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Abstract

- **Purpose:** The paper examines the changes in the price impact of trades in the major Korean stock market following the introduction of disclosure to all traders of the top five brokers on the buy-side and the top five brokers on the sell-side of trades in real time for each stock in the KOSDAQ market.
- **Design/methodology/approach:** The paper uses several alternative metrics for the price impact of trades. The study applies estimation methodology that accounts for the potential endogeneity of other market quality proxies, which are used as control variables in price impact regressions, by utilizing two-stage-least-square methods with fixed effect specification.
- **Findings:** This study finds that the permanent price impact (information effect) of both buyer- and seller-initiated trades increases, which indicates that information is disseminated quicker in a transparent market. Uninformed trades have a larger permanent price impact than informed trades on both the buy and sell sides. The liquidity price effects are found to be mixed for buys and sells.
- **Research implications:** The study supports the current policy of the Korean Exchange to publicly display the five most active broker IDs on both the buy and sell sides, as it attracts both informed and liquidity traders, leading to faster price discovery in a more transparent market. However, a future study which analyzes the change in the market quality in both local markets would provide a complete picture of the effects of the policy.
- **Originality/value:** Earlier studies documenting the effect of broker ID disclosure on market quality used effective spreads, market depth or order book imbalance as market quality measures. This study contributes to the existing literature by examining the changes in direct measures of the private information effect and liquidity effect of trades in a stock market – the Korean Stock Exchange – when the other part of the exchange (the KOSDAQ stock market) shifts to public broker ID transparency at the same transparency level.

JEL Classification: G10, G15, G18

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Introduction

Transparency in stock markets is generally considered to lead to greater fairness, more efficient information acquisition and better governance. When it comes to the optimal design of a securities market the impact of transparency becomes more complicated, as important informed market participants may feel exposed in a fully transparent environment. The only stock exchange in the world that promotes transparency to the public is the Korean Exchange (since October 1999), while a number of other exchanges have altered their market in the opposite direction. The Korean Exchange is the integration of the Korean Stock Exchange, Korea Futures Exchange and KOSDAQ Stock Market. Before October 25th 1999, the identities of the top five buy and the top five sell brokers by cumulative buy and sell volumes, respectively, were displayed in real time to the public for each stock listed on the Korean Stock Exchange. However, this information was hidden for stocks listed on the KOSDAQ Stock Market. Since October 25th 1999, the similar policy on the disclosure of broker identifications has come into force in the KOSDAQ Stock Market. This paper investigates changes in the liquidity-related and information-related price impact of trades following the introduction of broker identity dissemination to the public on October 25th 1999 for the top 55 largest stocks in the Korean Stock Exchange[2]. The study contributes to the existing literature by examining the changes in direct measures of the private information effect and liquidity effect of trades in a stock market – the Korean Stock Exchange – when the other part of the exchange (the KOSDAQ stock market) shifts to public broker ID transparency at the same transparency level.

There are a few studies documenting the direct effect of the disclosure of broker IDs on market quality. For example, Foucault, *et al.* (2007) study the change from pre- to post-event

[2] According to the Korean Exchange website, there is no separate member admission requirement for the Korean Stock Exchange and the KOSDAQ stock market. So naturally, members of one exchange can be members of the other exchange as long as they are registered in both markets. There is no interaction between the order flows of the two markets, so brokers are not required to route orders to the market with better quotes.

when the limit order book for stocks listed on Euronext Paris became anonymous in 2001, and find that spreads and volatility decline significantly. Comerton-Forde, *et al.* (2005) investigate a collection of stock exchanges, including the Korean Stock Exchange, and find that the policy of hidden broker IDs results in a decrease in relative bid-ask spreads and effective spreads in both Euronext Paris and the Tokyo Stock Exchange. They find higher relative bid-ask spreads and effective spreads in the Korean Stock Exchange with the opposite policy on broker ID disclosure. Comerton-Forde and Tang (2009) find a lower spread and decline in the level of order aggressiveness following the switch to anonymity in the Australian Stock Exchange (ASX). Mercorelli, *et al.* (2008) look at the same event in the ASX and find an increase in information asymmetry and order book imbalances. Frino, *et al.* (2008) examine the impact of the removal of broker mnemonics on the Sydney Futures Exchange and document an improvement in liquidity. Poskitt, *et al.* (2011) provide contrasting results for the NZX50 in the New Zealand Stock Exchange, which show that market liquidity deteriorates in a more opaque market. In general, all of these studies use effective spreads, market depths or order book imbalance as market quality proxies.

The main contributions of this study are three-fold. Firstly, Hasbrouck (2009) and Qian (2011) show that correlation between market quality measures such as effective and relative spreads, permanent and temporary price impact, quoted depth, and trading volume are sometimes low. This suggests that these measures reflect different aspects of market quality. Comerton-Forde, *et al.* (2005) examine the effect of broker ID disclosure on market quality on the Korean Stock Exchange, using the top 250 stocks by market capitalization. Using the bid-ask spread, they find that liquidity improved by increased anonymity and adversely affected by decreased anonymity. This study examines different attributes of market quality including information-related and liquidity-related price impact of trades, contributing to the

literature by revealing a more complete picture of the effects of the change in broker ID policy.

