise. For the seller of a put, the value of the contract is $\theta(X - \underline{V})$ if a firm's future is high and zero if the future value is low. According to the value of a put contract, ask and bid quotes for a put option are as follows:

$$b_p = E[Value\_of\_put \mid Sell\_Put]$$
$$= (X - \underline{V})\theta \frac{\delta(1-\mu)d}{(1-\delta)\mu(1-\kappa)(1-\alpha_{\overline{V}})(1-\beta_{\overline{V}}) + (1-\mu)d} \qquad (5)$$

$$
\begin{aligned}
a_p &= E[Value\_of\_put \mid Buy\_Put] \\
&= (X-\underline{V})\theta \frac{\delta\mu(1-\alpha_{\underline{v}})(1-\beta_{\underline{v}})+\delta(1-\mu)c}{\delta\mu(1-\alpha_{\underline{v}})(1-\beta_{\underline{v}})+(1-\delta)\mu\kappa(1-\alpha_m)(1-\beta_m)+(1-\mu)c}
\end{aligned}
\tag{6}
$$

$$
\frac{\partial b_p}{\partial \kappa} = (X-\underline{V})\theta \frac{\delta\mu(1-\mu)d(1-\delta)(1-\alpha_{\overline{V}})(1-\beta_{\overline{V}})}{[(1-\delta)\mu(1-\kappa)(1-\alpha_{\overline{V}})(1-\beta_{\overline{V}})+(1-\mu)d]^2} > 0
$$

$$
\frac{\partial a_p}{\partial \kappa} = -(X-\underline{V})\theta \frac{[\delta\mu(1-\alpha_{\underline{v}})(1-\beta_{\underline{v}})+\delta(1-\mu)c](1-\delta)\mu(1-\alpha_m)(1-\beta_m)}{[\delta\mu(1-\alpha_{\underline{v}})(1-\beta_{\underline{v}})+(1-\delta)\mu\kappa(1-\alpha_m)(1-\beta_m)+(1-\mu)c]^2} < 0
$$

Similar to the other markets, the bid quote on a puts market increases and the ask quote decreases as a result of manipulation, and this leads to narrowed bid-ask spreads.

3.4 Profits and Losses of Informed Traders

Given the expectation of manipulative trading before an offer, market makers become less pessimistic when they observe bear signals, such as selling stocks, writing calls, or buying puts. Market makers' optimism about future stock values benefits informed traders with unfavorable private information because they can trade stocks or options at better prices. In addition, market makers' responses to bear signals make it difficult for people to manipulate stock prices. The impact of market makers' rational anticipation on the profits of different types of traders will be shown in the model developed in the following sections.

3.4.1 Profits of Informed Traders with Unfavorable Information

If informed traders know that future stock values will be low, they will choose to either sell stocks, writer calls, or buy puts. Their expected profit from selling stocks on the equity market is $(b_s - \underline{V})\gamma$. Specifically, their profit will be

$$P_{uf\_stock} = (b_s - \underline{V})\gamma = (\overline{V} - \underline{V})(1-\delta)\gamma \frac{\mu\kappa\alpha_m + (1-\mu)b}{\delta\mu\alpha_{\underline{v}} + (1-\delta)\mu\kappa\alpha_m + (1-\mu)b} \qquad (7)$$

The expected profit from writing calls is

$$P_{uf\_call} = b_c = (\overline{V} - Y)(1-\delta)\theta \frac{\mu\kappa(1-\alpha_m)\beta_m + (1-\mu)f}{\delta\mu(1-\alpha_{\underline{v}})\beta_{\underline{v}} + (1-\delta)\mu\kappa(1-\alpha_m)\beta_m + (1-\mu)f} \qquad (8)$$

The expected profit from buying puts is

$$P_{uf\_put} = -a_p + (X - \underline{V})\theta$$
$$= (X - \underline{V})\theta(1-\delta)\frac{\mu\kappa(1-\alpha_m)(1-\beta_m) + (1-\mu)c}{\delta\mu(1-\alpha_{\underline{v}})(1-\beta_{\underline{v}}) + (1-\delta)\mu\kappa(1-\alpha_m)(1-\beta_m) + (1-\mu)c} \qquad (9)$$

Corollary 1: The profits of informed traders with unfavorable information increase with the market makers' anticipated probability of manipulation.

$$\left(\frac{\partial P_{uf\_stock}}{\partial \kappa} > 0, \frac{\partial P_{uf\_call}}{\partial \kappa} > 0 \text{ and } \frac{\partial P_{uf\_put}}{\partial \kappa} > 0\right)$$

As indicated at the beginning of this section, market makers become more optimistic about stocks' future values if they anticipate that some of the bear signals are tricks, and this optimism benefits informed traders with adverse news.

3.4.2 Profits of Nonmanipulative Informed Traders with Favorable Information

When nonmanipulative traders know future stock values will be high, they may choose to buy stocks, buy calls, or write puts.

If investors choose to buy stocks, their expected profit is

$$P_{f\_stock} = (-a_s + \overline{V})\gamma = (\overline{V} - \underline{V})\delta\gamma \frac{(1-\mu)a}{(1-\delta)\mu(1-\kappa)\alpha_{\overline{V}} + (1-\mu)a} \tag{10}$$

If they choose to buy calls, the expected profits will be

$$P_{f\_call} = -a_c + (\overline{V} - Y)\theta = (\overline{V} - Y)\delta\theta \frac{(1-\mu)e}{(1-\delta)\mu(1-\kappa)(1-\alpha_{\overline{V}})\beta_{\overline{V}} + (1-\mu)e} \tag{11}$$

If investors choose to write puts, the expected profits will be

$$P_{f\_put} = b_p = (X - \underline{V})\delta\theta \frac{(1-\mu)d}{(1-\delta)\mu(1-\kappa)(1-\alpha_{\overline{V}})(1-\beta_{\overline{V}}) + (1-\mu)d} \tag{12}$$

Corollary 2: The profits of nonmanipulative informed traders with favorable information increase with the level of market makers' anticipation of manipulation:

$$\left(\frac{\partial P_{f\_stock}}{\partial \kappa} > 0, \frac{\partial P_{f\_call}}{\partial \kappa} > 0 \text{ and } \frac{\partial P_{f\_put}}{\partial \kappa} > 0\right)$$

Informed traders who trade on their private information earn more if market makers suspect the presence of manipulation. In addition, the profits earned by these informed traders increase with the market makers' anticipation of κ. This occurs because the reverse trading of manipulators reduces the true information incorporated into stock prices, and therefore, regular informed traders can buy stocks and calls at relatively lower prices or write puts at relatively higher prices.

3.4.3 Losses of Manipulators in the Secondary Markets

In a continuous market, informed traders do not trade contrary to their private information because this type of trading will result in losses. If these traders are able to purchase a large number of new shares from the issuing market, however, they may choose to disguise their information by trading in the opposite direction.

If manipulators sell stocks, the expected loss will be

$$P_{m\_stock} = (b_s - \overline{V})\gamma = (\overline{V} - \underline{V})\delta\gamma \frac{-\mu\alpha_{\underline{v}} - (1-\mu)b}{\delta\mu\alpha_{\underline{v}} + (1-\delta)\mu\kappa\alpha_m + (1-\mu)b} \tag{13}$$

The expected loss of writing calls will be

$$\begin{aligned} P_{m\_call} &= b_c - (\overline{V} - Y)\theta \\ &= (\overline{V} - Y)\delta\theta \frac{-\mu(1-\alpha_{\underline{v}})\beta_{\underline{v}} - (1-\mu)f}{\delta\mu(1-\alpha_{\underline{v}})\beta_{\underline{v}} + (1-\delta)\mu\kappa(1-\alpha_m)\beta_m + (1-\mu)f} \end{aligned} \tag{14}$$

If manipulators buy puts, the expected loss will be

$$\begin{aligned} P_{m\_put} &= -a_p \\ &= (X - \underline{V})\delta\theta \frac{-\mu(1-\alpha_{\underline{v}})(1-\beta_{\underline{v}}) - (1-\mu)c}{\delta\mu(1-\alpha_{\underline{v}})(1-\beta_{\underline{v}}) + (1-\delta)\mu\kappa(1-\alpha_m)(1-\beta_m) + (1-\mu)c} \end{aligned} \tag{15}$$

Corollary 3: The losses incurred by manipulators decrease with the level of market makers' anticipation of manipulation:

$$\left(\frac{\partial P_{m\_stock}}{\partial \kappa} < 0, \frac{\partial P_{m\_call}}{\partial \kappa} < 0 \text{ and } \frac{\partial P_{m\_put}}{\partial \kappa} < 0\right)$$

From Corollary 3, I know that the anticipation of manipulation reduces manipulators' losses caused by converse trading. However, this is not good news for manipulators because their goal is to drive down stock prices and recoup losses by purchasing shares at a reduced offer price. These reduced losses show that it is difficult for manipulators to distort the stock market using converse trading if their activity is anticipated. Therefore, it is predicted that market makers' rational anticipation of manipulation can, to some extent, inhibit manipulative behaviors.

3.5 TRADING STRATEGIES OF DIFFERENT TYPES OF TRADERS

Once the expected profits and losses of informed traders on the equity, calls, and puts markets are known, we can find the equilibrium for the propensity of each type of trader to choose a particular trading vehicle (i.e., the equilibrium values of $\alpha_{\underline{V}}, \alpha_{\overline{V}}, \alpha_m$ and $\beta_{\underline{V}}, \beta_{\overline{V}}, \beta_m$). Equilibrium requires that the expected profits will be the same in any of the three markets. Specifically, to find equilibrium, I need to discover the values of $\alpha_{\underline{V}}, \alpha_{\overline{V}}, \alpha_m$ and $\beta_{\underline{V}}, \beta_{\overline{V}}, \beta_m$ and make Equations 7 = 8 = 9, 10 = 11 = 12, and 13 = 14 = 15. For simplicity sake, I assume the strike prices of puts and calls are the same (i.e., X = Y).

3.5.1 Trading Strategies of Informed Traders

Proposition 1: Given the constant anticipation about the percentage of manipulators, κ, the values of $\alpha_{\underline{V}}, \alpha_{\overline{V}}, \alpha_m$ and $\beta_{\underline{V}}, \beta_{\overline{V}}, \beta_m$ required by multimarket equilibrium are as follows:

(a) $\alpha_{\overline{V}} = \dfrac{a[(d+e)(1-\mu)(\gamma-\theta)+\gamma(1-\delta)\mu(1-\kappa)]}{(1-\delta)\mu[(d+e)\theta+\gamma a](1-\kappa)}$

(b) $\alpha_{\underline{V}} = \dfrac{[\mu+(1-\mu)(b+c+f)]\kappa\alpha_m+(1-\kappa)(1-\mu)b}{\mu\kappa+(1-\mu)(b+c+f)}$

(c) $\beta_m = 0$

(d) $\beta_{\overline{V}} = \dfrac{e}{d+e}$

(e) $\beta_{\underline{V}} = \dfrac{(1-\mu)f[(1-\alpha_{\underline{V}})-\kappa(1-\alpha_m)]}{[\mu\kappa(1-\alpha_m)+(1-\mu)(c+f)](1-\alpha_{\underline{V}})}$

Condition a predicts the equilibrium propensity of informed traders with favorable information to trade on an equity market. An increase in the relative leverage on an options market, (γ-θ), encourages more informed traders with favorable information to trade on the options market. However, an increase in market makers' anticipation of manipulation encourages more informed traders to trade on an equity market. The informed traders' inclination to trade on the equity market is a result of the asymmetric impact of manipulative trading on these markets. Manipulation on an equity market not only affects market makers' estimation of probability of low future stock value, δ, but also directly improves the supply on the equity market, which drives down stock prices. As discussed in the last section, informed traders with favorable information benefit from manipulative trading. The distortion effects of manipulation through equity trading are more direct and effective than those through options trading. Therefore, informed traders move to an equity market to enjoy more benefits from manipulation.

Condition b shows how manipulators' propensity to trade on an equity market is related to the propensity of informed traders with bad information. It is easily seen that $\alpha_{\underline{V}}$ increases with $\kappa\alpha_m$ because informed traders with negative information can earn more by behaving like manipulators. However, these informed traders would not exactly copy the strategies of manipulators because they are also able to make more profits by concealing their information in large volume uninformed trading. Therefore, relative market depth, b/(b+c+f), is also taken into account by informed traders with bad information.

Condition c shows that all manipulators who trade on an options market will choose to manipulate stock prices by buying puts. This condition is also supported by practice. When the future stock value will be high, the loss incurred by buying a put is fixed, while the loss incurred by writing a call is infinite. In order to limit their losses on an options market, manipulators must buy puts. It is assumed that call trading and put trading of the same volume will depress stock prices equally.

Condition d shows that the propensity of informed traders with favorable information to select calls or puts is a function of the relative depth of the call and put markets. High-trading volume and open interest on a market increase market liquidity, which makes it more difficult for market makers to detect the trading of informed traders. In addition, I find that informed traders' choices of trading venue are not affected by the existence of manipulators.

Condition e indicates that when private information is unfavorable, those informed traders who choose to trade on an options market tend to mimic the trading strategies of manipulators by trading puts, or they trade on options markets with high market depth.

3.6 Mechanism of Distorting Stock Prices and Market Makers' Rational Anticipation

In this section, I investigate when an informed trader with favorable information will choose to manipulate stock prices. In addition, I examine whether market makers' rational anticipation of manipulation will increase the difficulty of manipulative activities.

3.6.1 Manipulative Behavior in the Absence of Market Makers' Anticipation

Before I examine an informed trader's potential to become a manipulator, it is necessary to describe how a manipulator distorts stock prices. Market makers make judgments about the possibility of low future stock values, δ, based on their observation of bear signals on both equity and options markets. If they observe more bear signals on the markets, they will adjust their estimation of δ upwards. If they observe more bull signals, they will decrease the estimation of δ downwards. Manipulators mimic the trading of informed traders with bad information and send fake signals to market makers, and this causes market makers to increase the estimated likelihood of low future stock values and depresses prices in a secondary market.

Assume future stock prices are high. When there are no informed traders to take part in manipulation, market makers' would believe that $\delta = \delta_0$, where $0 \leq \delta_0 \leq 1$. Their belief would switch to $\delta = \delta_1$, where $0 < \delta_0 < \delta_1 < 1$ when all informed traders are manipulators. When future stock prices are high, and with probability ρ informed traders will manipulate stock prices, manipulative trading will cause market makers to believe that the possibility of low future values is $\delta_0 + \rho * (\delta_1 - \delta_0)$. In addition, I assume that an informed trader with favorable information will be allocated λ shares in seasoned equity offerings. Also, for simplicity sake, I assume that offer prices are at quote price, and bid-ask spreads are immaterial to stock prices.

