MARKET QUALITY AND INSIDER TRADING ON AN EXPERIMENTAL CAPITAL MARKET

Gernot Hinterleitner¹, Philipp Hornung²

¹, ²Doctoral Student, Faculty of Social and Economic Sciences, Karl-Franzens-University, Graz, Austria

Abstract: This experimental study is based on an examination by Theissen (2000), who compared single trading mechanisms. In contrast to his work, trading behaviour, market efficiency and market liquidity are also analyzed on an extended market, consisting of a call and a continuous auction in one trading period. In addition, the experimental design incorporates traders with perfect information of the fundamental value of the tradeable asset. The asymmetric information and the special market structure lead to new interesting results regarding the market quality and the risk-attitude of the traders.

Keywords: applications of theory and methods to the financial sector; modeling asymmetric or imperfect dynamical information.

1. Introduction

The quality of capital markets is generally described by its informational efficiency and liquidity (Oehler, 2000). The informational efficiency means that market prices reflect all available information (Fama 1970). The higher the informational efficiency of a market, the better an observable market price reflects the true fundamental value of the asset (Oehler, 1998). The liquidity is defined as the possibility to trade without time delay and price impact. (Baker, 1996). In normal trading phases it is likely that markets can generate a high level of market quality. Nevertheless, there are some phases during a trading day where the informational efficiency and the liquidity are reduced, especially during the opening of the market. A few empirical studies show that transaction costs and volatility are higher at the market opening (Wood et al., 1985), leading to a less efficient price discovery.

The lower level of market quality at the opening is mostly dedicated to the preceding non-trading-period (Amihud/Mendelson, 1987) and the market structure (Stoll/Whaley, 1990) which is used at the opening. This paper focuses on the second factor. Concerning the market structure, some stock exchanges (e.g. New York Stock Exchange, Deutsche Börse) use a Call-Auction (CA) during the opening because of its ability of the simultaneous batching of orders, therefore generate liquidity and execute orders at one price (Economides/Schwartz, 1995). After the CA, the continuous trading (mostly the Continuous Double Auction (CDA)) is started.

First of all, using a CA at the opening is advocated by some studies (eg. Madhavan, 1992; Baciodore/Lipson, 2001) but there still exists further research which does not absolutely prefer a CA at the opening (e.g. Ellul et al., 2005) because of potentially order imbalances and thereby lower liquidity during the CA. However, these studies do not analyze the potential influence of an opening CA on the following CDA. Therefore, the question how an opening CA influences the following CDA has been analyzed by only a few empirical papers so far.

Some of these studies found that because of an opening CA the market quality of the CDA was increased (e.g. Chang et al., 2008), whereas there is some literature which does not agree to this opinion (Comerton-Forde, 2007; Camilleri/Green, 2009) mainly because of a lower attraction of this trading mechanism to the CDA which leads to lower liquidity and approximately lower price efficiency of the CA. One shortfall of these empirical studies is that they analyzed different trading locations with different market rules and market quality measures. Furthermore, the informational efficiency was analyzed by using approximate measures, therefore the advantage of an opening CA and its potential influence on the continuous trading phase is questionable.

We use the experimental method for analyzing the question if an opening CA has a positive influence on the market quality of the following CDA and if there exists an advantage of using CA at this difficult trading phase. The experimental method fits best for analyzing these questions because of the
ability to control distributions of information among the traders. Furthermore the experimenters know fundamental values of the asset. This allows a comparison between the different market structures without interfering and not observable variables. Therefore we can draw a comparison to empiric studies on the one hand and even obtain a complete picture of the behaviour of the participants on the others. Results like timing of orders can be linked to answers of a questionnaire and help to examine underlying reasons for specific decisions (Sunder, 1995).

The basis for our experimental design is an experiment from Theissen (Theissen, 2000), comparing single trading mechanisms. His research work comprised different treatments, each presenting a specific market structure. In contrast to his work, we examine trading behaviour, market efficiency and market liquidity not only on a CDA, but on a complimentary market (CM), consisting of a CA and a CDA, as well. This combination of the two main trading forms does not only reflect the real process used on many stock exchanges, but provides us with the possibility to identify the influence of the CA by systematic comparison of the CDA and the CM. Whereas previous experiments examining market quality have only focused on specific trading structures, our experiment is the first one that allows a detailed comparison of a single auction and of a complimentary market in terms of market quality.