Secondly, in the Korean Exchange, a qualified member of one local market is also a qualified member of the other local market. Thus, all traders have the option to trade in either of the local markets. Unlike other stock markets[3] all investors (including individuals) have been able to observe the broker IDs in both local markets since the policy change in the KOSDAQ Stock Market. Accordingly, their choices of trading venues prior to the policy change were likely to be affected by the transparency levels of the markets. Thus, the study of price impact in the most active stocks in the main stock exchange when the other local market implemented the same policy is worthwhile.

Thirdly, this study sheds light on the different effects of the policy on the information content of trades, conditional on a trade being informed prior to the change in transparency in the major market. Utilizing segmented analysis on uninformed and informed trades on each trade side, the paper provides evidence about whether informed (uninformed) trades contain more or less information after the change in transparency.

This paper finds that the information-related price impact of both buyer- and seller-initiated trades increases following the introduction of public broker IDs. The observable impact is higher for the uninformed than for the informed trades, especially on the buy side. Consistent with Hendershott and Jones' (2005) and Linnainmaa and Saar's (2012) interpretation, this finding implies greater private information is disclosed with faster price discovery in a more transparent market, which indicates a more efficient market. Uninformed traders are likely to benefit more from high transparency than the informed traders. The liquidity-related price impact of buy trades is shown to be higher when public investors are able to observe post-

[3] For example: broker IDs were displayed to only a certain group of market members in the Australian Stock Exchange prior to November 28th 2005.

trade broker IDs, in which uninformed trades are more affected than informed trades. However, sell trades provide the reverse direction. The study finds a lower temporary price effect of both of uninformed and informed trades in the more transparent market, with a smaller effect of uninformed trades. These mixed findings on the two trade sides are not consistent with the existing literature mentioned early in the paper.

The remainder of the paper is organized as follows. Section 2 describes the institutional details. Section 3 presents the data description and methodology, while the results are presented in Section 4. Section 5 concludes.

1 Institutional details

The Korean Stock Exchange is a typical order-driven market, where buy and sell orders compete for best prices. The whole trading procedure – from order placement to trade confirmation – is conducted in an electronic order-driven system. Orders are matched during the trading hours according to price and time priority. The opening and closing prices are determined by call auctions. In the Korean Stock Exchange, every stock has a daily price variation limit set at ±15% of the previous day closing price. Orders outside this limit are rejected.

The Korean Stock Exchange opens from 9:00 a.m. to 3:00 p.m. during weekdays. Investors can submit their orders from 8:00 a.m.[4], one hour before the market opening. Orders delivered to the market during the period from 8:00 a.m. to 9:00 a.m. are queued in the order book and matched in a call auction at 9:00 a.m. to determine opening prices. After opening prices are determined, the trades are conducted by continuous auction until 2:50 p.m., 10

[4] Since December 2003, the pre-hours session has lasted from 7:30 – 8:30 am with the closing prices of the previous day applied for orders. Orders delivered to the market from 8:30 – 9:00 are queued in the order book and matched by the call auction method to determine opening prices.

minutes before the market closing. During the last 10 minutes, orders are pooled again and executed by call auction to determine closing prices of the day. Lunchtime breaks were abolished in May 2000. From 3:10 p.m. to 4:00 p.m. the Korean Stock Exchange operates an after-hours session for 50 minutes. During the after-hours sessions, orders are matched at the closing prices of the day. Beside limit and market orders, the Korean Stock Exchange allows another type of order, namely the limit-or-market-on-close order. This order is a limit order that automatically converts to a market order at the market closing to participate in the call auction for closing price determination. The trading unit is 10 shares for stocks. Orders with sizes smaller than the trading units (‘odd-lots’) are traded at the after-hours session or on the OTC market. The tick sizes vary according to the price levels.

Since 1996, the Korean Stock Exchange has increased the transparency of order and trade information. The exchange provides various means of information dissemination. Market information on price and trading volume such as current price, highest/lowest prices, opening/closing prices, trading volume and value, is available on a real time basis through information terminals distributed by KOSCOM (the Korea Securities Computer Corporation), commercial telecommunications networks, and websites of the Korean Stock Exchange and securities firms.

The order book information is open to the public. During call auctions (08:00–09:00 and 14:50–15:00), all investors can get information about expected matching prices (opening and closing prices), expected quantities to be matched at the expected matching prices, and the prices as well as order quantities of expected best bid and ask quotations. During continuous auctions (09:00–14:50), order information on the five best bid and ask quotations for all listed stocks is disclosed to the public on a real time basis along with the aggregate order quantity of each side. From January 2002, the scope of the bid/ask information disclosed expanded to the ten best bid and ask quotations. This change was designed to prevent any attempt to

mislead investors by placing unreasonably large orders (fake orders) at prices that are unlikely to be matched, i.e., intentionally increasing the aggregate order quantity of a certain issue. The identification of the five most active brokers has also been disseminated to the public since October 25th 1999.