Informed traders determine whether to manipulate stock prices by comparing profits from trading on their private information and profits from manipulation. If uninformed traders trade on their private information, their total expected profits from a secondary market and issuing market are

$$(-a_s + \overline{V})\gamma + (\overline{V} - a_s)\lambda = (\overline{V} - \underline{V})\delta_0(\gamma + \lambda)\frac{(1-\mu)a}{(1-\delta_0)\mu\alpha_{\overline{V}} + (1-\mu)a} \tag{16}$$

compared to the total expected profits from manipulation:

$$\begin{aligned}&(b_s - \overline{V})\gamma + (\overline{V} - b_s)\lambda \\ &= (\overline{V} - \underline{V})[(\delta_1 - \delta_0)\rho + \delta_0](\lambda - \gamma)\frac{\mu\alpha_{\underline{v}} + (1-\mu)b}{[(\delta_1 - \delta_0)\rho + \delta_0]\mu\alpha_{\underline{v}} + (1-\mu)b}\end{aligned} \tag{17}$$

If λ is larger than γ, the total expected profits from manipulation increase with the propensity of manipulation, ρ. The maximum profits are $(\overline{V}-\underline{V})(\lambda-\gamma)\delta_1 \dfrac{\mu\alpha_{\underline{v}}+(1-\mu)b}{\delta_1\mu\alpha_{\underline{v}}+(1-\mu)b}$ when all informed traders choose to conduct converse trading.

Informed traders will not manipulate stock prices if the following condition is not satisfied:

$$(\gamma+\lambda)\delta_0 \frac{(1-\mu)a}{(1-\delta_0)\mu\alpha_{\overline{V}}+(1-\mu)a} < (\lambda-\gamma)\delta_1 \frac{\mu\alpha_{\underline{v}}+(1-\mu)b}{\delta_1\mu\alpha_{\underline{v}}+(1-\mu)b} \tag{I.1}$$

First, the more shares informed traders are allocated (i.e., λ), the more likely they are to distort stock prices. Second, market makers' higher estimation about the probability of informed traders, μ, makes manipulation relatively easier. Third, the higher the propensity of regular informed traders to trade on an equity market ($\alpha_{\underline{V}}$ and $\alpha_{\overline{V}}$), the easier the manipulation will be. Third, the minimum and maximum estimations of probability of low future values, δ_0 and δ_1, are also important factors. The lower value of δ_0 or the higher value of δ_1 promotes manipulative trading. The difference between δ_0 and δ_1 reflects the sensitivity of market makers to bear signals.

3.6.2 Manipulative Trading with the Presence of Market Makers' Anticipation

In section 3.4, I analyze the profits and losses of trading in the presence of market makers' rational anticipation of manipulation. From Equations 13 to

15, I find that market makers' rational anticipation of manipulation increases the difficulty of distorting stock prices by sending bear signaling. In this section, I analyze the impact of rational anticipation on informed traders' manipulative actions.

Given the rational anticipation of market makers, κ, the total expected profits from trading on private information is

$$(-a_s+\overline{V})\gamma+(\overline{V}-a_s)\lambda=(\overline{V}-\underline{V})\delta_0(\gamma+\lambda)\frac{(1-\mu)a}{(1-\delta_0)\mu(1-\kappa)\alpha_{\overline{V}}+(1-\mu)a},$$

while the total expected profits from trading against private information is

$$\begin{aligned}&(b_s-\overline{V})\gamma+(\overline{V}-b_s)\lambda\\&=(\overline{V}-\underline{V})[(\delta_1-\delta_0)\rho+\delta_0](\lambda-\gamma)\frac{\mu\alpha_{\underline{v}}+(1-\mu)b}{[(\delta_1-\delta_0)\rho+\delta_0]\mu\alpha_{\underline{v}}+(1-(\delta_1-\delta_0)\rho-\delta_0)\mu\kappa\alpha_m+(1-\mu)b}\end{aligned}$$

Informed traders decide to distort stock prices only when the following inequality holds:

$$(\gamma+\lambda)\delta_0\frac{(1-\mu)a}{(1-\delta_0)\mu(1-\kappa)\alpha_{\overline{V}}+(1-\mu)a}<(\lambda-\gamma)\delta_1\frac{\mu\alpha_{\underline{v}}+(1-\mu)b}{\delta_1\mu\alpha_{\underline{v}}+(1-\delta_1)\mu\kappa\alpha_m+(1-\mu)b}\tag{1.2}$$

In addition to the specific implications stated in section 5.1, I find that an increase in κ makes manipulation more costly, but it makes nonmanipulative informed trading more profitable. Therefore, informed traders have less incentive to manipulate in the presence of market makers' rational anticipation of manipulation.

3.7 SHORT SALES CONSTRAINTS AND SEO PRE-OFFER MARKET

3.7.1 Short Sales Constraints and Bid-Ask Spreads in Each Market

I examine how quotes are affected when manipulative trading and informative trading on an equity market are restricted. I analyze the pricing strategies of market makers in section 3.3. Equation 1 shows that informed trading on an equity market not only affects market makers' estimation of δ, but also drives down stock prices by breaking the balance between supply and demand. Therefore, it is predicted that even though informed traders can circumvent short-sales constraints by trading on an options market the impact of this type of trading on market makers' quote setting would be smaller.

I anatomize the impact of short-sales constraints on bid and ask quotes here. First, I examine the equity market. Recall Equations 1 and 2. Ask on an equity market is not affected by this constraint; however,

$$\frac{\partial b_s}{\partial \alpha_{\underline{v}}} = \frac{(\underline{V} - \overline{V})\delta\mu(1-\delta)[\mu\kappa\alpha_m + (1-\mu)b]}{[\delta\mu\alpha_{\underline{v}} + (1-\delta)\mu\kappa\alpha_m + (1-\mu)b]^2} < 0$$

$$\frac{\partial b_s}{\partial \kappa\alpha_m} = \frac{(\overline{V} - \underline{V})(1-\delta)\mu\delta[\mu\alpha_{\underline{v}} + (1-\mu)b]}{[\delta\mu\alpha_{\underline{v}} + (1-\delta)\mu\kappa\alpha_m + (1-\mu)b]^2} > 0$$

This means a decrease in $\alpha_{\underline{V}}$ leads to an increase in b_s and narrows the bid-ask spread. This occurs because informed traders move out of the equity market. Conversely, a decrease in α_m drives down bid quotes and widens bid-ask spreads. Manipulators trade against their private information, and their trading benefits market makers. Therefore, bid-ask spread decreases when there is manipulation. When manipulation on an equity market is restricted, market makers should re-open the spread.

It is worth noting that when I compare the bid-ask spread during a pre-restricted period to a restricted period after the adoption of short-sales constraints rule I only need to consider the impacts of $\alpha_{\underline{V}}$ because under the short-sales constraints there is no manipulator in both periods. The decreases in $\alpha_{\underline{V}}$ are associated with the narrowing of bid-ask spreads, so it is predicted that the bid-ask spread decreases during the restricted period under this regulation.

Second, I examine the calls market. From Equations 3 and 4, it is easy to observe that $\frac{\partial b_c}{\partial \alpha_{\underline{V}}} > 0$, $\frac{\partial b_c}{\partial \alpha_{\underline{m}}} < 0$ while $\frac{\partial a_c}{\partial \alpha_{\underline{V}}} = \frac{\partial a_c}{\partial \alpha_{\underline{m}}} = 0$. These facts show that ask quotes are unaffected by short-sales constraints. However, decreases in $\alpha_{\underline{V}}$ lower bid quotes and widen the bid-ask spread, while decreases in α_m increase bid quotes and narrow the bid-ask spread.

Similarly, from Equations 5 and 6, I find that $\frac{\partial a_p}{\partial \alpha_{\underline{V}}} < 0$, $\frac{\partial a_p}{\partial \alpha_m} > 0$ while $\frac{\partial b_p}{\partial \alpha_{\underline{V}}} = \frac{\partial b_p}{\partial \alpha_{\underline{m}}} = 0$. In the puts market, the restriction on $\alpha_{\underline{V}}$ increases the ask quotes and widens the bid-ask spread, while a restriction on α_m decreases the ask quotes and narrows the bid-ask spread.

The movement direction of quote and changes in bid-ask spread on the equity market and options market are summarized in Table 1.

<Insert Table 1 here.>

The market makers on options markets widen the bid-ask spread because more informed traders are driven to the options market. However, market makers anticipate that more manipulators may trade on an options market, and they decrease the bid-ask spread accordingly.

3.7.2 Short Sales Constraints and Venue for Informed Trading

When direct short sales are restricted on an equity market, informed traders with unfavorable information and potential manipulators move to options markets and make synthetic short sales, such as writing calls or buying puts. I examine whether short-sales constraints on an equity market influence informed traders' choice between puts markets and calls markets. For simplicity sake, I assume that the trading of both types of traders is completely prohibited by short-sales constraints. In particular, it is assumed that $\alpha_m = 0$ and $\alpha_{\underline{V}} = 0$ during the SEC rules' restricted period.

Proposition 2: As a result of strict short-sales constraints on an equity market, and given the anticipation of a constant percentage of manipulators, κ, the values of $\alpha_{\overline{V}}$ and $\beta_{\underline{V}}, \beta_{\overline{V}}, \beta_m$ required to attain multimarket equilibrium are as follows:

(a) $\alpha_{\overline{V}} = \dfrac{a[(d+e)(1-\mu)(\gamma-\theta)+\gamma(1-\delta)\mu(1-\kappa)]}{(1-\delta)\mu[(d+e)\theta+\gamma a](1-\kappa)}$

(b) $\beta_m = 0$

(c) $\beta_{\overline{V}} = \dfrac{e}{d+e}$

(d) $\beta_{\underline{V}} = \dfrac{(1-\mu)f(1-\kappa)}{\mu\kappa + (1-\mu)(c+f)}$

Corollary 4: A decrease in $\alpha_{\underline{V}}$ leads to an increase in $\beta_{\underline{V}}$, while a decrease in α_m leads to a decrease in $\beta_{\underline{V}}$.

(Recall that $\beta_{\underline{V}} = \dfrac{(1-\mu)f[(1-\alpha_{\underline{V}}) - \kappa(1-\alpha_m)]}{[\mu\kappa(1-\alpha_m) + (1-\mu)(c+f)](1-\alpha_{\underline{V}})}$ when $\alpha_{\underline{V}} \neq 0$.)

Comparing Proposition 2 with Proposition 1, I find that short-sales constraints have no effect on the venue choice of informed traders with favorable information (i.e., Condition a and Condition c). In addition, manipulators still tend to choose the put markets as a trading venue (i.e., Condition b).

The venue choice of informed traders with adverse information is a little complicated. On one hand, a decrease in α_m leads to a decrease in $\beta_{\underline{V}}$. As manipulators shift to the puts market, informed traders with unfavorable information are more likely to trade puts in order to earn profits by mimicking manipulators. On the other hand, a decrease in $\alpha_{\underline{V}}$ is associated with an increase in $\beta_{\underline{V}}$. This negative relation between $\alpha_{\underline{V}}$ and $\beta_{\underline{V}}$ occurs if too many informed traders crowd onto put markets, and the bear signals become so powerful that both market makers and uninformed traders tend to downgrade their estimation of stock values, which harms informed traders with unfavorable information. Therefore, when too many informed traders are jammed onto a puts market, some informed traders with bad information will move to call markets.

3.7.3 Short Sales Constraints and Manipulative Conducts

Recall the inequality I.1 in section 3.6:

$$(\gamma+\lambda)\delta_0 \frac{(1-\mu)a}{(1-\delta_0)\mu\alpha_{\overline{V}}+(1-\mu)a} < (\lambda-\gamma)\delta_1 \frac{\mu\alpha_{\underline{v}}+(1-\mu)b}{\delta_1\mu\alpha_{\underline{v}}+(1-\mu)b} \tag{I.1}$$

This is the condition required for an informed trader to distort stock prices on an equity market. I find that if informed traders with negative news are banned from trading on an equity market, the value of the right side of the inequality decreases. This means that it is more costly to manipulate stock prices using equity trading under strict short-sales constraints.

Is it also difficult to manipulate stock prices using options trading? The expected profits from trading on private information on an options market is

$$\begin{aligned} & b_p+(\overline{V}-a_s)\lambda \\ &= (\overline{V}-\underline{V})\delta_0[\theta\frac{(1-\mu)d}{(1-\delta_0)\mu(1-\alpha_{\overline{V}})(1-\beta_{\overline{V}})+(1-\mu)d}+\lambda\frac{(1-\mu)a}{(1-\delta_0)\mu\alpha_{\overline{V}}+(1-\mu)a}] \end{aligned} \tag{18}$$

while the maximized expected profits from trading against private information on an options market is

$$\begin{aligned} & -a_p+(\overline{V}-a_s)\lambda \\ &= (\overline{V}-\underline{V})\delta_1[-\theta\frac{\mu(1-\alpha_{\underline{v}})(1-\beta_{\underline{v}})+(1-\mu)c}{\delta_1\mu(1-\alpha_{\underline{v}})(1-\beta_{\underline{v}})+(1-\mu)c}+\gamma\frac{(1-\mu)a}{(1-\delta_1)\mu\alpha_{\overline{V}}+(1-\mu)a}] \end{aligned} \tag{19}$$

Informed traders manipulate stock prices only when (18) < (19).

$$\delta_0[\theta\frac{(1-\mu)d}{(1-\delta_0)\mu(1-\alpha_{\overline{V}})(1-\beta_{\overline{V}})+(1-\mu)d}+\lambda\frac{(1-\mu)a}{(1-\delta_0)\mu\alpha_{\overline{V}}+(1-\mu)a}]<$$
$$\delta_1[\gamma\frac{(1-\mu)a}{(1-\delta_1)\mu\alpha_{\overline{V}}+(1-\mu)a}-\theta\frac{\mu(1-\alpha_{\underline{v}})(1-\beta_{\underline{v}})+(1-\mu)c}{\delta_1\mu(1-\alpha_{\underline{v}})(1-\beta_{\underline{v}})+(1-\mu)c}] \tag{I.3}$$

I find that a decrease in $\alpha_{\underline{V}}$ causes the value of the right-hand side to drop. Therefore, when short-sales constraints drive more informed traders with negative information out of the equity market, manipulation becomes more difficult on the options market.

4. DATA

My model predicts that if informed traders choose to manipulate stock prices on an options market they are more likely to select puts as a manipulating vehicle, and it is very costly for manipulators to successfully distort stock prices under strict short-sales constraints. In the following sections, I empirically examine the trading activities of different types of traders on pre-offer markets.