In addition to the impact of a preceding CA, our experiment incorporates traders which have perfect information of the fundamental value of the tradeable asset. The combination of the two topics arouses a whole set of questions. For example it is of interest to find out whether a CA is advantageous for insiders (Güth/Krahnen/Rieck, 1997), whether inside information will immediately reflect a more efficient opening price (Oehler/Heilmann/Laeger, 2000) or whether insiders will be more successful within a specific market structure (Krahnen/Rieck/Theissen, 1999).

Another new and important component of our experiment is the way in which insiders gain their special information. Unlike previous experiments investigating insider trading, the number of insiders in one trading period is not fixed nor is the insider classification determined from the outset. As participants can actively opt for or against their insider status, the number of insiders in the market is neither only very high nor only very low, but will be alternating. This approach creates a variable proportion of insiders which may influence market efficiency and liquidity. In addition we designed the way of how to acquire inside status as a two-stage process, which allows for a separation of the questions of honesty and risk-aversion (Gaa/Nainar/Shehata, 2006).

In order to figure out the best final experimental design for our requirements, we carried out three pilot studies. The first one was a slight modification of the experiment by Huber, Kirchler and Sutter (Huber/Kirchler/Sutter, 2006). In addition to their work we included the option to buy perfect information. After a short test run with 20 participants, we created a new and more comprehensive experiment for the second pilot study. The experimental design reflected Theissen’s work but included the CM mentioned above. During the study we tested market sizes of six and twelve traders, but could not make out a significant difference. After 48 subjects had participated we modified the experiment. This third pilot study included the option to receive a perfect price signal. Additionally, we carried out two treatments with different spreads in the distributions of information. Again, we did not notice a significant change in efficiency after five runs of the experiment.

Eventually we agreed on the final experimental design: The market size is fixed at twelve traders who can trade one asset among themselves. After three test periods during which the subjects can get to know the market game, there will be twelve periods, each lasting five minutes, which will count towards the overall results. Each participant has the same endowment of shares and virtual currency and receives a very own price signal at the beginning of each period. This price signal lies within 10% of the fundamental value of the asset. In order to create the same conditions the distances will even out among all traders during the course of the experiment. During each period each trader can conduct long or short sales by creating orders or accepting orders created by others. After six periods there is the option to gain inside information, reflecting the fundamental value of the asset. In order to obtain this information, participants have to answer two questions asking if they want to acquire the perfect signal. The first one aims at the willingness to use illegal information, while the second incorporates a random probability of detection of the inside trade. This probability is uniformly distributed and can reach from 10% to 90%, displayed in steps of 10. Illegal behaviour is being detected depending on this probability and every trader detected will receive a penalty of 10% of the value of his portfolio. The acquaintance, existence and detection of inside information are not publically shown.
At the end of each experimental cycle the participants are being presented a questionnaire that we have created from the scratch. This questionnaire comprises 27 questions dealing with the trader’s strategy, behaviour, estimations and attitudes.

Afterwards we hand out a copy of the HPI (Hamburger Persoenlichkeitsinventor), a standardised questionnaire trying to find out a subject’s personality in terms of specific categories such as altruism or open-mindedness (Andresen, 2003, 2005). Of all six categories, the two of the utmost interest to us are risk-aversion and controlledness. Finally all participants obtain a financial award according to their performance that is being paid in cash at the end of the experiment. The payment is the sum of a fixed show up fee and an amount depending on the rank of the total value of their portfolios. In order to create incentives for trading the ranking is exponentially structured.

All of our subjects were students of either business administration or economics and volunteered to attend our experiment. We did neither preselect them in a specific way nor did we examine their knowledge of financial markets or their experience in stock trading beforehand. However our questionnaire presented an according question asking for self-assessment. To ensure that each participant had a well-grounded understanding of the trading process and the graphical user interface we handed out a short test before the trading started. As students of business and economics present themselves as the common and main pool of potential subjects, we believe that this process is sufficient and that it does not create any special bias. All participants were only allowed to take part once.

So far, we have carried out two different treatments, one being a lone CDA and one representing a CM. The two-minute opening CA of the latter is constructed as a blackbox. The experiment was programmed and conducted with the software z-Tree (Zurich Toolbox for Readymade Economic Experiments), the state-of-the-art program for developing economic laboratory experiments (Fischbacher, 2007).

2. Results

As described above, the first six periods of the experiment are dedicated to the question how an opening CA influences the market quality of the following CDA. As cited above, there are some studies advocating an opening CA because of generating a higher market quality at this time of the trading day. Additionally there exists heterogeneous information and uncertainty concerning the fundamental value which is still greatest at the opening of the market. It is expect that the CDA should profit from an opening CA, although there exists other empirical studies which don’t prefer a CA at this trading time. This leads to the first central hypotheses.