2 Data and Methodology

3.1 Data

The initial sample consists of the top 55 stocks traded in the Korean Stock Exchange[5] by the average daily market capitalization during the period 1999–2001. The change in price effect is examined for five months around the event date. Consistent with Madhavan, *et al.* (2005), I allow a time delay prior to and after the event date to avoid possible biases from proximity to the event. The pre-period and post-period are defined as 01 May 1999 to 30 Sep 1999 and 01 Nov 1999 to 31 Mar 2000, respectively.

All stocks with more than two missing days during the investigated period from 01 May 1999 to 31 March 2000 are excluded from the sample. As a result, the dataset contains 49 stocks that have the intraday trade and quote data with associated prices, volumes, and bid and ask sizes for each stock. The intraday data is obtained from the Thomson Reuters Tick History, made available through Securities Industry Research Centre of Asia-Pacific (SIRCA). Daily market capitalization of all stocks is obtained from the Thomson Financial Datastream.

3.2 Methodology

[5] The Korea Stock Exchange and KOSDAQ markets trade different stocks although some stocks have been cross-listed. The 50 stocks examined in the paper were traded in the Korea SE only.

Following Hendershott and Jones (2005), permanent price impact is used as a simple measure of the amount of information in trades, a measure of adverse selection risk[6]. The more information trades contain, the more prices will move in the direction of the trade (up following purchases and down following sales). Traders incorporate the information in the order flow imbalance by permanently adjusting their quotes upwards (downwards) after a series of buy (sell) orders (Glosten and Milgrom (1985)). Prior studies document that markets react differently to buyer- and seller-initiated transactions (see Keim and Madhavan (1996), Gemmill (1996), Koski and Michaely (2000)). The literature also provides evidence of "the identification of the trade indicator as the key variable for extracting adverse selection from observable data" (see Mercorelli, *et al.* (2008)). Thus, all analyses in this study are carried out separately on buyer- and seller-initiated trades. The Lee and Ready (1991) rule is employed to classify a trade as a buy (sell) if the associated trade price is above (below) the prevailing midpoint price. The tick rule categorizes all other trades. This rule classifies the transaction above (below) the previous price as a buy (sell). If there is no price change, but the previous tick change was up (down), then the trade is classified as a buy (sell).

Permanent price impact is defined as the change in the quote midpoint 30 minutes after the trade signed by the trade direction, following Bessembinder (2003). This is referred to as 'permanent price effect to 30 minutes'. A temporary price effect measure is also employed to examine liquidity relating to price pressure. This proxy is defined as the difference between the midpoint prices prevailing at the subsequent trade less the current price. Two relative measures are equal to the two proxies scaled by the initial midpoint price.

All of the price impact measures are weighted using daily volume to take into account the volume effect and to minimize noise, which is consistent with Frino, *et al.* (2008) and Ting

[6] The simple measure of permanent price impact is used widely in the literature to measure information content of trades. (see Hendershott and Jones (2005), Linnainmaa and Saar (2012), Hasbrouck (2007), Frino, *et al.* (2010), Frino, *et al.* (2008)). However, it may be biased if trades are serially correlated.

(2006). The volume weight measures also reduce the skewness resulting from large trade size. The volume-weighted price effect is calculated as the sum of the product of the price effect and the traded volume divided by the total trading volume of the day.

All measures are calculated using intraday data and then averaged to produce one observation per stock per day[7]. The Student t-test is used to examine whether the means of the examined proxies are significantly different between the pre- and post-event periods.

Multivariate models are utilized to control factors other than the policy change that may affect the price impact proxies. In all multivariate analyses, I use log transformations of the absolute values of price effect metrics to derive a log-linear relationship with other variables in the regressions. Trades are classified into the informed and uninformed on each trade side to examine whether informed (uninformed) trades are more informative in more transparent markets. Informed trades are identified based on trade direction and permanent price effect to the closing price, which is calculated as the change in the final midpoint price recorded at the end of the day after the trade on the same side. A trade is informed if the permanent price effect to the closing price is positive for buyer-initiated and negative for seller-initiated trades.

A time trend variable is included in the regressions to capture daily changes in the dependent variable holding all other explanatory variables constant, and to prevent the possibility that the findings on design changes are simply due to trends. The time trend variable begins with a value of 1 and increases by 1 unit for each investigated day. As market conditions will affect the price movement, the variance of return is included in the model. Following Hendershott and Jones (2005), volatility is derived for each stock per day by taking the daily difference between the logarithm of highest and lowest transaction price. The sample is split

[7] The daily measures explain the change in the average price impact, but do not take into account the different behaviour of trades at the beginning and the end of the day. Thus, using several trade windows within a trading day would provide insight into the price effect, which is an important task for future research.

into 5 quintiles by market capitalization on January 4th 1999, in which quintile 1 and 5 contain the smallest and largest stocks by market value, respectively. The division using stock sizes is consistent with Eom, *et al.* (2007) and Comerton-Forde and Tang (2009).