My sample includes 237 firms that issued SEO on NYSE and had options listed on any U. S. options exchange from April 2002 to December 2004. The SEO sample is obtained from the Security Data Company (SDC). Units, rights, and closed-end funds are excluded from my sample. Following Safieddine and Wilhelm (1996) and Corwin (2003), I designate the day following the SDC offer date as the offer date if on the day following the SDC offer date the trading volume is more than twice the trading volume on the SDC offer date and more than twice the average daily trading volume over the 250 trading days before the offer.

The daily options data are collected from DeltaNeutral.com.[2] The data provided by DeltaNeutral are for every optionable stock, index, and ETF on the U.S. markets. It consists of underlying stock symbols, underlying stock price, option symbol root, option extension, contract type, expiration date, quote date, strike, last transaction price, last bid price, last ask price, trading volume, and open interest.

Intraday stock trade and quote data are obtained from the Trade and Quote Database (TAQ), while stock daily data, such as daily stock price and daily trading volume, are obtained from the Center for Research in Security Prices (CRSP).

5. EMPIRICAL RESULTS

5.1 VOLUME, OPEN INTEREST, AND SPREAD FOR CALLS AND PUTS AROUND SEO PRICING

After the implementation of Rule 10b-21, short sales are restricted on an equity market, and informed traders with unfavorable information and manipulators must move to an options market. We, therefore, expect that trading volume and open interest on an options market will increase before SEO pricing.

<Insert Table 2 here.>

[2]http://www.deltaneutral.com/

Table 2 shows the level and change of volume, open interest, and relative bid-ask spread for calls and puts during the 5 trading days before an offer. The offer date is designated as day 0. The benchmark period is the 30 trading days ending 2 weeks before an offer (i.e., from day -40 to day –11). The changes in trading volume, open interest, and spread, $\Delta Volume$, ΔOI, and $\Delta Spread$, respectively, are calculated as follows[3]:

$$\Delta Volume_t = \log(\frac{Volume_t}{Volume_b}) \tag{20}$$

$$\Delta OI_t = \log(\frac{OI_t}{OI_b}) \tag{21}$$

$$\Delta Spread_t = \log(\frac{Spread_t}{Spread_b}) \tag{22}$$

where t is from day -5 to day 5, and $Volume_b$, OI_b, and $Spread_b$ denote the median of trading volume, open interest, and relative bid-ask spread in the benchmark period, respectively.

In addition, I calculate the ratio of trading volume on a calls (puts) market and stock market and list the value, $call/stock_t$ ($put/stock_t$), and the change, $\Delta call/stock$ ($\Delta put/stock$), in Table 2, column 4:

$$call / stock(put / stock)_t = \frac{Volume_{call,t}(Volume_{put,t})}{Volume_{stock,t}} * 100$$

Similar to $\Delta VOLUME$, $\Delta call/stock$ ($\Delta put/stock$) is calculated as

[3] When calculating the changes in trading volume, open interest, and spread, I use the logarithm changes. This method is recommended by Chae (2005), which pointed out that the transformed measure is very close to normally distributed. The skewnesses for $\Delta Volume$, ΔOI, and $\Delta Spread$ are 0.71, 0.31 and 0.34, respectively.

$$\Delta call/stock(\Delta put/stock)_t = \log(\frac{call/stock_t(put/stock_t)}{call/stock_b(put/stock_b)}) \tag{23}$$

where $call/stock_b$ ($put/stock_b$) is the median of ratios of trading volume on a calls (puts) market and stock market.

Table 2, panel A shows that from day -5 to day -1 trading volume on a calls market increases greatly. The changes during the pre-offer period are between 0.2532 and 0.5335, which are all significant at the 1% level. Open interest on the calls market also increases, and the changes are mostly significant at the 10% level.

Table 2, panel B shows that there are also increases in trading volume on a puts market, which are all significant at the 1% level. As for open interest, during the 5 trading days before an offer, a puts market experiences more increases than a calls market. The increase in puts open interest is between 0.0866 and 0.1140, which are all significant at the 5% level, and on day -4, day –2, and day -1, the increases are significant at the 1% level. My finding of an increase in options open interest is consistent with Safieddine and Wilhelm's (1996) finding.

The movement of informed traders from a stock market to an options market can be seen in the change in call-stock ratio (put-stock ratio) shown in Table 2, column 4. On a calls market, the trading volume grows relative to the trading volume on an equity market. On day -5 and day -2, the change is 0.1725 and 0.1460, which are significant at the 5% level and the 10% level, respectively. In comparison, on a puts market, the changes in trading volume relative to a stock market are more remarkable. From day -5 to day -2, the changes in put-stock ratio relative to the benchmark period are between 0.1690 and 0.2829, which are significant at the 5% level.

As summarized in Table 1, the move of informed traders with unfavorable information to an options market will cause market makers on the options market to increase the bid-ask spread in order to avoid the loss of trading with these informed traders. However, if the informed traders moving to the options market are manipulators, market maker should decrease the spread. Table 2 shows that the relative bid-ask spread on a calls market changes slightly during the 5 trading days before an offer. In contrast, on day -1, the relative bid-ask spread on a puts market drops by about 0.1004, which is significant at the 1% level. The substantial decrease in bid-ask spread on the puts market is likely caused by the mass entry of manipulators onto the puts market.

5.2 CHANGE IN PUT-CALL RATIO BEFORE SEO PRICING

As suggested by Proposition 1 and Proposition 2, when private information is favorable, regardless of the existence of short-sales constraints, manipulators trading on an options market tend to choose the puts market as their trading venue. According to this reasoning, I expect that a puts market will become more active than the calls market before SEO pricing. Specifically, the increases in trading volume and open interest on a puts market should be higher than the increases on a calls market.

To compare the trading activity on a puts and calls market, I estimate the change of put-call ratio before SEO pricing relative to the benchmark period. The values and changes of put-call ratio for volume, open interest, and relative bid-ask spread are presented in Table 3.

<Insert Table 3 here.>

Table 3 shows that the average change in put-call ratio of trading volume during the 5 trading days before an offer is between 7.50 and 20.16, which are significant at the 5% level.[4] In addition, the average change in put-call ratio of open interest increases gradually during the 5 trading days before an offer. On day -5, the change is only about 0.0264, which is not significant, even at the 10% level, while on day -2 and day -1, the change reaches 0.0674 and 0.0794, respectively, which are both significant at the 5% level. The apparent increases in put-call ratio of volume and open interest in the pre-offer period corroborate my expectation that a puts market may attract relatively more trading activity as a result of the existence of potential manipulators.

This is an interesting finding. In almost all the studies that examine the options market around an information event, regardless of whether the event was prescheduled or not, a puts market plays a relatively minor role in disseminating private information compared to a calls market.[5] This occurs

[4]As a result of trading days with no or fewer calls or puts transactions, there are many missing values or outliers in the data about the put-call ratio of trading volume. This could bias my results.

[5]Cao, Chen, and Griffin (2005) find that the average put/call ratio of trading volume decreases by 22.8% in the pretakeover-announcement period. The results of Amin and Lee's (1997) study that examines an options market around an earnings announcement show that during the 3 trading days before an announcement the abnormal trading volume on a calls market are all

because the trading volume and open interest on a calls market are usually higher, and informed traders tend to trade in a more liquid market. Different from other information events, a puts market plays a more active role during the pre-SEO period. Manipulators choose to trade on a puts market in order to reduce their losses.

The put-call ratio of spread shows that the relative bid-ask spread of puts is about three times the size of the spread of calls, and although the ratio decreases gradually during the 5 pre-offer trading days, the change is not obvious. This occurs because the effects of entry of different types of informed trading on the bid-ask spread are mixed. The changes of spreads depend on the balance of effects of both types of informed traders. I examine the change in bid-ask spread under different situations in section 5.4.

5.3 Trading Activities upon Existence of Different Types of Information

As proposed in Proposition 1, sometimes informed traders with unfavorable information will follow the trading activities of manipulators in order to mislead market makers and uninformed traders and trade on better prices. Therefore, in order to differentiate manipulators from informed traders with favorable information, I divide my sample into two subsamples conditioned on the sign of 21-day, post-offer CAR. That is, if CAR[0, 20] is positive (negative), I assume private information before an offer is favorable

significant at the 5% level, while on day -2, the abnormal puts volume is significant at the 5% level.

(unfavorable). I present the changes in trading volume, open interest, and relative bid-ask spread of calls and puts for these two subsamples in Table 4.

<Insert Table 4 here.>

For a firm with private unfavorable information, as shown in Table 4, column 4, the trading volume on a calls market only slightly changes relative to an equity market during the 5 trading days before an offer. The changes in call-stock ratio are between -0.0580 and 0.0682, and they are not significant at the 10% level. In comparison, trading volume on a puts market shows remarkable increases relative to an equity market. During day -5 to day -2, the increases in the put-call ratio are above 11%. In particular, on day -3 and day -2, a puts market experiences a soar in the put-stock ratio of trading volume (i.e., 0.3093 and 0.3214, respectively), which are significant at the 1% level.

In addition, Table 4, column 3 shows that when more traders with unfavorable information choose puts as a trading vehicle the relative bid-ask spread on the calls market declines. On day -5 and day -4, bid-ask spreads decrease by above 0.08 and are significant at the 5% level. In contrast, during day -5 to day -2, bid-ask spreads on a puts market increase slightly. These findings indicate that, as expected by my proposition, before an offer a small number of informed traders with unfavorable information tend to trade on a puts market in the same way as manipulators.

In comparison, Table 4, column 8 shows that for a firm with private favorable information both trading volume on a calls market and trading volume on a puts market relative to an equity market increase during the restricted period. In addition, on the calls market, open interest increases greatly during day -5 and day -4. The increases are about 0.1126 and 0.0922, respectively, which are significant at 5% level. The pre-offer puts market also experiences large increases in open interest. It can be seen from Table 4, column 6 that the increases in open interest are between 0.0841 and 0.1392, which are significant at the 10% level. Compared to a calls market, the increase in open interest on a puts market is more remarkable.

Table 4, column 7 shows that the bid-ask spread of calls increases slightly in the pre-offer period, while the bid-ask spread of puts decreases substantially. During day -4 to day -1, bid-ask spreads on a puts market declines by more than 0.07. In particular, on day -1, the decrease in bid-ask spreads reaches 0.1706, which is significant at the 1% level. The drop in bid-ask spread, accompanied by the increase in trading volume and open interest, indicate that manipulators tend to trade on a puts market before an offer.

A comparison of Table 4, column 2 and column 6 shows that the open interest on a puts market changes slightly for a firm with unfavorable information, while the open interest of puts increases for a firm with private favorable information. Recall Corollary 4. When there are strict short-sales constraints on an equity market, $\beta_{\underline{V}}$ increases with the decline of $\alpha_{\underline{V}}$ because if too many informed traders are jammed onto a put market the bear signals will be too powerful. Therefore, it is advisable for some of these informed traders to trade on a calls market. That is, although informed traders with unfavorable information are inclined to trade puts on a pre-offer market, their inclination is much weaker than the inclination of manipulators.

5.4 Change in Open Interest and Change in Bid-Ask Spread

The findings in Table 1 suggest that the entry of informed traders with unfavorable information will increase bid-ask spreads on an options market, while the entry of manipulators will lead to a decline in bid-ask spreads. Therefore, bid-ask spread increases (decreases) related to an increase in open interest may indicate that there are more informed traders (manipulators) trading on this market. Table 5 presents the relationship between a change in open interest and change in relative bid-ask spread.

<Insert Table 5 here.>

Table 5 shows that the correlation between changes in puts open interest and changes in puts bid-ask spread is -0.1745, which is significant at the 1% level. This means that the active trading on a puts market before an offer is probably caused by the entry of manipulators. However, on a calls market, the correlation between the change of open interest and the change of bid-ask spread is only 0.0308, which is not significant, even at the 10% level. This indicates that neither informed traders nor manipulators dominate the calls trading on a pre-offer market. These findings support my proposition that manipulators are inclined to choose puts as a trade vehicle during a pre-offer period.

The increase in puts open interest is also associated with the lower 5-day pre-offer cumulative abnormal return (CAR). On a puts market, the correlation between the change in open interest and 5-day pre-offer CAR is -0.1484, which is significant at the 5% level. In contrast, I find no obvious relationship between the change in open interest and CAR on a calls market.

5.5 Change in Open Interest and 5-day Pre-offer CAR

I have shown in the previous sections that abnormally high trading activities on a puts market is the result of manipulative activities. Manipulators try to depress stock prices on an equity market by buying puts on an options market. However, the analysis in section 3 suggests that it is difficult for manipulators to drive down stock prices when there are short-sales constraints on an equity market. To reach their goals, manipulators have to trade more puts and lose more money on the options market. Therefore, unless they can profit more on the issuing market, they will not carry out this type of manipulative trading.

In this section, I examine whether manipulators can depress stock prices using this type of manipulative trading. The whole sample is divided into three categories equally sorted by change in open interest. Table 6, panel A and panel B list 5-day pre-offer CAR across categories of change in puts open interest and across categories of change in calls open interest, respectively.

<Insert Table 6 here.>

Table 6, panel A shows that a 5-day pre-offer CAR decreases as a change in puts open interest increases. The pre-offer CAR across the three categories are equal to 0.6983, -2.1436, and -2.9351, respectively. The p value of the ANOVA test is 0.0014, which indicates that CARs are not equal across the three categories. Similarly, the results of nonparametric tests, that is, the Wilcoxon test ($p = 0.0128$) and a median test ($p = 0.0666$), also show that 5-day pre-offer CARs decrease with an increase in open interest on a puts market.

In contrast, I do not find clear evidence of a relationship between 5-day CARs and a change in the open interest of calls. The ANOVA test and both of the nonparametric tests show that 5-day pre-offer CARs are almost equal across the three categories. These findings indicate that a puts market is related to manipulative trading.

5.6 PRE-OFFER CAR AND POST-OFFER CAR

To determine whether manipulators can distort stock price successfully and the cost of this activity, I estimate a correlation between pre-offer CAR and post-offer CAR across three categories of change in open interest on an options market. Kim and Shin (2004) suggest using the correlation between pre-offer CAR and post-offer CAR to determine whether short selling before an offer is information-based or manipulative. Specifically, if pre-offer CAR and post-offer CAR are negatively correlated, a price decline before SEO pricing is considered to be temporary, and the short selling may be manipulative;

otherwise, the price decline is permanent, and the short selling is information-based.

The correlation between CAR[-5, -1] and CAR[0, 5] across the three categories of change in puts open interest and across the three categories of change in calls open interest are displayed in Table 7.