**H1: An opening CA leads to less efficient transaction prices in the CDA.**

To test this hypothesis, at first we have to analyze if an opening CA has at least a more efficient opening price than the single-CDA. In experimental studies we are able to measure the informational efficiency by calculating the deviation of transaction prices from the fundamental value (Theissen, 2000). The efficiency of the opening price is calculated by the Market-Relative-Error-measure, which is defined by the following equation:

\[
MRE = \frac{|P - V|}{V}
\]  

where \(P\) determines the opening price and \(V\) the fundamental value of the asset which is not known by the traders; the MRE-measure leads to the following results for the four series of the single CDA-Market and the CM:

<table>
<thead>
<tr>
<th>Series</th>
<th>Single-CDA</th>
<th>CA (of the CM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4,49%</td>
<td>1,49%</td>
</tr>
<tr>
<td>2</td>
<td>2,35%</td>
<td>2,17%</td>
</tr>
<tr>
<td>3</td>
<td>4,67%</td>
<td>1,51%</td>
</tr>
<tr>
<td>4</td>
<td>3,88%</td>
<td>1,09%</td>
</tr>
<tr>
<td>Mean</td>
<td>3,85%</td>
<td>1,56%</td>
</tr>
</tbody>
</table>

1 Hypotheses presented in this paper are phrased negatively.
A t-test (independent sample) of the twenty-four periods supports the literature (e.g. Madhavan, 1992) of a more efficient opening price of the CA. The result is highly significant on a 99%-level. In a further step, we have to test the central hypothesis, that the CDA shall profit from an opening CA. To calculate the efficiency of all transaction prices during the continuous trading phase, we use the following adapted version of the MRE-Measure:

\[ MRE_i = \frac{|P_i - V_i|}{V_i} \cdot \frac{S_i}{\sum_{i=1}^{n} S_i} \]  

(2)

where \( P_i \) is the price of transaction i, \( V_i \) is the fundamental value of period t, \( S_i \) is the stock trading volume of transaction i. As it is the case, the MRE of period t is calculated by measuring the MRE of each transaction of a period and then being weighted by its stock trading volume (Theissen, 2000).

The following table shows these MRE-values for the four series so far for the CDA with (CM) and without (single-CDA) an opening CA:

<table>
<thead>
<tr>
<th>Series</th>
<th>single-CDA</th>
<th>CDA (of the CM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.54%</td>
<td>2.37%</td>
</tr>
<tr>
<td>2</td>
<td>2.14%</td>
<td>2.93%</td>
</tr>
<tr>
<td>3</td>
<td>4.08%</td>
<td>3.81%</td>
</tr>
<tr>
<td>4</td>
<td>7.31%</td>
<td>2.79%</td>
</tr>
<tr>
<td>Mean</td>
<td>4.27%</td>
<td>2.98%</td>
</tr>
</tbody>
</table>

The difference is only weak significant (90%-level, independent sample t-test); therefore, the CDA may profit from an opening CA but it seems that the CDA without an opening CA is most of the time able to find an adequate efficient price path. Therefore, we also analyzed if the level of efficiency of the CA has an impact on the MRE of the following CDA and if the MRE of the CA can explain the difference of MRE between the CDA with and without an opening CA. The regression tests (results are not shown) indicate that the efficiency level of the CA has no influence on the different efficiency levels of the two CDA. It also supports the result of Chang et al. (2008): in their study, analyzing the Singapore Stock Market, they found that even on days with no opening prices at the CA, the CDA has a higher approximately efficiency than the period before without an opening CA. The existence and non-existence of an opening price is additional information in contrast to the situation where no opening CA is carried out. About 80% of the traders in our experiment still answered at the questionnaire of our experiment, that the opening CA price was most important information. As in real stock markets it is useful to overview the market and derive its own price level for trading. Summarizing, hypothesis H1 has to be rejected.

Market Quality is also determined by the liquidity of the market. The liquidity of the market is determined by fast trading opportunities and implicit transaction costs. One main problem concerning to liquidity is its measurement (e.g. Baker, 1996). One of the most used measures of liquidity is the bid ask spread, which shows the implicit transaction costs for a trader who wants to trade as fast as possible. In our experiment the bid-ask-spread is the difference between the actual ask- and bid-price before the transaction occurred (Theissen, 2000). For comparing the different periods and series, we calculated the Relative-Inside-Spread (RIS):

\[ RIS = \frac{P_A - P_B}{MQ} \]  

(3)

where \( P_A \) is the ask-price and \( P_B \) is the bid-price before a transaction occurred. MQ is the midquote between the bid- and ask-price.