3 Results

4.1. Univariate analysis

Table 1 reports the means of the volume-weighted relative temporary price effect, and the permanent price effect to 30 minutes for five size quintiles and for the full sample in the pre-period and the post-period. The change between the two periods is reported in 'Difference' with the Student t-test.

<Insert Table 1 here>

Panel A presents the results of the two price effect measures of buyer-initiated trades. Panel A1 shows that the liquidity related price impact declines significantly by 0.04% and 0.03% in the two largest stock quintiles, leading to a fall of 0.03% for the full sample in the post-period. This finding suggests that liquidity improves with the disclosure of broker IDs to the public. It is observed in Panel A2 that there is no significant change in the shorter-term permanent effect for quintiles and the full sample.

Panel B1 reports changes in the mean of the temporary price effect of sell trades when the market began disclosing broker IDs to the public. Seller-initiated trades have a negative temporary price impact, and an absolute increase in this proxy implies a greater effect on the trade price on the sell side. Panel B1 reports that this impact decreases by 0.02% for the full sample, indicating there is a more liquid market in the post-period, which is consistent with the finding on the buy side. An improvement in liquidity is observed in quintile 4 with a 0.05% reduction in the temporary price effect, whereas there is no change in this proxy documented for the other quintiles. Similar patterns for permanent price impact of the buyer-

initiated trades are found for seller-initiated trades, suggesting higher transparency does not affect private information incorporated in sell trades in the post-period. However, the univariate results are likely to be affected by factors other than the change in broker ID policy. Thus, a multivariate analysis is warranted.

4.2 Multivariate analysis

Following Foucault, *et al.* (2007), this study applies stock fixed effects to control for some of the heterogeneity across stocks. The following model is estimated to measure the effect of public broker IDs on the two price impact proxies:

$$Ln(PIP_{it}) = \alpha + \beta_1 Volatility_{it} + \beta_2 Volatility_{it} * Dummy_t + \beta_3 Trend_t + \beta_4 Dummy_t + \sum_{i=2}^{n} \gamma_i S_i + \varepsilon_{it}, \quad (1)$$

where for each stock i on day t, PIP_{it} is volume-weighted temporary price effect and volume-weighted permanent price effect to 30 minutes, respectively; $Volatility_{it}$ is range-based volatility; $Trend_t$ is the time trend variable; $Dummy_t$ is a dummy variable for broker ID transparency taking the value 0 if opaque and 1 otherwise; S_i is the stock-specific dummy variables allowing for the stock fixed effect; and n is the number of stocks in the sample. The regression is applied to four categories separately: informed and uninformed buyer-initiated trades, and informed and uninformed seller-initiated trades. Coefficient β_4 is the impact of the introduction of broker IDs to the public on conditional to zero volatility, which is not of interest. Thus, the study actually seeks the effect of the investigated event on the two price impact at the average of volatility. The size and direction of the impact of the broker ID policy is estimated as $\beta_2 * Mean\_Volatility_{Post\_period} + \beta_4$, in which $Mean\_Volatility_{Post\_period}$ is the average of range-based volatility over the post-period.

4.2.1 Fixed effect OLS results

Table 2 presents the results of the multivariate models for the price impact measures.

<Insert Table 2 here>

All of the two price impact metrics are positively related to volatility in each of the four categories, suggesting a positive association between market volatility and both temporary and permanent price effects. The coefficient β_3 is significantly negative for the temporary measure in each of the four regressions, indicating a decreasing trend temporary price effect over time for all informed and uninformed buyer- and seller-initiated trades. However, the results are mixed for the longer-term effect on trade price. Specifically, the permanent effect to 30 minutes (Panel 2) shows β_3 of -0.002 and 0.001 are highly significant in the regressions for informed buyer- and informed seller-initiated trades, respectively. These findings suggest that informed trades initiated by buyers (sellers) follow a decreasing (increasing) trend over time. The coefficient β_4 of $Dummy_t$ variable is insignificant for the permanent measures, but significant for the temporary price effect except for uninformed trades initiated by sellers. The direct effect of the transparent dummy is positive where the coefficient β_4 is statistically significant, while the interaction coefficient β_2 is negative. A potential problem of the fixed effect model (1) is that volatility – a control variable – may change as a result of more transparent market that leads to biased results due to the endogeneity issue.

A univariate analysis of range-based volatility is implemented for the full sample and separately for each quintile. Table 3 presents the Student t-test to examine whether there is any statistically significant change in average range-based volatility prior to and after the event date of October 25th 1999 for the full sample and the quintiles.