<Insert Table 7 here.>

Table 7, panel A shows that the correlation between CAR[-5, 0] and CAR[0, 5] is -0.0899 for the two categories with the lowest change in puts open interest, but this correlation is not significant, even at the 10% level. In the second category, where the change of open interest is around zero, the correlation is equal to 0.1960, which is statistically significant at the 10% level, but the relationship is positive. In the category with the highest increase in open interest on a puts market, where the minimum value of change in open interest is 0.2317, the correlation is -0.2595, which is significant at the 5% level. This finding shows that although manipulative trading can drive down stock prices the cost of this type of trading is very high because manipulators have to trade more puts to reach their goals. For robustness, I divide the sample into four and five groups, and the results show that the correlation between pre-offer CAR and post-offer are significantly correlated only in the category with the highest change in puts open interest (the results are not reported in the table).

In contrast, if I divide the sample into three categories by sorted change in calls open interest, shown in Table 7, panel B, I cannot find a significant correlation in any of the categories. The results are robust, regardless of the number of the categories.

These results indicate that manipulators can distort stock prices by trading on the puts market, but this type of trading is very costly. In addition, these findings are important for investors. That is, abnormally high buying transactions on a puts market are likely the result of manipulative trading, and investors may consider buying stocks when they observe this type of selling signal on a puts market.

6. CONCLUSION

In this paper, I analyze the trading strategies of potential manipulators, other informed traders, and uninformed traders before an offer on multiple markets. My model predicts that as a result of the short-sales constraints imposed by Rule 10b-21 informed trading will shift to an options market. In addition, compared to other informed traders, manipulators are more likely to select puts as a trading vehicle in order to cap the losses incurred when distorting stock prices. The empirical results support these predictions. I find an increase in options trading volume and open interest during a pre-offer period. I also find that the increase in volume and open interest on a puts market are much larger than the increase on a calls market, which partially reveals the existence of manipulators on the options market.

My analysis of the setting of bid and ask quotes on both equity and options markets suggests that market makers should widen the bid-ask spread when they expect the existence of informed traders and narrow the bid-ask spread when they expect the existence of manipulators. Empirically, when dividing the whole sample into two subsamples, with private favorable information and with private unfavorable information conditioned on the sign of post-offer CAR, I find that the increase in puts open interest is associated with a decrease in bid-ask spread on the puts market for firms with private favorable information, which implies that manipulators tend to choose the puts market as a trading venue.

My model also predicts that as a result of market makers' rational anticipation of manipulation on an options market and constraints on short sales imposed by Rule 10b-21 it will be very costly for a manipulator to distort stock prices, whether through direct short sales on an equity market or through synthetic short sales on an options market. The empirical tests show that pre-offer CAR and post-offer CAR are significantly and negatively correlated only in the category with highest increase in puts open interest, which indicates that manipulators have to spend a large amount of money to depress stock prices.

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Table 1
Effects of Short Sales Constraints on Bid-ask Spreads

	Decrease in $\alpha_{\underline{V}}$	Decrease in α_m
b_s	Increase	Decrease
a_s	No change	No change
Bid-ask spread in the stock market	Decrease	Increase
b_c	Decrease	Increase
a_c	No change	No change
Bid-ask spread in the call market	Increase	Decrease
b_p	No change	No change
a_p	Increase	Decrease
Bid-ask spread in the put market	Increase	Decrease

Table 2
Change of Volume, Open Interest and Spread for Calls, Puts around SEO Pricing

Panel A (Panel B) of this table presents the logarithm of the ratio of the daily call (put) volume, open interests, relative bid-ask spread and call-stock ratio (put-stock ratio) around SEO pricing (i.e., from day -5 to day 5) to medians of call (put) volume, open interests, relative bid-ask spread and call-stock ratio (put-stock ratio) during the benchmark period (i.e., from day -40 to day -11). The call-stock ratio (put-stock ratio) is the daily number of calls (puts) traded relative to the number of shares traded. The null hypothesis of no difference in means between the benchmark period and event days is tested by using the t-test. The sample includes 237 firms that issued seasoned equity offerings (SEOs) on NYSE and had options listed on any U. S. options exchange from April, 2002 to December, 2004. The offer date is designated as day 0.

Panel A: Calls

Day	Volume		Open Interest		Spread		Call/Stock (Volume)	
	Level	Change	Level	Change	Level	Change	Level	Change
-5	724.26	0.38***	23340.38	0.07***	0.1643	-0.02	0.0334	0.17**
		(0.0000)		(0.0098)		(0.5064)		(0.0293)
-4	747.78	0.25***	23720.24	0.06*	0.1634	-0.03	0.0305	0.06
		(0.0026)		(0.0601)		(0.4186)		(0.4142)
-3	585.76	0.32***	20775.27	0.06*	0.1633	-0.00	0.0294	0.09
		(0.0001)		(0.0528)		(0.9783)		(0.2647)
-2	795.01	0.41***	22955.15	0.05	0.1635	-0.02	0.0353	0.15*
		(0.0000)		(0.1091)		(0.6217)		(0.0666)
-1	1124.57	0.53***	22397.54	0.05*	0.1618	-0.00	0.0510	-0.01
		(0.0000)		(0.0813)		(0.9445)		(0.8592)
0	1532.21	1.23***	23131.71	0.08***	0.1687	0.03	0.0191	-0.31***
		(0.0000)		(0.0038)		(0.3998)		(0.0002)
1	1063.74	0.81***	23507.88	0.16***	0.1712	0.03	0.0228	-0.09
		(0.0000)		(0.0000)		(0.4108)		(0.2481)
2	915.78	0.49***	23877.86	0.19***	0.1615	0.00	0.0280	0.01
		(0.0000)		(0.0000)		(0.9501)		(0.9293)
3	848.44	0.42***	23110.39	0.20***	0.1724	0.04	0.0277	0.01
		(0.0000)		(0.0000)		(0.2804)		(0.8553)
4	576.92	0.31***	23153.83	0.21***	0.1683	0.03	0.0230	-0.04
		(0.0006)		(0.0000)		(0.4908)		(0.6047)
5	746.23	0.28***	23187.22	0.23***	0.1756	0.03	0.0297	-0.04
		(0.0051)		(0.0000)		(0.4220)		(0.6540)

*Significant at the 10% level
**Significant at the 5% level
***Significant at the 1% level

Panel B: Puts

Day	Volume		Open Interest		Spread		Put/Stock (Volume)	
	Level	Change	Level	Change	Level	Change	Level	Change
-5	470.23	0.28***	20764.37	0.09**	0.2283	-0.01	0.0218	0.17**
		(0.0008)		(0.0129)		(0.7175)		(0.0262)
-4	674.90	0.29***	21142.41	0.09***	0.2321	-0.01	0.0244	0.18**
		(0.0020)		(0.0098)		(0.7185)		(0.0443)
-3	686.08	0.45***	19151.21	0.09**	0.2278	-0.02	0.0277	0.28***
		(0.0000)		(0.0141)		(0.5288)		(0.0007)
-2	710.71	0.36***	20631.73	0.10***	0.2267	-0.02	0.0290	0.19**
		(0.0001)		(0.0069)		(0.4819)		(0.0276)
-1	717.73	0.39***	20313.36	0.11***	0.2115	-0.10***	0.0223	0.07
		(0.0001)		(0.0039)		(0.0058)		(0.4316)
0	1109.95	0.71***	21153.74	0.14***	0.1979	-0.12***	0.0131	-0.28***
		(0.0000)		(0.0004)		(0.0016)		(0.0006)
1	884.60	0.49***	21492.04	0.16***	0.1945	-0.12***	0.0143	-0.13*
		(0.0000)		(0.0001)		(0.0005)		(0.0915)
2	758.06	0.37***	21637.50	0.18***	0.2075	-0.09**	0.0183	0.08
		(0.0000)		(0.0000)		(0.0125)		(0.2834)
3	448.59	0.32***	20248.20	0.17***	0.2134	-0.10***	0.0195	0.09
		(0.0003)		(0.0001)		(0.0038)		(0.2766)
4	412.00	0.27***	20286.44	0.19***	0.2141	-0.08**	0.0195	0.08
		(0.0024)		(0.0000)		(0.0349)		(0.3478)
5	607.61	0.31***	20418.72	0.22***	0.2196	-0.07*	0.0143	0.12*
		(0.0001)		(0.0000)		(0.0587)		(0.0727)

*Significant at the 10% level
**Significant at the 5% level
***Significant at the 1% level

Table 3
Put-Call Ratios around SEO Pricing

This table presents the logarithm of the ratio of the daily put-call ratio for volume, open interest and the relative bid-ask spread around SEO pricing (i.e., from day -5 to day 5) to medians of put-call ratios of volume, open interests and relative bid-ask spread during the benchmark period (i.e., from day -40 to day -11). The null hypothesis of no difference in means between the benchmark period and event days is tested by using the t-test. The sample includes 237 firms that issued seasoned equity offerings (SEOs) on NYSE and had options listed on any U. S. options exchange from April, 2002 to December, 2004. The numbers in parentheses are p-values.

	Change in Put-Call Ratio					
	Volume		Open Interest		Spread	
Day	Level	Change	Level	Change	Level	Change
-5	1.6066	7.50***	0.9031	0.03	3.1868	0.04
		(0.0046)		(0.4009)		(0.5487)
-4	3.4564	20.16*	1.1845	0.05	3.1719	0.05
		(0.0636)		(0.1607)		(0.4383)
-3	3.4609	11.57***	0.9438	0.05	3.0164	-0.01
		(0.0022)		(0.1574)		(0.8653)
-2	6.1027	11.93**	0.9742	0.07**	2.7370	0.00
		(0.0317)		(0.0493)		(0.9585)
-1	2.1512	8.73***	0.9719	0.08**	2.7284	-0.09
		(0.0004)		(0.0224)		(0.1844)
0	0.9845	3.30***	0.9627	0.08**	2.7685	-0.13*
		(0.0000)		(0.0271)		(0.0567)
1	1.2386	4.36***	0.8055	0.02	2.8055	-0.10
		(0.0000)		(0.5979)		(0.1097)
2	1.3723	6.13***	0.8709	0.00	2.9589	-0.06
		(0.0001)		(0.9279)		(0.3517)
3	2.4612	11.37**	0.8575	-0.02	2.5806	-0.14**
		(0.0408)		(0.6472)		(0.0368)
4	1.2953	6.47***	0.8706	-0.00	2.5458	-0.13*
		(0.0005)		(0.9934)		(0.0650)
5	1.3354	5.17***	0.8742	0.00	2.7998	-0.10
		(0.0000)		(0.9339)		(0.1583)

*Significant at the 10% level
**Significant at the 5% level
***Significant at the 1% level

Table 4
Change in Volume, Open Interest and Spread for Calls, Puts around SEO Pricing

Panel A (Panel B) of this table presents the logarithm of the ratio of the daily call (put) volume, open interests, relative bid-ask spread and call-stock ratio (put-stock ratio) around SEO pricing (i.e., from day -5 to day 5) to medians of call (put) volume, open interests, relative bid-ask spread and call-stock ratio (put-stock ratio) during the benchmark period (i.e., from day -40 to day -11) of subsample with private unfavorable information and subsample with private favorable information. The call-stock ratio (put-stock ratio) is the daily number of calls (puts) traded relative to the number of stocks traded. Private information before an offer is assumed to be favorable (unfavorable) if CAR[0, 20] is positive (negative).The null hypothesis of no difference in means between the benchmark period and event days is tested by using the t-test. The numbers in parentheses are p-values.

Panel A: Calls

	Unfavorable Information (n=123)				Favorable Information (n=114)			
	ΔVolume	ΔOI	ΔSpread	ΔCall/Stock	ΔVolume	ΔOI	ΔSpread	ΔCall/Stock
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
-5	0.21*	0.04	-0.08**	0.01	0.56***	0.11***	0.05	0.36***
	(0.0675)	(0.3097)	(0.0346)	(0.9637)	(.0000)	(0.0076)	(0.2644)	(0.0015)
-4	0.24**	0.02	-0.08**	0.07	0.27**	0.09**	0.04	0.06
	(0.0403)	(0.5676)	(0.0406)	(0.5097)	(0.0285)	(0.0378)	(0.4541)	(0.6197)
-3	0.24**	0.05	-0.06	0.01	0.41***	0.07	0.06	0.17
	(0.0308)	(0.2425)	(0.1750)	(0.9363)	(0.0014)	(0.1180)	(0.2279)	(0.1329)
-2	0.28**	0.05	-0.08*	0.04	0.55***	0.04	0.06	0.26**
	(0.0209)	(0.2063)	(0.0560)	(0.7079)	(0.0000)	(0.3228)	(0.2291)	(0.0249)
-1	0.44***	0.03	-0.06	-0.06	0.64***	0.07	0.06	0.03
	(0.0006)	(0.3436)	(0.1576)	(0.5995)	(0.0000)	(0.1399)	(0.2681)	(0.7770)
0	1.10***	0.06	0.01	-0.39***	1.36***	0.11**	0.05	-0.21**
	(0.0000)	(0.1283)	(0.8568)	(0.0016)	(0.0000)	(0.0111)	(0.3411)	(0.0437)
1	0.70***	0.12***	0.00	-0.16	0.93***	0.20***	0.06	-0.03
	(0.0000)	(0.0023)	(0.9918)	(0.1743)	(0.0000)	(0.0000)	(0.2778)	(0.8218)
2	0.44***	0.14***	-0.02	0.03	0.55***	0.25***	0.03	-0.01
	(0.0003)	(0.0010)	(0.6264)	(0.8245)	(0.0002)	(0.0000)	(0.6439)	(0.9125)
3	0.28***	0.14***	0.04	-0.07	0.57***	0.26***	0.04	0.10
	(0.0077)	(0.0010)	(0.3792)	(0.5041)	(0.0002)	(0.0000)	(0.4986)	(0.4046)
4	0.25**	0.14***	0.03	-0.08	0.39***	0.28***	0.02	0.00
	(0.0307)	(0.0012)	(0.4752)	(0.4657)	(0.0077)	(0.0000)	(0.7509)	(0.9935)
5	0.16	0.15***	0.06	-0.16	0.44***	0.31***	0.00	0.09
	(0.2792)	(0.0008)	(0.2028)	(0.1718)	(0.0053)	(0.0000)	(0.9803)	(0.5052)

*Significant at the 10% level
**Significant at the 5% level
***Significant at the 1% level