The higher the RIS the higher are the implicit transaction costs for traders and therefore the lower the liquidity. Several factors can influence the level of liquidity like uncertainty about the fundamental value, asymmetric information or market structure (Theissen, 2000; O’Hara, 2004). Because of the opening CA
uncertainty about the value of the asset and the distribution of information should be reduced therefore lower spreads during the CDA are expected. This leads to the second hypothesis:

**H2: An opening CA leads to higher spreads in the following CDA.** To test this hypothesis we calculated the RIS as postulated in the formula above for all transactions. The following table shows the descriptive RIS of the four series so far.

<table>
<thead>
<tr>
<th>Series</th>
<th>single-CDA</th>
<th>CDA (of the CM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6,957%</td>
<td>3,574%</td>
</tr>
<tr>
<td>2</td>
<td>6,175%</td>
<td>5,392%</td>
</tr>
<tr>
<td>3</td>
<td>3,017%</td>
<td>2,899%</td>
</tr>
<tr>
<td>4</td>
<td>5,185%</td>
<td>2,466%</td>
</tr>
<tr>
<td>Mean</td>
<td>5,333%</td>
<td>3,583%</td>
</tr>
</tbody>
</table>

A t-test (independent sample) rejects the hypothesis that the RIS of the CDA after an opening CA is above the spread of the single-CDA. The difference is significant on a 95%-level. This supports the opinion that traders aren’t as reluctant as in the pure CDA to supply “good” prices to the market which leads to the reduced spreads. The difference of the spreads between the CDA of the CM and the single-CDA is therefore highest at the first half of continuous trading. This is a further support for the usefulness of an opening CA, which seems to reduce uncertainty and leads to higher liquidity during the following continuous trading. Therefore hypothesis H2 has to be rejected; the opening CA still leads to lower spreads and higher liquidity during the CDA.

**H3: The denying probability of inside information does not dependent on the probability of detection.** It can be assumed that the decision for or against the insider status will be influenced by the probability of detection, and therefore by the probability of a penalty, which is displayed to each participant. As stated in the introduction, this indication is separated from the note that the use of inside information is illegal. Therefore, the matter of dishonesty of a subject does not interfere with the decision whether to accept the perfect price signal, as only participants willing to indulge in an illegal activity are informed of the probability of detection. As a first result, we presume that the denial of inside information in the second stage of the process will only depend on this probability. The answers to a corresponding question in the questionnaire have not shown the contrary. In order to examine the relationship between the decision and the probability, a Wilcoxon signed-rank test has been conducted. The result shows a significant relation on a 99% level, meaning that the higher the probability of detection the higher the denying probability of the insider status. Therefore the hypothesis has to be rejected.

In addition we examined at what level of probability of detection, the denying probability is higher than the acceptance probability. We found that this critical value is located at around 40%. This gives an interesting insight into the behaviour and the decision process of the participants. Of course the decision might even be dependent on the magnitude of the penalty. As we are aware of this fact, we tried to diminish the influence by setting the penalty very high to a prohibitive size. Our pilot studies have shown that once a participant’s portfolio has been reduced by 10%, it will be very difficult to recover this loss. This fact is mentioned in the instruction which all participants have to read prior to the trading.

The above examinations are the first results of our experiment. In addition to them we have performed more tests and analyzed further hypotheses which have partly been noted in the introduction. During the course of this year we are going to carry out more series of our treatments. All in all we are expecting about 240 participants which will result in a sample large enough, yielding a more reliable investigation of our hypotheses.

### 3. Conclusion

The results indicate that an opening CA leads in summary not to a lower market quality of the following CDA. Although the difference concerning the efficiency of the transaction prices is only weak significant, the liquidity of the CDA after an opening CA is significantly higher than in the single-CDA.
Therefore the results support the practice of stock exchanges using the CA at the opening to improve market quality in general. Nevertheless, the experiments so far used a special kind of CA design, namely the blackbox. This means that traders can not observe any orders or potential prices during the CA. In further experiments it shall be analyzed, how different CA-designs with a higher level of transparency, can influence the CDA performance. The discussions of the transparency of CA indicate that higher levels of transparency as it is the case at most stock exchanges around the world do not have to lead to a higher market quality (e.g. Friedman, 1993). The studies so far analyzed only the CA but not its influence on continuous trading. This question in combination with implemented inside information as above is an interesting area for further research.

References