<Insert Table 3 here>

Table 3 reports that the smallest stocks have a higher level of volatility after the change to disclosure of broker IDs. There is no significant statistical evidence of changes in volatility

for larger stocks. However, overall the full sample experiences a higher level of volatility of 0.67% in the post-period. The findings and the results discussed in Section 4.2.1 suggest that price impact proxies and volatility may change simultaneously as a result of the broker ID disclosure policy. Thus, the results from the OLS regressions presented in Section 4.2.2 may be biased due to the endogenous control variable. As a result, a two stage least squared regression should be implemented to avoid biased results.

4.2.2 Fixed effect 2SLS results

Two Stage Least Squared (2SLS) models with stock fixed effect specification are estimated using two price effect measures that recognize volatility as a potentially endogenous control variable. $PIP_{it-1}, Trend_t$, $Ln(MCap_{it})$ and S_i are used as instruments in which $MCap_{it}$ is the daily market capitalization of stock i on day t. These are valid instruments as they are either pre-determined variables or obviously exogenous. The results are presented in Table 4.

<Insert Table 4 here>

There is also almost no observable trend for the two price impact changes when the endogeneity of volatility is corrected using the instrumental variable method. The coefficient of interaction variable between broker dummy and volatility β_2 is significantly positive in all measures. Dummy coefficient β_4 is also significantly negative regardless of the trade initiations. Thus, the impact of transparency on price effect would be subject to changes in volatility as well. As a result, the final effect of transparency on the price impact is calculated as $\beta_2 * Mean\_Volatility_{Post\_period} + \beta_4$, in which $Mean\_Volatility_{Post\_period}$ is the average of range-based volatility over the post-period for the full sample and five quintiles separately. The total effect of the broker ID disclosure is estimated using the coefficients β_2 and β_4 taken from the fixed effect 2SLS regressions presented in Table 4 and $Mean\_Volatility_{Post\_period}$ for

the full sample and separately for each quintile taken from Table 3. The results are reported in Table 5.

<INSERT Table 5 here>

The first columns of Table 5 present the change in temporary (liquidity related) and the permanent (information related) price effects of informed buyer-initiated trades for the full sample and for each quintile. The table shows significant increases in the two relative price effect measures of informed buy trades in the post-period for the full sample, in which the longer term shows a higher price impact of trade. Specifically, the price impact of informed buyer-initiated trades increases by 5.2% temporarily and 11.0% for the proxy to 30 minutes in the more transparent market. The higher permanent price impact indicates that the price of informed buyer-initiated trades moves more in the direction of trade in the post-period.

Looking at the changes in the two proxies for the quintiles, the smallest stocks (quintile 1) experience the highest increases in price impact over all time horizons, with approximately 13.3% and 39.0% increases for the temporary and 30 minute horizons, respectively. The impact mitigates as the stock size increases from quintile 2 to quintile 4, at less than 10% for the temporary measure for both quintiles, and from 16% to 7%, respectively, for the permanent measure to 30 minutes. However, price impact for the largest stocks (quintile 5) significantly falls in the post-period by 2.1% for the temporary measure and 14.0% for the 30-minute measure.

Overall, the results imply that private information contained in the informed buyer-initiated trades is higher in the market following the disclosure of broker IDs to the public, especially for the smallest stocks. The informed buy trades for the largest stocks contain less private information, as the public can obtain the five most active broker IDs for each stock free of charge. Temporary price impact is a proxy of liquidity provider's compensation. The study

documents a lower liquidity-related price impact of trade for the largest stocks, and adversely effect on the smaller shares. This finding suggests that in the more transparent market, informed traders might have to trade more aggressively and strategically to reserve their relative advantage. As a result, competition in liquidity provision could become stronger in large but weaker in small market segments. The results for uninformed trades initiated by purchasers are reported in the second column of Table 5. Similarly to the informed sample, the price impact of uninformed buyer-initiated trades in the post-period is higher than in the pre-period in the full sample. The temporary price effect and the permanent price effect to 30 minutes increases by 16% and 17%, respectively, in the post-period. This figure for uninformed trades presents a greater rise than for informed buyer-initiated trades.

The temporary price effect of the uninformed trades is larger in the post-period, which is in the range of 9% to 24% for the largest to the smallest stocks, respectively. These increases for uninformed trades are much higher than for informed trades on the buy side of the same quintiles. A reasonably similar pattern of changes is found in the permanent price impact to 30 minutes.