Panel B: Puts

	Unfavorable Information (n=123)				Favorable Information (n=114)			
	ΔVolume	ΔOI	ΔSpread	ΔPut/Stock	ΔVolume	ΔOI	ΔSpread	ΔPut/Stock
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
-5	0.24**	0.06	0.04	0.14	0.33***	0.11**	-0.07	0.20*
	(0.0344)	(0.1944)	(0.3679)	(0.1705)	(0.0093)	(0.0217)	(0.1220)	(0.0781)
-4	0.19	0.07	0.05	0.11	0.39***	0.11**	-0.08*	0.24**
	(0.1404)	(0.1647)	(0.3281)	(0.3752)	(0.0034)	(0.0205)	(0.0723)	(0.0468)
-3	0.47***	0.09*	0.03	0.31***	0.42***	0.08*	-0.08*	0.25**
	(0.0002)	(0.0812)	(0.5263)	(0.0063)	(0.0019)	(0.0849)	(0.0753)	(0.0397)
-2	0.48***	0.09	0.03	0.32***	0.21*	0.11**	-0.08*	0.03
	(0.0004)	(0.1028)	(0.5135)	(0.0096)	(0.0937)	(0.0231)	(0.0777)	(0.7632)
-1	0.38***	0.09	-0.03	0.08	0.40**	0.14***	-0.17***	0.06
	(0.0045)	(0.1386)	(0.4971)	(0.5343)	(0.0107)	(0.0045)	(0.0008)	(0.6288)
0	0.91***	0.12*	-0.05	-0.14	0.49***	0.17***	-0.19***	-0.44***
	(0.0000)	(0.0516)	(0.2827)	(0.1959)	(0.0044)	(0.0012)	(0.0005)	(0.0004)
1	0.57***	0.16**	-0.11**	-0.07	0.40***	0.16***	-0.13**	-0.19*
	(0.0001)	(0.0110)	(0.0179)	(0.5176)	(0.0036)	(0.0029)	(0.0121)	(0.0724)
2	0.43***	0.17***	-0.09**	0.17	0.30**	0.20***	-0.08	-0.02
	(0.0003)	(0.0095)	(0.0358)	(0.1048)	(0.0163)	(0.0002)	(0.1454)	(0.8467)
3	0.36***	0.14**	-0.10**	0.13	0.28**	0.20***	-0.09*	0.05
	(0.0082)	(0.0292)	(0.0179)	(0.3150)	(0.0143)	(0.0002)	(0.0828)	(0.6414)
4	0.23**	0.17**	-0.10**	0.03	0.31**	0.22***	-0.04	0.12
	(0.0491)	(0.0100)	(0.0257)	(0.7702)	(0.0215)	(0.0002)	(0.4324)	(0.2859)
5	0.42***	0.19***	-0.13***	0.24**	0.17	0.25***	0.00	-0.01
	(0.0001)	(0.0047)	(0.0039)	(0.0111)	(0.1186)	(0.0000)	(0.9694)	(0.8898)

*Significant at the 10% level
**Significant at the 5% level
***Significant at the 1% level

Table 5
Correlation between Pre-offer CAR, Change in Open Interest and Change in Spread

This table presents Person correlation coefficient matrix. Pre-offer CAR, CAR[-5, -1], is the five-day cumulative abnormal return preceding the offer date of seasoned equity offerings (SEOs). The sample includes 237 firms that the issued seasoned equity offerings (SEOs) on NYSE and had options listed on any U. S. options exchange from April, 2002 to December, 2004. Abnormal returns are calculated using the market model:

$$R_{it} = \hat{\alpha} + \hat{\beta} R_{mt}\text{, where t} = -120, \ldots, -11$$

$$AR_{it} = R_{it} - \hat{\alpha} - \hat{\beta} R_{mt}$$

$$CAR[-5,-1] = \sum_{t=-5}^{-1} AR_{it}$$

ΔOI_call $_{-1}$, ΔSpread_call $_{-1}$, ΔOI_put $_{-1}$ and ΔSpread_put $_{-1}$ denote the logarithm of the ratio of calls open interests, calls bid-ask spread, puts open interests and puts bid-ask spread on the day immediately prior to the offer date (i.e., day -1) to the median of calls open interests, calls bid-ask spreads, puts open interests and puts bid-ask spreads during the benchmark period (i.e., day -40 to day -11), respectively. The numbers in parentheses are p-values.

	CAR[-5, -1]	ΔOI_call $_{-1}$	ΔSpread_call $_{-1}$	ΔOI_put $_{-1}$	ΔSpread_put $_{-1}$
CAR[-5, -1]	1.0000	-0.0406	-0.3890***	-0.1484**	0.3043***
	-	(0.5354)	(<.0001)	(0.0229)	(<.0001)
ΔOI_call $_{-1}$	-	1.0000	0.0308	0.4616***	0.0035
	-	-	(0.6454)	(<.0001)	(0.9579)
ΔSpread_call $_{-1}$	-	-	1.0000	0.1078	-0.4646***
	-	-	-	(0.1061)	(<.0001)
ΔOI_put $_{-1}$	-	-	-	1.0000	-0.1745***
	-	-	-	-	(0.0086)
ΔSpread_put $_{-1}$	-	-	-	-	1.0000
	-	-	-	-	-

*Significant at the 10% level
**Significant at the 5% level
***Significant at the 1% level

Table 6
Five-day Pre-offer CAR by Categories

Panel A (Panel B) of the table lists mean five-day pre-offer CAR, CAR[-5, -1], for terciles of seasoned offers ranked according to ΔOI_put_{-1} (ΔOI_call_{-1}). ΔOI_put_{-1} (ΔOI_call_{-1}) is the logarithm of the ratio of puts (calls) open interest on the day -1 to the median of puts (calls) open interests during the restricted period (i.e., day -40 to day -11). The sample includes 237 firms that issued seasoned equity offerings (SEOs) on NYSE and had options listed on any U. S. options exchange from April, 2002 to December, 2004. Abnormal returns are calculated using the market model:

$$R_{it} = \hat{\alpha} + \hat{\beta}R_{mt}\text{, where t} = -120, \ldots, -11$$

$$AR_{it} = R_{it} - \hat{\alpha} - \hat{\beta}R_{mt}$$

$$CAR[-5,-1] = \sum_{t=-5}^{-1} AR_{it}$$

The null hypothesis of no difference in CAR[-5, -1] across terciles is tested by using the ANOVA test, Wilcoxon test and Median test, respectively. The numbers in parentheses are p-values.

Panel A: CAR[-5, -1] for terciles of SEOs ranked by change in puts open interest

	Five-day Pre-offer CAR							
Change in Puts Open Interests	N	Mean	Std dev	Median	Minimum	Q1	Q3	Maximum
Tercile 1 (Low)	78	0.70	6.69	-0.32	-14.45	-2.32	2.07	25.47
Tercile 2 (Middle)	79	-2.14	5.91	-1.35	-22.76	-4.72	0.55	10.39
Tercile 3 (High)	78	-2.94	6.80	-2.20	-26.18	-4.52	1.64	9.22

Univariate Test across Categories for Pre-offer CAR

ANOVA Test		Wilcoxon Test		Median Test	
F stat	p-value	Chi-Square	p-value	Chi-Square	p-value
6.79	0.00***	8.71	0.01**	5.42	0.07

Panel B: CAR[-5, -1] for terciles of SEOs ranked by change in calls open interest

	Five-day Pre-offer CAR							
Change in Calls Open Interests	N	Mean	Std dev	Median	Minimum	Q1	Q3	Maximum
Tercile 1 (Low)	78	-1.07	6.62	-1.43	-26.18	-3.33	1.17	25.47
Tercile 2 (Middle)	79	-1.51	6.16	-1.16	-22.76	-4.20	1.46	18.02
Tercile 3 (High)	78	-1.81	7.16	-1.07	-25.34	-4.26	2.14	13.12

Univariate Test across Categories for Pre-offer CAR

ANOVA Test		Wilcoxon Test		Median Test	
F stat	p-value	Chi-Square	p-value	Chi-Square	p-value
0.25	0.78	0.02	0.99	1.18	0.55

*Significant at the 10% level
**Significant at the 5% level
***Significant at the 1% level

Table 7
Correlation between Pre-offer CAR and Post-offer CAR by Categories

Panel A (Panel B) of this table lists Person correlation coefficient between pre-offer cumulative abnormal returns, CAR[-5, -1], and post-offer cumulative abnormal returns, CAR[0, 20], for terciles of seasoned offers ranked according to ΔOI_put_{-1} (ΔOI_call_{-1}). ΔOI_put_{-1} (ΔOI_call_{-1}) is logarithm of the ratio of puts (calls) open interest on day -1 to the median of puts (calls) open interests during the restricted period (i.e., day -40 to day -11). The sample includes 237 firms that issued seasoned equity offerings (SEOs) on NYSE and had options listed on any U. S. options exchange from April, 2002 to December, 2004. Abnormal returns are calculated using the market model:

$$R_{it} = \hat{\alpha} + \hat{\beta} R_{mt}, \text{ where } t = -120, \ldots, -11$$

$$AR_{it} = R_{it} - \hat{\alpha} - \hat{\beta} R_{mt}$$

$$CAR[-5,-1] = \sum_{t=-5}^{-1} AR_{it}$$

$$CAR[0,20] = \sum_{t=0}^{20} AR_{it}$$

The numbers in parentheses are p-values.

Panel A: Correlation between CAR[-5, -1] and CAR[0, 20] for terciles of SEOs ranked by change in puts open interest

Change in Put/Call Ratio of Open Interest	N	Correlation (Pre-offer CAR, Post-offer CAR)
Tercile 1	78	-0.0899
		(0.4338)
Tercile 2	79	0.1960*
		(0.0834)
Tercile 3	78	-0.2595**
		(0.0218)

Panel B: Correlation between CAR[-5, -1] and CAR[0, 20] for terciles of SEOs ranked by change in calls open interest

Change in Put/Call Ratio of Open Interest	N	Correlation (Pre-offer CAR, Post-offer CAR)
Tercile 1	78	-0.1254
		(0.2740)
Tercile 2	79	0.0715
		(0.5313)
Tercile 3	78	-0.0760
		(0.5083)

*Significant at the 10% level
**Significant at the 5% level
***Significant at the 1% level

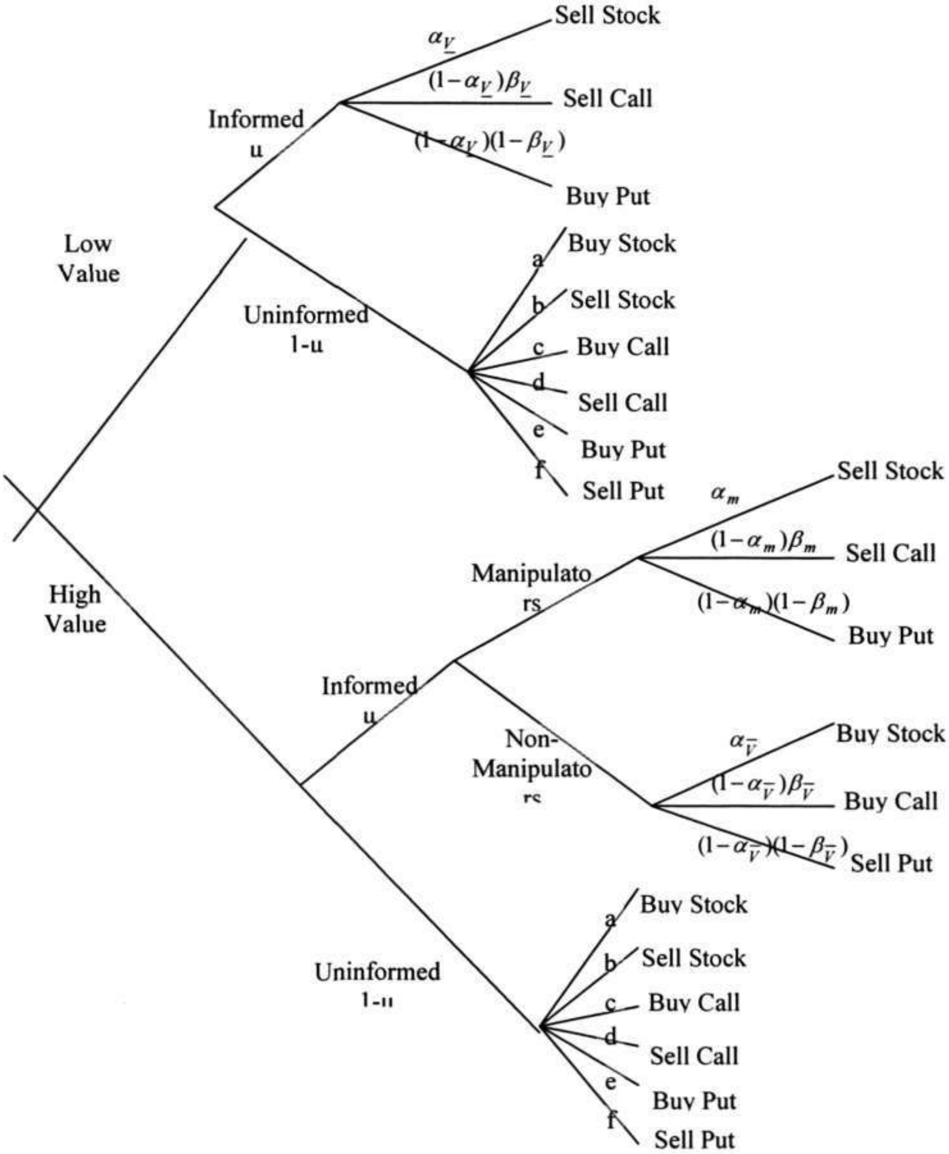

Figure 1: Trading Strategies of Informed and Uninformed Traders

The diagram displays trading strategies of informed and uninformed traders. With probability δ, the future stock value is low, $\underline{V}$, and with probability (1- δ), the future value is high, $\overline{V}$. μ and 1- μ denote the percentage of informed and uninformed traders, respectively. $\alpha_{\underline{V}}, \alpha_{\overline{V}}, \alpha_m$ denote an investor's propensity to trade in the equity market given he is an informed trader with unfavorable information, a "regular" informed trader with favorable information or a manipulator, respectively $\beta_{\underline{V}}, \beta_{\overline{V}}, \beta_m$ denote an option trader's propensity to trade calls in the options market if he is an informed trader with unfavorable information, a "regular" informed trader with favorable information and a manipulator, respectively. ρ denotes the percentage of informed traders with favorable information who trade contrary to their private information.