These outcomes suggest that uninformed traders are likely to benefit more from a transparent market than informed traders, which is consistent with Hendershott and Jones (2005). In an anonymous market, informed trades contain a certain amount of private information; meanwhile, uninformed traders lack information. When the market is more transparent, uninformed traders become quasi-informed and are able to incorporate newly disclosed information in their executed orders. The previous literature shows that seller-initiated trades usually convey less information than buyer-initiated trades. Panel 1 in the third column of Table 5 shows that the temporary price impact of informed sell trades reduces after the introduction of broker ID disclosure by 28%, 20%, 18%, 18% and 11% for quintiles 1 (smallest stocks) to 5 (largest stocks), respectively. Overall, the impact falls by 19% for the

full sample. A similar effect occurs for uninformed sell trades in the post-period, but is smaller in magnitude. The liquidity related price effect declines by approximately 17%, 10%, 8%, 8%, and 2% for quintiles 1 to 5, respectively, and 9% for the full sample. These results suggest an improvement in liquidity for sell trades initiated by both uninformed and informed traders in a market with a higher level of transparency. The changes in the temporary price impact of buy trades are less than that of sell trades initiated by informed traders. Nevertheless, the opposite is documented for trades created by uninformed traders.

The changes in the informational effect of informed sell trades after the disclosure of broker IDs are presented in the third column of Table 5, in Panel 2. The price effect to 30 minutes increases by 25.8% and 5.8% for the two smallest stock quintiles, but decreases by 1.5% and 2.0% for the two largest stocks quintiles, leading to an overall rise of 1.4% in the entire post-period market. Uninformed sell trades experience a strong increase in the informational price effect measures by 51.0% for the smallest stocks; approximately 5.0% for the largest stocks and 26.8% for the full sample (see Table 5, Panel 2, column 4).

Compared to the buy trades, the increase in the permanent price impact is less for uninformed and greater for uninformed seller-initiated trades. The fall in temporary price impact of trade for seller-initiated trades, which is opposite to buyer-initiated trades, indicates that the asymmetry between buyer and seller-initiated trades proposed by Saar (2001) holds.

4 Conclusions

This paper investigates the changes in temporary and permanent price impact in the major stock market in Korea when the second local market began displaying the same transparency level of broker IDs to the public. This study uses an intraday dataset of the top 55 stocks by the average market capitalization over three years from 1999–2001. The paper makes an attempt to address the potential endogeneity of other market quality proxies that are used as

control variables in price impact regressions by utilizing two stage least square methods with fixed effect specification.

This study finds that both buy and sell trades convey more private information when the broker IDs become observable to the public in the Korean Exchange. Uninformed traders benefit more from the increased transparency than informed traders, which is reflected in the higher permanent price impact of the uninformed trades in comparison to the informed trades on both buy and sell sides.

The findings are in agreement with Rindi (2008), who states that under full transparency, uninformed traders become 'quasi-informed', incurring no adverse selection cost, and thus are ready to offer liquidity. Under opacity, that identification is not possible; therefore, transparency increases liquidity. However, when information acquisition is endogenous, transparency reduces the incentive to acquire costly information and so reduces the number of informed traders. Accordingly, the previous results on the beneficial effect of pre-trade transparency on liquidity are reversed. As informed traders are liquidity suppliers and can better distinguish between endowment shocks and information, transparency lowers the number of informed agents who enter the market and so reduces liquidity. Therefore, the impact of transparency is dependent on what proportion of information acquisition is endogenous and what proportion remains unaltered by transparency.

Rindi's (2008) model may be used to explain the higher information related price impact of trades found in this study on the Korean Stock Exchange when the KOSDAQ Stock market started displaying the broker IDs. Before October 25th 1999, investors had the option to trade in the transparent main stock exchange or in the anonymous KOSDAQ market depending on their preferred transparency level. After this date, the transparency degrees are the same in the two markets. Therefore, the number of informed traders would not decline in the main market due to the broker ID dissemination, or might even increase due to the higher

transparency level in the KOSDAQ market, leading to more information being contained in the informed trades in the Korean Stock Exchange. The findings suggest that the main stock market is picking up both informed traders and liquidity traders when informed traders no longer find an advantage in trading in the previously anonymous KOSDAQ market.

The study finds mixed evidence about the liquidity effect of trades for the top 55 stocks in the major market after the shift of transparency level in the other local stock market. The temporary price impact of sell trades falls in the more transparent market, with a larger reduction for the informed traders. This finding indicates an improvement in liquidity when the public have access to broker IDs in real time. However, the reduction in anonymity is associated with a higher temporary price effect of the trades initiated by both the informed and uninformed traders on the buy side. These mixed results suggest liquidity effect may be worth investigating in the future.

The study supports the current policy of the Korean Exchange to publicly display the five most active broker IDs for each stock on both buy and sell sides, as it attracts both informed and liquidity traders, leading to faster price discovery in a more transparent market. However, a future study which analyzes the change in the market quality in both local markets would provide a complete picture about the impact of the policy.

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Table 1: Univariate Results for Price Impact

The table reports the mean price impact of buyer and seller-initiated trades on the Korean Stock Exchange during the pre- and post-periods surrounding the disclosure of broker IDs on October 25th 1999. The sample includes 49 stocks for the full sample and 5 size quintiles separately, with 10 stocks in each except for quintile 2. The pre-period and post-periods are defined as 01 May 1999 – 30 Sep 1999 and 01 Nov 1999 – 31 Mar 2000, respectively. Differences in the two alternative measures of price impact between the pre- and post-periods are tested using the Student t-test.