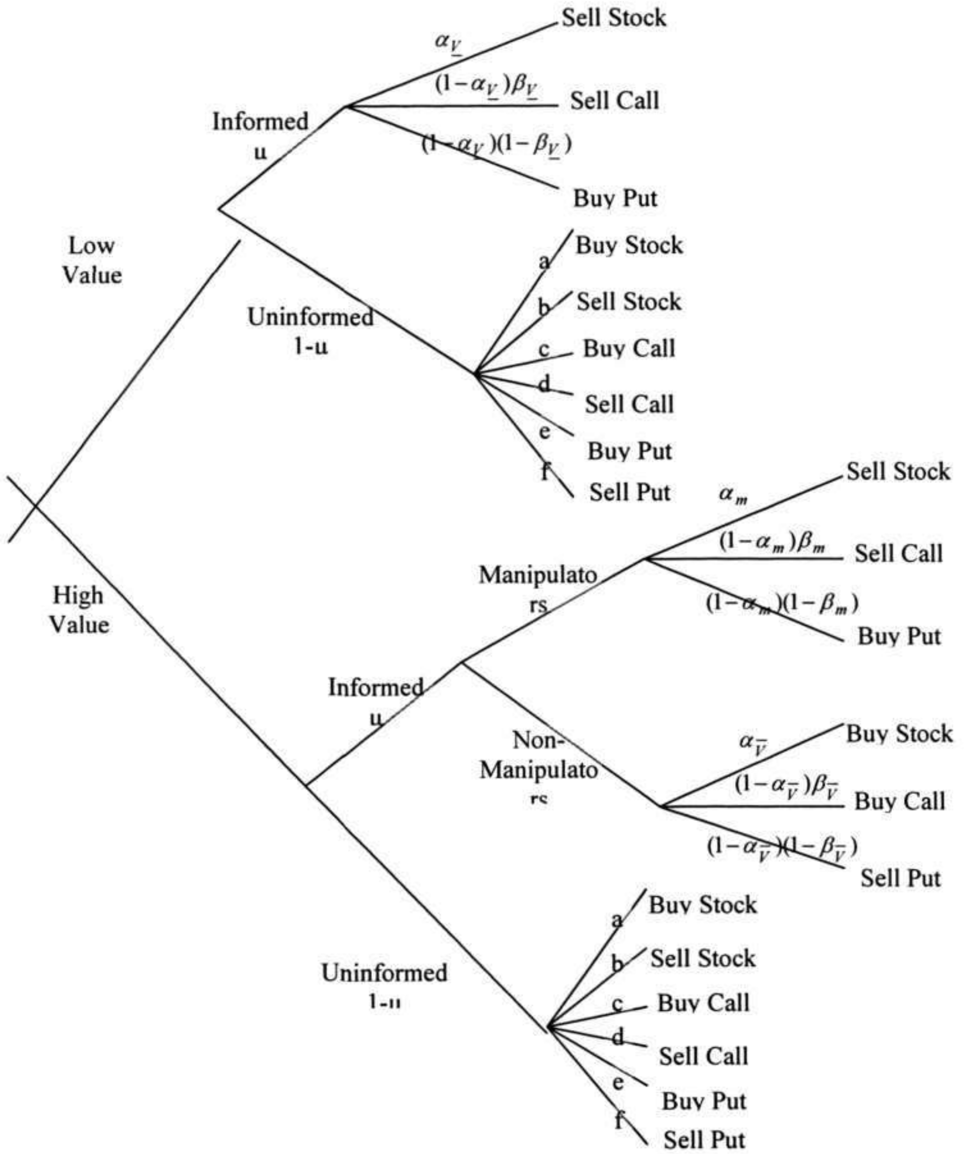

Figure 2: Market Makers' Anticipation on Existence of Manipulators

The diagram displays market makers' anticipation on existence of manipulators. With probability δ, the future stock value is low, $\underline{V}$, and with probability (1- δ), the future value is high, $\overline{V}$. μ and 1- μ denote the percentage of informed and uninformed traders, respectively. $\alpha_{\underline{V}}, \alpha_{\overline{V}}, \alpha_m$ denote an investor's propensity to trade in the equity market given he is an informed trader with unfavorable information, a "regular" informed trader with favorable information or a manipulator, respectively $\beta_{\underline{V}}, \beta_{\overline{V}}, \beta_m$ denote an option trader's propensity to trade calls in the options market if he is an informed trader with unfavorable information, a "regular" informed trader with favorable information and a manipulator, respectively. κ denotes underwriters' expectation of conditional probability of manipulating if an investor is an informed trader with favorable information.

ESSAY III

SEC RULE 105 AND PRICE DISCOVERY ON A SECONDARY MARKET

SEC RULE 105 AND PRICE DISCOVERY ON A SECONDARY MARKET

1. INTRODUCTION

The present study is designed to examine the effects of U.S. SEC Rule 105 on the amount and timing of price discovery on a secondary market during an offer day. Rule 105 was adopted by the SEC on April 1, 1997, to replace Rule 10b-21. Compared to its predecessor, Rule 105 has a shorter restricted period for short sales. In the first essay, I suggest that a shortened restricted period enables informed short sellers to trade before a restricted period and cover their positions using shares in the offering, which would decrease the information efficiency of pre-offer closing prices, make it difficult to interpret the information contained in offer price discounts, and slow down the speed of price discovery on an offer day.

In the present study, I compare SEOs issued during the Rule 10b-21 period to SEO issued during the Rule 105 period. I expect the speed of price discovery in these two periods to be different. Altinkilic et al. (2003) maintain that the difference between the actual and predicted discounts (i.e., discount surprise) is the most important component of information. A positive discount surprise reveals adverse information about a firm, and investors will adjust their evaluation of a firm's stock downward. In contrast, a negative discount surprise reveals favorable information that has not been incorporated into a stock price, and this situation should increase stock price on an offer day. However, if a pre-offer price is less informative, it becomes difficult for investors to judge the accurate information component in a discount surprise. In this situation, price discovery would slow down on an offer day.

I investigate the timing and efficiency of offer-day price discovery for SEOs issued on NASDAQ and the NYSE from 1993 to 2005. Three areas are examined: (1) speed of price adjustment on the offer day, (2) efficiency of price discovery on the offer day, and (3) the fraction of price discovery attributable to private information during the offer day.

First, I compare the amount of information that is incorporated into stock prices during each 15-minute interval throughout an offer day for SEOs issued under Rule 10b-21 and SEOs issued under Rule 105. I find that the price discovery for SEOs issued during the Rule 10b-21 period is much faster than for SEOs issued during the Rule 105 period. I observe a higher fraction of price discovery during the close-to-open period before the adoption of Rule 105. I also find that it takes a shorter time to complete 75% of the offer-day price discovery during the Rule 10b-21 period.

Second, I examine the efficiency of price discovery for each 15-minute interval on an offer day. I find that offer-day price discovery for SEOs issued under Rule 105 is less efficient than offer-day price discovery for SEOs issued under Rule 10b-21. Using the unbiasedness regression inspired by Biais, Hillion, and Spatt (1999), I find that price discovery is not efficient until the last trading hours during the Rule 105 period, but before the adoption of Rule 105, price discovery is efficient during most of the offer day, especially during the first trading hour.

Third, following Hasbrouck's (1991a, 1991b) technique, I estimate the fraction of price discovery attributable to private information. I observe a higher ratio of private information to total information after the adoption of Rule 105, which is consistent with the hypothesis that Rule 105 reduces the information efficiency of pre-offer closing prices and leads to higher information asymmetry on an offer day.

Overall, the results show that Rule 105 causes a low level of information efficiency for pre-offer stock prices and makes it difficult to interpret the information contained in SEO discounts and SEO discount surprises. As a result, price discovery is slowed down on an offer day during the Rule 105 period.

The remainder of the paper is organized as follows. Section 2 describes the sample data and summary statistics. Section 3 examines the amount and timing of price discovery on an offer day, analyzes the efficiency of offer-day price discovery and investigates the fraction of price discovery attributable to private information. Section 4 contains some conclusions.

2. DATA AND SAMPLE CHARACTERISTICS

2.1 SAMPLE SELECTION

My sample of SEO firms is obtained from the Thomson Financial Securities Data Company (SDC) new issue database, which provides data related to the offering characteristics of SEO firms, such as offer price, offer proceeds, shares issued, and number of shares outstanding. The sample consists of the seasoned equity issues of ordinary common shares of NASDAQ and NYSE from January 1993 to December 2005. I exclude unit offerings, shelf offerings, closed-end funds, real estate investment trusts (REIT), and American Depository Receipts (ADR) from my sample. In addition, I only include firms with offer prices higher than US$5 and firms that are in NYSE's Trade and Quote (TAQ) database or the CRSP database. The final sample contains 2,553 SEOs, including 1,890 NASDAQ SEOs and 663 NYSE SEOs.

Intraday data were collected from the NYSE TAQ database. Raw transactions data, however, may contain some problems, such as the existence of data outside regular trading hours. Therefore, observations that lie outside the trading interval between 9:30 a.m. and 4:00 p.m. Eastern Time are not included in the present study. Market information, such as stock prices, returns, and market capitalization, was obtained from the CRSP database.

The SDC database usually records the date of announcing offer prices as an offer date. Some firms, however, announce new offer prices after the market closes, and the effective offer date should be the next trading day after the SDC offer date. I follow the method suggested by Corwin (2003) and Lease et al. (1991) to correct the SDC offer date. In particular, I identify the date following the SDC offer date as the effective offer date if the trading volume on the day following the SDC offer date is more than twice the volume of the SDC offer date and more than twice the average daily trading volume over the 250 trading days before the offer date.

2.2 Descriptive Statistics

<Insert Table 1 here.>

Table 1 contains summary statistics that describe firm and offer characteristics associated with SEOs issued under Rule 10b-21 and Rule 105. Issuing firms that issue SEOs after the adoption of Rule 105 are larger, with an average market capitalization of US$1,050.46 million on NASDAQ and US$2,751.59 million on NYSE. Average offer proceeds for SEOs issued under Rule 105 are much larger as a result of higher level of the US stock market during Rule 105 period.

<Insert Table 2 here.>

Table 2 summarizes trading activities and price changes on an offer day for SEOs issued under Rule 10b-21 and Rule 105. NYSE-issued SEOs open later than NASDAQ-issued SEOs. On average, NYSE-issued SEOs open 16 minutes after 9:30 a.m. during the Rule 10b-21 period and 15 minutes after the market open during the Rule 105 period. NASDAQ-issued SEOs open less than 3 minutes after the market open during the Rule 10b-21 period and less than 1 minute after the open during the Rule 105 period. I do not find an obvious change in SEO discounts for NASDAQ-issued SEOs after the adoption of Rule 105, but I observe a significant increase in SEO discounts for NYSE-issued SEOs.

For NASDAQ-issued SEOs, the average price change from close to close increases after the adoption of Rule 105, but average price change from close to open decreases after the implementation of this rule. This finding indicates that a smaller portion of price discovery occurs before the market open during the Rule 105 period. For NYSE-issued SEOs, I do not observe an obvious change in average close-to-close returns during the Rule 105 period, but there is a large decrease in average close-to-open returns during this period.

For NASDAQ-issued SEOs, the opening trading volume is 0.48% of offered shares during the Rule 10b-21 period, but it decreases to 0.29% during the Rule 105 period. The average offer-day trading volume, however, increases after the adoption of Rule 105, which leads to a lower ratio or opening trading volume and offer-day trading volume. For NYSE-issued SEOs, the ratio of opening trading volume and offer-day trading volume also decreases during the Rule 105 period. These findings indicate that after the adoption of Rule 105 less traders trade at market open. Admati and Pfleiderer (1988) suggest that the timing of liquidity trading depends on the degree of competition among informed traders, and the timing of informed traders depends on the degree of concentration of liquidity trading. In particular, liquidity traders tend to trade when the opinions of informed traders are homogeneous and the competition between informed traders is intense. However, Rule 105 complicates the interpretation of information contained in offer prices, which leads to the diversity of informed traders' opinion and weakens the competition among informed traders. The exacerbation of terms of trade for liquidity traders results in thin trading of liquidity traders, which, in turn, leads to thin informed trading at market open.

3. EMPIRICAL RESULTS

3.1 PRICE DISCOVERY

In the previous sections, I analyze the effects of Rule 105 on speed of price discovery on an offer day. I expect that Rule 105 will reduce the information content of offer prices and slow down the process of price discovery. In this section, I estimate the amount of new information incorporated into stock prices during each 15-minute interval for the Rule 10b-21 period and Rule 105 period.

3.1.1 Weighted Price Contribution (WPC)

Following Barclay and Hendershott (2003), Barclay and Warner (1993), and Cao et al. (2000), the measure used to estimate the amount of price discovery is weighted price contribution (WPC) during each period.

For each 15-minute interval i, WPC is determined as

$$WPC_i = \sum_{s=1}^{S}\left(\frac{|ret_s|}{\sum_{s=1}^{S}|ret_s|}\right)*\left(\frac{ret_{i,s}}{ret_s}\right) \tag{1}$$

where $ret_{i,s}$ is the logarithmic price change over interval i for stock s, and ret_s is close-to-close stock return for stock s. The second term measures the fraction of price change during interval i relative to close-to-close return. The first term is the weight that is used to measure the contribution of each stock to the total absolute price change of all stocks on an offer day.

<Insert Table 3 here.>

As Barclay and Warner (1993) note, the use of a weighting scheme in a calculation of average price contribution reduces the effects of extreme values among observations. In particular, if absolute values of close-to-close return are very small, while the price change in some interval is relatively large, then the fraction of price change in that interval will be abnormally high, which will pull up the average price contribution in the interval. Weighted price contribution can avoid this problem by downweighting observations with a small absolute price change on an offer day. The distribution of weighted mean is unknown, however, and as a result, it is difficult to calculate the statistical inferences for the weighted average of price contribution and compare statistically the amount of price discovery between SEOs issued during the Rule 10b-21 period and the Rule 105 period. Therefore, I employ a bootstrap technique to conduct univariate tests for WPC and gauge the statistical difference in WPC (see Appendix for details).

Table 3, panel A contains interval-by-interval WPC for close-to-close returns for the two NASDAQ-issued subsamples conditioned on whether or not the offer is issued before April 1, 1997 (i.e., Rule 105 implementation date). This analysis produces two main results. First, most offer-day price discovery occurs during the close-to-open period and the first trading hour and the last trading hour of an offer day. For stocks issued on NASDAQ, approximately

40% of the price discovery occurs before market open, approximately 20% occurs during the first trading hour, and approximately 10% occurs during the last trading hour. Second, the speeds of price discovery for SEOs issued during the Rule 10b-21 period are much faster than the speed of price discovery for SEOs issued during the Rule 105 period. During the Rule 10b-21 period, 44.66% of the price discovery occurs during the close-to-open period. During the Rule 105 period, only 36.86% occurs during the close-to-open period. The bootstrap test shows that the difference in close-to-open WPC is significant at the 1% level. After further analysis, I find that the amount of price discovery declines rapidly after the open and falls close to zero after ¾ trading hours during the Rule 10b21 period, but during the Rule 105 period, price discovery persists throughout most of a trading day.

Table 3, panel B presents interval-by-interval WPC for close-to-close returns for NYSE-issued SEOs during the Rule 10b-21 period and the Rule 105 period. As with the results for NASDAQ-issued stocks, I observe a slower price discovery after the adoption of Rule 105. During the Rule 10b-21 period, 56.73% of the price discovery occurs before market open, but during the Rule 105 period, 52.82% occurs before market open. In addition, significantly positive price discovery lasts for a shorter amount of time during the Rule 10b-21 period than during the Rule 105 period.

3.1.2 Cumulative Weighted Price Contribution (Cum_WPC)

Table 4, panel A reports the cumulative weighted price contribution (Cum_WPC) based on close-to-close returns during each 15-minute interval for NASDAQ-issued SEOs. I find that the amount of price discovery increases monotonically during trading hours. Notably, the price discovery is faster for SEOs issued before the adoption of Rule 105. During the Rule 10b-21 period, it takes 1.5 trading hours to complete 75% of the price discovery. During the Rule 105 period, it takes 2.25 trading hours to complete 75% of the price discovery. In addition, during the first trading hour, the difference in price discovery for the two periods is significant at the 1% level. The gap shrinks gradually over time, and the difference in price discover for the two periods becomes insignificant after 3 trading hours.

<Insert Table 4 here.>

Table 4, panel B contains the cumulative weighted price contribution during each 15-minute interval for both categories of SEOs. Similar to the results in Table 4, panel A, Rule 105 reduces the speed of price discovery. During the Rule 10b-21 period, it takes less than 1 trading hour to complete 75% of the price discovery; however, during the Rule 105 period, it takes 1.75 hours to complete 75% of the price discovery.

3.2 EFFICIENCY OF PRICE DISCOVERY

3.2.1 Unbiasedness Regression

Biais et al. (1999) suggest that the orders placed during the preopen period could be noisy (i.e., noise hypothesis) or informative and equal the conditional expectation of the asset value (i.e., learning hypothesis). In a similar way, the price discovery that occurs during trading hours may be the result of noisy trading by liquidity traders. Liquidity trading could result in a temporary price move that would eventually revert. Therefore, it is necessary to estimate the informativeness of stock prices and the efficiency of price discovery by using an unbiasedness regression inspired by Biais, Hillion, and Spatt (1999).

The following unbiasedness regression model is estimated:

$$close - close = \alpha + \beta_i(price_i - close) + \varepsilon_i \tag{2}$$

where I refer the closing price of an offer day to a new equilibrium value for the asset and take offer price as the proxy for old market equilibrium prices. $price_i$ indicates the stock price for each 15-minute interval.

I estimate the cross-sectional regression for each 15-minute interval during an offer day. If the indicative price is conditional on an expectation of asset value, I expect to find that the slope of the coefficient is equal to one. If otherwise, the price change during the first trading hours are mainly the result of noisy trading, and the coefficient is expected to be significantly different from 1.

<Insert Table 5 here.>

Table 5, panel A contains the slope coefficients for NASDAQ-issued SEOs. I find that the slope coefficients are not significantly different from 1 during the first and last trading hours before the adoption of Rule 105, which indicates that the trading activities are informative and stock prices are efficient during these periods. After the adoption of Rule 105, the slope coefficients are different from 1 until the last trading hour before market close, which indicates that price discovery is less efficient during most of the trading period. In addition, the bootstrap test for difference in slope coefficients between the Rule 10b-21 period and the Rule 105 period suggests that offer-day price discovery is more efficient during the Rule 10b-21 period than during the Rule 105 period.

Table 5, panel B presents the slope coefficients for the NYSE-issued SEOs. As with the results for NASDAQ-issued SEOs, I find that offer-day price discovery is more efficient before the adoption of Rule 105 than after the adoption of this rule. During the Rule 10b-21 period, the slope coefficients for each interval are not all significantly different from 1, but during the Rule 105 period, the slope coefficients are only close to 1 during the first half hour of trading and the last hour of trading. The bootstrap test supports the idea that offer-day price discovery is more efficient during the Rule 10b-21 period.

In addition, I estimate the adjusted *R* squares for each interval and for each category of SEOs. Adjusted *R* square can reflect the uncertainty about the equilibrium of stock value after I take into account the information contained in the indicative stock prices. The uncertainty should decrease when more information is incorporated into stock prices, and the adjusted *R* square should increase.

Table 5, panel A shows that the *R* squares for both categories of SEOs increase monotonically during trading hours. During the Rule 10b-21 period, the *R* square increases rapidly from 0.51 to 0.81 during the first 1.5 trading hours. After 11:00 a.m., the *R* square continues to increase, but the speed slows down until it reaches 1 at market close. During the Rule 105 period, the *R* square increases rapidly from 0.42 to 0.80 during the first 2 trading hours, and then it slows down. In particular, during the first 1.5 trading hours, the adjusted *R* square for SEOs issued during the Rule 10b-21 period is significantly higher than the adjusted *R* square for SEOs issued during the Rule 105 period. These findings show that the efficient price discovery for SEOs issued during the Rule 10b-21 period occurs much earlier than the efficient price discovery for SEOs issued during the Rule 105 period. The results are similar for NYSE-issued SEOs and NASDAQ-issued SEOs.

3.2.2 Convergence of Stock Price to Equilibrium Asset Value

In the last section, I point out that the more information that is incorporated into a stock price, the closer the stock price will be to the market equilibrium asset value. Therefore, a convergence tendency between stock price and close price should be observed during an offer day.

I measure the extent of divergence between stock price and offer-day closing price using the following formula:

$$divergence_i = abs(\log(close / price_i)) \tag{3}$$

where close is the closing price on an offer day, and $price_i$ is price at the end of each 15-minute interval during an offer day.

<Insert Table 6 here.>

Table 6, panel A shows the extent of divergence from an offer day's closing price in each 15-minute interval for NASDAQ-issued SEOs. I find that divergence between stock price and closing price shrinks quickly during the 2 trading hours after market open. In particular, the divergence of SEOs issued before the adoption of Rule 105 is much smaller than the divergence of SEOs issued after the implementation of this rule. During the Rule 10b-21 period, the average divergence is 2.86 at market open. During the Rule 105 period, the average divergence is 3.98. Until the last half-hour of trading, the divergence for NASDAQ-issued SEOs is much lower than the divergence for NYSE-issued SEOs.

Table 6, panel B shows similar results for NYSE-issued SEOs. At market open, the average divergence between stock price and offer-day closing price for SEOs issued during the Rule 10b-21 period is 1.39 compared to 1.91 for SEOs issued during the Rule 105 period. In addition, throughout the offer day, the divergence for SEOs issued during the Rule 10b-21 period is much lower than the divergence for SEOs issued during the Rule 105 period.

3.3 Public versus Private Information

The implementation of Rule 105 has resulted in less informative pre-offer prices, which makes it difficult to interpret the information contained in offer prices. Therefore, during the Rule 105 period, the ratio of public information on an offer day should be relatively lower than the ratio of public information on an offer day during the Rule 10b-21 period.

In this section, I decompose information into its public and private components following Hasbrouck's (1991a, 1991b) technique. I estimate the following VAR models for each category of SEOs:

$$r_t = \sum_{i=1}^{p} \alpha_i r_{t-i} + \sum_{i=0}^{p} \beta_i x_{t-i} + \varepsilon_{1,t} \tag{4}$$

$$x_t = \sum_{i=1}^{p} \gamma_i r_{t-i} + \sum_{i=0}^{p} \delta_i x_{t-i} + \varepsilon_{2,t} \tag{5}$$

where r_t denotes the percent change (in logarithm) in the quote midpoint subsequent to the t-th transaction. x_t denotes the trading direction inferred by Lee and Ready's (1991) method, which equals 1 for a buyer-initiated order and 0 for a seller-initiated order. The lags used in the equations are 10.

<Insert Table 7 here.>

Table 7 reports the ratio of private information to total information (σ_x^2/σ_v^2) for each category of SEOs. Consistent with my expectation, the ratio of private information to total information increases after the adoption of Rule 105. For SEOs issued on NASDAQ, the fraction of price discovery attributable to private information is 8.03% during the Rule 10b-21 period and 14.68% during the Rule 105 period. For NYSE-issued SEOs, the ratio of private information increases from 29.07% to 32.73% after the adoption of Rule 105.

4. CONCLUSION

In 1997, the SEC adopted Rule 105 to shorten the restricted period for short sales in order to reduce the adverse effects on informed short sales. The shortened restricted period, however, enables informed traders to trade in a relatively narrow period of time immediately before the start of a restricted period and cover their short positions using offering shares. The timing of informed trading would lead to the lower information efficiency of pre-offer stock prices and make it difficult to interpret the information component in offer price discounts, which could slow down price discovery on an offer day.

Using a bootstrap technique, I compare the speed of price discovery throughout an offer day for SEOs issued during the Rule 10b-21 period and the speed of price discovery for SEOs issued during the Rule 105 period. I find a substantial decrease in the speed of price discovery after the adoption of Rule 105.

I find that the trades during an offer day have large temporary price impacts that produce noise in stock prices and price discovery is less efficient after the adoption of Rule 105. In addition, the convergence of stock prices to equilibrium asset values is lagged under Rule 105.

There is a higher fraction of price discovery attributable to private information under Rule 105, which is consistent with my hypothesis that a shortened restricted period makes it difficult to interpret the information contained in offer price discounts and causes high information asymmetry on an offer day.

APPENDIX

I generate a bootstrap distribution under the null hypothesis of no difference of information efficiency for pre-offer stock price between the Rule 10b-21 period and the Rule 105 period. I merge a sample of 851 (311) NASDAQ (NYSE) SEOs issued before the adoption of Rule 105 and a sample of 1039 (352) NASDAQ (NYSE) SEOs issued after the adoption of Rule 105. A sample of 851 (311) SEOs is taken randomly (with replacement) from the combined sample and called the Rule 10b-21 sample, and a sample of 1039 (352) SEOs is taken randomly (with replacement) from the combined sample and called the Rule 105 sample. I then calculate weighted average price discovery and convergence of stock price to equilibrium value and run Biais, Hillion, and Spatt's (1999) unbiasedness regression model to get β and adjusted R square. I repeat this procedure 2,000 times to build up a distribution of sample statistics under the null hypothesis that the distribution of sample statistics for the Rule 10b-21 sample is the same as the distribution for the Rule 105 sample. The test on difference of sample statistics is one-sided.

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Table 1
Summary Statistics for Seasoned Offers

This table presents means [medians] for a sample of 2553 seasoned offers issued on Nasdaq or NYSE from January 1993 to December 2005. The statistics for Nasdaq-issued SEOs are reported in Panel A and the statistics for NYSE-issued SEOs are reported in Panel B. The sample is divided conditioned on whether the offer is issued before April 1, 1997 (Rule 105 implementation date) or not. The *p-value* is from a test of the restriction that means [medians] are equal across subperiod based on t-test [wilcoxon test]. Market capitalization equals the closing price times the number of shares outstanding of the day prior to the offer. Offer proceeds equals the offer price times the number of offered shares.

		By Category		
	All	Rule 10b-21	Rule 105	*p-value*
Panel A: Nasdaq				
Number of SEOs	1890	851	1039	
Market Capitalization ($ mil.)	730.10	338.96	1050.46	0.00
	[281.78]	[194.53]	[339.29]	[0.00]
Offer Price ($)	27.44	22.10	31.81	0.00
	[22.00]	[20.00]	[23.75]	[0.00]
Offered Shares ($ mil.)	2.31	1.92	2.62	0.00
	[2.00]	[1.70]	[2.10]	[0.00]
Offer Proceeds ($ mil.)	87.99	56.10	114.11	0.00
	[55.50]	[41.60]	[71.00]	[0.00]
Panel B: NYSE				
Number of SEOs	663	311	352	
Market Capitalization ($ mil.)	2084.25	1328.94	2751.59	0.00
	[783.48]	[630.21]	[995.94]	[0.00]
Offer Price ($)	30.96	29.41	32.32	0.03
	[27.31]	[27.75]	[26.98]	[0.67]
Offered Shares ($ mil.)	4.56	3.73	5.32	0.00
	[3.00]	[2.50]	[3.29]	[0.00]
Offered Proceeds ($ mil.)	186.84	134.66	232.94	0.00
	[113.90]	[84.70]	[137.05]	[0.00]

Table 2
Trading Activity and Price Change for SEOs

This table presents means [medians] for a sample of 2553 seasoned offers issued on Nasdaq or NYSE from January 1993 to December 2005. The statistics for Nasdaq-issued SEOs are reported in Panel A and the statistics for NYSE-issued SEOs are reported in Panel B. The sample is divided conditioned on whether the offer is issued before April 1, 1997 (Rule 105 implementation date) or not. The *p-value* is from a test of the restriction that means [medians] are equal across subperiod based on t-test [wilcoxon test]. Opening delay is the number of minutes from 9:30:00 to the opening trade. SEO discount is defined as -1 times the return from the previous day's closing transaction price to the offer price. Close-to-close return is defined as the return from the previous day's closing transaction price to the offer day's closing transaction price. Close-to-open return is defined as the return from the previous day's closing transaction price to the offer day's opening transaction price. Opening trading volume is the number of shares traded in the opening trade. Day 1 trading volume is the number of shares traded on the offer day.

	By Category		
	Rule 10b-21	Rule 105	*p-value*
Panel A: Nasdaq			
Opening Delay (min)	2.70 [0.52]	0.82 [0.08]	0.00 [0.00]
SEO Discount (%)	3.22 [2.29]	3.14 [2.32]	0.63 [0.74]
Close-to-close Return (%)	-0.37 [-0.63]	0.75 [-0.05]	0.00 [0.15]
Close-to-open Return (%)	-1.51 [-1.10]	-0.89 [-0.44]	0.00 [0.00]
Opening Trading Volume (% of offered shares)	0.48 [0.06]	0.29 [0.03]	0.29 [0.00]
Day 1 Trading Volume (% of offered shares)	112.18 [61.43]	131.91 [78.22]	0.33 [0.00]
Panel B: NYSE			
Opening Delay (min)	16.54 [13.05]	15.05 [10.24]	0.32 [0.00]
SEO Discount (%)	1.10 [0.43]	1.80 [0.99]	0.00 [0.00]
Close-to-close Return (%)	0.39 [0.00]	0.32 [-0.21]	0.82 [0.17]
Close-to-open Return (%)	-0.22 [0.00]	0.05 [0.00]	0.23 [0.80]
Opening Trading Volume (% of offered shares)	20.02 [11.97]	34.94 [11.88]	0.33 [0.93]
Day 1 Trading Volume (% of offered shares)	58.19 [38.66]	110.95 [52.29]	0.19 [0.00]

Table 3
Weighted Price Contribution from Close to Close by Time Period

This Table presents the weighted price contribution of each 15-minute-interval to the close-to-close return for a sample of 2553 seasoned offers issued on Nasdaq or NYSE from January 1993 to December 2005. For each 15-minute-interval i the weighted price contribution is calculated as follows:

$$WPC_i = \sum_{s=1}^{S} \left(\frac{|ret_s|}{\sum_{s=1}^{S} |ret_s|} \right) * \left(\frac{ret_{i,s}}{ret_s} \right)$$

where $ret_{i,s}$ is the logarithmic price change over interval i for stock s and ret_s is close-to-close stock return for stock s. The statistics for Nasdaq-issued SEOs are reported in Panel A and the statistics for NYSE-issued SEOs are reported in Panel B. The sample is divided conditioned on whether the offer is issued before April 1, 1997 (Rule 105 implementation date) or not. Values that are significantly larger than zero at the 0.05 level are denoted with an *. The *p-value* is from a test of the restriction that weighted price contributions are equal across subperiod based on bootstrap test. *p-values* that are lower than 0.01, 0.05, and 0.10 are denoted with *, **, and ***, respectively.