	Quintiles					
	1 (smallest)	**2**	**3**	**4**	**5 (largest)**	**All stocks**
Panel A: Buyer Initiated						
Panel A1: Volume-weighted relative temporary price effect						
Pre-period	0.0038	0.0043	0.00309	0.0031	0.0023	0.0033
Post-period	0.0037	0.0038	0.00307	0.0027	0.002	0.003
Difference	-0.0001	-0.0005	-0.00002	-0.0004*	-0.0003*	-0.0003**
Panel A2: Volume-weighted relative permanent price effect to 30min						
Pre-period	-0.0009	-0.00083	-0.0011	-0.001	-0.0006	-0.0009
Post-period	-0.0011	-0.00082	-0.0014	-0.0011	-0.0007	-0.001
Difference	-0.0002	0.00001	-0.0003	-0.0001	-0.0001	-0.0001
Panel B: Seller Initiated						
Panel B1: Volume-weighted relative temporary price effect						
Pre-period	-0.0041	-0.0042	-0.0032	-0.0031	-0.0023	-0.0033
Post-period	-0.0038	-0.0039	-0.003	-0.0026	-0.0021	-0.0031
Difference	0.0003	0.0003	0.0002	0.0005*	0.0002	0.0002***
Panel B2: Volume-weighted relative permanent price effect to 30min						
Pre-period	0.001554	0.0011	0.0008	0.00096	0.0006	0.00098
Post-period	0.001616	0.0013	0.00078	0.00074	0.0007	0.00101
Difference	0.0001	0.0002	-0.00002	-0.00022	0.0001	0.00003

* denotes significance at the 5% level.
** denotes significance at the 1% level
*** denotes significance at the 0.1% level.

Table 2: **Fixed Effect Regression Model for Price Impact.**
This table reports the results of regression of the form:

$$Ln(PIP_{it}) = \alpha + \beta_1 Volatility_{it} + \beta_2 Volatility_{it} * Dummy_t + \beta_3 Trend_t + \beta_4 Dummy_t + \sum_{i=2}^{n} \gamma_i S_i + \varepsilon_{it}, (1)$$

where for each stock i day t, PIP_{it} is volume-weighted temporary price effect and volume-weighted permanent price effect to 30 minutes, respectively; $Volatility_{it}$ is range-based volatility; $Trend_t$ is the time trend variable; $Dummy_t$ is a dummy variable for broker ID transparency taking the value 0 if opaque and 1 otherwise; S_i is the stock-specific dummy variables allowing for the stock fixed effect; n is the number of stocks in the sample. The table contains the results for the 49 stocks with t-statistics in parentheses.

	Fixed Effect OLS regression			
	Buy informed	**Buy uninformed**	**Sell informed**	**Sell uninformed**
Panel 1: Volume-weighted temporary price effect				
Volatility	5.48	5.44	6.18	4.24
	(23.47)***	(25.70)***	(29.31)***	(21.24)***
Dummy*Volatility	-0.726	-1.459	-1.37	-0.085
	(-2.32)*	(-5.18)***	(-4.94)***	(-0.32)
Trend	-0.001	-0.001	-0.002	-0.0009
	(-6.83)***	(-7.86)***	(-10.40)***	(-6.24)***
Dummy	0.096	0.1017	0.132	0.0026
	(2.91)**	(4.06)***	(5.0)***	(0.10)
R-squared	0.48	0.42	0.54	0.43
Panel 2: Volume-weighted permanent price effect to 30min				
Volatility	17.53	13.11	18.3	14.82
	(21.40)***	(21.37)***	(23.47)***	(22.96)***
Dummy*Volatility	1.487	-2.79	-1.786	0.89
	(1.36)	(-3.42)***	(-1.75)***	(1.02)
Trend	-0.002	0.0008	0.001	-0.0005
	(-3.60)***	(1.90)	(2.53)*	(-1.07)
Dummy	-0.0474	0.14	-0.0018	-0.0725
	(-0.41)	(1.93)	(-0.02)	(-0.87)
R-squared	0.26	0.14	0.21	0.20

* denotes significance at the 5% level;
** denotes significance at the 1% level;
*** denotes significance at the 0.1% level.

Table 3: Univariate Analysis of Volatility

The table reports differences in the mean range-based volatility of stocks on the Korean Stock Exchange during the pre- and post-periods surrounding the disclosure of broker IDs on October 25th 1999. The sample includes 49 stocks for the full sample and 5 size quintiles separately, with 10 stocks in each except for quintile 2. The pre-period and post periods are defined as 01 May 1999 – 30 Sep 1999 and 01 Nov 1999 – 31 Mar 2000, respectively. Differences between the pre- and post-periods are tested using the Student t-test.