Panel A: Nasdaq

15-minute-interval	Rule 10b-21	Rule 105	*p-value (bootstrap)*
Close to open	44.66*	36.86*	***
1	14.64*	13.57*	
2	3.42*	5.40*	
3	4.62*	3.98*	
4	1.79	3.59*	
5	2.53	1.49	
6	0.85	2.07*	
7	1.33	2.24*	
8	1.66	1.85*	
9	1.40	1.62*	
10	2.56*	1.77*	
11	-0.54	1.27*	*
12	1.44	1.41*	
13	-0.41	1.44*	*
14	0.76	1.01	
15	1.60	1.09	
16	-0.17	1.42*	
17	2.14	1.11	
18	-0.94	0.75	
19	2.74*	1.80*	
20	2.16	1.81*	
21	0.78	1.79*	
22	0.23	1.20	
23	1.55	2.96*	
24	2.11	1.95*	
25	2.73*	3.20*	
26	4.33*	1.34	**

Panel B: NYSE

15-minute-interval	Rule 10b-21	Rule 105	*p-value (bootstrap)*
Close to open	56.73*	52.82*	
1	0.02	2.16	
2	8.20*	5.51*	
3	4.02*	4.87*	
4	2.52	2.89*	
5	2.04	1.05	
6	2.61*	0.80	
7	-1.45	2.00*	***
8	0.83	1.89*	
9	0.48	1.04	
10	3.32*	1.50	***
11	1.88	2.14*	
12	0.66	1.98*	
13	1.61	1.08	
14	0.44	0.11	
15	1.78	1.07	
16	0.65	0.85	
17	1.91	0.90	
18	1.54	1.35	
19	1.79	1.75*	
20	1.07	1.40	
21	0.51	1.93	
22	-0.20	2.63*	**
23	2.62*	1.75	
24	3.42	1.43	
25	2.54*	3.02*	
26	-1.53	0.08	

Table 4
Cumulative Weighted Price Contribution from Close to Close by Time Period

This Table presents the cumulative weighted price contribution of each 15-minute-interval to the close-to-close return for a sample of 2553 seasoned offers issued on Nasdaq or NYSE from January 1993 to December 2005. For each 15-minute-interval i the weighted price contribution is calculated as follows:

$$WPC_i = \sum_{s=1}^{S}\left(\frac{|ret_s|}{\sum_{s=1}^{S}|ret_s|}\right)*\left(\frac{ret_{i,s}}{ret_s}\right)$$

where $ret_{i,s}$ is the logarithmic price change over interval i for stock s and ret_s is close-to-close stock return for stock s. The statistics for Nasdaq-issued SEOs are reported in Panel A and the statistics for NYSE-issued SEOs are reported in Panel B. The sample is divided conditioned on whether the offer is issued before April 1, 1997 (Rule 105 implementation date) or not. Values that are significantly larger than 75 at the 0.05 level are denoted with an *. The *p-value* is from a test of the restriction that weighted price contributions are equal across subperiod based on bootstrap test. *p-values* that are lower than 0.01, 0.05, and 0.10 are denoted with *, **, and ***, respectively.

Panel A: Nasdaq

15-minute-interval	Rule 10b-21	Rule 105	*p-value (bootstrap)*
Close to open	44.66	36.86	***
1	59.30	50.43	***
2	62.73	55.83	***
3	67.35	59.81	***
4	69.14	63.40	**
5	71.67	64.89	***
6	72.52*	66.96	**
7	73.84*	69.21	**
8	75.51*	71.06	**
9	76.91*	72.68*	**
10	79.47*	74.44*	***
11	78.93*	75.72*	*
12	80.37*	77.13*	*
13	79.97*	78.57*	
14	80.73*	79.58*	
15	82.33*	80.67*	
16	82.16*	82.09*	
17	84.30*	83.20*	
18	83.36*	83.95*	
19	86.10*	85.75*	
20	88.27*	87.56*	
21	89.04*	89.35*	
22	89.28*	90.55*	
23	90.83*	93.51*	
24	92.94*	95.46*	
25	95.67*	98.66*	
26	100.00*	100.00*	-

Panel B: NYSE

15-minute-interval	Rule 10b-21	Rule 105	*p-value (bootstrap)*
Close to open	56.73	52.82	
1	56.76	54.97	
2	64.96	60.49	
3	68.98	65.36	
4	71.50*	68.24	
5	73.54*	69.29	
6	76.14*	70.09	*
7	74.70*	72.10*	
8	75.52*	73.98*	
9	76.01*	75.02*	
10	79.33*	76.52*	
11	81.21*	78.67*	
12	81.87*	80.65*	
13	83.47*	81.73*	
14	83.91*	81.84*	
15	85.69*	82.91*	
16	86.34*	83.76*	
17	88.25*	84.67*	
18	89.79*	86.01*	*
19	91.58*	87.76*	*
20	92.65*	89.16*	*
21	93.16*	91.09*	
22	92.96*	93.72*	
23	95.58*	95.47*	
24	99.00*	96.90*	
25	101.53*	99.92*	
26	100.00*	100.00*	-

Table 5
Unbiasedness Regressions by Time Period

This Table presents the slope coefficients and adjusted R-squares of unbiasedness regressions for each 15-minute-interval for a sample of 2553 seasoned offers issued on Nasdaq or NYSE from January 1993 to December 2005. For each 15-minute-interval i , the following regression model is estimated:

$$close - close = \alpha + \beta_i(price_i - close) + \varepsilon_i$$

The statistics for Nasdaq-issued SEOs are reported in Panel A and the statistics for NYSE-issued SEOs are reported in Panel B. The sample is divided conditioned on whether the offer is issued before April 1, 1997 (Rule 105 implementation date) or not. Slope coefficients that are significantly larger than 1 at the 0.05 level are denoted with an *. The *p-value* is from a test of the restriction that weighted price contributions are equal across subperiod based on bootstrap test. *p-values* that are lower than 0.01, 0.05, and 0.10 are denoted with *, **, and ***, respectively.

Panel A: Nasdaq

	Slope Coefficient (β)			Adjusted R-square ($Adj.\ R^2$)		
15-minute-interval	Rule 10b-21	Rule 105	*p-value (bootstrap)*	Rule 10b-21	Rule 105	*p-value (bootstrap)*
Close to open	1.02	1.22*	***	0.51	0.42	**
1	1.02	1.24*	***	0.64	0.58	*
2	1.03	1.22*	***	0.68	0.64	*
3	1.05	1.21*	***	0.73	0.68	*
4	1.05*	1.19*	***	0.75	0.71	*
5	1.06*	1.21*	***	0.78	0.74	*
6	1.08*	1.19*	***	0.81	0.76	**
7	1.07*	1.18*	***	0.82	0.78	**
8	1.05*	1.18*	***	0.82	0.80	
9	1.05*	1.17*	***	0.83	0.82	
10	1.07*	1.16*	***	0.86	0.82	***
11	1.08*	1.14*	**	0.86	0.83	**
12	1.07*	1.13*	**	0.86	0.84	*
13	1.06*	1.13*	**	0.86	0.85	
14	1.05*	1.12*	**	0.86	0.86	
15	1.06*	1.11*	**	0.87	0.87	
16	1.06*	1.10*	*	0.88	0.88	
17	1.05*	1.10*	**	0.88	0.89	
18	1.05*	1.09*	*	0.88	0.89	
19	1.03	1.08*	**	0.90	0.90	
20	1.03	1.07*	**	0.91	0.91	
21	1.02	1.05*		0.92	0.92	
22	1.03*	1.05*		0.92	0.93	
23	1.02	1.02		0.93	0.94	
24	1.01	1.02		0.94	0.95	
25	0.98	0.99		0.94	0.97	
26	1.00	1.00	-	1.00	1.00	-

Panel B: NYSE

15-minute-interval	Slope Coefficient (β) Rule 10b-21	Rule 105	*p-value (bootstrap)*	Adjusted R-square (*Adj.* R^2) Rule 10b-21	Rule 105	*p-value (bootstrap)*
Close to open	1.03	1.08		0.74	0.59	*
1	1.04	1.11		0.75	0.61	*
2	1.03	1.14*	*	0.78	0.66	
3	1.05	1.16*	*	0.83	0.72	*
4	1.06	1.13*		0.85	0.75	*
5	1.06	1.13*		0.86	0.76	*
6	1.05	1.15*	*	0.87	0.79	*
7	1.06	1.15*	*	0.87	0.81	
8	1.07	1.13*		0.89	0.82	
9	1.07	1.13*		0.90	0.83	*
10	1.06	1.13*		0.90	0.84	*
11	1.05	1.13*	*	0.92	0.86	*
12	1.05	1.11*		0.92	0.87	*
13	1.04	1.10*	*	0.92	0.88	
14	1.05	1.11*		0.92	0.89	
15	1.04	1.11*	*	0.93	0.90	
16	1.02	1.10*	**	0.93	0.89	
17	1.02	1.11*	**	0.94	0.90	*
18	1.01	1.09*	**	0.94	0.90	*
19	1.00	1.08*	**	0.95	0.92	
20	1.00	1.07*	**	0.95	0.93	
21	1.00	1.06*	**	0.96	0.93	**
22	1.02	1.03		0.97	0.95	**
23	1.00	1.02		0.97	0.96	
24	0.96	1.01		0.95	0.98	
25	0.96	0.99		0.96	0.99	
26	1.00	1.00		1.00	1.00	-

Table 6
Convergence of Stock Price to Equilibrium Value by Time Period

This Table presents the average convergence of stock price to equilibrium value of each 15-minute-interval for a sample of 2553 seasoned offers issued on Nasdaq or NYSE from January 1993 to December 2005. The extent of divergence between stock price and offer-day closing price using the following formula:

$$divergence_i = abs(\log(close / price_i))$$

where close is the closing price of the offer day, and $price_i$ is price at the end of each 15-minute interval. The statistics for Nasdaq-issued SEOs are reported in Panel A and the statistics for NYSE-issued SEOs are reported in Panel B. The sample is divided conditioned on whether the offer is issued before April 1, 1997 (Rule 105 implementation date) or not. The *p-value* is from a test of the restriction that weighted price contributions are equal across subperiod based on bootstrap test. *p-values* that are lower than 0.01, 0.05, and 0.10 are denoted with *, **, and ***, respectively.

Panel A: Nasdaq

15-minute-interval	Rule 10b-21	Rule 105	*p-value (bootstrap)*
Close to open	2.86	3.98	***
1	2.46	3.28	***
2	2.24	2.98	***
3	2.02	2.83	***
4	1.95	2.71	***
5	1.83	2.56	***
6	1.75	2.47	***
7	1.66	2.36	***
8	1.64	2.26	***
9	1.59	2.15	***
10	1.47	2.09	***
11	1.47	2.01	***
12	1.43	1.94	***
13	1.46	1.87	***
14	1.46	1.83	***
15	1.37	1.75	***
16	1.30	1.69	***
17	1.31	1.62	***
18	1.28	1.60	***
19	1.18	1.54	***
20	1.12	1.43	***
21	1.09	1.35	***
22	1.02	1.27	***
23	0.96	1.14	***
24	0.85	1.01	***
25	0.78	0.79	
26	0.00	0.00	-

Panel B: NYSE

15-minute-interval	Rule 10b-21	Rule 105	*p-value (bootstrap)*
Close to open	1.39	1.91	***
1	1.37	1.82	***
2	1.25	1.67	***
3	1.12	1.54	***
4	1.04	1.43	***
5	0.96	1.37	***
6	0.93	1.32	***
7	0.93	1.25	***
8	0.87	1.22	***
9	0.85	1.18	***
10	0.81	1.14	***
11	0.73	1.10	***
12	0.71	1.05	***
13	0.70	1.03	***
14	0.71	1.00	***
15	0.67	0.96	***
16	0.65	0.96	***
17	0.59	0.93	***
18	0.58	0.91	***
19	0.56	0.86	***
20	0.53	0.81	***
21	0.49	0.75	***
22	0.41	0.64	***
23	0.38	0.54	***
24	0.32	0.44	***
25	0.19	0.24	
26	0.00	0.00	-

Table 7
Public and Private Information: Variance Decomposition

This table presents the means [medians] of variance component of stock prices on the offer day for a sample of 2553 seasoned offers issued on Nasdaq or NYSE from January 1993 to December 2005. The statistics for Nasdaq-issued SEOs are reported in Panel A and the statistics for NYSE-issued SEOs are reported in Panel B. The sample is divided conditioned on whether the offer is issued before April 1, 1997 (Rule 105 implementation date) or not. The following VAR system for quote revisions and trades are estimated:

$$r_t = \sum_{i=1}^{p} \alpha_i r_{t-i} + \sum_{i=0}^{p} \beta_i x_{t-i} + \varepsilon_{1,t}$$

$$x_t = \sum_{i=1}^{p} \gamma_i r_{t-i} + \sum_{i=0}^{p} \delta_i x_{t-i} + \varepsilon_{2,t}$$

where r_t denotes the percent change (in logarithm) in the quote midpoint subsequent to the t-th transaction. x_t denotes the trading direction inferred by Lee and Ready (1991)'s method, which equals 1 for a buyer-initiated order and equals 0 for a seller-initiated order. The lags used in the equations are 10.

	σ_x^2/σ_v^2		
	Rule 10b-21	Rule 105	*p-value*
Nasdaq	8.03 [4.80]	14.68 [13.83]	0.00 [0.00]
NYSE	29.07 [27.15]	32.73 [32.60]	0.00 [0.00]