	Volatility
Quintile 1	
Pre-period	0.0747
Post-period	0.0876
Difference	0.0129*
Quintile 2	
Pre-period	0.0671
Post-period	0.0759
Difference	0.0088
Quintile 3	
Pre-period	0.064
Post-period	0.0714
Difference	0.0074
Quintile 4	
Pre-period	0.0662
Post-period	0.0716
Difference	0.0054
Quintile 5	
Pre-period	0.0611
Post-period	0.0605
Difference	-0.0006
Full sample	
Pre-period	0.0666
Post-period	0.0733
Difference	0.0067*

* denotes significance at the 5% level
** denotes significance at the 1% level
*** denotes significance at the 0.1% level.

Table 4: **Fixed Effect 2SLS Regression Model for Price Impact.** This table reports the results of regression of the form:

$$Ln(PIP_{it}) = \alpha + \beta_1 Volatility_{it} + \beta_2 Volatility_{it} * Dummy_t + \beta_3 Trend_t + \beta_4 Dummy_t + \sum_{i=2}^{n} \gamma_i S_i + \varepsilon_{it}, \quad (1)$$

where for each stock i day t, PIP_{it} is volume-weighted temporary price effect and volume-weighted permanent price effect to 30 minutes, respectively**;** $Volatility_{it}$ is range-based volatility; $Trend_t$ is the time trend variable; $Dummy_t$ is a dummy variable for broker ID transparency taking the value 0 if opaque and 1 otherwise; S_i is the stock-specific dummy variables allowing for the stock fixed effect; and n is the number of stocks in the sample. The table contains the results for the 49 stocks with t-statistics in parentheses. In the fixed effect 2SLS regressions, $Volatility_{it}$ are considered as an endogenous variable using PIP_{it-1}, $Trend_t$, $Ln(MCap_{it})$ and S_i as instruments. $MCap_{it}$ is daily market capitalization of stock i day t.

	Fixed Effect 2SLS regression			
	Buy informed	**Buy uninformed**	**Sell informed**	**Sell uninformed**
Panel 1:Volume-weighted temporary price effect				
Volatility	-53.05	-59.79	-51.77	-60.8
	(-21.52)***	(-31.21)***	(-26.63)***	(-26.64)***
Dummy*Volatility	5.672	5.467	6.293	5.572
	(4.43)***	(5.31)***	(5.77)***	(4.93)***
Trend	0.001	-0.0006	-0.002	0.001
	(1.42)	(-0.73)	(-2.54)*	(1.23)
Dummy	-0.364	-0.239	-0.27	-0.32
	(-2.16)*	(-2.06)*	(-2.09)*	(-2.32)*
R-squared	0.90	0.91	0.93	0.90
Panel 2: Volume-weighted permanent price effect to 30min				
Volatility	-50.92	-66.88	-67.47	-57.37
	(-17.14)***	(-26.49)***	(-21.44)***	(-22.49)***
Dummy*Volatility	19.51	11.48	17.08	17.14
	(12.48)***	(8.73)***	(10.29)***	(13.18)***
Trend	-0.00009	0.002	0.002	0.0003
	(-0.07)	(1.80)	(1.43)	(0.28)
Dummy	-1.32	-0.668	-1.238	-0.988
	(-6.43)***	(-4.52)***	(-6.28)***	(-6.18)***
R-squared	0.88	0.87	0.87	0.87

* denotes significance at the 5% level;
** denotes significance at the 1% level;
*** denotes significance at the 0.1% level.

Table 5: Analysis of interaction variables in Price impact regressions

This table reports the final effect of the broker ID disclosure on the price impact. The total effects are computed as $\beta_2 * Mean\_Volatility_{Post\_period} + \beta_4$, where $Mean\_Volatility_{Post\_period}$ is the average of range-based volatility over the post-period for the full sample and 5 quintiles separately. Coefficients β_2 and β_4 are taken from the fixed effect 2SLS regressions presented in Table 4. $Mean\_Volatility_{Post\_period}$ for the full sample and separately for each quintile are taken from Table 3.

	Total impact for price effects			
Quintiles	**Buy informed**	**Buy uninformed**	**Sell informed**	**Sell uninformed**
Panel 1:Volume-weighted temporary price effect				
1(smallest)	0.133	0.240	0.281	0.168
2	0.067	0.176	0.208	0.103
3	0.041	0.151	0.179	0.078
4	0.042	0.152	0.181	0.079
5 (largest)	-0.021	0.092	0.111	0.017
Full sample	0.052	0.162	0.191	0.088
Panel 2: Volume-weighted permanent price effect to 30min				
1(smallest)	0.389	0.338	0.258	0.513
2	0.161	0.203	0.058	0.313
3	0.073	0.152	-0.018	0.236
4	0.077	0.154	-0.015	0.239
5 (largest)	-0.140	0.027	-0.205	0.049
Full sample	0.110	0.173	0.014	0.268

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